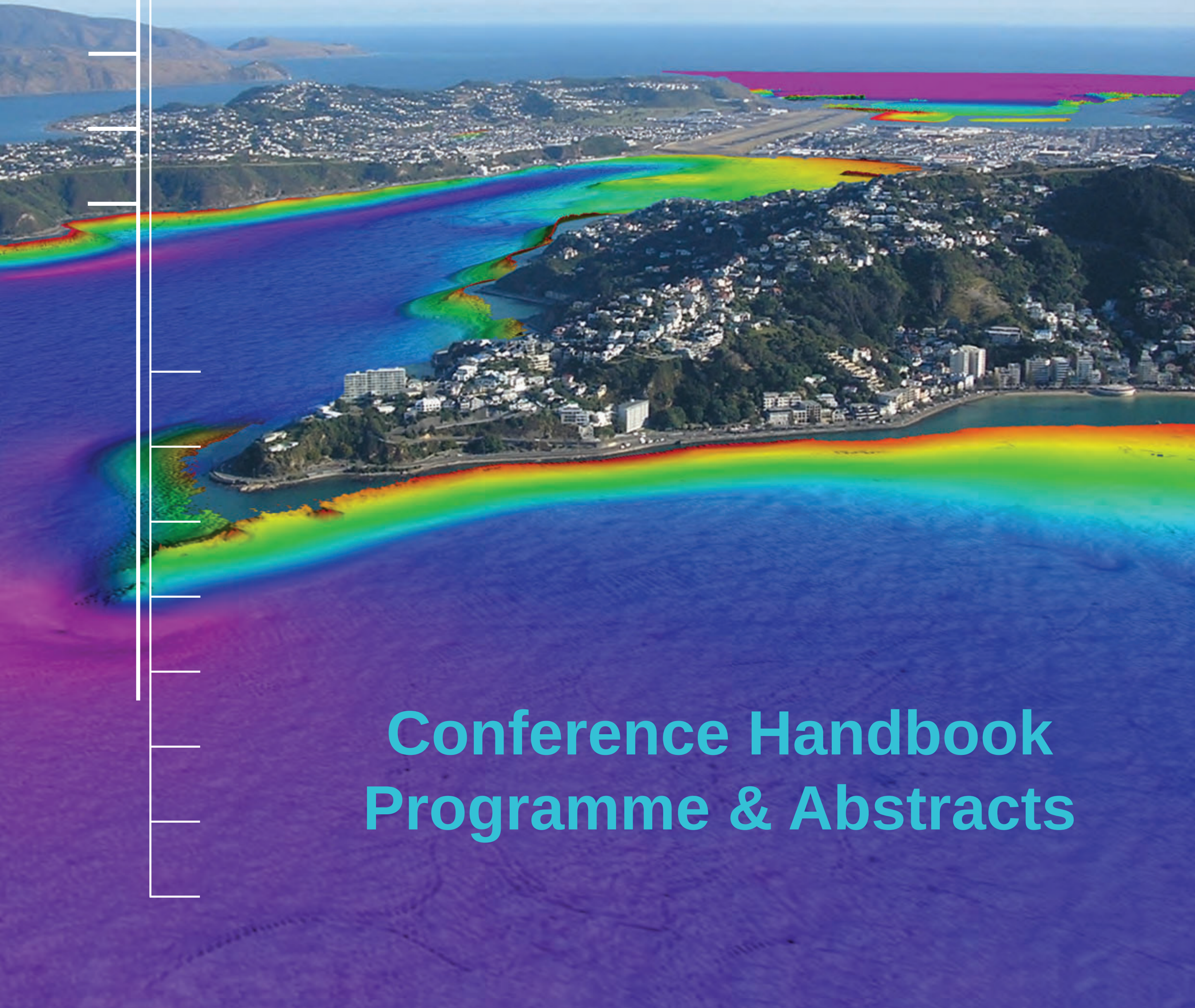
GEOHAB
Marine Geological and Biological Habitat Mapping

GEOHAB 2010

Wellington, New Zealand

4-7 May 2010

Characterisation, Quantification and Diversity of Extreme Habitats



Conference Handbook
Programme & Abstracts

Programme

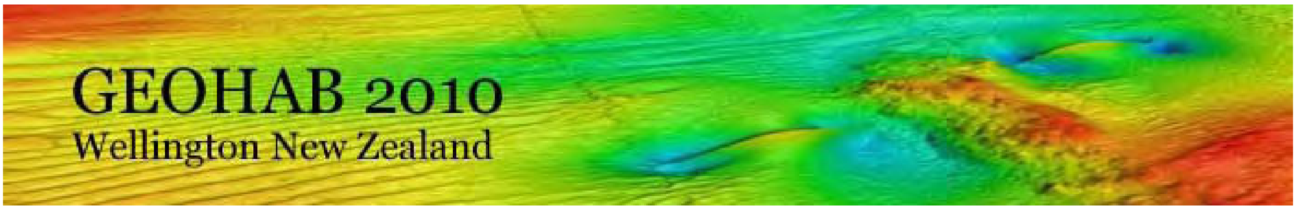
MONDAY 3 MAY	
09:30	IVS3D - ESRI Workshop
10:45	Morning Tea
11:00	IVS3D - ESRI Workshop
12:00	Lunch
13:00	IVS3D - ESRI Workshop
15:30	Afternoon Tea
17:00	Icebreaker
19:00	**End of day**

TUESDAY 4 MAY	
08:30	Mihimihi (Traditional Maori Welcome)
08:40	Convenor's opening
09:00	Gold Sponsors' addresses
09:10	Keynote address: Andy Wheeler An Atlas of Ireland's Deep-water Seabed: the preview
09:40	Session 1 - Mapping metrics (Chair. Brian Todd)
10:20	Morning Tea
10:50	Session 1 - Mapping metrics, cont. (Chair. Vaughan Stagpoole)
12:30	Lunch
13:30	Session 1 - Mapping metrics, cont. (Chair. David Bowden)
15:10	Afternoon Tea
15:40	Session 1 - Mapping metrics, cont. (Chair. Andrew Heap)
17:00	Break
17:10	Special Meeting: Glossary (Chair. Mark Costello)
17:40	Special Session (S6): ATLAS (Chair. Peter Harris)
19:00	**End of day**

WEDNESDAY 5 MAY	
08:30	Keynote address: Xavier Lurton Credibility of Sonar Backscatter Strength measurement, modelling and inversion
09:00	Session 2 - Statistical Analysis (Chair. Vanessa Lucieer)
10:20	Morning Tea
10:50	Session 2 - Statistical Analysis, cont. (Chair. Vladimir Kostylev)
12:30	Lunch
13:30	Session 2 - Statistical Analysis, cont. (Chair. Ian Wright)
13:50	Session 3 - Geo-Bio Interaction (Chair. Ian Wright)
15:10	Afternoon Tea
15:40	Session 3 - Geo-Bio Interaction, cont. (Chair. Judi Hewitt)
17:20	Break
18:30	Barbecue
22:00	**End of day**

THURSDAY 6 MAY	
08:30	Keynote address: Malcolm Clark Habitat as a proxy for biodiversity: how can seamount classification systems aid the scientific design of marine protected areas
09:00	Session 3 - Geo-Bio Interaction, cont. (Chair. Bernard Pelletier)
10:20	Morning Tea
10:50	Session 4 - Vulnerable Habitat (Chair. Miquel Canals)
12:30	Lunch
13:30	Session 5 - National Programmes (Chair. Nic Bax)
15:10	Afternoon Tea
15:40	Session 5 - National Programmes, cont. (Chair. Gary Greene)
16:40	Break
17:10	Wrap-up discussion - AGM
18:10	**End of day**

FRIDAY 7 MAY	
07:50	Field Trip



Wellington Town Hall, 4 – 7 May 2010

GEOHAB
Marine Geological and Biological Habitat Mapping

GEOHAB 10th International Conference:

Characterisation, Quantification and Diversity of Extreme Habitats

Conference Handbook
Programme and Abstracts

Geoffroy Lamarche
(Convenor and Committees' Chair)

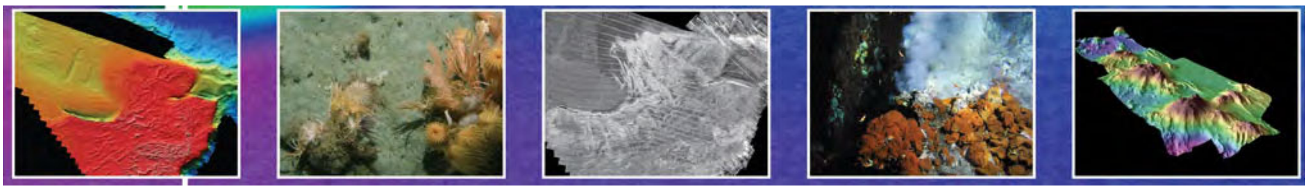
Organising Committee

Suze Baird
David Bowden
Malcolm Clark
Martin Cryer
Andrew Heap
Judi Hewitt
Cathy Joanne
Yves Lafoy
Vanessa Lucieer
Alison MacDiarmid
Alan Orpin
Ashley Rowden
Janet Simes
Vaughan Stagpoole

Scientific Committee

Tara Anderson
Gary Greene
Andrew Heap
Kerstin Kroger
Yves Lafoy
Vanessa Lucieer
Xavier Lurton
Ashley Rowden
Terje Thorsnes
Brian Todd

http://www.geohab.org



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Front picture: Photo: Geoffroy Lamarche
Bathymetry: Arne Pallentin
Figure: Erika Mackay

CONTENTS

ORGANISING COMMITTEE

Local Organising Committee

Geoffroy Lamarche	Chair, NIWA
Suze Baird	NIWA
David Bowden	NIWA
Malcolm Clark	NIWA
Martin Cryer	Ministry of Fisheries
Andrew Heap	Geoscience Australia
Judi Hewitt	NIWA
Yves Lafoy	Government of New Caledonia
Vanessa Lucieer	TAFI, University of Tasmania
Alison MacDiarmid	NIWA
Alan Orpin	NIWA
Vaughan Stagpoole	GNS Science
Ashley Rowden	NIWA

International Scientific Committee

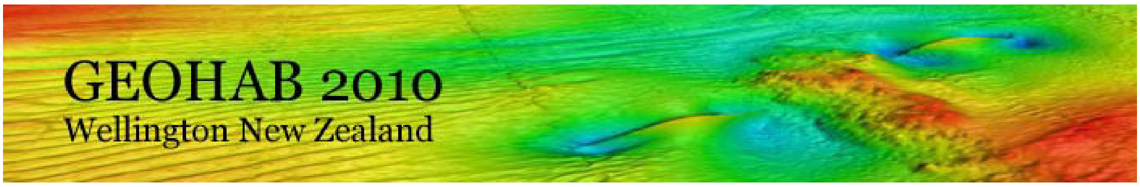
Geoffroy Lamarche	Chair, NIWA
Tara Anderson	Geoscience Australia
Gary Greene	Moss Landing Marine Labs, USA
Andrew Heap	Geoscience Australia
Kerstin Kroger	Institute of Marine Research, Norway
Yves Lafoy	Government of New Caledonia
Vanessa Lucieer	TAFI, University of Tasmania
Xavier Lurton	Ifremer
Ashley Rowden	NIWA
Terje Thorsnes	Geological Survey of Norway, NGU
Brian Todd	Natural Resources Canada

Conference Manager

Janet Simes	Absolutely Organised Ltd.

Handbook Formatting, Secretariat

Lisa Bragg	NIWA
Cathy Joanne	NIWA/GeoAzur



Welcome to Geohab 2010

Nau mai, haere mai ki Te Whanganui-a-Tara, ki Aotearoa.

A very warm welcome to the 10th GeoHab meeting in Wellington, New Zealand!

During this three day conference you will be able to hear 55 scientists presenting their work and discuss around more than 50 posters. Each day will commence by an exclusive keynote presentation - which should properly wake you up and tune your mind for the day. The science programme promises to address a wide range of issues associated with habitat mapping in the largest sense of the term!

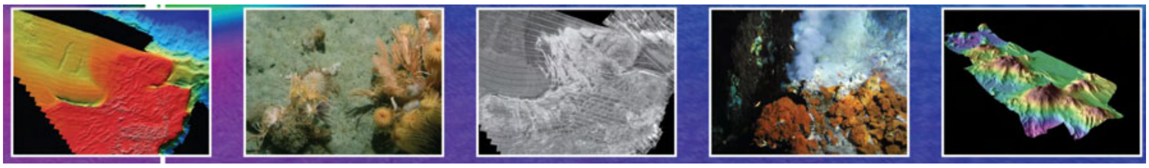
I want to thank particularly the local scientific committee who has put an extraordinary effort in organising this event. Together, we tried eagerly to remain within the spirit of Geohab, that is a one-session-fits-all and ample time for discussion and socialising, yet without compromising whatsoever the quality of the science. Our passion and dedication is in fundamental research science and is what should be celebrated during these three days.

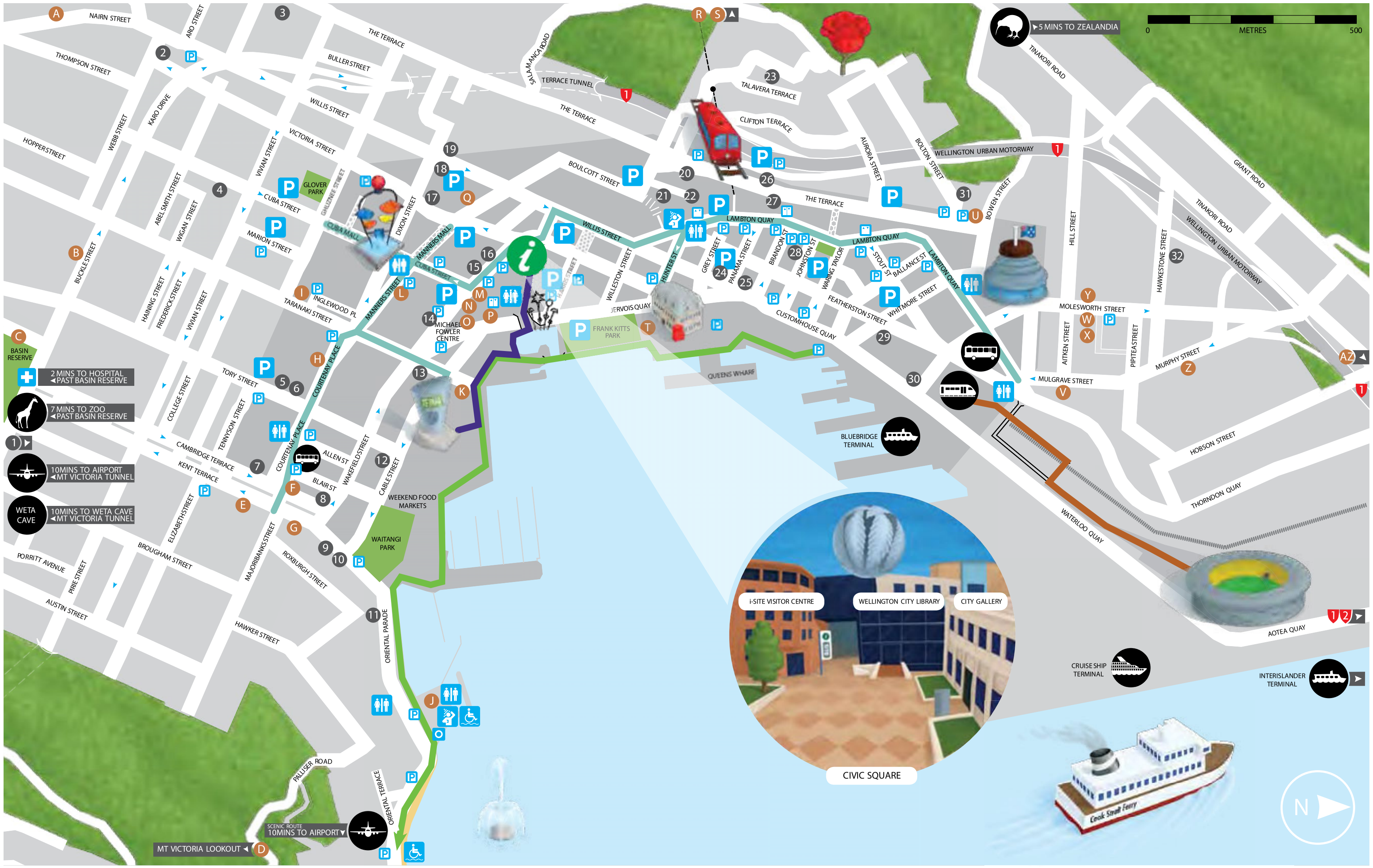
The support and financial contributions made by our sponsors and exhibitors has been absolutely critical to the organisation of the event, in particular our two Gold sponsors, Kongsberg Maritime and the Commonwealth Environment Research Facilities - Australian Marine Biodiversity Research Hub. Without their support, we would have had to give up on the beautiful location, the quality of the audio-visual or the social programme (but not the quality of the science presented!). Sponsors support is all the more impressive in these times of economic difficulties and insecurity. Please, take time to visit their booth and discuss with the exhibitors.

Wellington, the capital city of New Zealand is a vibrant place, located around a beautiful harbour. Everything you could possibility want in a city is within easy walking distance. For those of you with energy left after the science programme and social events, a walk around the waterfront or to the top of Mount Victoria would be my recommendation. I hope you will get time to enjoy the city the same way I have enjoyed it for the last 22 years.

Welcome all, enjoy the programme to the full and make the most of your time in Aotearoa-New Zealand.

Geoffroy Lamarche
Convenor, Geohab 2010





Wellington
WellingtonNZ.com New Zealand

KEY ATTRACTIONS
- Beehive and Parliament Buildings
- Museum of New Zealand Te Papa Tongarewa
- Cable Car
- Botanic Garden
- Westpac Stadium
- Museum of Wellington
- Wellington Zoo
- ZEALANDIA: The Karori Sanctuary Experience
- Weta Cave

TRANSPORT
- Wellington Domestic & International Airport
- Railway Station & national bus services
- Inter-island Ferries
- Local Bus Terminal
- Cruise Ship Terminal
- State Highways
- One way streets
- Pedestrian streets

AMENITIES
- Wellington Hospital
- Public Toilets
- Public Showers
- Accessible Playground
- Car Parking
- Mobility Car Parks
- Wheelchair Beach Access
- Lifts

ROUTES
- Civic Square to Te Papa
- Accessible Walkway & Writers Walk
- Railway Station to Westpac Stadium
- Accessible City Route

DRIVING DISTANCES

Wellington to Makara	25 mins	11 km
Wellington to Porirua	20 mins	21 km
Wellington to Petone	15mins	13 km
Wellington to Lower Hutt	20 mins	16 km
Wellington to Upper Hutt	35 mins	33 km
Wellington to Greytown	1 hr 10mins	76 km
Wellington to Martinborough	1 hr 15mins	81 km
Wellington to Masterton	1 hr 35 mins	100 km

FOR MORE INFORMATION

on Wellington visit the i-SITE Visitor Centre, in Civic Square. They can assist you with all your enquiries and bookings for Wellington and around New Zealand. Phone +64 4 802 4860 or visit our website, WellingtonNZ.com

ATTRACTIONS

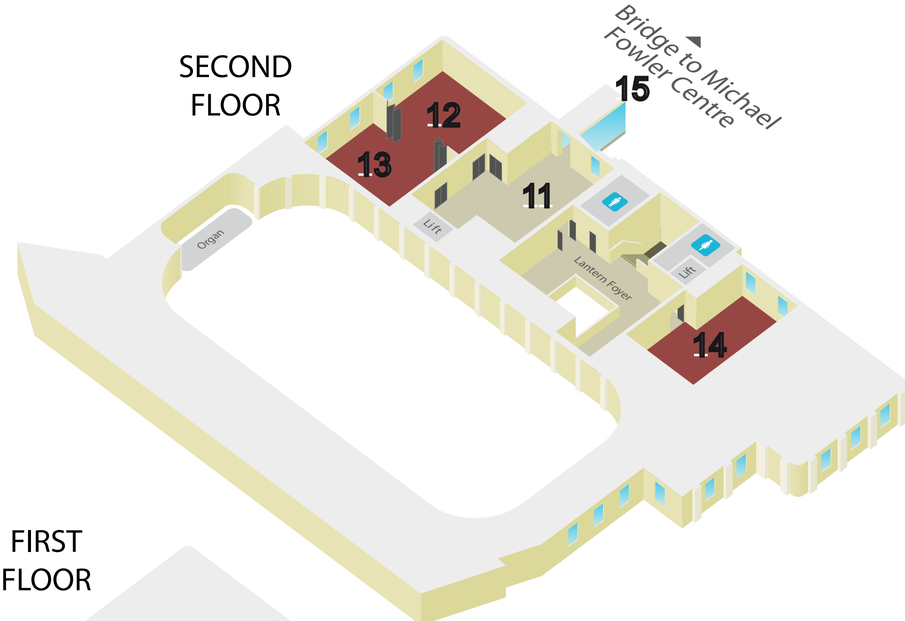
- A Colonial Cottage Museum
- B National War Memorial & Carillon
- C New Zealand Cricket Museum
- D Mount Victoria Lookout
- E Embassy Theatre
- F Downstage Theatre
- G BATS Theatre
- H St James Theatre
- I The Film Archive
- J Freyberg Pool
- K Circa Theatre
- L The Opera House
- M Wellington Convention Centre
- N Wellington Town Hall
- O Michael Fowler Centre
- P E Capital
- Q Department of Conservation
- R Wellington Cable Car Museum
- S Carter Observatory
- T TSB Bank Arena
- U Reserve Bank Museum
- V Archives New Zealand
- W National Library
- X Alexander Turnbull Library
- Y Wellington Cathedral
- Z Old St Paul's
- AZ Katherine Mansfield Birthplace

ACCOMMODATION

1. Brentwood Hotel (Kilbirnie)
2. Mercure Hotel Willis Street
3. Mercure Hotel Wellington
4. Quality Hotel Wellington
5. Grand Mercure Wellington
6. Century City Apartments
7. Wellywood Backpackers
8. Base Backpackers Wellington
9. YHA Wellington City
10. The Bay Plaza Hotel
11. Ohtel
12. Copthorne Hotel Oriental Bay
13. Museum Hotel
14. At Home Wellington City
15. Duxton Hotel Wellington
16. Nomads Capital
17. West Plaza Hotel
18. Central City Apartment Hotel
19. Abel Tasman Hotel
20. Trinity Hotel
21. James Cook Hotel Grand Chancellor
22. Travelodge Wellington
23. CityLife Wellington
24. Lambton Heights
25. Inter Continental Wellington
26. Hotel Ibis Wellington
27. Quest on the Terrace
28. Novotel Wellington
29. Quest on Johnston
30. Holiday Inn Wellington
31. Downtown Backpackers
32. Bolton Hotel
33. Kingsgate Hotel Wellington

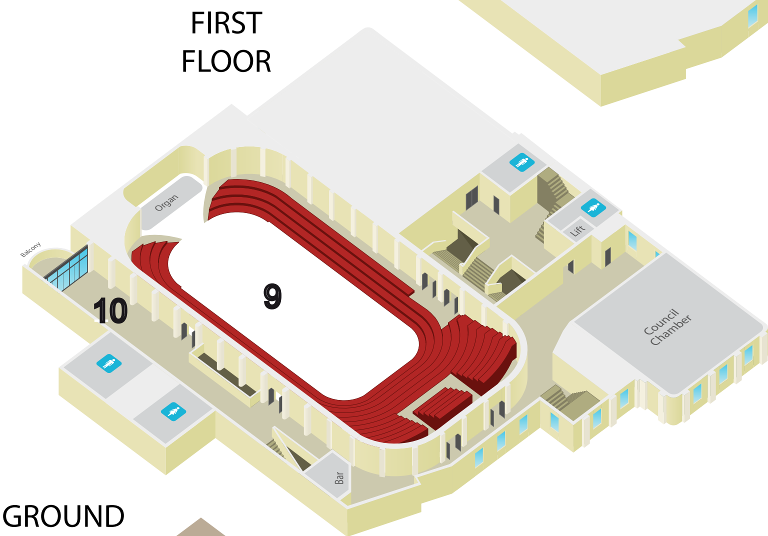
Wellington Town Hall

SECOND FLOOR



11: Civic Ante Room
12: Civic Suite 1
13: Civic Suite 2
14: Civic Suite 3
15: Link Bridge

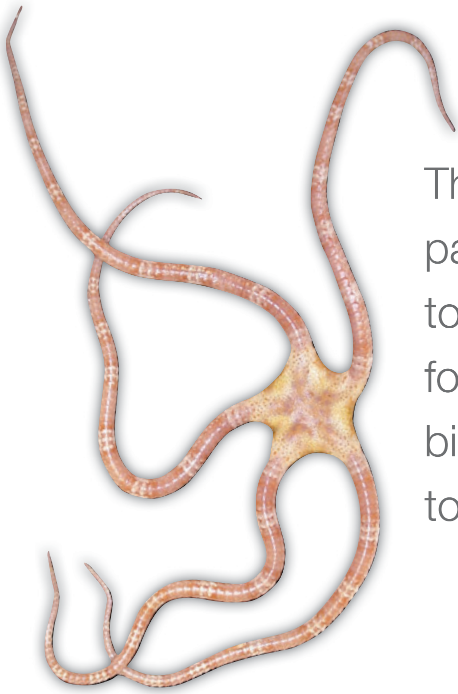
FIRST FLOOR



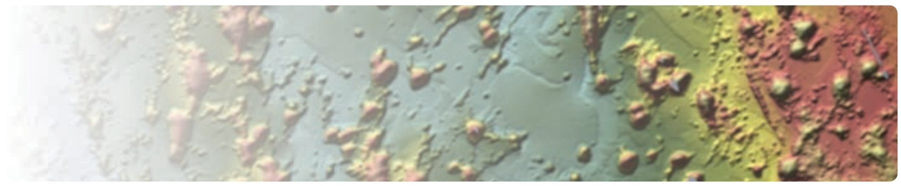
9: Auditorium Gallery
10: West Gallery

GROUND FLOOR

1: Main entrance
2: Green Room
3: Square Affair 1
4: Square Affair 2
5: Auditorium
6: Ilott Theatre
7: West Court
8: Civic Square entrance



The **Marine Biodiversity Hub** is analysing the patterns and dynamics of marine biodiversity to determine the appropriate units and models for effectively predicting Australia's marine biodiversity. It is developing novel options and tools for managing Australia's marine biodiversity.

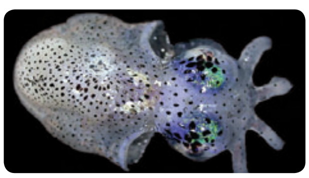


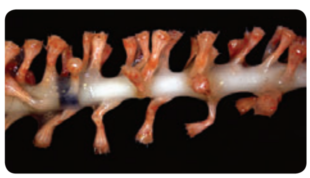
MARINE BIODIVERSITY RESEARCH

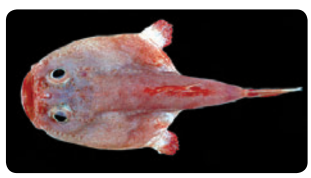
Prediction and Management of Australia's Marine Biodiversity

Describe
↓
Explain
↓
Predict
↓
Management options
↓
Knowledge brokering

By 2012, Australia will have a National Representative System of Marine Protected Areas. The NRSMPA is a major step towards the conservation of Australia's marine biodiversity and with off-reserve management will provide a new standard in marine planning. The Marine Biodiversity Hub is developing the knowledge to characterise, predict and manage biodiversity inside and outside the reserve system. Together, the NRSMPA and off-reserve management provide the best option for long term protection and sustainable use of our marine biodiversity.







www.marinehub.org

Australian Government
Department of the Environment, Water, Heritage and the Arts

tafi Tasmanian Aquaculture and Fisheries Institute

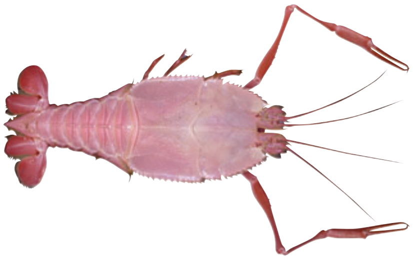
MUSEUMVICTORIA

Australian Government
Geoscience Australia

National Research FLAGSHIPS
Wealth from Oceans
CSIRO

Australian Government
Australian Institute of Marine Science

The Marine Biodiversity Hub is funded through the Commonwealth Environment Research Facilities Program (CERF), administered through the Australian Government's Department of the Environment, Water, Heritage and the Arts. The key aim of CERF is to provide sound advice to inform environmental public policy objectives and to better the management of Australia's unique environment. (Our stakeholder partners are: AFMA, APPEA, CFA, DAFF, DEWHA, DAFF, the Tourism CRC, and WWF Australia)



Marine Biodiversity Hub Partners

CSIRO > www.csiro.au/wfo

CSIRO is Australia's national science agency and is involved in the CERF Marine Biodiversity Hub through its Wealth from Oceans Flagship. The Flagship's marine conservation and biodiversity research will provide scientific understanding and management tools to underpin conservation of Australia's marine biodiversity in Commonwealth and state waters.

Geoscience Australia > www.ga.gov.au

Geoscience Australia is Australia's national geoscience research agency. One of the key activities of the agency is to create, maintain and disseminate geographic and geological knowledge to provide information about the marine jurisdiction for environmental, economic and social purposes.

Museum Victoria > www.museum.vic.gov.au

Museum Victoria provides expertise in taxonomy of marine invertebrates that is critical for understanding the biodiversity, biogeography and evolution of Australia's biota.

Tasmanian Aquaculture and Fisheries Institute – University of Tasmania > www.utas.edu.au/tafi/

The Tasmanian Aquaculture and Fisheries Institute is a partnership between the University and the Tasmanian Government that supports the development and sustainable management of living marine resources in the region. Research is centred around three programs: Sustainable Fisheries, Estuaries & Coasts and Sustainable Aquaculture.

Australian Institute of Marine Science > www.aims.gov.au

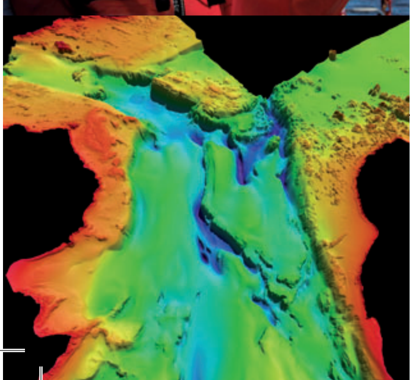
The Australian Institute of Marine Science (AIMS) generates and transfers knowledge to support the sustainable use and protection of the tropical marine environment through innovative, world class research. The Institute is a leader in tropical marine science with strong national and international collaborative links. AIMS has highly developed capabilities in marine biodiversity, impacts and adaptation to climate change, water quality and ecosystem health and has established a new research direction in marine microbiology. The Institute's research programs support the management of tropical marine environments around the globe, with an emphasis on the Great Barrier Reef World Heritage Area, northwest Australia and Ningaloo Marine Park in Western Australia.

Hub Stakeholders

Australian Fisheries Management Authority	www.afma.gov.au
Australian Petroleum Production and Exploration Association Limited	www.appea.com.au
Commonwealth Fisheries Association	
Department of the Environment, Water, Heritage and the Arts	www.environment.gov.au
Department of Agriculture, Fisheries and Forestry	www.daff.gov.au
Sustainable Tourism CRC	www.crctourism.com.au
World Wildlife Fund Australia	www.wwf.org.au

MARINE BIODIVERSITY RESEARCH

Prediction and Management of Australia's Marine Biodiversity



GENERAL INFORMATION

Venue

The venue for the conference is the Civic Suites, Level 2, Wellington Town Hall, located in the Wellington Convention Centre at 111 Wakefield Street. The presentations will be in Civic 1 & 2 and the poster sessions and refreshment breaks will be held across in the Civic Foyer, the Lantern areas and foyer and Civic 3 (see plans).

Registration and Help Desk

The registration and information desk is located in the Lantern Foyer, Level 2, Wellington Town Hall, amongst the posters, trade displays and catering. There will also be a registration desk at the icebreaker.

The registration desk opens 30 minutes prior to the start of the sessions (9.00 am on Monday, 8.00 am on Tuesday, Wednesday and Thursday).

Please wear you name badge at all time.

Satchels and abstract volume

Abstract volumes are available on the USB drive provided in your folder. Pre-ordered bound copies will be delivered at registration.

Oral presentations

All oral presentations are 20 minute long (including questions), except for plenary talks, which are 30 minute long. There is only ONE screen available for presentations.

Presentations can be given as PowerPoint 2003 (*.ppt or *.pps) or PDF files only (note however that the Microsoft converter patch for Office 2007 will be loaded on all laptops, so that documents generated with the 2007 versions of Word, Excel and PowerPoint 2007 will be readable). Presentations must be uploaded onto the supplied laptops prior to each session and the start of the day.

Please use a standard font set. If you have movies or animations in your talk, you MUST check that your presentation functions on the supplied computers. Conference staff will be there to assist you.

Unless there are compelling logistical reasons why the supplied laptops are not suitable, presenters should not anticipate that they can plug their own laptops into the projector during the session. Should this be unavoidable, presenters must alert the session chair prior to commencement of the session.

Poster presentations

Poster sessions are held during the refreshment and lunch breaks, located in the Civic Suite Foyer, Civic Suite 3 and the Lantern Areas. Poster presenters are encouraged to stand by their poster during the morning and afternoon refreshment breaks on Wednesday 5 May.

Poster presentations must be no wider than 1.15m. The poster boards are 1.5 m high. Velcro dots will be available at the registration desk to secure the posters to the boards. Pins are not suitable.

Refreshments

Morning and afternoon refreshments and lunches are provided. These are served from two locations – please use both throughout the conference and visit the trade exhibits throughout the Civic Foyer, the Lantern Areas and Civic Suite 3.

Communication / Internet

A comprehensive wireless internet network is available for use throughout all venues. A voucher for 24 hours access with unlimited traffic can be purchased for $10 per 24 hours at the Michael Fowler Centre reception. This cost is NOT covered by your registration to Geohab 2010.

Hardwire broadband is also available but will incur a $100 set up fee and $50 per day hire. This cost is NOT covered by your registration to Geohab 2010.

In respect for the presenters, please refrain from using your laptop in the conference room. Remember to turn you mobile phones OFF.

Student Award

Students must collect their cheques from Gary Greene.

Transport and Parking

Car parking in town is tight, but usually available in the Michael Fowler Centre Car Park, the James Smith Car Park adjacent to the Duxton Hotel, Lombard Street car park and Queens Wharf Event Centre car park. Daily parking costs are $15-25.

Transport to and from the airport

Use a bus (Airport Flyer, ~ $8), door-to-door shuttle (~$15) or taxi (~$30) to go from the airport to the city and back. Most taxis will accept major credit cards.

There are five rental car agencies that have desks at ground level of the main terminal in Wellington Airport.

Check http://www.wellington-airport.co.nz/html/parkingtransport/bus.php

As many of you will arrive at the same time at Wellington Airport, sharing a taxi may prove cost efficient and environmentally friendly!

Dining out in Wellington

Wellington has the highest concentration of cafés and restaurants of any city in New Zealand. The downtown area can cater for just about any taste. There are a number of restaurants in Blair and Allen Streets around 500 m east of the conference venue. There are also many restaurants in Cuba Street to the south. Expect to pay around NZD$18-30 for a main dish (there is no gratuity). During the day there are several cafés within a 500 m radius of the town hall.

Wellington Weather

Wellington is situated at 41° south. Funnelling of wind through the nearby Cook Strait has provided the city with the legendary title of the world's windiest city. Weather is never still and never the same from one hour to the next. The way I see it: Wellington is a 5-dimensional city: w, x, y, z, t (w for wind).

May is the end of autumn. Days will be short (sunrise 7:15 am, sunset 5:30 pm) and daytime maximum temperatures can range from 17°C (63F) to 11° (52F). But wind chill can make these temperatures feel much cooler! Rain is likely but you can expect some bright and beautiful days too – New Zealand isn't green by mistake!

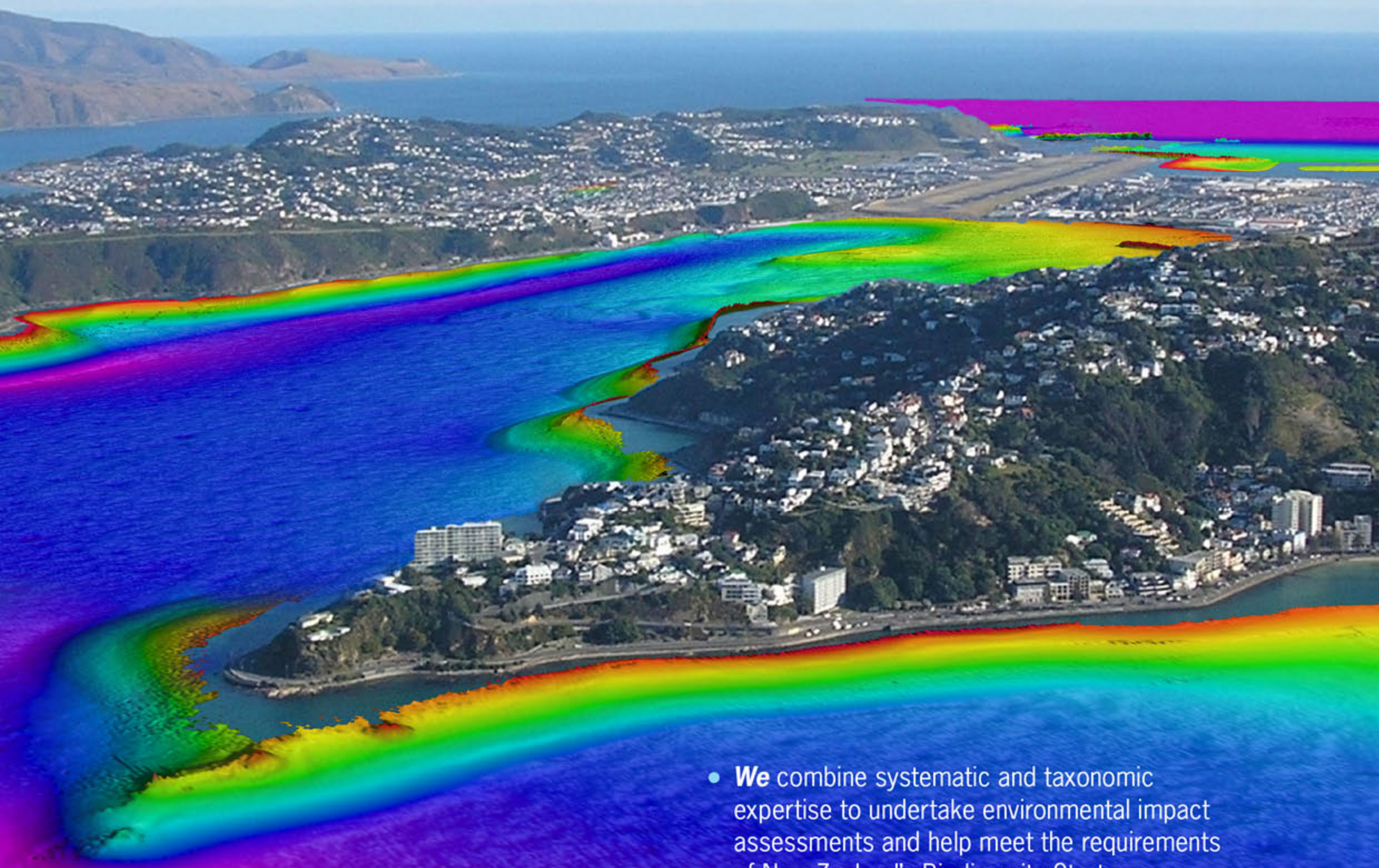
3 to 5 days forecast: http://www.metservice.com/towns-cities/wellington

Time

In May the time zone is New Zealand Standard Time (NZST), which is GMT/UTC + 12 hrs.

NIWA
Taihoro Nukurangi

NIWA's ocean geology and ecology science and services



- ***Our*** science expertise helps manage New Zealand's marine resources to benefit the economy and protect the environment.
- ***We*** acquire bathymetry data and develop underpinning quantitative mapping methods for hydrographic surveying, habitat mapping, and resource assessment.
- ***Our*** seascape research focuses on fundamental geological processes to understand and mitigate natural hazards, such as active faults, submarine landslides, and volcanism.
- ***We*** combine systematic and taxonomic expertise to undertake environmental impact assessments and help meet the requirements of New Zealand's Biodiversity Strategy.
- ***We*** developed the New Zealand Marine Environment Classification (MEC), as an ecosystem-based spatial framework designed for marine management purposes.
- ***Our*** flagship research vessel *Tangaroa* supplies full logistical and scientific support throughout the Southern Ocean.
- ***We*** collaborate with leading research institutions worldwide allowing us to share and develop state-of-the-art equipment and scientific knowledge.

Contacts:

Geoffroy Lamarche
Principal Scientist Marine Geology and Geophysics
g.lamarche@niwa.co.nz

Ashley Rowden
Principal Scientist Marine Ecology
a.rowden@niwa.co.nz

National Institute of Water & Atmospheric Research Ltd
Wellington, New Zealand

NIWA – leading environmental science

ph+64 4 386 0300 www.niwa.co.nz

SOCIAL PROGRAMME

Icebreaker - Monday 3 May, 17:00

An informal "Icebreaker" function will be held in conjunction with registration at **“Mac's Brewery Bar & Restaurant”**, corner of Taranaki and Cable Streets on the Wellington Waterfront. This will commence at 5:00-7.00 pm Monday 3 May and there will be an opportunity to catch up with fellow registrants. Snacks and refreshments will be served.

Mihimihi - Tuesday 4 May, 08:30

Whaikorero and mihimihi are traditional Maori speeches of welcome, which take place at the beginning of a gathering. The welcoming establishes links between the hosts (tangata whenua) and their visitors (manuwhiri). Mihimihi involve representatives from both the host and the visiting parties to stand and introduce themselves by sharing their whakapapa (genealogy, ancestral ties) and other relevant information. It is important for Māori to know and to share their whakapapa as to know one’s whakapapa is to know one’s identity.

The hosts will usually identify specific geographical features associated with their tribal area including their maunga (mountain), awa (river) and moana (sea). They may also identify their waka (ancestral canoe), hapū (sub tribe), iwi (tribe), marae and an eponymous ancestor. This information is considered more important than the individual’s own name which may be the last piece of information given in mihimihi. They will also acknowledge the main reason for the conference and also what they hope to achieve.

Barbecue - Wednesday 5 May, 18:30

A barbecue will be held in the Wardroom located on the ground floor **Royal Port Nicholson Yacht Club**, 103 Oriental Bay, an easy walk from the Town Hall and most centrally located accommodation. This will commence at 6:30 pm and run through until about 10:00 pm. A full barbecue-type meal will be served and some refreshments provided. All registrants are welcome to attend but please wear your nametag as your entry ticket.

A cultural event will be performed during the BBQ.

Field Trip - Friday 7 May, 07:50

For those who chose to take the fieldtrip from our capital city to the peace of rural Wairarapa (Maori for “glistening waters”), you will experience some of the geology and natural history of New Zealand during the one and a half hour trip to the world-renown vineyard historic town of Martinborough in the center of Wairarapa. Here, you will taste premium wines from award-winning vineyards, learn about the terroir that makes this wine-making area so special, and share a succulent lunch before travelling to the wild southern coast of this region to explore the dramatic landforms known as the Putangirua Pinnacles.

See detail p. 29.

Australian Government
Geoscience Australia

Marine and Coastal *Environment* Group

As Australia's national geoscience research agency Geoscience Australia's mission is to use geoscientific information and knowledge for the economic, social and environmental benefit of Australia.

The Marine and Coastal Environment Group (MCEG) within Geoscience Australia's Petroleum and Marine Division provides geoscientific advice and products as required by government to meet its goals in the implementation of the National Ocean's Policy within Australia's EEZ.

The Group's work addresses Government priorites for preservation and maintenance of biodiversity, ecosystem based management and support of offshore pertoleum exploration.

The Group is also responsible for determining the location of Australia's marine boundaries and provides information to government in relation to the limits of the extended continental shelf as defined by the United Nations Convention on the Law of the Sea (UNCLOS).

Further information about the Group's activities can be found on our webpage:
www.ga.gov.au/marine

A list of publications can be found at:
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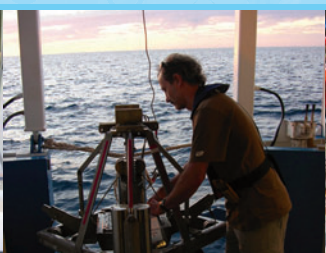
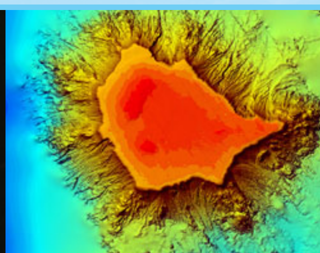
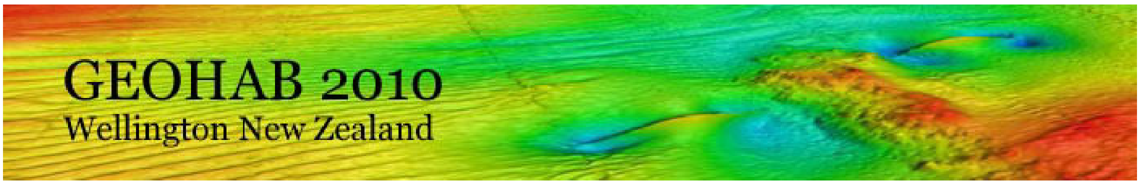


APPLYING GEOSCIENCE TO AUSTRALIA'S MOST IMPORTANT CHALLENGES



SPECIAL SESSIONS

Special Glossary Meeting – Tuesday 4 May, 17:10

“Towards an international marine geo-bio-ecological glossary…”

Chair: Mark Costello (University of Auckland)

"Standardised terminology facilitates readers understanding of publications, from maps to science papers; reduces new alternative uses of words and their perpetuation and resulting confusion; and enables the comparison of data across datasets by researchers. This session proposes to establish a process involving volunteer scientists to develop a recommended glossary for marine habitat and related ecological and geological terminology.

This process will include a small editorial group who will prepare a first version, using existing glossaries and their own. This will (a) include comments about alternative uses of words, and (b) be published online where users can submit questions about definitions and propose additional words to be defined. The final product and continuing process would seek endorsement by major international initiatives, such as IOC, IODE, EoL, GBIF, TDWG, IHO and others. This session is the first call for contributors and editors to begin this process."

Special ATLAS session (Session 6) – Tuesday 4 May, 17:40

“Geohab Atlas of seafloor geomorphic features and benthic habitats”

Chair: Peter Harris (Geoscience Australia)

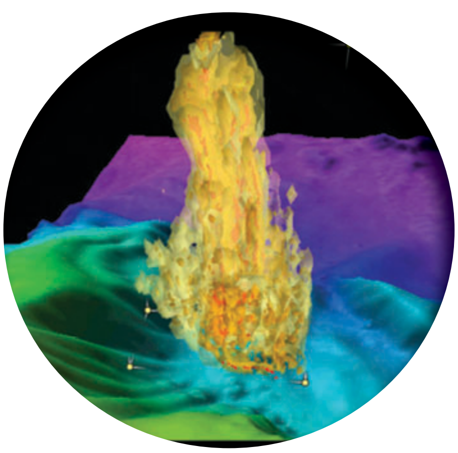
The work of GeoHab scientists demonstrates how habitat maps compiled for different seabed geomorphic features can be used as surrogates for the benthic communities that they typically support. In this way, conservation priorities can be identified using geomorphic feature and seabed habitat maps as a guide. Knowledge of the geomorphology and biogeography of the seafloor has improved markedly over the past 10 years. Using multibeam sonar, the benthic ecology of submarine features such as fjords, sand banks, coral reefs, seamounts, canyons, mud volcanoes and spreading ridges has been revealed in unprecedented detail. Habitat maps of these features are created when acoustic data are coupled with seabed video and biological sampling, thus providing a powerful tool for understanding benthic ecosystems and spatial patterns of biodiversity.

In this session, 12 case studies will be presented from the >60 studies offered for publication in a new book sponsored by GeoHab and scheduled for publication by Elsevier in 2011. The case studies will represent a range of seabed features where detailed bathymetric maps have been combined with seabed video and sampling to yield an integrated picture of the communities that are associated with different types of benthic habitat.

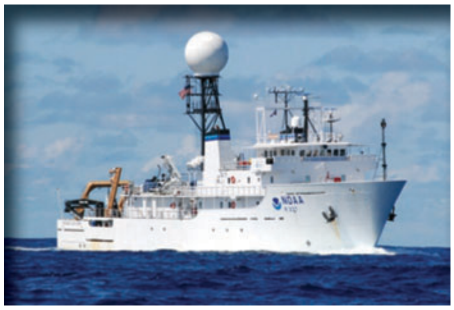
NOAA Ship Okeanos Explorer, 'America's Ship for Ocean Exploration' makes a major discovery using the Kongsberg Multibeam System EM 302

The NOAA Ship Okeanos Explorer is the only United States ship assigned to explore systematically our largely unknown ocean for the purpose of discovery and the advancement of knowledge. On its first voyage using the EM 302 it made a major discovery of what are believed to be methane gas plumes.

EM 302 water column data detected plumes located in location identified above while transiting to the Cordell Bank National Marine Sanctuary working grounds from Astoria, Oregon. The plumes were located in water depths between 1200 and 1900 meters. All plumes were observed to rise to a water depth between 500-550 m making their heights between 700-1400 meters.



NOAA EM 302 Image of Plumes using IVS3D Fledermaus



NOAA Ship 'Okeanos Explorer'

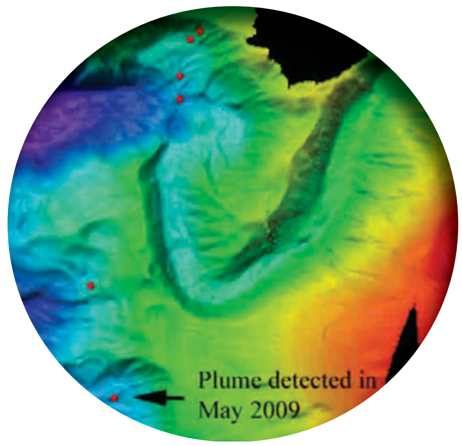
Interactive Visualization Systems (IVS3D) developed the Fledermaus mid water software tool as part of a project with the Center for Coastal and Ocean Mapping (CCOM)/ Joint Hydrographic Center (JHC) of the University of New Hampshire. Fledermaus was made available to this project.

Dr. Jim Gardner and Mashoor Malik (CCOM/JHC) suggest "that the plumes are made up of a stream of methane bubbles coated with a veneer of methane-rich ice. That ice coating, a material called methane hydrate, is stable in deep water, where pressure is high and the water is cold. When the ice-cloaked bubbles ascend into warmer waters near the surface, the ice melts and the methane dissolves into the sea." "Although seafloor sediments in shallow areas closer to the coast are known to harbor methane, which often bubbles free of the ocean bottom, no one has reported such plumes in waters this deep, the researchers report. The newly discovered plume appears to originate within a previously unknown, amphitheater-shaped basin on the ocean floor. This 3.6-kilometer-wide scar was probably caused by a massive undersea landslide"

Gardner, J. V., Malik, M. A., Walker, S. , 2009, "Plume 1400 Meters High Discovered at the Seafloor off the Northern California Margin", EOS Transactions, American Geophysical Union, Vol. 90, No. 32, pp. 275 - 275. Journal Article.

Next-Generation 3D Mapping System

"The Okeanos Explorer has been outfitted with a new Multibeam swath mapping system. The hull-mounted, first of its kind, Kongsberg EM 302 will provide explorers with high-resolution maps of the seafloor from 40 to 4000 meters. Maps from the system will be used to identify unique seafloor features for further exploration and will be integrated into the high-precision DVL-Nav navigation system to provide a road map for exploring a particular site with the ROV."



NOAA EM 302 Image of Amphitheater-Shaped Plume Basin

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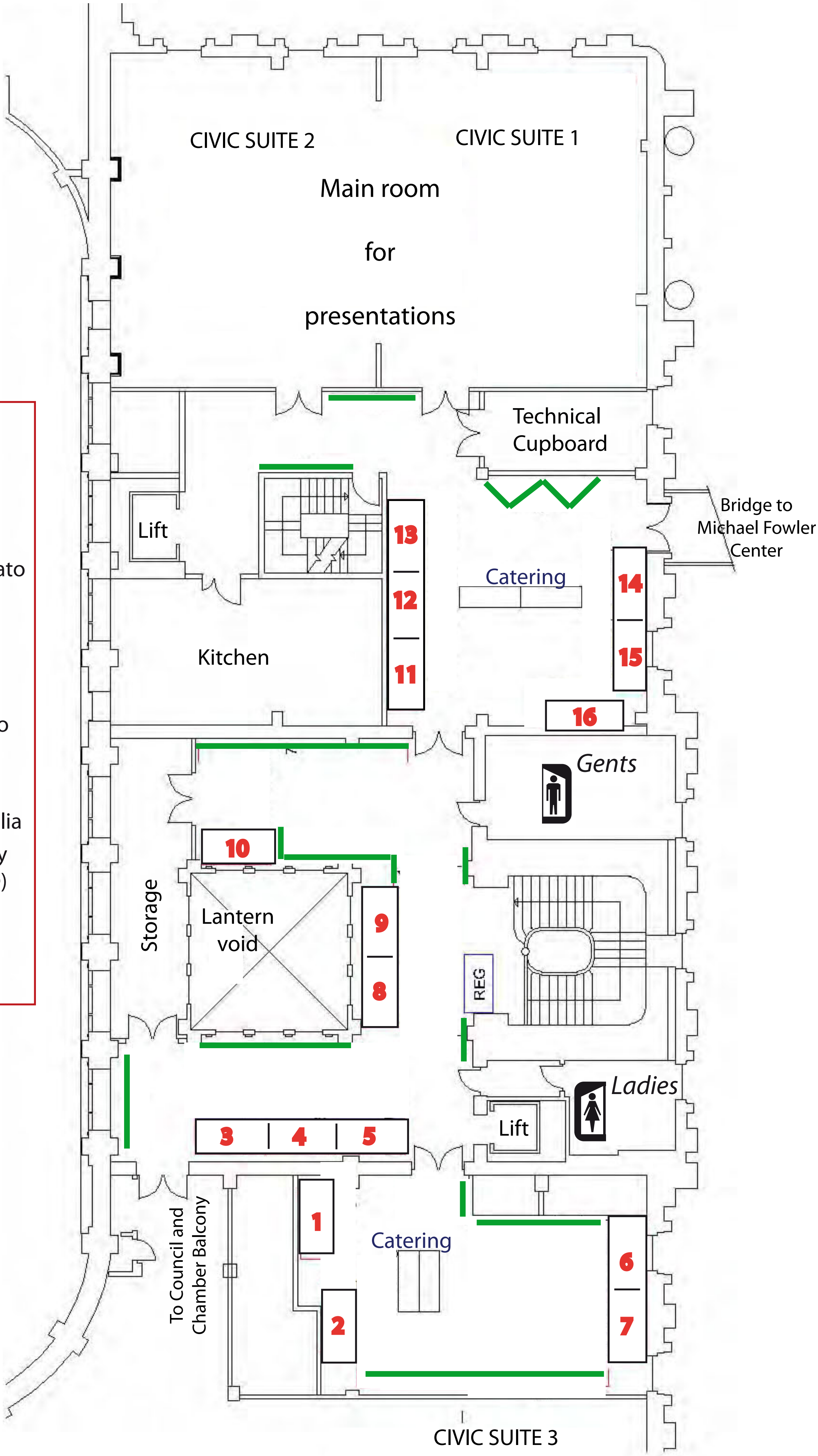

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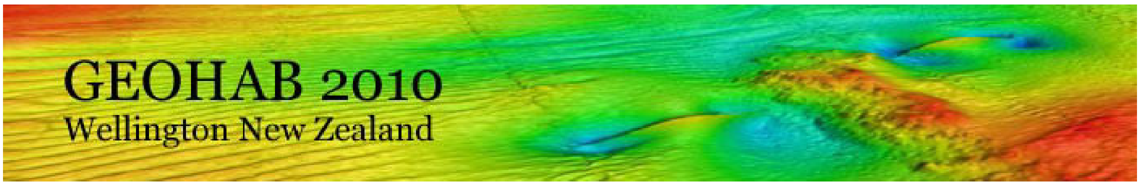

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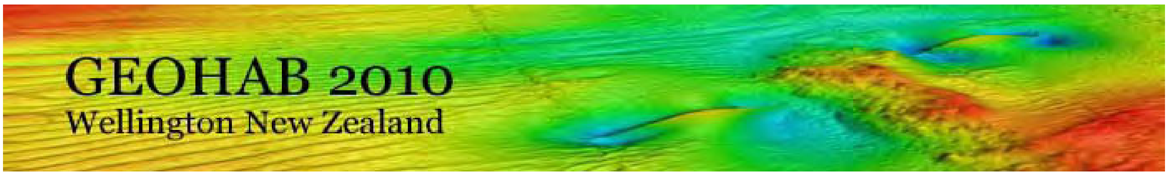
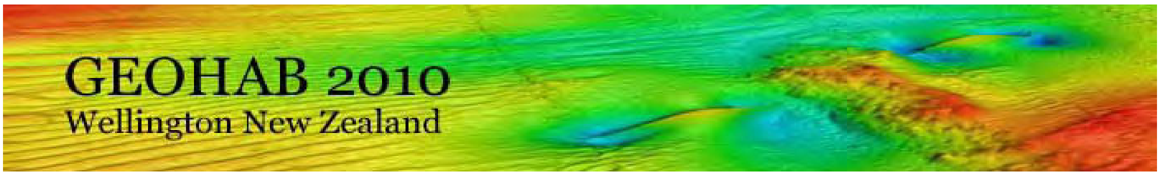


Monday 3 May

Reg.	09:00	**Workshop registration open**
Workshop ESRI	09:30	**Welcome and Introduction to IVS-ESRI workshop** **by** Douglas Bergersen (IVS3D)
	09:45	**ESRI Tools for Habitat Mapping** **by** Robin Smith (ESRI)
	10:15	**IVS Tools for Habitat Mapping** **by** Lindsay Gee (IVS3D)
Bk	10:45	**Tea Break (Civic Suite 2)**
Workshop ESRI	11:00	**Use of the ARC Marine Data Model in the context of Habitat Mapping** **by** Robin Smith (ESRI)
	11:30	**IVS-ESRI Habitat Mapping Workflow applied to the NIWA Cook Strait data set** **by** Douglas Bergersen (IVS3D)
Break	12:00	**Lunch Break (Civic Suite 2)**
Workshop ESRI	13:00	**Case Example 1** **by** Jens Greinhart (Royal Netherlands Institute for Sea Research)
	13:40	**Case Example 2** **by** Arne Pallentin (National Institute of Water and Atmospheric Research, NZ)
	14:20	**Case Example 3** **by** Scott Nichol (Geoscience Australia)
	15:00	**Final Comments and questions** **by** Douglas Bergersen (IVS3D)
Break	15:30	**Tea Break (Civic Suite 2)**
	16:00	
Social Event	17:00	**Icebreaker and Conference Registration** **17:00-19:00, Mac's Brewery Bar & Restaurant**

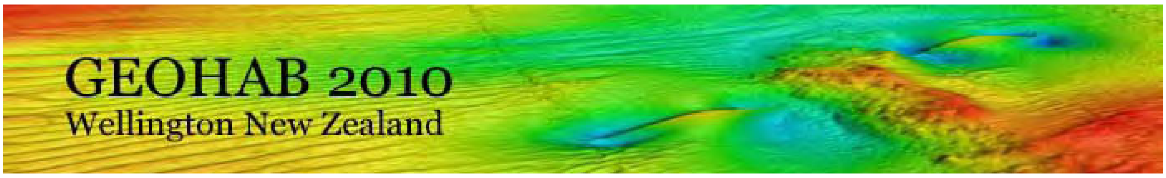


Tuesday 4 May

Reg.		08:00	**Conference Registration open**
Welcoming		08:30	**Mihimihi (Traditional Maori Welcome)**
		08:40	**Convenor's opening**
		08:50	
		09:00	**Gold Sponsors' addresses**
Keynote speaker	Chair: Brian Todd	09:10	***KEYNOTE ADDRESS* : "An Atlas of Ireland's Deep-water Seabed: the preview"** **by** Andy Wheeler, Boris Dorschel, Xavier Monteys and Koen Verbruggen
S1 - Mapping Metrics		09:40	**"A picture on the wall: 3D habitat mapping in deep-sea canyons"** **by** Veerle A.I. Huvenne, Doug G. Masson, Paul A. Tyler, Veit Hühnerbach and the ISIS ROV Team
		10:00	***STUDENT AWARD* : "A system for mapping nearshore, marine habitats on a tight budget"** **by** Kelly C. Kingon
Break		10:20	**Tea Break (Civic Suite 2)**
S1 - Mapping Metrics	Chair: Vaughan Stagpoole	10:50	**"Seafloor sediment classification in a tidal inlet channel: The influence of shell debris and seafloor rugosity"** **by** Dietmar Burk, Martina Heineke, H. Christian Hass, Ralf Vorberg and Rolf Riethmüller
		11:10	**"Geo-statistical mapping of sediment composition with application to habitat classification"** **by** David Stephens**,** Markus Diesing and Roger Coggan
		11:30	**"Deep-Water Forage Habitats - The Next Step Forward in Marine Benthic Habitat Mapping?"** **by** H. Gary Greene**,** J. Vaughn Barrie and Tina Wyllie-Echeverria
		11:50	**"Geoacoustic mapping of cold seep habitats along the Hikurangi margin, New Zealand"** **by** Ingo Klaucke**,** Andrew T. Jones, Wilhelm Weinrebe, David Bowden and C. Jörg Petersen
		12:10	**"Seamount habitat mapping on the Condor Bank (Azores, NE Atlantic)"** **by** Fernando Tempera**,** E. Giacomello, F. Porteiro, A. Martins, I. Bashmachnikov, A. Henriques, J. Nuno Pereira, T. Morato, D. Catarino, R. Santos and G. Menezes
Break		12:30	**Lunch** **Kindly sponsored by Imarest** **Served in Civic Suite 2**
S1 - Mapping Metrics	Chair: David Bowden	13:30	**"The role of physical environmental variables in shaping seabed biodiversity patterns"** **by** Roland Pitcher, Nick Ellis, Peter Lawton, Stephen Smith, Chi-Lin Wei, Lew Incze, Michelle Greenlaw, Jess Sameoto, Nick Wolff, Tom Shirley and Gil Rowe
		13:50	**"Mapping and Predicting Benthic Habitats, Biological Assemblages, and Biodiversity across the Carnarvon Shelf, Western Australia"** **by** Tara J. Anderson, Andrew Heyward, Scott Nichols, Matthew McArthur, Christine Schoenberg, Jamie Colquhoun, Zhi Huang, Maggie Tran and Brendan Brooke
		14:10	**"Multibeam sonar in the deep-sea: can it really tell us much about benthic habitats and fauna?"** **by** David Bowden, Judi Hewitt, Anne-Laure Verdier and Arne Pallentin
		14:30	**"Habitat-based assessment of epibenthos using AUV Optical imagery, northwest Australia"** **by** Jamie Colquhoun**,** Oscar Pizarro, Andrew Heyward, Max Rees, Stefan Williams, Rebecca O'leary and Ben Radford
		14:50	**"A GIS analysis of New Zealand's Trawl Footprint"** **by** Jenny Black and Ray Wood
Break		15:10	**Tea Break (Civic Suite 2)**
S1 - Mapping Metrics	Chair: Andrew Heap	15:40	**"A geospatial approach to coral reef geomorphology"** **by** Javier Leon**,** Colin Woodroffe, Kevin Parnell and Scott Smithers
		16:00	**"A comparison of fish diversity estimates made by stereo-video systems and traps at depths ranging from 50 to 900m"** **by** Vincent Zintzen**,** Clive Roberts, Andrew Stewart, Marti J. Anderson and Euan Harvey
		16:20	**"Application of an Integrated GIS and 4D Visualisation Tool Kit to the NIWA Cook Strait Data Set"** **by** Douglas Bergersen**,** Moe Doucet, Lindsay Gee and Robin Smith
		16:40	**"Making Technology Transparent - A key to better science is spending more time studying the data than collecting it"** **by** Francois Leroy
Bk		17:00	
Special Meeting	Mark Costello	17:10	**Special Glossary Meeting:** **"Towards an international marine geo-bio-ecological glossary"** (See details in General Information, p. XV)
S6 - ATLAS	Chair: Peter Harris	17:40	**Special ATLAS Session:** **"Geohab Atlas of seafloor geomorphic features and benthic habitats"** (See details in General Information, p. XVI) (~ 90 min)
		19:10	

Wednesday 5 May

Session	Chair	Time	Programme
Reg.		08:00	**Registration open**
Keynote speaker	Chair: Vanessa Lucieer	08:30	***KEYNOTE ADDRESS*: "Credibility of sonar Backscatter Strength measurement, modelling and inversion"** **by** Xavier Lurton and Jean-Marie Augustin
S2 - Statistical Analysis	Chair: Vanessa Lucieer	09:00	**"Can oceanographic conditions explain species distribution patterns on the Chatham Rise and Challenger Plateau"** **by** Kathryn Julian**,** Tanya J. Compton and David Bowden
S2 - Statistical Analysis	Chair: Vanessa Lucieer	09:20	**"Some issues in predicting biodiversity using spatially modelled covariates"** **by** Hideyasu Shimadzu**,** Scott D. Foster and Ross Darnell
S2 - Statistical Analysis	Chair: Vanessa Lucieer	09:40	**"Spatial predictability of species diversity and abundance of epimacrobenthos in turbid nearshore using bathymetric LiDAR"** **by** Antoine Collin**,** Bernard Long and Philippe Archambault
S2 - Statistical Analysis	Chair: Vanessa Lucieer	10:00	**"Modelling species distributions: the application of predicted habitat models to define demersal fish distributions"** **by** Cordelia H. Moore**,** Ben Radford, Euan S. Harvey and Kimberly Van Niel
Break			**Tea Break (Civic Suite 2)**
S2 - Statistical Analysis	Chair: Vladimir Kostylev	10:50	**"Towards Automated Classification of Benthnic Environments using Rugosity, Slope and Aspect from Bathymetric Stereo Image Reconstructions"** **by** Ariell Friedman **(*STUDENT AWARD*),** Oscar Pizarro and Stefan Williams
S2 - Statistical Analysis	Chair: Vladimir Kostylev	11:10	**"Object based segmentation of multibeam backscatter data: methods for spatial analysis of shallow coastal seabeds, South Eastern Tasmania, Australia"** **by** Vanessa Lucieer**,** Nicole Hill and Neville Barrett
S2 - Statistical Analysis	Chair: Vladimir Kostylev	11:30	**"Deriving "mappable" biological assemblages from underwater footage using classification tree models"** **by** Genoveva Gonzalez-Mirelis **(*STUDENT AWARD*),** and Mats Lindegarth
S2 - Statistical Analysis	Chair: Vladimir Kostylev	11:50	**"Image-based habitat classification and analysis using generative models"** **by** Oscar Pizarro**,** Stefan Williams, Jamie Colquhoun and Cordelia Moore
S2 - Statistical Analysis	Chair: Vladimir Kostylev	12:10	**"Automated delineation of acoustic themes from Multibeam backscatter data for seafloor characterization, Tapuae Marine Reserve, NZ"** **by** Alexandre C.G. Schimel**,** Yuri Rzhanov, Luciano Fonseca, Larry Mayer and Terry R. Healy and Dirk Immenga
Break		12:30	**Lunch** **Kindly spondored by Gardline Environmental** **Served in Civic Suite 2**
S2	Chair: Ian Wright	13:30	**"Predicting Groups of Species: application of finite mixture models to species prediction"** **by** Piers K. Dunstan**,** Scott D. Foster and Ross Darnell
S3 - Geo-Bio Interaction	Chair: Ian Wright	13:50	**"Environmental classifications, acoustic remote assessment and ecosystem valuing"** **by** Judi E. Hewitt**,** Joanne Ellis, David Bowden and Ian Tuck
S3 - Geo-Bio Interaction	Chair: Ian Wright	14:10	**"Diversity in benthic habitats and sediments at Great Barrier Island, New Zealand"** **by** Tuan Meng Lee **(*STUDENT AWARD*),** Kala Sivaguru, Roger Grace, Timothy J. Langlois and Mark J. Costello
S3 - Geo-Bio Interaction	Chair: Ian Wright	14:30	**"Geomorphological characterisation of cold water corals habitats (Bay of Biscay, NE Atlantic)"** **by** Jean-Francois Bourillet**,** Thierry Schmitt, Alessandra Savini, Brigitte Guillaumont and Sophie Arnaud-Haond
S3 - Geo-Bio Interaction	Chair: Ian Wright	14:50	**"The Catalan submarine canyon heads, NW Mediterranean Sea: coupling seafloor morphology and biological diversity"** **by** Miquel Canals**,** Galderic Lastras, David Amblas, Ben De Mol and "Euroleón" Cruise Shipboard Party
Break		15:10	**Tea Break (Civic Suite 2)**
S3 - Geo-Bio Interaction	Chair: Judi Hewitt	15:40	**"GIS-Mapping of Marine Benthic Habitats using Expert-based and Statistical Methodologies"** **by** Roland Pesch**,** Susanne Ranft, Marc Busch and Winfried Schroder
S3 - Geo-Bio Interaction	Chair: Judi Hewitt	16:00	**"Relationships between seabed assemblages in the Gulf of Maine and their physical environment using Random Forests"** **by** Peter Lawton**,** Stephen J. Smith, Lewis S. Incze, Michelle E. Greenlaw, Nicholas H. Wolff, Jessica Sameoto, Roland Pitcher, Nick Ellis
S3 - Geo-Bio Interaction	Chair: Judi Hewitt	16:20	**"Geostatistical and landscape analysis of fine-scale eelgrass (Zostera marina) habitat patterns"** **by** Jeffrey Barrell **(*STUDENT AWARD*)** and Jon Grant
S3 - Geo-Bio Interaction	Chair: Judi Hewitt	16:40	**"Dynamics of benthic patch structure across two seasons in a coastal embayment"** **by** Zhi Huang**,** Lynda Radke and Matthew Mcarthur
S3 - Geo-Bio Interaction	Chair: Judi Hewitt	17:00	**"Physical controls on deep-water coral communities on the George V margin, East Antarctica"** **by** Alexandra L. Post**,** P.E. O'brien, R.J. Beaman and M.J. Riddle
Break		17:20	
Social Event		18:30	**Barbecue** **18:30-22:00, Royal Port Nicholson Yatch Club**



Thursday 6 May

Session	Chair	Time	Programme
Reg.		08:00	**Conference Registration open**
Keynote Speaker	Chair: Bernard Pelletier	08:30	***KEYNOTE ADDRESS*** **: "Habitat as a proxy for biodiversity: how can seamount classification systems aid the scientific design of marine protected areas"** **by** Malcolm R. Clark**,** Ashley A. Rowden, Les Watling, John M. Guinotte and Craig R. Smith
S3 - Geo-Bio Interactions	Chair: Bernard Pelletier	09:00	**"Environmental - biological covariance in the soft sediments surrounding Lord Howe Island"** **by** Matthew McArthur**,** Hideyasu Shimadzu and Brendan Brooke
S3 - Geo-Bio Interactions	Chair: Bernard Pelletier	09:20	**"The Influence of Physical Parameters on Benthic Communities – A Case Study in the Gulf of Finland, the Baltic Sea"** **by** Anna-Leena Downie and Anu M. Kaskela
S3 - Geo-Bio Interactions	Chair: Bernard Pelletier	09:40	**"Spatial prediction of demersal fish habitat suitability from remotely-sensed observation and hydroacoustic datasets"** **by** Jacquomo Monk**,** Daniel Ierodiaconou, Alecia Bellgrove, Euan Harvey, Alex Rattray, Laurie Laurenson and Gerry Quinn
S3 - Geo-Bio Interactions	Chair: Bernard Pelletier	10:00	**"Quantifying trawling impacts on deep-sea ecosystems using ROV video and scanning-sonar data"** **by** Maeva Gauthier**,** S. Kim Juniper, J. Vaughn Barrie, Rosaline R. Canessa and James A. Boutillier
Break		10:20	**Break (Civic Suite 2)**
S4 - Vulnerable Habitat	Chair: Miquel Canals	10:50	**"Identifying ecologically and biologically significant deepwater habitat"** **by** Nicholas J. Bax and Alan Williams
S4 - Vulnerable Habitat	Chair: Miquel Canals	11:10	**"Using GIS Models to Delimit Vulnerable Marine Ecosystem (VME) Boundaries in the Northwest Atlantic Regulatory Area (NRA)"** **by** Andrew T. Cogswell**,** Ellen L.R. Kenchington and Camille G. Lirette
S4 - Vulnerable Habitat	Chair: Miquel Canals	11:30	**"Predictive cold-water coral habitat mapping in the Western Mediterranean Sea"** **by** Ben De Mol**,** David Amblas, Miquel Canais, Galderic Lastras, Anna Sanchez, Antonio Calafat, and Darwin Cd178, Euroleon and Hermesione Shipboard Party
S4 - Vulnerable Habitat	Chair: Miquel Canals	11:50	**"The alkaline hydrothermal field of the Prony Bay, Southern New Caledonia"** **by** Bernard Pelletier and Claude E. Payri
S4 - Vulnerable Habitat	Chair: Miquel Canals	12:10	**"Seabed habitats of the Beaufort Sea Shelf (Canadian Arctic)"** **by** Vladimir E. Kostylev**,** Kerstin Jerosch and Steve Blasco
Break		12:30	**Lunch Break (Civic Suite 2)**
S5 - National Programmes	Chair: Nic Bax	13:30	**"Mapping habitat and biological diversity in coastal ecosystems: Bay of Islands, New Zealand"** **by** Mark Morrison**,** & the NIWA Ocean Survey 20/20 Project Team
S5 - National Programmes	Chair: Nic Bax	13:50	**"Mesophotic Coral Ecosystems of Puerto Rico"** **by** Roy A. Armstrong and Hanumant Singh
S5 - National Programmes	Chair: Nic Bax	14:10	**"Seabed mapping for Australia's energy security"** **by** Andrew D. Heap**,** Rachel Przeslawski, Scott Nichol, Lynda Radke, Chris Battershill and Stephen Whalan
S5 - National Programmes	Chair: Nic Bax	14:30	**"Mapping and modelling spatial distribution of important nature types such as kelp forest, sea grass beds and shell sand, procedures and results from a national mapping program in Norway with focus on the Skagerrak region"** **by** Eli Rinde, Janne Gitmark, Hartvig Christie, Wenche Eikrem, Heidi Olsen, Reidulv Bøe, Henning Steen and Torjan Bodvin
S5 - National Programmes	Chair: Nic Bax	14:50	**"Phanerogame meadows: a characteristic habitat of the Mediterranean shelf. Examples from the Tyrrhenian Sea"** **by** Silvana D'angelo and Andrea Fiorentino
Break		15:10	**Tea Break (Civic Suite 2)**
S5 - National Programmes	Chair: Gary Greene	15:40	**"Habitat Mapping in Aitutaki, Cook Islands"** **by** Ashishika Sharma **(*STUDENT AWARD*),** Jens Krüger, Salesh Kumar, Chris Roelfsema and Ngere George
S5 - National Programmes	Chair: Gary Greene	16:00	**"ZoNeCo: a multidisciplinary approach to Marine Habitats in New Caledonia"** **by** Yves Lafoy**,** A. Rivaton and D Buisson
S5 - National Programmes	Chair: Gary Greene	16:20	**"Mapping and modelling seabed nature-types in Norway's MAREANO programme – lessons learned"** **by** Margaret F.J. Dolan**,** Pål Buhl-Mortensen, Kim Picard, Terje Thorsnes, Sigrid Elvenes, Valérie K. Bellec, Lene Buhl-Mortensen and Reidulv Bøe
Break		16:40	
Discussion		17:10	**Wrap-up discussion (~1h)** **AGM**

Friday 7 May

FIELD TRIP : Discover faults, rocks, food and wine

07:50	Please assemble near the Wellington Town Hall The Tranzit coach will be parked in Wakefield Street, outside the Wellington Town Hall, opposite the West Plaza Hotel.
08:00	Depart Wellington, driving past the Parliament Buildings and “The Beehive” before heading north on the motorway that travels alongside the Wellington Fault (optional stop on the Wellington Fault outcrop). After skirting Wellington Harbour, we travel up the Hutt River valley, then across the spectacular Rimutaka Hill Road (summit 550 m) to the Wairarapa region, with stops to inspect the sights.
10:15	Meet our Zest guide at the entrance to the Martinborough Wine Village, then visit Martinborough Vineyard – one of the founding vineyards and wineries in the district – meet the viticulturist and/or winemaker and taste the wine’s terroir in the glass, especially the Pinot Noir for which the district is renowned.
12:00	Lunch at Coney Wines, a winery and cafe about 10 minutes south of Martinborough Village. Relax and refuel with good food and wine.
13:45	Depart Coney Wines and travel to the South Coast of the North Island, to walk up Putangirua Stream (cut through ancient gravel layers) to see the striking Putangirua Pinnacles landforms (you might recognise them as a scene stealer in “Lord of the Rings”).
16:00	Leave the coast and return to Featherston via the East-West Access Road with glimpses of Lake Wairarapa, and back to Wellington over the Rimutaka Hill Road
18:00 (approx)	Arrive back in Wellington, at the Town Hall (Wakefield Street)

zest
food tours of new zealand

LIST OF TALKS

Authors	Title	Session	Date / Time
Allee et al.,	Two Shelf Edge Marine Protected Areas in the Eastern Gulf of Mexico	6	Tue, 17h40
Anderson et al.,	Mapping and Predicting Benthic Habitats, Biological Assemblages, and Biodiversity across the Carnarvon Shelf, Western Australia	1	Tue, 13h50
Armstrong et al.,	Mesophotic Coral Ecosystems of Puerto Rico	5	Thu, 13h50
Barrell et al. ***Student Award***	Geostatistical and landscape analysis of fine-scale eelgrass (Zostera marina) habitat patterns	3	Wed, 16h20
Barrie et al.,	Inland Tidal Seas of the Northeastern Pacific	6	Tue, 17h40
Bax et al.,	Identifying ecologically and biologically significant deepwater habitat	4	Thu, 10h50
Bergersen et al.,	Application of an Integrated GIS and 4D Visualisation Tool Kit to the NIWA Cook Strait Data Set	1	Tue, 16h20
Black et al.,	A GIS analysis of New Zealand's Trawl Footprint	1	Tue, 14h50
Bourillet et al.,	Geomorphological characterisation of cold water corals habitats (Bay of Biscay, NE Atlantic)	3	Wed, 14h30
Bowden et al.,	Multibeam sonar in the deep-sea: can it really tell us much about benthic habitats and fauna?	1	Tue, 14h10
Brooke et al.,	Seabed diversity of the shelf surrounding Lord Howe Island	6	Tue, 17h40
Burk et al.,	Seafloor sediment classification in a tidal inlet channel: The influence of shell debris and seafloor rugosity	1	Tue, 10h50
Canals et al.,	The Catalan submarine canyon heads, NW Mediterranean Sea: coupling seafloor morphology and biological diversity	3	Wed, 14h50
Clark et al., **Keynote speaker**	Habitat as a proxy for biodiversity: how can seamount classification systems aid the scientific design of marine protected areas	4	Thu, 8h30
Cogswell et al.,	Using GIS Models to Delimit Vulnerable Marine Ecosystem (VME) Boundaries in the Northwest Atlantic Regulatory Area (NRA)	4	Thu, 11h10
Collin et al.,	Spatial predictability of species diversity and abundance of epimacrobenthos in turbid nearshore using bathymetric LiDAR	2	Wed, 9h40
Colquhoun et al.,	Habitat-based assessment of epibenthos using AUV Optical imagery, northwest Australia	1	Tue, 14h30
D'angelo et al.,	Phanerogame meadows: a characteristic habitat of the Mediterranean shelf. Examples from the Tyrrhenian Sea	5	Thu, 14h50
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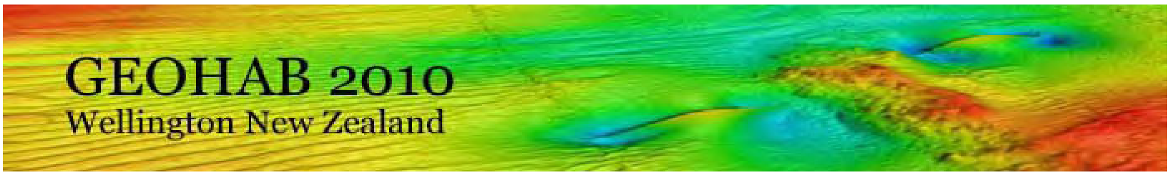
De Mol et al.,	Alboran Seamounts, Western Mediterranean sea	6	Tue, 17h40
Diesing et al.,	Rocky reef in the central English Channel	6	Tue, 17h40
Dolan et al.,	Mapping and modelling seabed nature-types in Norway's MAREANO programme – lessons learned	5	Thu, 16h20
Downie et al.,	The Influence of Physical Parameters on Benthic Communities – A Case Study in the Gulf of Finland, the Baltic Sea	3	Thu, 9h20
Dunstan et al.,	Predicting Groups of Species: application of finite mixture models to species prediction	2	Wed, 13h30
Friedman et al., ***Student Award***	Towards Automated Classification of Benthnic Environments using Rugosity, Slope and Aspect from Bathymetric Stereo Image Reconstructions	2	Wed, 10h50
Gauthier et al.,	Quantifying trawling impacts on deep-sea ecosystems using ROV video and scanning-sonar data	3	Wed, 10h00
Gonzalez-Mirelis et al., ***Student Award***	Deriving “mappable” biological assemblages from underwater footage using classification tree models	2	Wed, 11h30
Greene et al.,	Deep-Water Forage Habitats - The Next Step Forward in Marine Benthic Habitat Mapping?	1	Tue, 11h30
Greene et al.,	Outer Shelf Rocky Habitats of Alaska	6	Tue, 17h40
Heap et al.,	Seabed mapping for Australia's energy security	5	Thu, 14h10
Hewitt et al.,	Environmental classifications, acoustic remote assessment and ecosystem valuing	3	Wed, 13h50
Huang et al.,	Dynamics of benthic patch structure across two seasons in a coastal embayment	3	Wed, 16h40
Huvenne et al.,	A picture on the wall: 3D habitat mapping in deep-sea canyons	1	Tue, 9h40
Huvenne et al.,	Habitat heterogeneity in deep-sea canyons offshore Portugal	6	Tue, 17h40



Authors	Title	Session	Date / Time
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James et al.,	Sand wave field: The OBel Sands, Bristol Channel, U.K.	6	Tue, 17h40
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Klaucke et al.,	Geoacoustic mapping of cold seep habitats along the Hikurangi margin, New Zealand	1	Tue, 11h50
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Kotilainen et al.,	Glacial coastal formations, western Finland	6	Tue, 17h40
Lafoy et al.,	ZoNeCo: a multidisciplinary approach to Marine Habitats in New Caledonia	5	Thu, 16h00
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Lawton et al.,	Relationships between seabed assemblages in the Gulf of Maine and their physical environment using Random Forests	3	Wed, 16h00
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Leroy	Making Technology Transparent - A key to better science is spending more time studying the data than collecting it	1	Tue, 16h40
Lucieer et al.,	Object based segmentation of multibeam backscatter data: methods for spatial analysis of shallow coastal seabeds, South Eastern Tasmania, Australia.	2	Wed, 11h10
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Pitcher et al.,	The role of physical environmental variables in shaping seabed biodiversity patterns	1	Tue, 13h30
Pizarro et al.,	Image-based habitat classification and analysis using generative models	2	Wed, 11h50
Post et al.,	Physical controls on deep-water coral communities on the George V margin, East Antarctica	3	Wed, 17h00
Rinde et al.,	Mapping and modelling spatial distribution of important nature types such as kelp forest, sea grass beds and shell sand, procedures and results from a national mapping program in	5	Thu, 14h30
Schimel et al.,	Automated delineation of acoustic themes from Multibeam backscatter data for seafloor characterization, Tapuae Marine Reserve, NZ.	2	Wed, 12h10
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Shimadzu et al.,	Some issues in predicting biodiversity using spatially modelled covariates	2	Wed, 9h20
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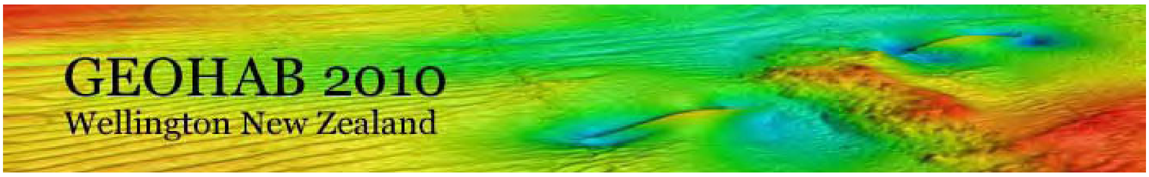
Todd et al.,	Seabed habitats of the German Bank glaciated shelf, Atlantic Canada	6	Tue, 17h40
Todd et al.,	Large submarine sand wave fields on Georges Bank, Gulf of Maine, Atlantic Canada	6	Tue, 17h40
Wheeler et al., ***Keynote speaker***	An Atlas of Ireland's Deep-water Seabed: the preview	5	Tue, 9h10
Zintzen et al.,	A comparison of fish diversity estimates made by stereo-video systems and traps at depths ranging from 50 to 900m	1	Tue, 16h00



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Baird et al.	Use of multibeam swath data and still images to describe potential habitats of deepwater underwater features in New Zealand waters	2	12
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ABSTRACTS

(in alphabetical order by first author)

Natural habitat of *Ipomoes aquatica* and its invitro antimicrobial activity

Othman Abd Samah, Sarah Ilya Othman, and Ridzwan Hashim

International Islamic University Malaysia, 25200 Kuantan, Malaysia

Ipomoea aquatica known as water convovulus or swamp cabbage is prolific in many parts of Asia. The plant species which might be a native to China is rich in nutrient and very popular among Asian cuisine. In Malaysia, Indonesia, Sri Lanka and Vietnam the plant is called kangkong whereas in Japan it is known as kankon. The plant has a creeping growth and it is well adapted to swampy land. It usually grows erect in an aquatic environment at optimum pH 5.3 – 6.0 and it flourishes naturally in many waterways. In pond water the presence of 2.5 – 10.2 ppm dissolved oxygen and 0.04 – 2.3 ppm nitrates may help the plants to attain a good growth as reported in India. The stems may reach 2–3 meters in length, rooting at the nodes, and they are hollow which help them to float. The plant acts as ecological threat because it forms dense floating mats of intertwined stems over water surfaces, shading out native submerged plants competing with native emergents. Accumulation of heavy metals in *Ipomoea aquatica* has been reported in Asia because the plants often grow in polluted water. Comparatively, sewage polluted surface waters contain greater numbers of bacteria than that in water supplies. We have evaluated the antimicrobial properties of *Ipomoea aquatica* using methanol and chloroform crude extracts of leaves and stems both by disc diffusion method and the minimum inhibitory concentration assay. All crude extracts demonstrated inhibition zones against certain species of pathogenic microorganisms such as *Staphylococcus aureus* and *Bacillus subtilis* and *Candida albican.* The chloroform crude extracts of stems are most active against *Pseudomonas aeruginosa* and *Escherichia coli* at concentrations of 50 and 20 mg/mL, respectively. However, in the methanol crude extract of leaves it shows the highest inhibition zones of 8 mm, with minimum inhibitory concentration of 6.25 mg/mL against *Staphylococcus aureus*. Undoubtedly, natural compounds present in an aquatic plant such as *Ipomoea aquatica* could be considered a source of potential biological control agents.

Two Shelf Edge Marine Protected Areas in the Eastern Gulf of Mexico

Rebecca J. Allee[1], Andrew W. David[2], David F. Naar[3]

[1]National Oceanic and Atmospheric Administration, Gulf Coast Services Center, Stennis Space Center, Mississippi, USA
[2]National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Panama City, Florida, USA
[3]College of Marine Science, University of South Florida, St. Petersburg, Florida, USA

The Madison-Swanson Marine Protected Area (MPA) is a 394 km^2 area located south of Panama City, Florida at the margin of the continental shelf and slope in 60 to 140 m of water and is a site of spawning aggregations of gag (*Mycteroperca microlepis*) and other reef fish species (Koenig et al. 2000). Located roughly 80 km south of Apalachicola, Florida, the Madison-Swanson MPA is one of the two marine protected areas established in 2000 in the Northeastern Gulf to protect spawning populations of grouper. Prominent within the Madison-Swanson MPA is a limestone ridge, thought to be the remnants of a 15,000-year-old coral reef. Fisheries studies of the Madison-Swanson MPA indicate that grouper and snapper are associated with hard bottom features, with spawning aggregations of gag and/or scamp confirmed at several sites (Figure 1). Pulley Ridge (Figure 2) is a 100+ km-long series of N-S trending, drowned, barrier islands on the southwest Florida Shelf approximately 250 km west of Cape Sable, Florida. The corals *Agaricia* sp. and *Leptoceris cucullata* are most abundant, and are deeply pigmented in shades of tan-brown and blue-purple, respectively. (http://www.gulfbase.org/reef/view.php?rid=pulley). It appears to be formed on top of an ancient coastal barrier island or strand line dating back approximately 14,000 years when sea level was ~ 80 to 65 m lower and is one of the deepest photosynthetic coral reefs in the world. Both areas have been mapped using high-resolution multibeam bathymetry, submersibles and remotely operated vehicles, and a variety of geophysical tools.

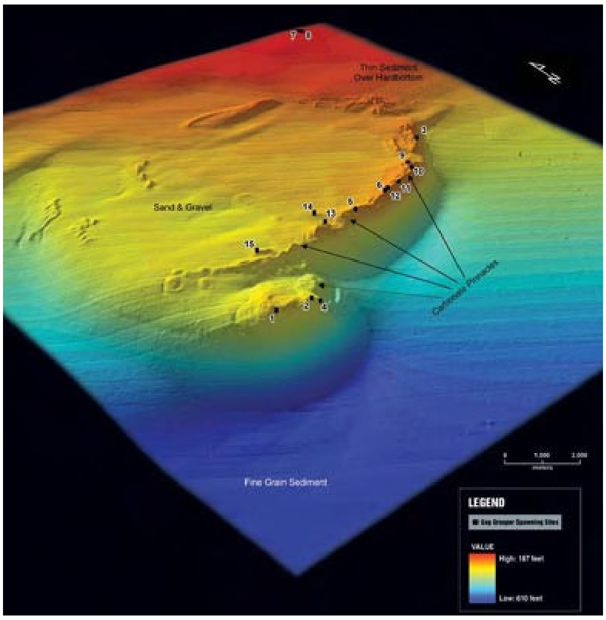


Figure 1. Madison-Swanson spawning sites.

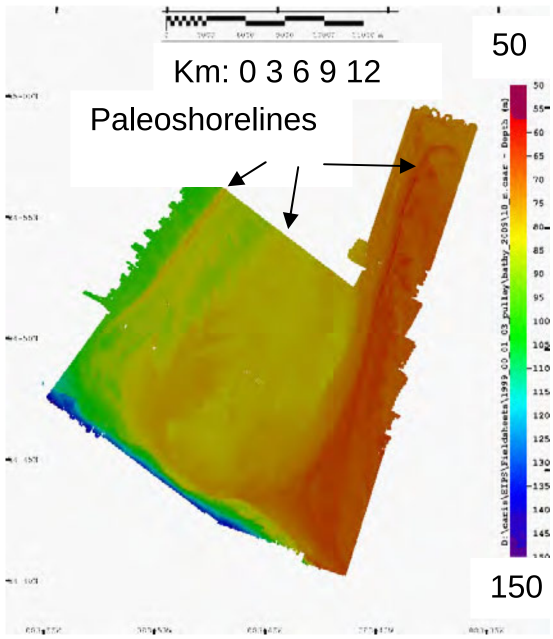


Figure 2. Pulley Ridge bathymetry.

Natural and anthropogenic impacts on the Catalan Continental Shelf habitats, NW Mediterranean

David Amblas, Miquel Canals, Ben De Mol, Ruth Durán, Galderic Lastras, Camino Liquete, Caroline Lavoie and RV Lluerna, Arraix shipboard party

GRC Geociències Marines, Universitat de Barcelona/Parc Científic de Barcelona, Barcelona, Spain

Anthropogenic impacts on the seabed of the Catalan Continental Shelf (CCS) are omnipresent as a result of intensive trawling activities, construction of offshore infrastructures, extraction of sediment resources, dense populated coasts and aquatic tourism. To facilitate a sustainable offshore management and mitigate these impacts, there is a need to map the seafloor and the natural and anthropogenic habitats in high-resolution. Since 2004 the CCS has been the focus of intensive surveying with the aim to produce detailed thematic maps (up to 0.5 x 0.5 m grid size). Acoustic surveying is made by means of very high-resolution swath bathymetry, backscatter imagery and parametric seismic profiles. Groundtruthing is provided by a combination of ROV transects and sediment sampling. At present 2775 km^2, or almost half of the CCS have been mapped.

Based on morphological, sedimentologic and tectonic mesoscale analyses, we subdivide the CCS in three main segments: North Catalan, South Catalan and Ebro. The North Catalan Continental Shelf (NCCS) is dissected by three large canyons (Cap de Creus, La Fonera and Blanes canyons) with the heads located very close to the coastline (up to 800 m in La Fonera Canyon). Such dramatically morphological relief affects the shelf oceanographic currents and sediment transport pattern, whose traces can be observed on swath bathymetry. The South Catalan Continental Shelf (SCCS) is 6 to 18 km wide and, unlike the NCCS, the submarine canyon systems are generally restricted to the continental slope. The SCCS seafloor is basically characterised by relict fluvial and coastal morphology. Finally, the Ebro Continental Shelf (ECS) is up to 70 km wide and their modern macroscale and microscale seafloor morphological expression is largely determined by the Ebro River evolution.

The SCCS coastal zone, including Barcelona, has a particularly extensive human pressure impacting the seabed and creating non-natural habitats. Although human impacts are also present on the NCCS and ECS, their influence on seabed morphology is scarcer. On the CCS the most important biotope *Posidonia oceanica*, an endemic Mediterranean seagrass species that creates underwater meadows, is very sensitive to changes in their environment. The different zones of the CCS have been classified by morphology, sediment type and habitats by unsupervised and supervised mapping techniques, combining all available datasets. This illustrates human and natural impacts that determine habitat distribution and persistence in CCS target areas.

Mapping and Predicting Benthic Habitats, Biological Assemblages, and Biodiversity across the Carnarvon Shelf, Western Australia

Tara J. Anderson, Andrew Heyward, Scott Nichols, Matthew McArthur, Christine Schoenberg, Jamie Colquhoun, Zhi Huang, Maggie Tran and Brendan Brooke

Geoscience Australia, Canberra, Australia

Habitat surrogates (or proxies) are receiving increased attention as a management tool for marine systems. Marine flora and fauna are often strongly correlated with the physical attributes of the seabed such as substrata, relief and sediment grain size, and consequently these physical attributes may provide a powerful tool to predict and explain marine biodiversity patterns. In this study we examined the relationships between biological assemblages and the physical structure and composition of the seabed for the Carnarvon shelf, a tropical shelf system in Western Australia. EM3002 multibeam bathymetry was collected from three spatial grids along the Carnarvon shelf at Mandu Creek (22^{o}10'S), Pt Cloates (22^{o} 30$^{'}$S) and Gnaraloo (23^{o} 45$^{'}$S). Each area was 10 km wide and extended from the inner shelf to the shelf break, and in combination covered 682 km^{2} of the seabed, representing the diversity of habitats along and across the shelf. Bio-physical samples (towed video transects, sediment and infaunal grabs, and epifaunal sleds) were co-collected from stations covering the spatial extent and known complexity of these areas. Spatial position on the shelf (alongshore and offshore position), in combination with substratum type and relief, were important predictors of the distribution and abundance of biological assemblages in this region. Habitat complexity decreased with distance offshore, but alongshore patterns in substrata and relief were also important predictors of biological diversity. In each area, habitat complexity was highest inshore, dominated by moderate to high relief coral reefs that were often bordered by rhodolith beds at their base. Mid-shelf habitats were less complex and dominated by coarse-grained sands in rippled or waved bedforms that supported few epifauna or infauna, with some patchy low-relief outcrops supporting diverse sponge assemblages. Offshore habitats were the least complex with coarse-sand and gravel dominated habitats and a few low-relief outcrops with small invertebrates, including hydroids and sponges. While these offshore patterns were prominent, habitat complexity and assemblage composition also varied alongshore as a function of substratum type and relief. For example, rhodolith beds were more dominant inshore in the north at Mandu, while the biomass, size and areal extent of sponge assemblages were higher in the southern habitats at Gnaraloo. The inner- and mid-shelf zones of Pt Cloates were the most complex of the habitats surveyed, and supported the richest assemblage of sessile filter feeders such as corals, sponges and octocorals, as well as motile species such as crinoids, sea cucumbers, and seastars. A combination of modelling and analytical approaches is being developed to determine how much biotic variability can be explained by different components of the physical environment and how space mediates these patterns. The Carnarvon shelf provides a valuable tropical case study to evaluate how the relative contributions of spatial, physical and habitat variables can be used as surrogates of biotic diversity.

Mesophotic Coral Ecosystems of Puerto Rico

Roy A. Armstrong[1] and Hanumant Singh[2]

[1]University of Puerto Rico, Mayaguez, Puerto Rico
[2]Woods Hole Oceanographic Institution, Woods Hole, MA

Mesophotic coral ecosystems (MCEs) are ecologically-important benthic habitats dominated by zooxanthellate corals, sponges and algae at depths from 30 to 100 m or more. The basic geomorphology, benthic community structure, and biodiversity of MCEs in the U.S. Caribbean remain largely unknown. This includes ecologically-relevant parameters such as percent living coral cover, reef rugosity, incidence of bleaching, and species richness and diversity. Deeper reefs are known habitats of commercially important fish species and could serve as refugia for a large number of sessile-benthic species during times of environmental stress. MCEs are typically located far from sources of terrestrial runoff resulting in high water transparency and little or no sediment stress. They also appear to be largely unaffected by hurricane disturbances and human impacts

Insular shelf MCEs covers large areas of the Puerto Rico – U.S. Virgin Island geological platform between the islands of St. Thomas, Culebra and Vieques. Well-developed and structurally complex reefs, dominated by a flattened-plate morphotype of *Montastraea annularis* complex, are common in this area at depths from 30 to approximately 47 m. Macroalgal coverage, mainly by *Lobophora variegata*, was also abundant at these depths as well as turf and coralline algae. *Geodia neptuni*, *Xestospongia muta* and several species of the genera *Aplysina* and *Agelas* were the most abundant sponges.

Since the insular shelf and slope areas between 30 to 100 m in the U.S. Caribbean have an area of approximately 3,300 km^2 (or 43% of the total area between 0-100 m), it is impractical to rely solely on diving surveys to adequately map and characterize these potential MCE habitats. We have used the automated mapping ability of the Seabed autonomous underwater vehicle (AUV) to obtain over 100,000 digital images of mesophotic zones in the U.S. Virgin Islands and Puerto Rico. At the Hind Bank Marine Conservation District (MCD), south of St. Thomas, U.S. Virgin Islands, seven 1-km long AUV photo transects have provided quantitative data on benthic species composition and abundance at depths of 30-54 m. Within the western side of the MCD, well-developed MCEs with 43% mean living coral cover were found at depths of 40-47 m (Figure 1). These long (km-scale) photo transects have provided the first large-scale effort to map and characterize MCEs using high resolution optical imagery.

Figure 1. Mesophotic coral ecosystem at the MCD obtained by Seabed AUV at a depth of 45m

Use of multibeam swath data and still images to describe potential habitats of deepwater underwater features in New Zealand waters

Susan Jane Baird, Malcolm Clark and Robert Stewart

NIWA, New Zealand

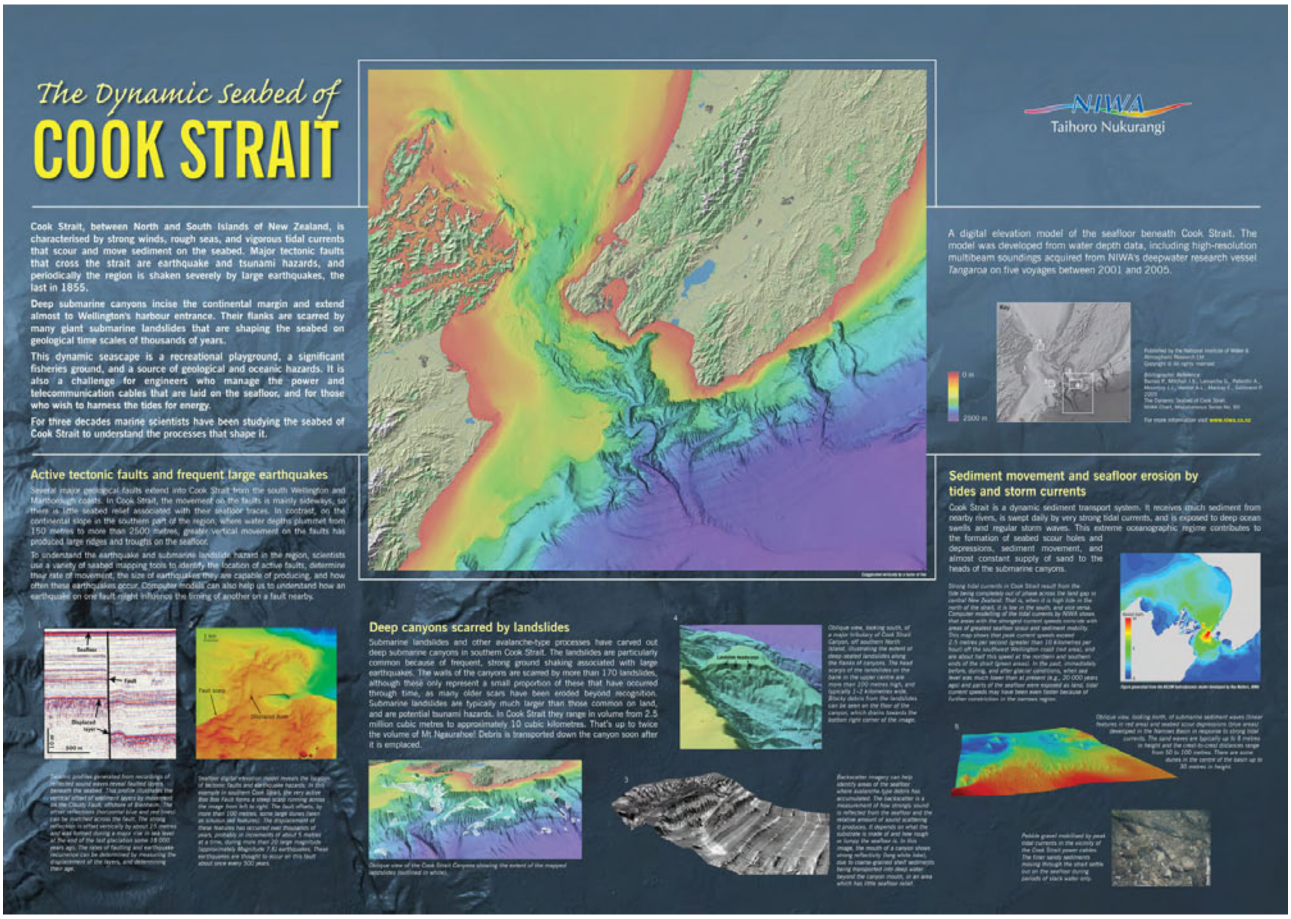
The Graveyard Complex of small underwater features in depths of about 1100 m lies on the northwest Chatham Rise, east of New Zealand and has been surveyed to study biodiversity, species associations, and the effects of fishing. Characterisation of the seafloor geology is crucial for habitat classification of this area. A 2006 survey collected still images of the seafloor and associated fauna from transects made in a star pattern from the tops of the major features. These images were categorised into 6 substrate classes and analysed in conjunction with derivatives of multibeam bathymetry data (at a resolution of 25 x 25 m cells). Five geomorphological classes, each considered to be biologically sensible, were derived using the Benthic Terrain Modeller tool in ArcGIS. Substrate type and the presence of major faunal groups were mapped to groundtruth the modelled classes and to indicate associations. Any spatial interpolation of the substrate data was limited by several aspects of data collection; particularly, the image transect design, the resolution of the bathymetry data compared with that of the image data, and the accuracy of the locations of the image data.

The Dynamic seabed of Cook Strait

Philip Barnes, John Mitchell, Geoffroy Lamarche, Arne Pallentin, Josh Mountjoy, Anne-Laure Verdier, Philip Gillibrand

National Institute of Water and Atmospheric Research (NIWA), Private Bag 14-901, Wellington 6241, New Zealand

Cook Strait, between North and South Islands of New Zealand, is characterised by strong winds, rough seas, and vigorous tidal currents that scour and move sediment on the seabed. Major tectonic faults that cross the Strait are earthquake and tsunami hazards, and periodically the region is shaken severely by large earthquakes, the last in 1855. Deep submarine canyons incise the continental margin and extend almost to Wellington's harbour entrance. Their flanks are scarred by many giant submarine landslides that are shaping the seabed on geological time scales of thousands of years. This dynamic seascape is a recreational playground, a significant fisheries ground, a source of geological and oceanic hazards, and a challenge for engineers who manage the power and telecommunication cables that are laid on the seafloor, and those who wish to harness the tides for future energy. For three decades marine scientists have been studying the seabed of Cook Strait to understand the processes that shape it.



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Geostatistical and landscape analysis of fine-scale eelgrass (*Zostera marina*) habitat patterns

J. Barrell and J. Grant

Department of Oceanography, Dalhousie University, Canada

Eelgrass (*Zostera marina*) is an important and widespread component of shallow coastal areas in Atlantic Canada, offering valuable ecosystem services to both natural and human communities. The presence of eelgrass provides habitat and substrate for biological communities and helps to regulate physical and chemical conditions wherever it grows. Eelgrass habitat is also sensitive to changes in environmental conditions, suggesting its potential as an indicator of coastal ecosystem health. As eelgrass is structured by forces varying over a range of spatial scales, it is important to understand the spatial dynamics of the eelgrass-environment relationship to assist with ecosystem assessment, monitoring, and the identification of priority conservation or restoration areas.

The current research investigates the spatial structure of eelgrass using principles and techniques from remote sensing, landscape ecology, and geostatistics within a GIS framework. High-resolution eelgrass distribution data were collected from a shallow estuary in Richibucto, Canada using high frequency single-beam sonar and digital photography from a helium blimp-mounted aerial platform. Spatial structure was then characterized and quantified with pattern metrics from landscape ecology and geostatistical analysis of variogram structure. These results allow for a methodological comparison of the two sampling techniques over multiple spatial scales. More generally, the results will be used to examine the relationship between eelgrass habitat patterns and the biophysical processes that form them with an eye towards predictive modeling.

Inland Tidal Seas of the Northeastern Pacific

J. Vaughn Barrie[1], H. Gary Greene[2], Kim W. Conway[1] and Kim Picard[1]

[1]Geological Survey of Canada – Pacific, Institute of Ocean Sciences, Sidney, British Columbia, Canada
[2]Tombolo, Eastsound, Washington, USA

Along the Pacific coast of northwestern USA and western Canada, large inland marine straits, sounds and fjords are found with interconnecting narrow channels through island archipelagos to the open ocean. The Salish Sea is one of the world's largest inland seas encompassing 400 islands, 7,500 km of coastline and water depths to 650 m. These inland seas developed through Pleistocene glacial processes and the resultant geography provides for a meso to macro tidal environment. Typical features found are shallow banks, deltas, glacial troughs, rocky reefs, and subaqueous dune fields. The past and present physical processes have created a variety of fish habitats, such as steep, near vertical rock walls and stacked boulders, which offer habitat for juvenile and adult rockfish (*Sebastes* spp.), subaqueous dunes that shelter sand lances (*Ammodytes hexapterus*), broad intertidal mud flats that provide habitat for a variety of shellfish, and raised glacial deposits that allow for the formation of siliceous (glass) sponge reefs.

Seabirds, Sediment Dynamics and Benthic Habitats

J. Vaughn Barrie[1], H. Gary Greene[2] and Kim W. Conway[1]

[1]Geological Survey of Canada – Pacific, Institute of Ocean Sciences, Sidney, British Columbia, Canada
[2]Tombolo, Eastsound, Washington, USA

Deep-water Pacific sand lance (*Ammodytes hexapterus*) is a vital food source for 29 species of coastal NE Pacific seabirds, as well as several marine mammals and commercial and sport fish. Specifically, this species is primary component in the diet of Common Murres (*Uria allge*), Thick-billed Murres (*Uria lomvia*), Rhinoceros Auklets (*Cerorhinca monocerata*) and Tufted Puffins (*Fratercula cirrhata*). Common Murres are known to dive to 180 m water depth to feed, while Thick-billed Murres and Rhinoceros Auklets dive to 150 and 75 m water depths respectively. Sand lance are dependent upon benthic sediment habitats to bury into, therefore, this species is most often associated with oxygenated well-sorted medium to coarse-grained sand, particularly a grain size of 0.36 to 1.0 mm. Sediments in the tidal and storm dominated coastal NE Pacific that fall within this critical sediment criteria are normally part of medium to large subaqueous dune systems that are common along the continental shelf to depths to greater than 200 m. Satellite and observational data show a clear link between the location of sand wave systems, that fall within the grain-size limitations for sand lance, and the distribution of seabird feeding, particularly for these four species. However, the spawning conditions, relative abundance and distribution, and burying requirements for sand lance are largely unknown. From 2000-2007, at the largest seabird colony along the British Columbia coast (Scott Islands), an apparent reduction of sand lance has lead to a drastic decline in seabird fledging success. In order to protect these species that are either at risk or at a level of concern, wildlife marine protected areas have been proposed. The determination of the effective boundaries of a marine wildlife protected area depends on an understanding of the relationship between the abundance of sand lance and the availability of known habitat, and in particular, the distribution and dynamics of subaqueous dune systems.

The parting of the English Channel: how the environment sorts the sediments that sort the habitats

Christopher R S Barrio Froján, Roger Coggan, Markus Diesing

Centre for the Environment, Fisheries and Aquaculture Science, Lowestoft, UK

The centre of the English Channel is characterised by a bedload parting zone resulting from asynchrony between the M2 and M4 tides. Combined with strong currents in the area, the net result is a marked divergence of net sediment transport to the west and east of the parting zone. Over millennia this has resulted in a large scale sorting of surficial sediments, such that they are coarse (or even absent) around the axis of the parting zone but become progressively finer with distance from that zone. At the Dover Straits there is also a bedload convergence zone where fine sediments accumulate. This extreme environmental forcing is reflected in the unusual distribution of benthic habitat and fauna. Benthic faunal assemblages show a symmetrical distribution, with those furthest from the bedload parting zone on either side being more similar to each other than that inhabiting the parting zone itself. With increasing demands to assess the state of health of the seas, it is important that such localised variability is recognised as a natural phenomenon against which the relative magnitude of human impacts can be assessed.

Identifying ecologically and biologically significant deepwater habitat

Nicholas J. Bax[1,2] and Alan Williams[1]

[1]CSIRO Wealth from Oceans Flagship, Hobart, Australia
[2]TAFI, University of Tasmania, Hobart, Australia

Many schemes are used to prioritize marine habitats for conservation including the selection of representative areas and iconic habitats, but with typically 5% or less of deepwater marine areas surveyed, implementing these schemes is difficult and controversial. In June 2007, the Australian government declared the 226,458 sq km South-east Commonwealth marine Reserve Network – the first deepwater marine reserve network in the National Representative System of Marine Protected Areas that will be established around Australia by 2012, meeting Australia's commitment under the 2002 WSSD. In common with international trends, this reserve network has the conservation of biodiversity in general as its objective, and not just the protection of fisheries. We know even less about the general biodiversity of these areas than we do about the fishery resources. For example, recent biodiversity surveys off SE Australia, a comparatively well studied area, identified 80 new pinnacles, sometimes thought to be likely biodiversity hotspots or areas of high endemism. Sixty six percent of the 418 identified invertebrate species from this area were new to science.

In 2008, the Convention on Biological Diversity adopted scientific criteria for identifying ecologically or biologically significant marine areas in need of protection on the open oceans and deep seas (see www.gobi.org for further details). The seven criteria for identifying ecologically and biologically significant areas (EBSAs) are:

Rare: Uniqueness or rarity
Life History: Special importance for life history of species
Endangered: Importance for threatened, endangered or declining species and/or habitats
Fragile: Vulnerability, fragility, sensitivity, slow recovery
Productive: Biological productivity
Diverse: Biological diversity
Natural: Naturalness

The continental shelf and slope off SE Tasmania are comparatively well-surveyed by world standards. The first deepwater MPA was established here in 1998. In this talk we apply the seven criteria for identifying EBSAs reserve networks to this area to provide an indication of the difficulty of applying these criteria in the deep sea beyond national jurisdiction. We conclude that additional management options would be required to support marine reserve networks targeted at EBSAs in this area. Success in the context of marine reserve network design is not a thing but a process, one that not only addresses the need for adequately planning marine reserve networks, but as importantly monitors and manages the reserve system and matrix in which it sits.

Deepwater biodiversity of the Kermadec Islands Coastal Marine Area

Jennifer Beaumont, Ashley Rowden and Malcolm Clark

National Institute of Water and Atmospheric Research (NIWA),
Private Bag 14-901, Wellington 6241, New Zealand

The Kermadec region, including the Kermadec Islands, has been noted as a "key biodiversity area" for a variety of marine fauna. The Kermadec Islands Coastal Marine Area (KICMA) includes a large area offshore from the islands themselves that extends to depths of about 2500 m. However, there has been limited scientific research in the area at water depths below 100 m. In order to define the natural character of the KICMA, a variety of datasets held by NIWA on the deepwater benthic biodiversity in the KICMA and the surrounding area were analysed. This included data from a scientific observer programme, direct sampling, and seabed imagery from several seamounts and associated hydrothermal vents in the northern Kermadec area. A quantitative analysis of habitat and faunal diversity, generated from video footage and still images, is presented.

Application of an Integrated GIS and 4D Visualisation Tool Kit to the NIWA Cook Strait Data Set

Douglas Bergersen[1], Moe Doucet[2], Lindsay Gee[2], and Robin Smith[3]

[1]Acoustic Imaging, PO Box 4035 Pretty Beach, NSW 2257, Australia
[2]IVS 3D, 30 Maplewood Ave., Suite 205, Portsmouth, NH 03801, USA
[3]ESRI, 380 New York Street, Redlands, CA 92373, USA

Recent integration efforts have been completed between ESRI and IVS 3D on the seamless transfer of information between Arc workspaces and the 4D visualisation environment provided by Fledermaus. This paper presents an overview of the integration to date and discusses how tools within both software suites may be used to assist and optimise the characterisation and quantification of marine habitats. A National Institute of Water and Atmospheric Research Ltd (NIWA) data set from Cook Strait is employed as a case example.

Geographical Information Systems (GIS) are a common tool used by many major organisations for storing, analysing, and managing large data sets. The offshore industry poses particular challenges to standard GIS capabilities, often requiring specialised tools that have been developed by software companies catering specifically to the industry. An increase in requests by clients common to IVS 3D and ESRI has led to the cooperative development of a direct exchange architecture between Fledermaus and Arc workspaces, thus eliminating the need for intermediate file formats (e.g., Shapefiles). This direct exchange of information leads to more streamlined workflows and maximises the capabilities of each software package.

Data associated with habitat mapping typically consists of a combination of seabed imagery (bathymetry, mosaics, photographs, video), subsurface information (e.g., seismic profiles), regional information (e.g., charts, satellite imagery), seabed samples, and water column measurements. The ability to view all data types simultaneously in the 4D environment offered by Fledermaus provides new insights on the relationship between data types. In addition, some of the specialised tools offered by IVS 3D (e.g., bathymetry modelling and data cleaning, backscatter mosaicking, automated seabed characterisation) may be used to complement existing ArcGIS desktop extensions.

The NIWA Cook Strait data set used to assess potential processing, interpretation, and final product workflows consists of over 17GB of bathymetry and backscatter data supplemented by seabed sample and biological observations. The analysis presented in this paper covers processing times and pitfalls associated with the raw data, results from automated seabed characterisation relative to seabed samples, and derived products that may be used as part of a habitat mapping and monitoring strategy.

A GIS analysis of New Zealand's Trawl Footprint

Jenny Black[1] and Ray Wood[1]

[1]GNS Science, Lower Hutt, New Zealand

Trawl fishing occurs across New Zealand's Exclusive Economic Zone (EEZ). The Ministry of Fisheries collects information for each trawl (trawl catch effort processing returns - TCEPR), and compiles these into a database. The inherent imprecision in location information means that the effect of each trawl in unknown, but the aggregate extent of bottom trawling in New Zealand's EEZ and the potential effect on benthic biodiversity zones can be estimated.

This analysis has been applied for individual species to estimate the trawl footprint within species-specific Quota Management Areas and to calculate related statistics.

The TCEPR data from the Ministry of Fisheries database used for this study included 903,734 records from the EEZ. These were bottom trawl records and mid-water trawl records where the ground rope depth was equal to the bottom depth.

Analysis of the data included estimating the door-to-door area of sea floor swept by each trawl and then taking the union of these polygons. This provides an estimate of the total area and percentage of the EEZ contacted by bottom trawling gear. The results are also used to estimate the percentage of each of the WWF-NZ benthic biodiversity zones contacted by bottom trawl gear. The same is done for benthic-optimised marine environment classification (BOMEC) zones.

Using these results, it is possible to predict the distribution of areas affected by trawlines, including which parts of New Zealand's EEZ are unlikely to have been affected by trawling. This information can be used, for example, to develop suitable resource management and conservation measures to preserve these areas. The Benthic Protection Areas established in 2007 are an example of such an application of this analysis.

Opportunistic monitoring of environmental baselines in remote marine parks using satellite image analysis

Elizabeth J. Botha[1], Janet M. Anstee[1], Arnold G. Dekker[1], Young-Je Park[1]

[1]Environmental Earth Observation Group, CSIRO Land and Water, Australia

The management of remote marine protected areas, such as the Commonwealth Marine Reserves in Australia's north-west and Coral Sea, are often constrained by a lack of information on the ecosystems and associated large scale ecological processes. Satellite data offers extensive spatial and spectral information that can be used to quantify species richness, abundance, diversity and biomass on a habitat scale. It can thus be used to establish environmental baselines to track habitat change over time. Traditionally, interpretation of remote sensing data has been image-based, and thus empirical. However, empirical approaches are not easily transferrable across study areas or data types. Recently physics-based classification approaches have evolved to utilize semi-analytical (bio-optical) models that can incorporate water column properties and benthic substratum composition.

In collaboration with the Australian Department of the Environment, Water, Heritage and the Arts (DEWHA), CSIRO obtained archival high-resolution QuickBird satellite imagery of several Commonwealth Marine Protected Areas. Additionally, in situ data was collected for both model parameterisation and validation purposes. The aim of data collection was to create a representative database of optical properties of the water column and benthos. Validation data consisted of geo-located benthos type, habitat distribution and bathymetry. A standardised atmospheric correction was applied to the images to retrieve subsurface irradiance reflectance. From this estimates of bathymetry and substratum-type maps were produced for the optically shallow (i.e. visible from space) image portions by applying a physics-based inversion model. Model output was validated by GPS depth transects, towed GPS photo transects and field survey descriptions.

Model classification output provided an estimate of accuracy based on how well the model was able to simulate a subsurface reflectance spectrum, given the range of optical properties of the water column and benthos. Resultant benthic cover and bathymetry maps showed a good match with field observations.

This satellite imagery processing pathway enhances existing monitoring and management practises by offering a repeatable and objective approach to habitat mapping. The ability to collect opportunistic imagery after major events (i.e. bleaching, cyclones) provides additional information not otherwise obtainable during periodic field campaigns with revisit times that are not necessarily ecologically relevant. Furthermore, when this approach is used to detect change it becomes a cost-effective source of information because it can be opportunistically applied on historical, current and future images utilising the model parameters developed from the representative in situ database without the cost of additional field campaigns.

Geomorphological characterisation of cold water corals habitats (Bay of Biscay, NE Atlantic)

Jean-François Bourillet[1], Thierry Schmitt[1&2], Alessandra Savini[3], Brigitte Guillaumont[4] and Sophie Arnaud-Haond[4]

[1] Ifremer-Marine Geosciences dept, 29280 Plouzané, France
[2] SHOM, France
[3] Università di Milano-Bicocca, Dip. Scienze Geologiche e Geotecnologie, Italy
[4] Ifremer-Deep Ecosystems dept, France

Cold water corals (CWC) are declared vulnerable ecosystem by several international organizations. In European waters, tools to assess the impact on fisheries and the effectiveness of protected areas are lacking. European CoralFISH project aims to study the interaction between CWC, fish and fisheries thanks to an ecosystem-based approach. One of the objectives is to provide a comprehensive characterization of CWC habitats based on geophysical and ground-truthing data.

All along the northern margin of the Bay of Bisay, the succession of interfluves and deep canyons have shaped the passive margin (average slope of 5°). More than 130 canyons are organized into 8 large drainage networks. The complex hydrology (geostrophic and tidal currents, swells, internal waves) and the vast canyons systems play an important role in determining benthic habitat distribution and development. Occurrences of CWC have been sparsely documented by fishermen and scientists. Their link with particular morphology or hard sediment outcrops, their full extent and spatial patterns (e.g. reefs, scattered colonies, …) are poorly known.

A classification methodology based on depth, slope and Bathymetric Position indices was applied on existing MBES data of the French EEZ program (R/V *l'Atalante*, EM12D, DEM grid 125 m). It allows delineating the megageoforms (shelf, slope and rise) and next delineating smaller scale geoforms (crests, flanks, channels and canyons) thanks to a specific morphological analysis. Then occurences of *Lophelia pertusa* are related to the seaflor type. Uncertainty of corals locations and medium resolution of the DEM are the main limitations. New BobGeo survey (R/V *Pourquoi pas?*, RESON7150, DEM grid 20 m) covered 34 canyons and revealed morphological details as gullies, slide scars and steps on the flanks, falls in the thalwegs (Figure 1). Furthermore camera ground-truthings show dead corals on the head of canyons and on the interfluves, living reefs on the flanks and on the scarps of steps or of falls.

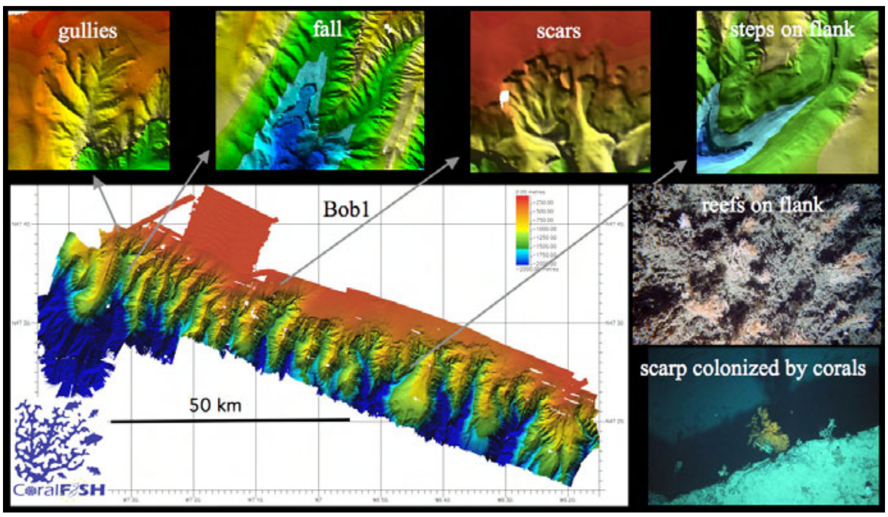


Figure 1. Geomorphological features and cold water corals habitats in the Bay of Biscay

Multibeam sonar in the deep-sea: can it really tell us much about benthic habitats and fauna?

David Bowden, Judi Hewitt, Anne-Laure Verdier, and Arne Pallentin

National Institute of Water and Atmospheric (NIWA) Research.
Private Bag 14-901, Wellington 6241, NZ

Multibeam sonar has great potential for remote characterisation of seafloor habitats and fauna but interpretation is highly scale-dependent. Under the Ocean Survey 20/20 programme (OS 20/20), New Zealand is collecting multibeam data combined with physical seabed samples across large areas of its Exclusive Economic Zone (EEZ). Here we use multibeam acoustic transects with nested physical and biological sample data from two deep-sea regions of the New Zealand EEZ to explore the utility of vessel-mounted multibeam for characterisation of seabed biological assemblages and habitats in the deep-sea. Multibeam sonar transects extending over 1000's km were collected from Chatham Rise and Challenger Plateau in depths from ca. 250 to 1800 m. At 150 sites nested within these transects, seabed biological assemblages and substrates were sampled, primarily by video transect and epibenthic sled. Two alternative methods for defining acoustic polygons at each site were trialled: (1) a buffered convex hull encompassing all samples at a site, and (2) a full swath-width rectangle centred on the site centroid and scaled by depth in the along-swath dimension such that polygon proportions, but not size, were consistent across all sites. Summary statistics were generated for each site polygon, for each method, based on (1) backscatter intensity, (2) bathymetry, and (3) class membership of a benthic terrain model generated from the bathymetry. Correlations between these acoustic data and biological and substrate data from the physical sampling gears were then explored using a range of statistical approaches.

Seabed diversity of the shelf surrounding Lord Howe Island

Brendan Brooke[1], Colin Woodroffe[2], Michelle Linklater[2] and Scott Nichol[1]

[1]Geoscience Australia, Canberra, Australia
[2]University of Wollongong, Wollongong, Australia

A shallow shelf dominated by temperate carbonate sediment surrounds Lord Howe Island, a relict volcano in the remote central Tasman Sea. In contrast to these temperate deposits, in the Holocene a coral reef grew around the island and today forms a conspicuous relict structure in the middle shelf. Inboard of the relict reef and outboard of the small modern fringing reef, there are large sand banks; while the outer margin of the shelf comprises terraces and sand-covered ledges. Seabed samples, including sediment and benthic infauna in combination with multibeam sonar bathymetry, acoustic sub-bottom profiles and underwater video footage have been used to map a range of distinctive benthic habitats on the shelf. The habitat maps are helping inform the management of this World Heritage-listed site, which includes Australian state and commonwealth government marine reserves.

Geomorphology and benthic habitats of the Lord Howe volcano

Brendan Brooke[1], Colin Woodroffe[2], David Kennedy[3], Michelle Linklater[2], Scott Nichol[1], Richard Mleczko[1] and Michele Spinoccia[1]

[1]Geoscience Australia, Canberra, Australia
[2]University of Wollongong, Wollongong, Australia
[3]Victoria University of Wellington, Wellington, New Zealand

Multibeam sonar bathymetry and acoustic sub-bottom profiler data collected on and in the vicinity of the Lord Howe Island volcano reveal distinctive seabed structures and habitats at a range of scales. These data provide important insights into hot-spot volcanism, subsequent sedimentary processes and likely broad-scale patterns of benthic biodiversity in this remote mid-ocean setting.

Legacy bathymetry data (multi and single beam) were compiled to improve the resolution of the regional seabed geomorphology (1500 – 4000 m deep; central W flank of Lord Howe Rise). These data were combined with near-continuous multibeam coverage of the Lord Howe volcano to provide comprehensive, relatively high-resolution bathymetric models of the volcano's flanks (2500 – 100 m; 100 m^2 grid) and shallow shelf (100 – 30 m deep; 40 and 8 m^2 grids). The new regional model identifies two previously unreported deep seamounts to the NW and SW of the Lord Howe volcano. These seamounts suggest that a number of submarine volcanoes formed during the Late Miocene when the Lord Howe volcano erupted. On the flanks of the Lord Howe volcano, canyons, sediment flow and slump features, including blocky debris, are clearly discernible. Mulitbeam backscatter indicates most of the flank and toe of the volcano are mantled in marine sediment, with hard substrate restricted to the rims of canyons. Large-scale, possibly rapidly formed slumps are discernible on the western flank of the volcano.

Near the top of the volcano, ledges extend around much of the outer margin of the shelf (~100 – 70 m depth) - a lack of thick sediment cover suggests the ledges are erosional, cut by waves during periods of lower sea level. In the middle of the shelf (~50 – 20 m depth) a relict reef is well-resolved and surrounds Lord Howe Island. Inboard of the reef, there are extensive sandy basins which sit slightly deeper than the relict reef. Sub-bottom profiles reveal a number of depositional units within the basin fill. Seabed samples indicate that the sediment is derived from both the reef and island. These data are better informing the management of this World Heritage-listed area by accurately delineating key seabed structures, enabling benthic habitats to be mapped throughout the marine parks and through the more effective selection of biological sample sites.

Seafloor sediment classification in a tidal inlet channel: The influence of shell debris and seafloor rugosity

Dietmar Bürk[1], Martina Heineke[1], H. Christian Hass[2], Ralf Vorberg[3] and Rolf Riethmüller[1]

[1] GKSS Research Centre, Institute of Coastal Research, 21502 Geesthacht, Germany
[2] Alfred-Wegener-Institute for Polar and Marine Research, 25992 List, Germany
[3] Marine Science Service, 21521 Dassendorf, Germany

Seafloor sediment maps provide an important basis for decisions concerning offshore constructions (e.g. offshore windfarms, pipelines, telephone cables) as well as decisions concerning the management of environmentally protected areas. Information about the seafloor surface sediments can be derived from sediment samples taken by van Veen grabs or box cores. But these tools provide only selective information about the seafloor. For area-wide mapping of the seafloor classification of multibeam imagery and sidescan sonar images is applied.

To study the sediment distribution in a tidal basin near the island of Sylt (German North Frisian Wadden Sea), several areas ranging from 5 to 35 metres water depth have been mapped with a Simrad EM 3002 300 kHz multibeam echosounder and a shallow-towed, high-resolution Imagenex YelloFin 300 kHz sidescan sonar. Ground truthing is available from several video surveys and 131 box core samples.

The surveyed area consists of deeper parts with water depths between 20 m and 30 m, showing only few sedimentary structures, seafloor at intermediate depths of 10 m to 20 m with large sand waves and ridges, and smooth shallow areas of less than 10 m water depth along the tidal flats. The backscatter strength of the multibeam system does not correlate with the water depth. From the video observations and the seafloor samples it can be concluded that the seafloor substrate mainly consists of fine to coarse sands, shell debris, silt and clay, glacial deposits, some vegetation and old mussel beds. To find out the relationship between seafloor substrate and backscatter amplitude, the grain sizes of 90 sediment samples have been analysed by laser granulometry. Additionally 22 of the samples have been sieved. The sediment fraction >2 mm consists to a large degree of shell debris. Because this fraction can not be analysed with the laser granulometer, it is separated by sieving and its portion is calculated in weight percent but also estimated visually.

For classification a boxcar filter is applied to the geoacoustic data. The filter can have various sizes and calculates several statistical parameters of the amplitude values, e.g. mean, 80% quantile, standard deviation, contrast and the gray-level co-occurrence matrix. In addition the rugosity of the bathymetry values is determined inside the filter area. These parameters form a feature vector attached to each cell of the geoacoustic data. A k-means clustering with all feature vectors results in several seafloor classes. Finally the correlation of the grain size parameters with the seafloor classes is investigated.

Benthic habitat surveys for coastal resource management off Wellington's south coast

Tamsen Tremain Byfield[1] and Dr. Jonathan P. A. Gardner[2]

[1]School of Biological Sciences, Victoria University of Wellington, New Zealand
[2]Centre for Marine Environmental and Economic Research, VUW

Critical to conservation of near-shore benthic communities is information on spatio-temporal patterns of habitat availability and type, and associated biological community structure and abundance. Direct (drop-camera, diver) survey techniques, combined with remote (multibeam) survey, can provide essential information on the composition patterns of communities in relation to the physical properties of the seabed. Here we present the results of surveys of a coastal temperate rocky-reef community that occurs partially within a newly-created marine reserve. Our aims were to: 1) provide resource managers with a baseline description of spatial patterns in benthic community structure and habitat availability; 2) compare the effects of different sampling and analysis strategies on the identification and description of these patterns; 3) correlate patterns in habitat and community with underlying seabed structure (backscatter signal) identified from a multibeam survey; and 4) develop a standardised hierarchical mapping classification scheme for use in other subtidal habitats in New Zealand. Analysis of drop-camera images identified benthic community composition, relative abundance of key species, physical habitat type, and topographic complexity. Results show that drop-camera mapping is an effective tool for identifying benthic community patterns and habitat distribution but is more effective when conducted in conjunction with a multibeam survey. Results were placed within a hierarchical classification scheme and presented as maps within a GIS framework. Classifications and maps effectively convey resource patterns to stakeholders from varied backgrounds and therefore constitute a valuable conservation tool.

Canonical Variate Plots for Categorising Benthic Classes using EM300 Multibeam Data

Norm Campbell[1], Tennille Irvine[2], John Keesing[2], Gordon Keith[3], Paul Kennedy[4]

[1]CSIRO Mathematics, Informatics and Statistics, Floreat WA
[2]CSIRO Marine and Atmospheric Research, Floreat WA
[3]CSIRO Marine and Atmospheric Research, Hobart Tasmania
[4]Fugro Technical Services, Balcatta WA

This study is part of a collaborative project to process 89 tracks of EM300 multibeam data collected onboard the Southern Surveyor in a cruise off Marmion, near Perth in WA in May 2007.

Backscatter values were extracted from the depth datagram from the raw *.all files using mblist. There are varying numbers of backscatter and incidence angle values from ping to ping. For the analyses reported here, the backscatter data have been interpolated to a constant set of incidence angles using linear interpolation.

Canonical variate analysis (CVA) is used to provide an exploratory supervised clustering of the data, based on groups formed by taking contiguous segments of 100 pings.

There are two main patterns in the CV plots: separation of sand and hard-bottomed sites along the first canonical variate; and separation of lightly-vegetated hard-bottomed sites from sponge-covered sites along the second canonical variate.

Five seabed cover types can be identified:

- sandy areas (CV1 scores 32 – 34) with strong ripples (CV2 scores 11 – 13)

- sandy areas with more diffuse ripples (CV2 scores 14 – 16)

- hard-bottomed areas with sparser vegetative cover (CV2 scores 12 – 14)

- hard-bottomed areas (CV1 scores 21 – 23) with dense vegetative cover (eg sponge-covered areas) (CV2 scores 8 – 10)

- areas which appear to be sandy on the video, with obvious ripples and some sparse cover, but with CV1 scores around 24 – 26 -- these sandy-looking areas initially caused some confusion in extrapolating the exploratory CV plots to other tracks, until they were recognised as probably representing another cluster.

The canonical variate scores are calculated and plotted for the other tracks in the study to identify areas associated with these five seabed cover types.

Distinguishing Between Benthic Classes - Full-Ping vs Moving-Window Separation

Norm Campbell[1], John Keesing[2], Tennille Irvine[2], Gordon Keith[3], Paul Kennedy[4]

[1]CSIRO Mathematics, Informatics and Statistics, Floreat WA
[2]CSIRO Marine and Atmospheric Research, Floreat WA
[3]CSIRO Marine and Atmospheric Research, Hobart Tasmania
[4]Fugro Technical Services, Balcatta WA

This study is part of a collaborative project to process 89 tracks of EM300 multibeam data collected onboard the Southern Surveyor in a cruise off Marmion, near Perth in WA in May 2007.

Canonical variate analysis (CVA) is used to provide an exploratory supervised clustering of the data, based on groups formed by taking contiguous segments of 100 pings. A related poster at this Conference gives more details of the approach.

Plots of CV scores are examined in conjunction with benthic video footage of the corresponding location of the multibeam data. Those parts of the CV index plots in which the CV scores remain “flat” for a reasonable period are likely to indicate habitats which are homogeneous within the limits of the multibeam differentiation.

There are two main patterns in the CV plots: separation of sand and hard-bottomed sites along the first canonical variate; and separation of lightly-vegetated hard-bottomed sites from sponge-covered sites along the second canonical variate.

Plots of backscatter – incidence (BS – IA) mean curves for five seabed cover types show that there are only subtle differences in the BS – IA curves for hard bare areas and dense sponge-covered areas.

The backscatter values for the sponge-covered sites overlap considerably with the backscatter values for the barer hard-bottomed sites at any one incidence angle. The subtle separation between the sponge-covered sites and the barer hard-bottomed sites is due to the overall differences in the shapes of the BS – IA curves over part or all of the range from 30^o to 65^o.

Examination of the discrimination provided by subsets of angles indicate that there is some separation along CV2 (which effects separation between the bare hard-bottomed and the sponge-covered areas) for a 30^o and 40^o range spanning the cross-over at 50^o, but little or no separation for a 10^o or 20^o range spanning the cross-over.

Plots of CV2 scores show that while a dip in CV2 scores is clearly evident for the CV analyses which include all angles from 0^o to 65^o, it becomes less apparent as the number of angles is reduced.

The Catalan submarine canyon heads, NW Mediterranean Sea: coupling seafloor morphology and biological diversity

Miquel Canals, Galderic Lastras, David Amblas, Ben De Mol
and "Euroleón" cruise shipboard party

GRC Geociències Marines, Universitat de Barcelona/Parc Científic de Barcelona, Barcelona, Spain

Cap de Creus, La Fonera and Blanes submarine canyons (Fig. 1) deeply dissect the continental shelf and slope of the northern Catalan margin (NW Mediterranean). They are an efficient link between the shelf and the deep basin, as they are able to transport large amounts of sediment by a combination of external forcings and sedimentary processes. New high-resolution geophysical data and ROV images display their sediment dynamics and its interaction with living communities, revealing the Catalan canyons as extreme habitats that need management measures to preserve them.

Cap de Creus canyon stands out as the most active among Catalan canyons. The upper and middle canyon are deeply incised, with steep walls and a flat canyon floor following a general W-E orientation. A dense field of mega-scale furrows on its southern flank (Fig. 1F)suggest the recurrence of dense shelf water cascading episodes. It is known that through these cascading episodes large quantities of dissolved and particulate matter are funnelled to the deep-sea, an essential process fuelling the deep-sea ecosystems and the local habitats. This process seems to determine the presence of cold-water coral species (*Madrepora oculata*, *Lophelia pertusa* and *Dendrophyllia cornigera*) observed in ROV video transects in the southern flank of the canyon. La Fonera canyon head displays a general N-S trend with several steep branches displaying close-to-vertical walls (Fig. 1E).ROV images show rocky outcrops with intensive mega-fauna colonisation including white coral *M. oculata*, *Desmophyllum* sp. and *Paramuricea clavata* gorgonian, sponges and other fauna (Fig. 1B and 1C). It is remarkable that the eastern wall rim of the La Fonera Canyon shows predominantly fine bioturbated sediment (Fig. 1D), intensively remoulded by trawling. Blanes Canyon shows a western rim smoothed by fluvial sediments coming from Tordera river, whereas the western wall becomes heavily gullied seawards. ROV video transects show biogenic debris (mainly shells) capping smooth relieves in the canyon rim (Fig. 1A).

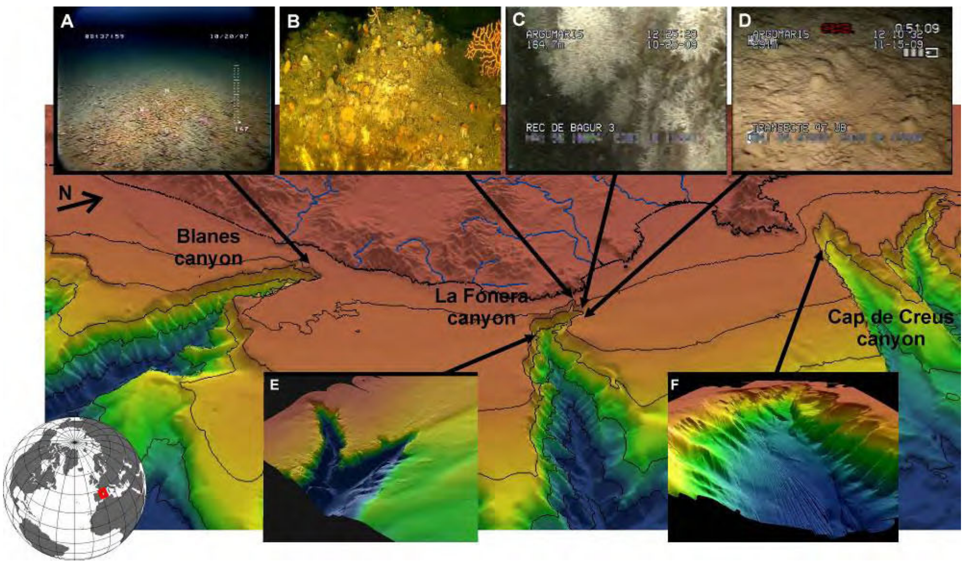


Figure 1. Bathymetric view of the northern Catalan margin and the three Catalan canyons. A to D, ROV video captures of different sites within the canyons. E-F, selected bathymetric views of La Fonera and Cap de Creus canyon heads.

Habitat as a proxy for biodiversity: how can seamount classification systems aid the scientific design of marine protected areas

Malcolm R. Clark[1], Ashley. A. Rowden[1], Les Watling[2], John M. Guinotte[3]; Craig R. Smith[2]

[1] National Institute of Water & Atmospheric Research, Wellington, New Zealand
[2] University of Hawaii at Manoa, Honolulu, USA
[3]Marine Conservation Biology Institute, Bellevue, USA

Seamounts are prominent features of the world's seafloor, and are the target of deep-sea commercial fisheries, and of interest for minerals exploitation. They can host vulnerable benthic communities, which can be rapidly and severely impacted by human activities. There have been recent calls to establish networks of marine protected areas on the High Seas, including seamounts. However, there is little biological information on the benthic communities on seamounts, and this has limited the ability of scientists to inform managers about seamounts that should be protected as part of a network.

In this paper we present examples of seamount classification systems based on "biologically meaningful" physical variables for which global-scale or regional data are available. The approach involves the use of key environmental variables (e.g., overlying export production, summit depth, oxygen levels, seamount proximity) to group seamounts with similar characteristics. This procedure can be done in a simple hierarchical manner, or using multivariate methods. The approach can give biologically realistic groupings, in a transparent process that can be used to either directly select, or aid selection of, seamounts to be protected.

Habitat Products of the California Sea Floor Mapping Program

Guy R. Cochrane[1], Eleyne Phillips[1], Lisa Krigsman[2], Nadine Golden[1], Pete Dartnell[1], Mary Yoklavich[2]

[1]USGS, Coastal and Marine Geology, Santa Cruz, California, US
[2]NOAA, National Marine Fisheries Service, Santa Cruz, California, US

The California Sea Floor Mapping Program, a consortium of Federal, state, academic, and industry organizations, is producing a suite of map products to address the State of California's needs for marine spatial planning and marine resource management. State waters are being mapped in blocks of approximately 300 square kilometers. For each block, a variety of products are being published, ranging in theme from geologic to biologic information. Two forms of maps intended for habitat analysis are being produced: a multi-attribute polygon based map, and a raster map that has fewer attributes but preserves the resolution of the sonar data collected per block.

The raster habitat map (called a Sea Floor Character Map) is classified into three substrate groups using towed camera-sled video observations to supervise a maximum likelihood classification of bathymetric rugosity and intensity of return from sonar systems. The three classes are: I) unconsolidated sediment, II) mixed sand, gravel, rock or low relief rock, and III) high-rugosity rock. A minority of the video observations are used to supervise the classification. The bulk of the video observations are used to assess the accuracy of the classification. Each observation point is assigned a class according to the visually-derived major/minor geologic component (*e.g.*, sand or rock) and the abiotic complexity (vertical variability) of the substrate. Circular buffers are created around individual observation locations using a 10-m radius to account for positional inaccuracies inherent to towed camera systems. The observation buffer is used as a mask to extract pixels from the Sea Floor Character Map. These pixels are compared to the class of the observation for accuracy. Reducing the uncertainty in the location of the video observation would make the accuracy number more meaningful in areas of patchy habitat where the position uncertainty can be an order of magnitude greater than the size of the substrate patch observed.

The observations from the towed camera sled include presence/absence data of macro-invertebrates associated with the observed substrates. Multivariate models are being developed using logistic regression to predict the distribution of key species, and couple these results with spatial distribution of substrate from the Sea Floor Character Map, depth from the bathymetry raster, and geographic latitude, to map the probability of occurrence of these important components of sea floor communities on a coast-wide scale.

Using GIS Models to Delimit Vulnerable Marine Ecosystem (VME) Boundaries in the Northwest Atlantic Regulatory Area (NRA)

Andrew T. Cogswell[1], Ellen L.R. Kenchington[1], Camille G. Lirette[1]

[1]Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada

The UN General Assembly Resolution 61/105, and the supporting International Guidelines for the Management of Deep-sea Fisheries in the High Seas, identified some cold water corals and sponges as indicators of vulnerable marine ecosystems (VMEs) and called upon member states (including Canada) and regional fisheries management authorities, such as the Northwest Atlantic Fisheries Organization (NAFO), to adopt measures for their protection from serious adverse impacts from fishing operations.

This work expands upon earlier efforts of the NAFO Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM) and the Working Group on Fisheries Managers and Scientists to establish encounter protocols for "significant" concentrations of sponge and coral. Furthermore, work described during the presentation not only describes the physical extent of sponge fields within the deep waters of the NRA, but also proposes a GIS fishing model as a means of testing the efficacy of the NRA VME closure areas issued in Bergen, Norway in September of 2009.

This presentation will briefly describe previous non-GIS efforts to establish areas of high coral concentration in the NRA. This will be followed by an in depth description of 2 ArcGIS models which: 1) use contours derived from kernel density analysis to calculate areas of sponge coverage at pre-defined by-catch weight intervals, and 2) estimate commercial by-catch, based on interpolated rasters of Fisheries and Oceans research vessel by-catch data, by selecting theoretical trawl locations weighted by historical fishing effort or any other underlying raster data that may influence trawling direction. Finally, the results derived from each model will be described in detail in addition to their ongoing and potential application.

Spatial predictability of species diversity and abundance of epimacrobenthos in turbid nearshore using bathymetric LiDAR

Antoine Collin[1], Bernard Long[2], Philippe Archambault[3]

[1] Insular Research Center and Environment Observatory, Papetoai, Moorea, French Polynesia
[2] Department of Geosciences, University of Quebec, QC, Canada
[3] Institute of Marine Sciences, University of Rimouski, QC, Canada

The diversity, abundance and spatial distribution of epimacrobenthic species interface with nature, heterogeneity and structural complexity of benthic habitat, according to the concept of Hutchinson's environmental niche. However, the monitoring of these benthos features, at regional scale, is heavily hindered by both shallow water depths and water turbidity. Supported by judiciously-chosen ground truthing, both seafloor type and morphometry in turbid nearshore are surveyable by bathymetric LiDAR.

The study took place along a part of the north shore of the Baie des Chaleurs (48°N, 65°W), southern Gulf of Saint-Lawrence, Quebec, Canada. 300 high resolution underwater photographs were analyzed and converted into a species-sediment matrix, which enabled to compute species diversity (richness, Simpson, Shannon and Pielou indices) and abundance, as well as seafloor type using Bray-Curtis index and hierarchical clustering. Based upon the LiDAR-derived morphometric features and a supervised classification, the seafloor map was generated with an overall accuracy of 0.82 (Kappa coefficient). A β-diversity filter was then applied to this map in order to enhance the spatial patterning of habitats. Generalized Linear Models processing revealed that Shannon index and abundance of epimacrobenthos appraised in situ were correlated with the 2 m LiDAR-derived seafloor parameters (such as the bathymetry and the total energy of the LiDAR bottom waveform) over areas as large as 8 km^2, surveyed in less than 2 hours. The study suggests that bathymetric LiDAR is capable of monitoring seafloor nature and inherent morphometric features over relatively (2-3 Secchi depth) turbid nearshore waters. Reliably assessing controlling factors such as the structural and spatial complexity of habitats, this LiDAR can perform predictive mapping at a scale relevant to epimacrobenthic assemblages. Furthermore, as *Laminaria* spp. and *Zostera marina* were better predicted with the LiDAR habitat complexity data, this technique could be used to map and model structural indices related to kelp fields and eelgrass meadows, and identify optimal locations for designing marine protected areas across turbid nearshores.

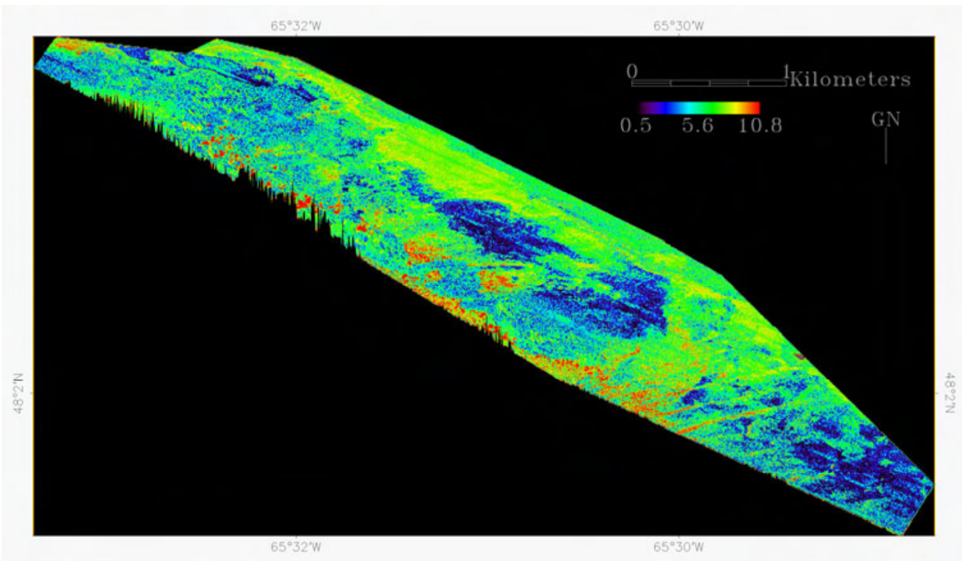


Figure 1. Map predicted species density model for Bonaventure's nearshore derived from the Generalized Linear Model applied to LiDAR-derived morphometric indices.

Habitat-based assessment of epibenthos using AUV Optical imagery, northwest Australia

Jamie Colquhoun[1], Oscar Pizarro[2], Andrew Heyward[1], Max Rees[1], Stefan Williams[2], Rebecca O'Leary[1], Ben Radford[1]

[1]Australian Institute of Marine Science, Perth, Western Australia
[2]Australian Centre for Field Robotics, University of Sydney, New South Wales, Australia

The versatility of AUV technology for marine benthic surveys is highlighted by the ability to acquire targeted, repeatable high resolution optical images over a large spatial scale. Current challenges lie in developing more efficient ways for data analysis, storage, visualization and processing, to provide timely and cost-effective outputs relevant to conservation managers and policy makers. In many marine habitats accessible to AUVs, where baseline data on even dominant taxa and their distribution may be poor or non-existent, an early objective will be to characterise the species present and describe their basic distribution and abundance. The North West Cape and Ningaloo Reef, Western Australia is recognised as a biodiversity 'Hotspot' and preliminary benthic surveys using towed video (up to 100 m depth) indicated that filter feeding communities, dominated by sponges, are abundant below routine diver depths.

We use as a case study a 2007 collaborative benthic habitat survey of northern Ningaloo Marine Park and Muiron Island management area, northwest Australia, between the Australian Institute of Marine Science and Australian Centre for Field Robotics. Seabed surveys were conducted by the autonomous underwater vehicle (AUV) 'Sirius' at 9 locations to test the vehicles' capability to capture high resolution optical imagery at various depths (18-250 m), in different types of terrain and conditions. One hundred and twenty six thousand geo-referenced stereo paired images were obtained from a survey area of approximately 27 km. Spatially explicit imagery was used to reconstruct 3D mosaics (meshes) for each mission to qualitatively evaluate within habitat variability as an initial step in the habitat characterisation process. Subsequently the most variable sections of seabed habitat were selected to inform development of a seabed classification system, for application in further fine scale analysis and to provide human-labelled training sets of images to test a developing automated classification system. The fine scale distribution and abundance of substrates, bed-forms and epibenthos was quantified over a range of depths (beyond diver depth) to ascertain potential relationships between depth, substrate, light and epibenthos.

A benthic optimized marine environment classification for New Zealand's EEZ

Tanya J. Compton[1], John Leathwick[2], Ashley A Rowden[3], Scott Nodder[3], Richard Gorman[1], Simon Bardsley[3], Suze Baird[3], Matthew Pinkerton[3], Mark Hadfield[3], Kim Currie[4]

[1]National Institute of Water and Atmospheric Research, Hamilton, New Zealand
[2]Department of Conservation, Hamilton, New Zealand
[3]National Institute of Water and Atmospheric Research, Wellington, New Zealand
[4]National Institute of Water and Atmospheric Research, Dunedin, New Zealand

Environmental classifications are a useful tool for summarizing broad-scale spatial patterns in ecosystem character, especially when biological data are limiting. Classifications are derived based on spatial patterns in environmental variation and their association to biological pattern. To estimate the association between environmental variation and biological pattern, a relatively simple approach was used in a previous classification of New Zealand's marine environment. That is a Mantel test was used to measure correlations between matrices containing estimates of biological and environmental differences. By contrast, generalized dissimilarity modelling can be used as a basis for biological community classifications. Specifically, generalized dissimilarity models can model the relationship between species turnover and environmental variation and also estimate the relative importance of environmental variables for species turnover. Here, we use generalized dissimilarity modelling to describe species turnover for six taxonomic groups of benthic fauna, with respect to environmental variation, in the New Zealand EEZ. We then construct a Benthic Optimized Marine Environment Classification based on these results.

Geological framework for geohabitat mapping: Bathymetry, backscatter and images from the Macquarie Ridge Complex

Chris Conway[1, 2], Anne-Laure Verdier[2], Helen Bostock[2]

[1]Victoria University Wellington, New Zealand
[2]NIWA, Wellington, New Zealand

The Macquarie Ridge Complex is a ~1600 km-long bathymetric ridge feature that extends south from New Zealand. The ridge is important because it represents the submarine expression of the Pacific-Australia plate boundary and forms a barrier to the Antarctic Circumpolar Current. A multidisciplinary oceanographic, geological and biological survey of the Macquarie Ridge Complex was undertaken by the National Institute of Water and Atmospheric Research (NIWA) on the *RV Tangaroa* during the TAN0803 voyage of March-April 2008.

This study uses the bathymetric and backscatter data acquired simultaneously by the vessel's *Kongsberg* EM300 multibeam echosounder during the voyage. Bathymetry and backscatter data were subsequently processed using the software programs *Hydromap* and *SonarScope*, respectively. The resulting bathymetry and backscatter maps reveal the morphology and geologic structures of ten elevated seamount features along the Macquarie Ridge Complex.

Approximately 25 hours of video footage and 6000 still images of the seafloor acquired by the NIWA Deep Towed Imaging System (DTIS) have also been analysed. The images have been used to ground-truth morphological interpretations and identify different seafloor substrates. A geochemical and isotopic investigation of volcanic and plutonic rock samples from the seamounts will be undertaken in 2010 to further understand the geological evolution of the plate boundary.

The morphological and substrate mapping results provide a geological framework for some fundamental research regarding the maintenance of biological diversity and the distribution of seabed fauna south of New Zealand. Specifically, there are many questions surrounding the importance of seamounts as hotspots for biodiversity and potential stepping stones for the distribution of organisms between Antarctica and the Pacific Ocean. Such questions will be addressed in the future once biological data from the voyage have been fully processed.

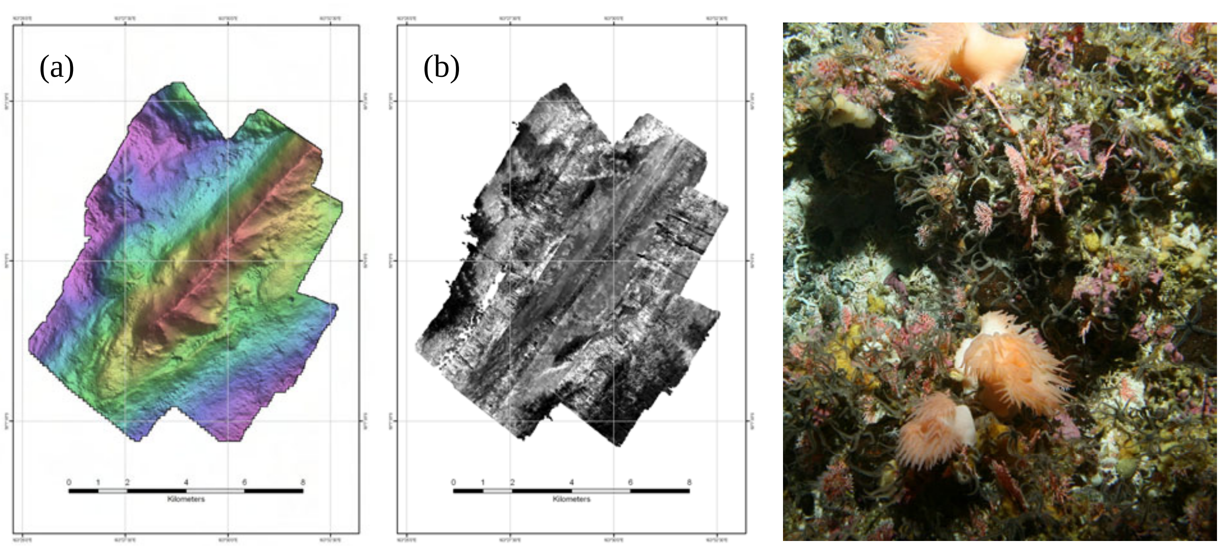


Figure 1. Bathymetry (a) and backscatter (b) maps for seamount 3 and an example DTIS image.

Phanerogame meadows: a characteristic habitat of the Mediterranean shelf. Examples from the Tyrrhenian Sea

Silvana D'Angelo and Andrea Fiorentino

ISPRA Institute for Environmental Protection and Research, Italy
Department for Soil Defense - Geological Survey of Italy

The Tyrrhenian sea is a deep basin developed as a back-arc episutural basin in a chain area originated by the Alpine and Apenninic orogenesis. The deeper areas are represented by the Vavilov and Marsili basins overlying an oceanic crust basement. It is surrounded by large slope-basins bordering the shelf.

The Italian continental shelf extension varies considerably. It can be extremely reduced, as it is along the Ligurian and Calabrian coasts, or wide and without a marked shelf-break, as it is around the Elba Island. Its average slope is approximately 1°. The sedimentary setting of each area varies according to the land geomorphology.

The characteristics of the coast also vary (22% is steep and rocky, whereas 78% is flat and sandy); however, phanerogame meadows develop in every setting. Among them *Posidonia oceanica* and *Cymodocea nodosa* are the most common species found in the Mediterranean Sea.

Posidonia oceanica represents a marine ecobiological system (biocoenosis) crucial for the Mediterranean Sea and its biosphere; it is protected by a law of the European Union (Council Directive 92/43/EEC). *Posidonia* meadows are considered habitats of Community interest (Site of Community Importance - SCI) and have priority in the protection strategies.

Posidonia meadows accommodate an abundant epiphyte community, composed of foraminifera, sponges, hydroids, serpulids, polychaetes, ascidians, bryozoans and several species of algae. It offers recovery to molluscs, gastropods, crustaceans, echinoderms and many fishes breed among its leaves.

Cymodocea nodosa is a typical pioneer species whose settlement prepares the substrate for less adaptive taxa such as *Posidonia*. It can tolerate anoxia and the presence in the soil of sulphurous hydrogen. Its leaves accommodate a community almost as abundant as that of *Posidonia*.

The relevant characteristics of this biocoenosis by an environmental point of view, beyond being an index of biological pollution, are: 1) Oxygen production, 2) Protection of the coast against erosion, 3) Biomass production, 4) Reproduction and protection of marine organisms, 5) Consolidation of incoherent seabottom.

Shallow-water marine geophysical surveying of the Bay of Islands and linked interpretation datasets

Bryan Davy[1]

[1]GNS Science, Lower Hutt, New Zealand

Imaging and interpretation of the shallow-water (< 30 m) seafloor and upper 20 m beneath the seafloor has made dramatic advances over the last decade with the development of high resolution marine geophysical survey technologies. Vertical resolutions of 0.2 m are now realisable for both seafloor topography using modern and portable swath bathymetry systems, and for sub-seafloor sedimentary horizon morphology using Chirp echo-sounders.

Sidescan and multi-beam imagery data enable characterisation of seafloor basin and outcrop composition while magnetic surveying provides constraints on sub-seafloor composition.

In early November 2009 GNS Science collected 220 line-km of Chirp seismic data and 170 km of magnetic data as part of the OS2020 study of the Bay of Islands. This data combined with swath bathymetry, seafloor imagery and boomer seismic data all collected by NIWA provides a multi-faceted interpretation of the seafloor and sub-seafloor in the Bay of Islands. Interpretations made possible by linking, for instance, surface information such as seafloor topography with cross-section information from seismic sections almost always provides a more comprehensive understanding of features than summing two isolated sets of interpretation.

Combining all the survey data sets into a 3-Dimensional visualisation package provides an intuitively simple link between the many datasets. With the imminent availability of swath bathymetry systems that can image features within the water-column, the approaching decade will see links established between subsurface sedimentary structure, seafloor habitat and overlying water-column contents.

A sense of what will be possible is provided by the high-resolution Chirp seismic data from the Bay of Islands where images of fish concentrations and ocean layer stratification can be linked to structure in the seafloor or the sub-surface beneath.

Predictive cold-water coral habitat mapping in the Western Mediterranean Sea

Ben De Mol, David Amblas, Miquel Canals, Galderic Lastras, Anna Sanchez-Vidal, Antonio Calafat, DARWIN CD178, EUROLEON, HERMESIONE shipboard party

GRC Geociències Marines Universitat de Barcelona/Parc Científic de Barcelona, Barcelona, Departament d'Estratigrafia, Paleontologia. i Geociències Marines Universitat de Barcelona / Facultat de Geologia Campus de Pedralbes, E-08028 Barcelona, Spain

Sclerectinian cold-water corals (CWC) have been reported in a wide distribution of settings and depths in the Western Mediterranean, but limited observations have been made of extensive living patches and thickets. Framework building corals *Madrepora occulata* and *Lophelia pertusa* have been reported in the Strait of Gibraltar and on seamounts/hills in the Alboran Sea as little thickets associated with dense layers of *Dendrophylia* sp. and *Desmophyllum* sp. On the flanks of canyon heads offshore Catalonia mainly *Madrepora oculata*, *Dendrophylia* sp. and *Desmophyllum* sp, have been observed.

In a first approach, a morphological classification of the continental slope and abyssal plain of the basin by multibeam data in 50-200 m girds have been made in order to identify sea-hills, steep slopes, representing low sedimentation environments or potential coral habitats.

In a second acquisition phase, well selected zones representing the potential CWC ecosystems (CWCE) are surveyed: canyons of the Catalan margin (Blanes, La Fonera, Cap de Creus canyon), the Djibouti bank in the Alboran Sea (including the Djibouti spur, Herradura, El Idrissi Bank and Little Djibouti bank) and the narrowest part of the Strait of Gibraltar by EM120 and EM1002 Swath bathymetry and backscatter imaginary, in combination with TOPAS parametric profiler. The data is acquired in equidistance mode and combine both sonars in order to generate 15m resolution grid over the depth interval of the case studies (15-2000m). The acoustically identified classes supervised morphology and non –supervised backscatter have been used for ground-truthing targets through sediment sampling, video and ROV transect.

In these complex morphological and sedimentological environments, the morphology of the seabed is the most dominant factor in the backscattering. A thematic map on the predicative supervised CWC distribution is generated based on the combined datasets in the case studies. In order to improve the acoustic mapping, oceanographic data have been collected and will be combined in the future to delimit the CWCE distribution more precisely. The coral distribution shows that they occur in areas with abrupt morphological changes, characterized by hard substratum, low sedimentation and in relatively shallow waters with influence of cold and fresher waters in the Western Mediterranean.

Alboran Seamounts, Western Mediterranean sea

Ben De Mol, David Amblas, Anna Sànchez, Antonio Calafat, Miquel Canals
and DARWIN CD178, EUROLEON HERMESIONE shipboard party

GRC Geociències Marines Universitat de Barcelona/Parc Científic de Barcelona, Barcelona, Departament d'Estratigrafia, Paleontologia. i Geociències Marines Universitat de Barcelona / Facultat de Geologia Campus de Pedralbes, E-08028 Barcelona, Spain

Seamounts, knolls and hills are prominent features of underwater topography in the Western Mediterranean region and especially in the Alboran Sea. By GIS spatial analyses the seahills have been catalogued and morphologically characterised based on available bathymetric datasets regridded to 500-200 m grid size. Additional superficial observations indicate a large dead benthic fauna of the cold-water coral *Dendrophyllia* sp (Algarrobo Bank), besides some dense colonisation of giant deep-sea oysters, associated with living and dead cold water corals *Lophelia pertusa* and *Madrepora occulata* (Chella Bank). It seems that *Dendrophyllia* sp. was widespread on the top and upper flank of the seahills during 5 ky (short relatively cold excursion in the Holocene) and 11 ky (Younger Dryas, cold period) and the last glacial maximum, associated with high primary production in the area (Barcena et al., 2001).
During the HERMESIONE -cruise with BIO Hesperides detailed data of the Djibouti bank (including the Djibouti spur, Herradura, El Idrissi Bank and Little Djibouti bank) have been obtained, by means of high resolution bathymetry mapping, backscattering analysis, superficial sediment sampling and a dense CTD cast grid in order to set the plot for more ecosystem research in this area. Swath bathymetry data in the Djibouti bank area were obtained using the EM120 and EM1002 at depths shallower than 650 m in combination of 33 CDT casts with a spacing of 2NM and 37 sediment samples for backscattering groundtruthing.

The seamounts display flat tops, peaking up at 207 m (El Idrissi Bank), 273 m (Herradura sur) and 422 m (Herradura little Djibouti bank), and rise ~400-600 m over the surrounding seafloor. The tops are characterised by minor ridges of rocky outcrops. Sediment cover on the top is in general thin and consists mainly of bioclastic coarse grain sediment. The seamount flanks are, up to 45º steep walls, with also smaller ridges, colonised with some corals. The micro-morphological classification in combination with the backscatter data has been ground truthed by grabsamples in order to get a sediment classification map. It illustrates that the corals prefer small narrow rocky ridges at the foot to the seamount.. his map of the present-day ecological parameters on the seamounts with cold-water coral occurrences is the start of studying the role of the seamounts in creating ecological hotspots in the Alboran Sea by changing climate.

Rocky reef in the central English Channel

Markus Diesing and Roger Coggan

Centre for Environment, Fisheries and Aquaculture Science (Cefas), Lowestoft, UK.

The English Channel is a tide-dominated shelf sea situated between France and England. The central region of the Channel is a low-depositional environment and previous to this study the seabed was generally perceived to comprise mostly lag gravel, with a few isolated rock outcrops. Our geophysical and biological analysis revealed an extensive reef system located 30 km south of the Isle of Wight (Figure 1) in water depths ranging between 40 m and 80 m below Chart Datum. The reef extends 100 km in east-west direction and 15 km in north-south direction, covering ca. 1100 km^2 of seafloor. The rock habitat supports a substantial coverage of fauna including sponges, bryozoans, hydroids and anemones. The area has been mapped to level 3/4 of the EUNIS habitat classification system, and is currently being considered as a Special Area of Conservation under the EU Habitats Directive.

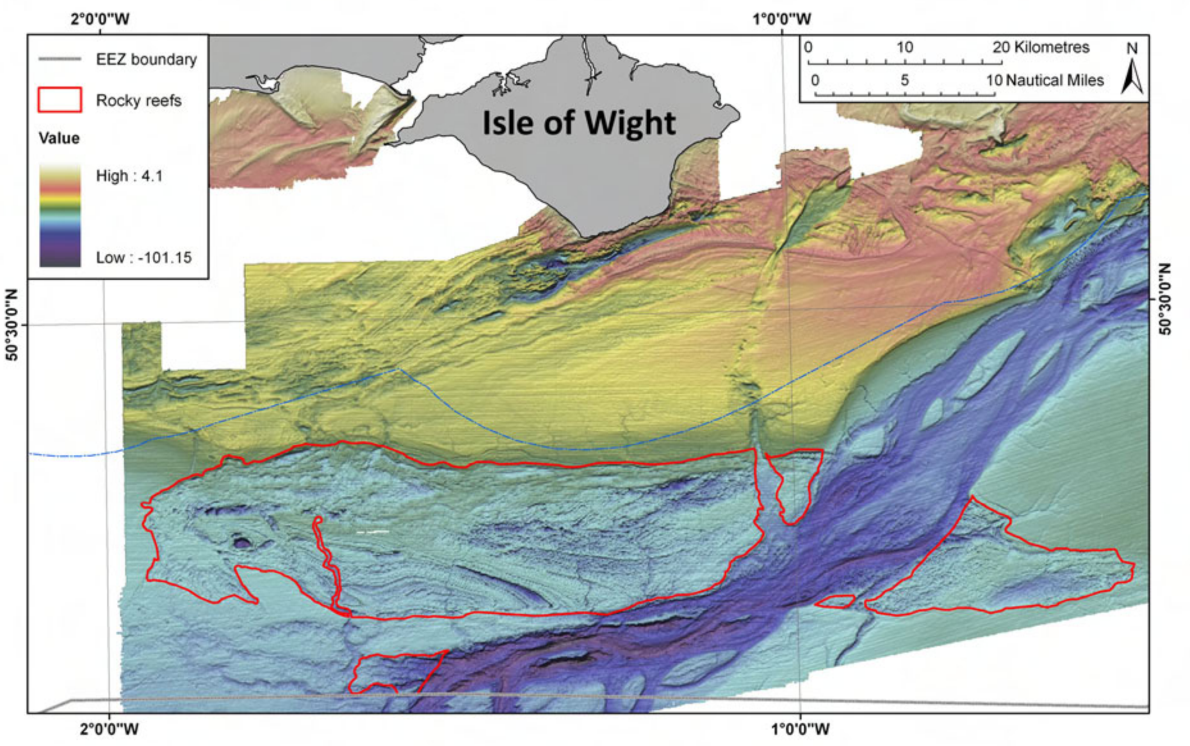


Figure 1. Mapped reef zones in the central English Channel.

Mapping and modelling seabed nature-types in Norway's MAREANO programme – lessons learned

Margaret F.J. Dolan[1], Pål Buhl-Mortensen[2], Kim Picard[1,3], Terje Thorsnes[1], Sigrid Elvenes[1], Valérie K. Bellec[1], Lene Buhl-Mortensen[2], Reidulv Bøe[1]

[1]Geological Survey of Norway (NGU)
[2]Insititute of Marine Research, Norway
[3]Geological Survey of Canada

Seabed nature-type (habitat) mapping is an important component of Norway's MAREANO mapping programme – www.mareano.no. Following initial trials on Tromsøflaket, a bank off the north coast, nature types are being mapped for the remaining MAREANO area across a range of spatial scales from landscape to ecosystem level. Within this MAREANO area we find diverse physical landscapes including extreme habitats such as canyons and submarine slide areas. This gives rise to diverse habitats and spectacular fauna including cold water corals, sponge communities, and deep water seapens. All nature-type (habitat) maps follow, and contribute to the development of the marine component of the Norwegian Nature Types (NiN) habitat classification system, and are published online at www.mareano.no when complete.

We report on progress in mapping, classification, modelling and prediction of nature types, focussing on the technical and practical lessons learned. At the landscape level we describe automated techniques used to help delineate landscape level features, while at the ecosystem level we discuss methods used to relate biological data with environmental information derived from multibeam derived data and geological interpretation. Through the use of case studies we examine results obtained from different classification and modelling approaches using GIS and other modelling software. We also compare maps based on field data with those based on more detailed video analysis which gives biological information at a lower taxonomic level. The relative merits of each approach will be discussed. Strategies for testing how good the resulting maps are will be discussed, together with challenges for conveying this information to end users and providing useful, useable maps.

The Influence of Physical Parameters on Benthic Communities – A Case Study in the Gulf of Finland, the Baltic Sea

Anna-Leena Downie[1] and Anu M. Kaskela[2]

[1] Marine Centre, Finnish Environment Institute, Helsinki, Finland
[2] Geological Survey of Finland, Espoo, Finland

There are still large gaps in the knowledge of the dispersion of benthic species and communities over large marine areas in Finland. Spatial analysis of existing data and marine habitat modeling has been used to fill in the gaps. Often the only spatial data available on substrates are marine geological maps. It is therefore essential to establish consistent links between biota and substrate, as well as the relationship between biologically relevant surface substrate and marine geological categories. The information of these connections is vital for future development of benthic landscapes (seascapes) and to ensure confidence in habitat distribution modelling.

Our aim was to investigate the structure of the benthic communities in our study area and to find connections with the physical environment, in view of using the data to model community distribution. We surveyed 40 sites in the Gulf of Finland using ROV and 50 sites using a Van Veen grab during the summer 2008. The sites represent a gradient from inside the sheltered archipelago to the open sea. The survey area is very diverse as the seafloor substrates and formations alter a lot within short distances. Thus sites were randomly located across varying substrates, depth and wave exposure. Video material was analysed to determine: (1) percent cover of substrates split into categories according to visually identifiable grain size; (2) percent cover of all visible and identifiable sedentary species; (3) relative abundance of indicators of infauna, such as empty shells and wormcasts; and (4) counts of mobile species. Substrate ratios in the Grab samples were visually determined. Abundance was recorded for each species in quantitative samples, and presences noted for species identified in qualitative samples.

We searched for significant community groupings in the two sets of biological data by running a cluster analysis in PRIMER with the SIMPROF estimate of significance for the clusters. These groups were visualized on MDS plots. We performed the same analyses for the substrate observations to establish how the sites grouped according to their substrate. We consequently compared the similarities of sites based on biota and substrate. The composition of substrate within the community types as well as the cluster classes derived from substrate were investigated. Surface substrate clusters were compared to marine geological categories. The results of this comparison were used to reclassify geological categories.

We expected that physical diversity would be reflected in ecology as variety of habitats and benthic species. We found five significant community types in both of the datasets. These communities were found to correlate well with the substrate. Not all clustered or marine geological substrate classes had significantly different biotas, but instead some could be grouped together. Combinations of the categories in marine geological maps can be used to predict biological communities in the Gulf of Finland. Of the other significant physical factors influencing the community composition and distribution, depth stands out as a major factor, which is also clear from the MDS plot. Wave exposure and distance from shore, which represent location on the archipelago gradient, were also found important.

Predicting Groups of Species: application of finite mixture models to species prediction

Piers K Dunstan[1], Scott D Foster[1,2], Ross Darnell[1,2]

[1]CSIRO Wealth from Oceans Flagship & CERF Marine Biodiversity Hub
[2]CSIRO Mathematical and Information Sciences

Statistically robust methods to simultaneously group and predict species in space are necessary to interpret multispecies ecological patterns and to manage ecosystems. Currently available methods of grouping are multi-staged and it is not clear how uncertainty is propagated. There is also no way of statistically determining the number of groups. We have developed a method of grouping species based on their response to physical covariates using finite mixture models. Species with similar responses to the environment are grouped together with minimal information loss. We have termed the groups 'species archetypes' as each group represents the responses of all the species within that group. Each archetype has a fitted glm model with parameter uncertainty and the appropriate number of archetypes can be determined using BIC or other information criteria. We demonstrate the application of the method on presence/absence data from fisheries surveys conducted in south eastern Australia. We modelled the responses of 100 species to 9 oceanographic and habitat gradients from 35^{o}S to 40^{o}S along the continental shelf and slope. We use the method to group species and predicted the archetypes into shelf and slope regions. The number of archetypes giving the lowest BIC was 10. The probability of presence of each archetype was strongly influenced by the variation in oceanographic gradients, principally temperature and oxygen and physical habitat variables, principally sand and gravel. The archetypes form ecologically reasonable groups. Species with known habitat preferences are placed in the same archetype. For example, gummy shark and latchet are known to occur in similar habitat and are grouped together using our method (Figure 1). This method has potential application to the analysis of ecological patterns and to ecosystem management.

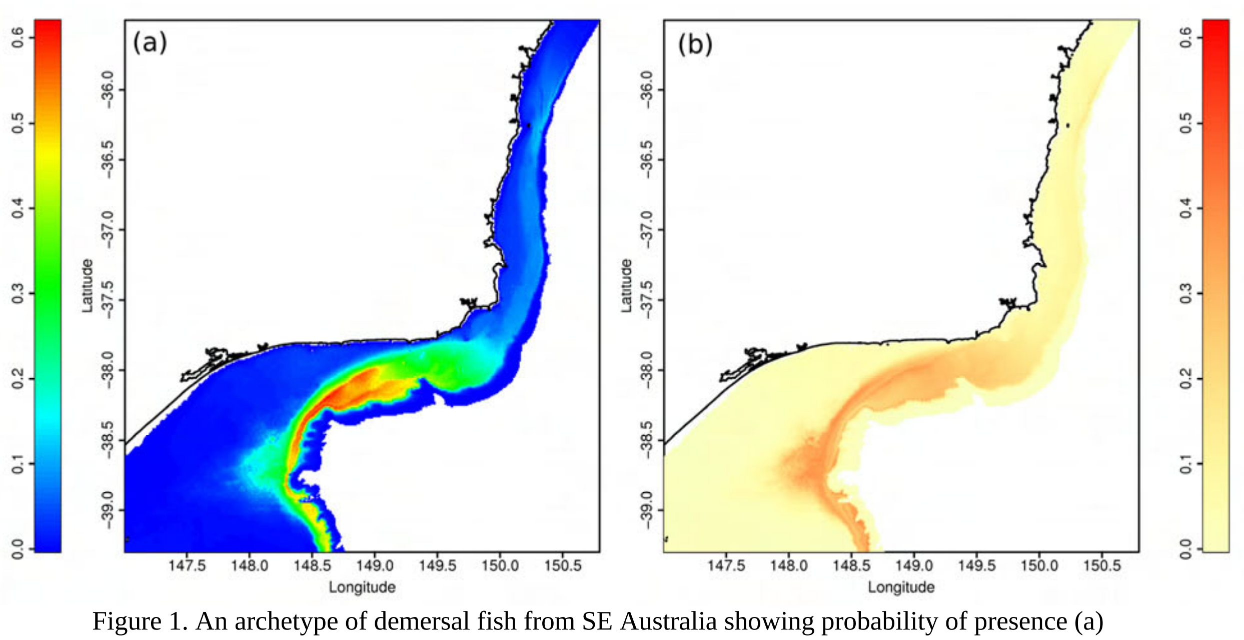


Figure 1. An archetype of demersal fish from SE Australia showing probability of presence (a) and uncertainty (b). This group includes gummy shark and Latchet.

Benthic habitats and benthic communities in South-Eastern Baltic Sea, Russian sector

Elena Ezhova[1], D. Dorokhov[1], V. Sivkov[1], V. Zhamoida[2], D. Ryabchuk[2] and O. Kocheshkova[1]

[1] P.P.Shirshov Institute og Oceanology, Atlantic Branch, Kaliningrad, Russia
[2] A.P. Karpinsky Russian Geological Research Institute, St-Petersburg, Russia

The Baltic Sea is an intracontinental shelf basin of the Atlantic ocean, located in a large depression inside the Baltic Shield and Russian plate of the East European Platform. Hence its shallow depths. The study area is the Russian sector of SE part of Gdansk Basin. In 2003-07 the area was sampled and mapped by A.P. Karpinsky Russian Geological Research Institute (sediments) and P.P. Shirshov Institute of Oceanology, Atlantic Branch (bathymetry and bathymetrical surface gradients, benthic communities). Digital maps were generated (bathymetric and bathymetrical surface gradients) using ArcGIS 9.2. Benthic quantitative data (1200 samples) collected by divers down to 15 m and grabs in deeper areas and lagoons. Slope map allowed to delineate four geomorphic features: **1 - Lagoon plain (LP)** is represented by the Baltic Sea two largest lagoons, the Vistula (VL) and Curonian (CL) lagoons. Both are very shallow (0-5 m VL, 0-6 m CL) with mainly soft bottoms, silt and mud prevail in the central part of the basins and differently-grained sand in the coastal zone. **2- Shallow water area (SW)** extends from 0-20 m in the south to 0-50 m in the north, over 2,700 km^2. Medium and fine sands prevail in the south, differently-grained sand, pebble and gravel in the north, bedrock and tillstones are presented in the centre. **3 - Gentle slope (GS)** borders the SW area and reaches 80-90 m depth, over 2,000 km^2. Muddy sediments dominate in the south, and fine and silty sand and in differently-grained sand, pebble and gravel occur in the central part. **4 - Deep water area (DW)** is the SE part of the Gdansk Deep, maximal depth is 107m, over 2,820 km^2 of muddy sediments. Benthic life in the study area is rather poor, 52 macrobenthic species were recorded, the most shallow (0-5 m) and deepest (>70 m) zones are depleted. Biomass ranges from 0.75 to 3077 g/m^2 depending on depth, bottom characteristics and hydrology. Four main bottom communities were distinguished, mainly with bivalve predominance: 1. *Mya arenaria* communities (av. biomass 606 g/m^2) occupies ca.15 % of SW area where water-bottom surface is enriched by thin sediment fractions. 2. *Mytilus edulis* community (1065 g/m^2) are recorded in **SW** area, its presence correlates with bedrock, tillstones, pebble and gravel beds 3. Poor community of spionid polychaetes *Pygospio elegans* and *Marenzelleria viridis* (7 g/m^2) were recorded in the SW areas in connection with fine sand. 4. *Macoma balthica* community (152 g/m^2), typical in the study area, occupies 50 % of SW area on sandy beds and most all **GS** and **DW** areas, excluding bottoms >76-80 m, where benthic animals are absent. **LP** is inhabited by uniform soft bottom communities: Chironomidae+Oligochaete (>70 % of bottom) in the Curonian Lagoon and polychaete worm *Marenzelleria neglecta* (90%) in VL. Communities, dominated by invasive species occupies not numerous hard substrata in both basins: Ponto-Caspian bivalve *Dreissena polymorpha* (CL) and New Zealand snail *Potamopyrgus antipodarum* (VL).

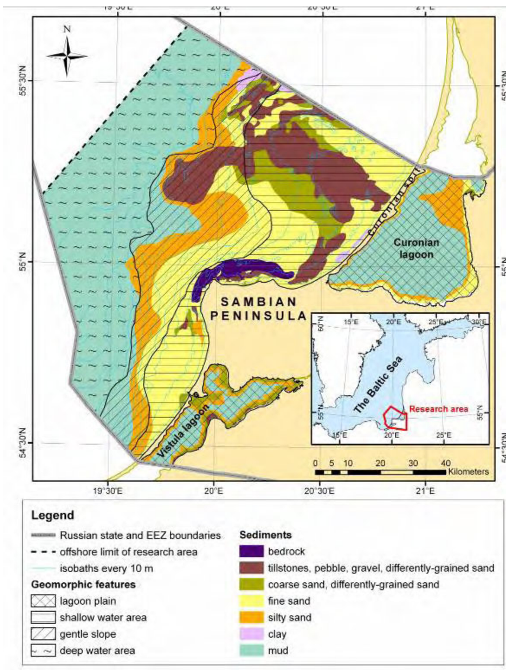


Figure 1. Large-scale geomorphic features and sediments of Russian part of Gdansk basin of the Baltic Sea

Move towards area based backscatter processing to support benthic mapping

Christian Fellinger[1] and Corey Collins[2]

[1]CARIS Asia Pacific, Adelaide, Australia
[2]CARIS, Fredericton, Canada

Over the past few years the interest in the different types of backscatter information obtained from Multibeam Echosounder (MBES) systems has increased. One reason for this is that the availability and quality of the backscatter information and the tools to process this have improved significantly.

The acoustic backscatter of MBES systems, as well as that of side scan sonars, carries important information about the seafloor and its physical properties. This information provides valuable data to aid in seafloor classification and benthic mapping, and important auxiliary information for a bathymetric survey.

A necessary step towards this characterization is the creation of a consistent and reliable mosaic of the acoustic backscatter. For this, it is necessary to carry out radiometric corrections, geometric corrections and mosaic blending on the acoustic backscatter. Tools for this can be found in Geocoder algorithms.

Geocoder's strengths are in its array of detailed backscatter corrections and its accurately modeled seafloor characterization algorithms. The challenge then is to blend these capabilities into a coherent workflow.

In this paper a new approach to backscatter processing is discussed. The workflow includes the use of the available bathymetry from MBES systems and Geocoder to process backscatter information to generate consistent mosaics and for the analysis of sediments in support of benthic investigation. The focus is on moving from line by line processing to an area based approach.

Towards Automated Classification of Benthic Environments using Rugosity, Slope and Aspect from Bathymetric Stereo Image Reconstructions

Ariell Friedman, Oscar Pizarro, Stefan Williams

Australian Centre for Field Robotics, The University of Sydney, Australia

Benthic monitoring programs that use towed platforms or Autonomous Underwater Vehicles (AUVs) to collect optical imagery produce vast, rapidly growing volumes of data. This data needs to be abstracted into information that is relevant to scientists and end users. Given the onerous, time consuming nature of human data interpretation, automated techniques are required for efficient and effective analysis.

Most attempts at image-based automated habitat classification use features extracted from monocular images to derive descriptors that can be fed into clustering or learning algorithms. Their success, however, depends on the explanatory power of the descriptors used, which are ultimately limited by the 2D nature of the images.

Simple habitat complexity indices, such as rugosity are often used as a proxy for marine biodiversity. Rugosity is typically collected *in situ* by divers using chain-tape methods or profile gauges. This approach is labour intensive, depth limited and puts humans at risk. An AUV capable of high precision navigation and equipped with stereo cameras can recover bathymetry at fine resolutions over relatively large, contiguous extents of seafloor. The geo-referenced stereo imagery can then be used to generate detailed 3D bathymetric reconstructions with the potential to combine interpretations based on 3D structure and visual appearance.

Our approach uses the 3D triangular meshes generated using data collected by the AUV *Sirius* to automatically generate measures of terrain complexity in the form of rugosity, slope and aspect. We present a brief outline of how multi-scale rugosity, slope and aspect are calculated from stereo surveys and explore the ability to distinguish habitat types based on these measures. Using data gathered from a number of sites around Australia, we present classification results from real datasets which cover several linear kilometres consisting of thousands of images. These results present, to our knowledge, the first use of fine scale habitat complexity measures for automated benthic habitat classification over a large extent and beyond diver depths. Figure 1 shows sample results from a dense AUV grid completed in Scott Reef off Western Australia.

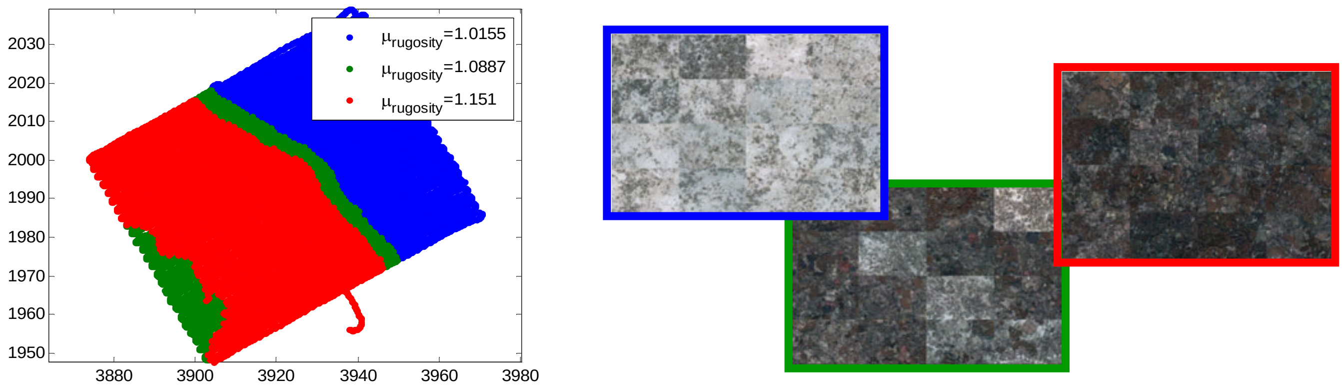


Figure 2: Spatial representation of classification results for a dense AUV grid (50 m × 75 m, 9,831 stereo image pairs) completed in Scott Reef off Western Australia. Using K-means clustering to form 3 classes, these results show the ability to discriminate sand (blue) from reef (red) from the boundary between the two (green), based solely on rugosity calculated from stereo-reconstructed bathymetry using a window size of approximately 1 m × 1 m.

Quantifying trawling impacts on deep-sea ecosystems using ROV video and scanning-sonar data

Maeva Gauthier[1], S. Kim Juniper[1], J. Vaughn Barrie[2], Rosaline R. Canessa[1], and James A. Boutillier[3]

[1] University of Victoria, Victoria, British Columbia (BC) Canada
[2] Natural Resources Canada, Pacific Geoscience Centre, Sidney, BC Canada
[3] Fisheries and Oceans, Pacific Biological Station, Nanaimo, BC Canada

The impacts of trawling on deep-sea ecosystems can vary depending on habitat types and species present. While cold-water corals on hard substrata are known to be severely affected by trawling, there have been few studies of trawling impacts on the diverse soft substratum communities that cover large areas of continental shelves and slopes. For these communities, habitat factors such as depth and bottom roughness (geological and biological) also affect diversity and composition; thereby confounding observation of any effects of trawling. We studied a 14 km transect along the upper continental slope (350-650 m depth) off Vancouver Island, BC, Canada that included areas of seafloor with visible trawl marks. Field data collection used the ROV ROPOS equipped with a 3CCD video camera and a high resolution scanning sonar. Faunal composition and abundance together with bottom characteristic information were extracted from video imagery and assembled using a custom-designed Access database. The same database was used to compile information on trawl marks detected in recorded sonar imagery. The sonar surveyed a 50 m radius around the submersible during transects, providing a broader view of evidence of trawling in the area. We will report on relationships between intensity of trawling and faunal abundance, diversity and species distribution.

Figure 1. Boulder covered with sea anemones, sessile holothurians, and ophiuroids along ROV transect off Vancouver Island, Canada (450 m depth).

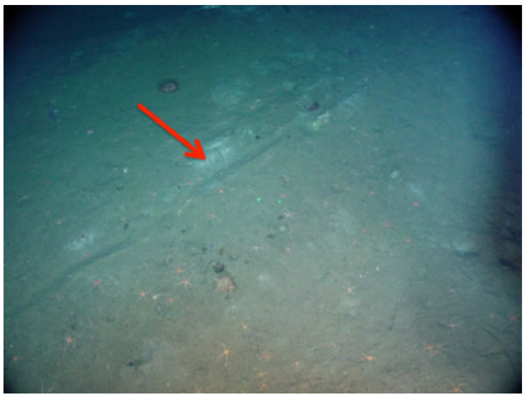


Figure 2. Trawl door mark in sediment along ROV transect. Ophiuroids, echinoids, holothurians, and sea anemones also visible.

Deriving "mappable" biological assemblages from underwater footage using classification tree models

Genoveva Gonzalez-Mirelis[1] and Mats Lindegarth[1]

[1]University of Gothenburg, Strömstad, Sweden

Spatially-explicit predictive models are relied upon for the estimation of the values of variables, commonly the presence of a given species or habitat, in locations for which no observations exist. The approach is welcome by the map-making community, as it allows to fill in the blanks and produce full-coverage maps of various entities of biodiversity. The mapping of remote habitats, such as those on the seabed, particularly benefits from this approach. However, decisions made along the way greatly affect the nature of what is eventually mapped. When the focus is placed on the biological community level (i.e., groups of species which tend to be found together, also referred to as assemblages), a widespread approach is "classify first, then predict". In this approach, a numerical classification technique is applied to the biological, survey data so that levels of similarity between sites can be calculated, and a classification of assemblages can then be derived. This classification is subsequently used to label the surveyed sites. The predictive model comes in to help predict the labels of unsurveyed locations, and ultimately, every single pixel across the area under consideration. The choice of the classification scheme, then, determines what will be depicted on the final map of spatial predictions.

This paper examines a novel method to derive a classification scheme of benthic assemblages that avoids arbitrary choices (such as the cutoff level of a dendrogram) and makes use of both biological data (obtained from ROV video) and environmental variables (depth, along with a suite of terrain variables). Classification trees are used here as a tool to find structure in a highly complex dataset, to gain insight into the question of how to derive a classification scheme of biological assemblages that makes ecological sense.

The models are used to compare the predictability of classes under various hierarchically-nested classification schemes. Intermediate levels (with numbers of classes between 9 and 20) were, as had been postulated, more successful than all others, with the 9-class classification scheme being the single best. Notably, some assemblages were easily predicted across hierarchical levels, while others popped up as strongly structured at different levels of the hierarchy. In general, deeper habitats (depth>45m) revealed themselves as more heterogeneous, only predictable when classified at the finer levels. The implications of mapping biodiversity at the assemblage level are discussed.

Outer Shelf Rocky Habitats of Alaska

H. Gary Greene

Tombolo/SeaDoc Society, Orcas Island, Washington, USA (tombolo@centurytel.net)

The outer continental shelf of Alaska is occupied by many rocky habitats that are excellent fishing grounds for commercial demersal shelf rockfish (DSR) and other bottomfishes. DSR, a seven species management complex of deep-water (20-120 m) rockfishes, including yelloweye rockfish (*Sebastes ruberrimus*) canary rockfish (*S. pinniger*), china rockfish (*S. nebulosus*), copper rockfish (*S. caurinus*), quillback rockfish (*S. maliger*), rosethorn rockfish (*S. helvomaculatus*), and tiger rockfish (*S. nigrocinctus*), as well as lingcod (*Ophiodon elongates*), are found in rugged and highly rugose geomorphologic features. These geomorphic features, such as Fairweather Ground (shown below) result from the active tectonic history of this oblique convergent and transform plate margin and are comprised of volcanic cones, elevated plutonic and metamorphic rocks, and deformed and differentially eroded sedimentary units. Much of the inner shelf parts of these rocky habitats have been altered by glaciation, which has generally smoothed the rugged relief of the outcrops thus destroying the rugosity that provide good habitat for DSR.

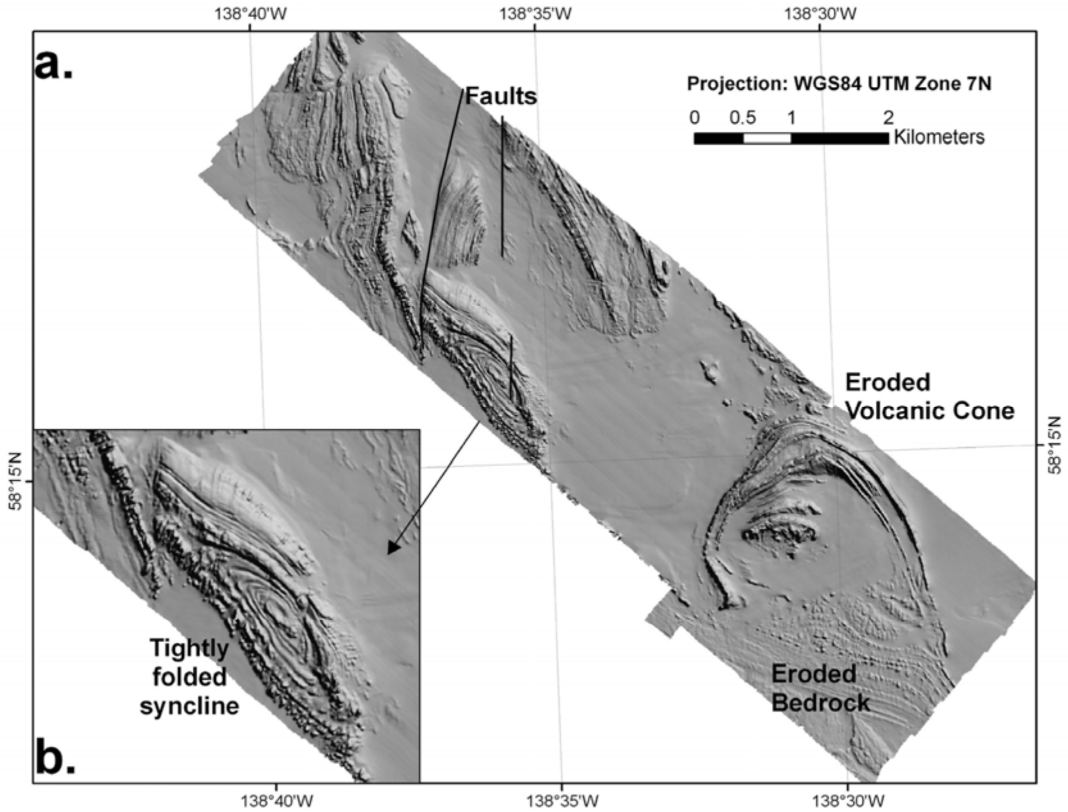


Figure 1. Outer shelf rocky habitat of SE Alaska, USA. This is the western bank of Fairweather Ground, a major commercial DSR fishing area (Reson 8111 image).

Deep-Water Forage Habitats –
The Next Step Forward in Marine Benthic Habitat Mapping?

H. Gary Greene[1], J. Vaughn Barrie[2], Tina Wyllie-Echeverria[3]

[1]Tombolo/SeaDoc Society, Orcas Island, Washington, US
[2]Geological Survey of Canada – Pacific, Institute of Ocean Sciences, Sidney British Columbia, Canada
[3]Wyllie-Echeverria Consulting, Shaw Island, Washington, USA

With the worldwide decline in many species of fish, birds and mammals and the advancement in seafloor acoustic technologies it appears that we are at a stage where the characterization of deep-water (30-100 m) marine benthic forage habitats with regard to their role in the lives of forage fish is possible. These habitats provide shelter for forage fish that are food for many of the declining species. For example, forage fish such as Pacific sand lance (*Ammodytes hexapterus*) and sandeel (*Ammodytes marinus*) serve as the primary link between zooplankton and higher order predators, and are a vitally important food source for many species of birds, marine mammals, and fishes. The burying behavior, recruitment rates and conditions, relative abundance and distribution, population structure, local spawning habits, and spawning and burying substrates remain largely unknown for Pacific sand lance (PSL). A disjunction occurs between the abundance of sand lance and the availability of known habitat, especially in deep water. Sand lance are dependent upon benthic sediment habitats to bury into and, therefore, this species is most often associated with fine- to coarse-grain sand- or gravel-oxygenated sediments and have been found to occupy dynamic bedforms such as sand wave fields.

In the Pacific Northwest of the US and Canada we have been investigating potential deep-water PSL habitats. We will report upon the quantification of the seafloor physical characteristics of dynamic bedforms that harbor PSL and discuss a predictive geomorphic model that can be used to identify potential PSL habitats in deep water (>30 m) using multibeam echosounder (MBES) bathymetric and backscatter images, seafloor sediment samplers, and video observations. Since little is known about PSL deep-water habitat, it is critical that specific characteristics be obtained to produce metrics by which areas of significant aggregation can be identified and managed. In addition, we will discuss preliminary characterization of gray whale foraging habitats off the west coast of the US where MBES data shows extensive feeding marks or depressions.

A Classification of Coastal Inlets Using Geophysical Information to Define Representative Types and to Assess Existing Protected Areas

Michelle Greenlaw[1] and John Roff[1]

[1]Acadia University, Wolfville, NS, Canada

Selection of candidate sites for designation as Marine Protected Areas (MPAs) in coastal waters still involves many arbitrary choices. Analysis of candidate sites, according to a combination of geophysical and ecological criteria, can lead to the recognition of representative coastal areas, and potentially reduce the arbitrary nature of these decisions. In coastal areas, estuaries have long been classified according to their geophysical properties. While bays and coves are as diverse (or more) in character, existing classifications are dependant largely upon descriptions of the benthic communities themselves and take little advantage of existing hydrographic and digital geographic information.

This thesis presents a classification of coastal marine inlet types designed to predict biological community patterns, including specific community types and α and β-diversity patterns. The classification is based on GIS analysis of existing digital hydrographic and associated data, and uses fuzzy cluster analysis to deal with uncertainty and intermediate types in the classification. This fuzzy inlet classification method was applied to Nova Scotia's Atlantic shoreline although this method could easily be applied globally to determine which inlet types are naturally repeating in each region of interest. On Nova Scotia's Atlantic shoreline, inlets fall into three primary categories and 17 recognizable inlet types, with intermediates quantified using a fuzzy classification.

Inlet types identified were then compared to the current and proposed protected areas along the Nova Scotia Atlantic shoreline to determine how well each inlet type is represented in the current and proposed protection scheme. Only 2% of the area of inlets on the Atlantic shoreline of Nova Scotia is currently protected, although 14% of the shoreline length is protected. The intermediate benthic estuary type was the only inlet type that was well protected (according to IUCN conservation objectives of 10%), with 58% of its area protected under the current protection scheme, while ten of the inlets had over 10% of their shoreline protected. Proposed protected areas (DFO's Ecologically and Biologically Significant Areas) are currently biased towards large bays and estuaries.

A comparison of grouping structures for ground reference data at Aldabra Lagoon, Seychelles

Sarah Hamylton, Annelise Hagan and Tom Spencer

Cambridge Coastal Research Unit, Department of Geography, University of Cambridge, UK

Effective use of remotely sensed data for mapping relies on establishing a robust relationship between the spectral makeup of the signal recorded by the sensor and the feature of interest on the ground. Interpretation of image classification in line with datasets collected *in-situ* is necessary for *i*. training algorithms to identify pixel clusters in feature space as belonging to a given cover type, and *ii.* assessing the accuracy of classification outputs. Spatial coordinates serve as a means to link the two frames of reference. Clustering algorithms are commonly used to group field data (records of ground cover collected *in-situ*) into a classification scheme in order to define map classes. Image classification algorithms that form the basis of most remotely sensed mapping methodologies group continuously varying numerical data on the basis of the spectral characteristics of different surface materials. However, interpretations that link the two methodologies implicitly assume that the grouping structure imposed through clustering (on the basis of ecological metrics) can be directly cross-referenced against groupings delineated by the remote sensing classification.

Four hundred and eighty seven records of the tropical shallow marine benthic community were obtained from the lagoon of Aldabra Atoll, southern Seychelles. Underwater video and photo records were subjected to a community-clustering algorithm, which resulted in the identification of six habitat groups. An unsupervised classification was performed using a maximum likelihood parametric rule on pre-processed Quickbird imagery, which also divided the Aldabra lagoon into six benthic cover groups. The extent to which the methods of grouping the data assigned consistent group memberships was subsequently established by matrix correlation. Ungrouped datasets correlated more strongly than grouped ones, suggesting that comparisons between field and image datasets are more valid when ground reference data are treated as continuous in character, rather than when groupings are identified.

Seabed mapping for Australia's energy security

Andrew D. Heap[1], Rachel Przeslawski[1], Scott Nichol[1], Lynda Radke[1],
Chris Battershill[2] and Stephen Whalan[2]

[1] Geoscience Australia, GPO Box 378, Canberra, ACT 2601
[2] Australian Institute of Marine Sciences, PMB 3, Townsville, Qld 4810

Geoscience Australia and the Australian Institute of Marine Science are conducting seabed mapping surveys in northern Australia to generate regional baseline information on seabed environments. The data are being made available to Australia's offshore oil and gas industry to assess the wider significance of planned infrastructure developments designed to bring on regional gas reserves. In 2009 the first of these surveys focused on the Van Diemen Rise, a series of submerged carbonate banks and channels on the tropical, macrotidal northern Australian shelf. Geological and biological data were obtained to characterise the seabed environments and investigate surrogacy relationships. A total of 1,154 km^2 of multibeam sonar data and 340 line-km of shallow (<100 mbsf) sub-bottom profiles were collected in four study areas on the Van Diemen Rise covering the outer to inner shelf. The data reveal a relatively complex seabed geomorphology comprising banks, terraces, plains, ridges, and deep/hole/valleys. Environments in a valley >200 m deep, which is the second deepest known channel on northern Australian shelf, were mapped for the first time. Acoustic scattering occurs in the water column above pockmarks on the inner shelf although the cause of this is unknown. Sub-bottom profiles reveal a relatively complex sub-surface geology dominated by multiple northward dipping strata that are expressed as terraces, banks and ridges on the surface. Fluid escape features are observed beneath the pockmarks. Samples collected from 63 stations indicate that the banks, terraces and ridges are characterised by partially-cemented coarse carbonate sands supporting species-rich sponge and octacoral communities. The presence of extensive Lithistid reefs is in contrast to the *Halimeda* and scleractinian coral dominated banks and reefs on other parts of the northern Australian shelf. These 'stony sponges' are an old group and tend to cement reefs. The plains and deep/hole/valleys are dominated by muddy fine to medium carbonate sands containing abundant polychaetes and crustaceans. The survey data will be combined with regional datasets to provide a synthesis of seabed environments for the northern Australian shelf. Follow-up surveys are planned for August 2010 and late 2011 to progress the development of a regional model for the origins and evolution of the shelf environments to support industry activities.

Environmental classifications, acoustic remote assessment and ecosystem valuing

Judi E Hewitt[1], Joanne Ellis[2], David Bowden[1], Ian Tuck[1]

[1]NIWA, New Zealand
[2] Crydium Group Ltd, St John's, Newfoundland, Canada

A key question for environmental managers is whether classifications, developed from environmental data and broad-scale mapping tools, are able to capture aspects of ecosystems important for valuation and conservation. Such aspects include biodiversity and ecosystem function at a variety of spatial scales. Possibly this question is most important for marine systems due to the difficulties in mapping broad-areas and the shorter history of research. In New Zealand, as in many other countries, effort has recently been placed into developing an environmental classification covering the EEZ and beyond, and in mapping large areas with acoustic techniques. Here we examine whether strong links exist between classification levels, acoustic habitats and macrobenthic biodiversity and function in a number of different marine systems, from shallow coastal areas to the deeper continental shelf (1200m).

Reef fish spawning aggregations and seafloor characteristics in the Caribbean

William D. Heyman[1] and Shinichi Kobara[1]

1Texas A&M University, Texas, U.S.A.

Reef fishes play important roles in the health of coral reefs and associated ecosystems. Most commercially-important reef fishes such as grouper and snapper in the Caribbean travel relatively long distances over days or weeks to the aggregation site for spawning during a very specific time, often a portion of one or two months of the year, and are considered “transient” spawning species. Occasionally, several species were observed to share their spawning sites with others at different season. Because of this specific biological feature, transient reef fishes have been overfished, in many cases at their spawning aggregation sites, and are currently endangered or have dramatically declined. Based on anecdotal information about the timing and location of several reef fish spawning aggregations (FSAs), we attempted to evaluate if there exists a common geomorphological signature among FSA sites.

The specific goals of the study were to: (1) map the seafloor at historically known grouper and snapper spawning aggregation sites in three different countries, and (2) characterize quantitatively the geomorphology of the sites, including bottom depth at spawning sites, distance between spawning sites and shelf-edges/reef promontory tips, and the shortest distance between the spawning sites and 100 m water depth. These data were field-collected with a global positioning system (GPS) and eco-sounder that provided latitude/longitude and depth.

This study revealed that all 13 known and 1 previously-unknown transient reef fish spawning aggregation sites in Belize and 5 known sites in the Cayman Islands were all located at convex-shaped seaward extending reefs (reef promontories) jutting into deep water, within 1 km of reef promontory tips. All of the studied FSA sites occurred less than 550 m from the tip of reef promontories, and within 100 m of shelf edges. Sixteen of the 19 sites were documented as multi-species spawning aggregation sites, providing spawning habitat for a variety of large, commerically-important grouper (Serranidae) and snapper (lutjanidae) species. These general characteristics were used to predict an undiscovered multi-species spawning aggregation in Belize. A successful prediction in Belize, together with the compiled data from multiple sites indicate: 1) reef promontories are vital locations for transient reef fish spawning aggregations, 2) three-dimensional information and analysis are necessary to locate grouper and snapper FSA sites, and 3) this study provides a potential tool for not only design for marine protected areas but also prediction of unknown spawning sites throughout the wider Caribbean.

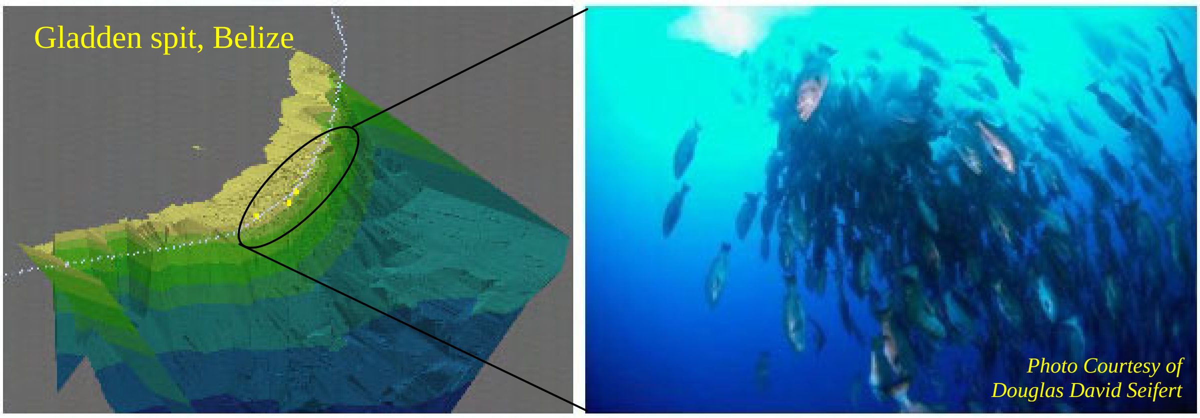


Figure 1. The multi-species spawning aggregation site at Gladden Spit, Belize. The curved line represents the shelf edge line ~ 30 m, derived from classification of Landsat imagery. The points represent fish spawning aggregation sites for various species.

Dynamics of benthic patch structure across two seasons in a coastal embayment

Zhi Huang, Lynda Radke and Matthew McArthur

Marine and Coastal Group, Geoscience Australia

Recognition of patterns in the spatial and temporal variability of soft-sediments is essential to understanding the processes that contribute to species diversity in these systems. This study, as part of the Surrogates Program in the Commonwealth Environmental Research Facilities (CERF) Marine Biodiversity Hub, investigated changes in the biogeochemistry, sedimentology and infauna of soft-sediments in Jervis Bay (New South Wales, Australia).

Marine surveys were conducted in June 2008, August 2008 and February 2009 to collect a full coverage of multibeam bathymetry and backscatter data and samples for geochemical (chlorophyll *a*, total sulphur, benthic mineralization rates, and available bioactive elements), sedimentological (%mud, sorting, and %bulk carbonate) and infauna analyses. A predictive model of Boosted Decision Tree (BDT) using the bathymetry, backscatter and derived morphological and textural variables as explanatory variables, and the spatial interpolation technique of Cokriging using the sample depth as the secondary variable, were used to generate continuous geochemistry and sediment layers from these samples. The predicted spatial distributions of these variables were reasonable with the cross-validation accuracies ranging from 29% to 77% variances explained. The individual layers were then classified into 2-3 categories using a fuzzy classification approach, and separate habitat maps for geochemistry and sedimentology were generated by combining the classified maps. Final habitat maps, which integrated both sedimentology and geochemistry, were then derived.

The inter-seasonal comparisons indicate that the geochemistry variables underwent substantial changes, while seasonal differences for the sediment variables were minor. Focal variety analyses of the final habitat maps show that the most physically diverse areas were mainly found near the centre of the study area, especially between the 20 and 25 metre contours in the summer. Indeed, the 20 m depth contour was a productivity hotspot noted for relatively higher benthic mineralization rates and chlorophyll *a* concentrations. Overlaying of the existing broad habitat map on the focal variety maps indicates that polychaete hummocks were the most physically diverse. This is mainly due to geochemical patchiness. Various biodiversity measures calculated for the infauna samples were evaluated against the physical diversity maps. The results show notable relationships between biodiversity and physical diversity. Redox variations appear to influence some of the patterns we observed. In summary, the approach used here can be used in other soft sediment systems.

A picture on the wall: 3D habitat mapping in deep-sea canyons

V.A.I. Huvenne, D.G. Masson, P.A. Tyler, V. Hühnerbach and the ISIS ROV Team

National Oceanography Centre, Southampton, UK

Submarine canyons form the main transport pathways between continental shelves and the deep sea. They provide a very heterogeneous environment, breaking the monotony of the continental slope, and therefore form true ecosystem hotspots. However, they are also notoriously difficult to study. Their steep terrain makes the use of conventional sampling and surveying techniques difficult or inadequate. Furthermore, the enormous heterogeneity in the terrain results in a much larger habitat patchiness than commonly found along the continental slope, which means that survey, mapping and sampling activities have to be carried out at an even higher resolution to fully capture the nature and variability of the terrain.

However, recent discoveries have shown that, although deep-sea canyons are generally considered as important habitats, their true value has been underestimated so far. The richest communities of sessile fauna seem to occur on near-vertical cliffs and under overhangs, where they are protected from excessive sedimentation and from potential human impacts such as fishing, but where they are also seldom discovered. Increased use of ROV video surveying has revealed the presence of these communities, but their spatial structure is still difficult to assess.

Here we present the first results of a new technique to map the habitats associated with overhangs and cliffs in complex deep-sea terrains. During the recent cruises JC035 and JC036 an extensive survey was carried out over the Whittard Canyon, Celtic Margin, NE Atlantic. The four main branches of the system were mapped with 30 kHz TOBI sidescan sonar and EM120 shipborne multibeam bathymetry, after which dives with the UK ROV *Isis* were used to ground-truth the features and backscatter patterns, and to distinguish different faunal assemblages. One dive site consisted of a 120 m high cliff at ca. 1400 m water depth, covered with a mature cold-water coral ecosystem, including all the associated fauna known from, for example, large cold-water coral banks offshore Ireland. To establish the spatial structure and distribution of the coral habitat, we placed the ROV multibeam system on the front of the vehicle and mapped the cliff at different distances, flying the ROV in traverse.

After the development of an adapted processing routine, taking into account the navigation and attitude of the vehicle in a rotated coordinate system, the results provided a series of nested maps with increasing detail, illustrating the geological structure, stratification and differential erosion of the cliff, plus the distribution of the cold-water coral frameworks and their association with certain strata. High-resolution photo transects allow the identification of the macrofauna, and comparisons in terms of faunal assemblages with the Irish cold-water coral mounds will be carried out. Further genetic studies will have to clarify the potential relation between the Whittard Canyon and other cold-water coral communities along the NE Atlantic margin, but it is expected that several overhangs and steep cliffs in canyons, uncharted so far, may provide a refuge (e.g. from human impacts) for fragile ecosystems. A more systematic mapping of these terrains may lead to new insights in species distributions.

Habitat heterogeneity in deep-sea canyons offshore Portugal

V.A.I. Huvenne, A.D.C. Pattenden, D.G. Masson, P.A. Tyler

National Oceanography Centre, Southampton, UK

Acting as main transport pathway between the continental shelf and the deep sea, submarine canyons provide a range of habitats for a diverse fauna. This study presents Nazaré Canyon, one of the main submarine canyons offshore Portugal. Over 200 km long and up to 1600 m deep, Nazaré Canyon is not connected to a major river system. Sediment input is through the interception of longshore transport.

The canyon was surveyed using ship-borne and ROV-borne multibeam, 30kHz sidescan sonar and video footage. High terrain heterogeneity is the main cause of the observed patchiness in benthic communities. The fauna is dominated by filter-feeders, especially in the upper and middle canyon, where most of the steeper terrain is found. Deposit feeders are dominant on sedimented terraces in the middle canyon, and in the lower canyon. The thalweg axis is generally devoid of fauna, due to the repeated disturbance and high current velocities.

Combining varying resolution survey data to produce a robust deep seabed classification

Colin L. Jacobs[1], Lucy Porritt[2] and Kerry Howell[3]

[1]National Oceanography Centre, Southampton, United Kingdom
[2]University of British Columbia, Vancouver, Canada
[3]University of Plymouth, Plymouth, United Kingdom

The whole of the United Kingdom's claimed deep water (>200m) territory in its northwest approaches has been the subject of a broad geology, geomorphology, process and substrate-type seafloor classification. This was a very large area (>350,000 km^2) that had yet to be fully surveyed to modern standards, however, pressing requirements for marine spatial planning and MPA selection meant that a pragmatic approach had to be taken and the classification was based upon existing interpreted acoustic and other deep water datasets. Survey data resolution varied from >500 m pixels (in GLORIA long range reconnaissance sonar data) to sub-metre pixels (high resolution sidescan). We assigned each different type of data used in the study a "Confidence" that was aligned to a combination of the acoustic resolution, the navigation system accuracy and any ground—truthing. This approach allowed us to produce, at a broad scale, a classification scheme that was both of significance for benthic ecology and gave downstream users an indication of the confidence of the classification. The product of our work was a 5-layer GIS overview, using "**Confidence**" (data quality), "**Physiography**" (primarily to help policy makers and other non-marine specialists), "**Substrate**" (surface sediment types), "**Deposit**" (to indicate active processes such as contourite, debris flow deposit etc), and "**Modifiers**" (such as iceberg ploughmarks) to show whether or not the substrate and deposits have been further perturbed. Expert interpretation of the acoustic data lay behind the identification of each classification unit, with the highest resolution data being used where possible to guide lower resolution data interpretations. The approach taken, of combining all available datasets without regard to the differing resolutions, and assigning varying levels of confidence to the interpretations from the different data sets, has so far we believe been unique. The classification results have been stored and are displayed as a series of Geographical Information System (GIS) overlays so that end users (planners and policy makers) can view the classified layers and gain an insight into the level of confidence with which the boundaries of, and sub-divisions within layers have been defined. Further, the use of GIS has allowed for the entire area to be classified without data gaps so the results can relatively easily be fed into automated 3rd party spatial planning software.

Open shelf valley system, Northern Palaeovalley, English Channel, U.K.

Ceri James[1], Bryony Pearce[2], Roger Coggan[3] and Angela Morando[1]

[1]British Geological Survey, Keyworth, Nottingham
[2]MES Ltd, Bath
[3]Cefas, Lowestoft

The Northern Palaeovalley is an open shelf valley system in the English Channel. It may be >100 km long and varies in width from 8 km to <15 km. Its floor lies at depths of ~40 to 100 m with margins up to 30 m high. Net sediment transport is west to east with rock and coarse sediment in the valley floor in the west and a gradual eastward increase in sand cover and volume, culminating in two large linear sand banks up to 28 km long along the north-east margin of the valley. The rock habitat includes sponges and supports good epifaunal growth. Epifauna in the coarse sediment is relatively scarce, the queen scallop Aequipecten and sun-star Crossaster are characteristic motile epifauna and there are some dense ophuroid beds; infauna is rich and varied. The sands sustain little epifauna but infauna are quite varied with errant polychaetes and amphipods.

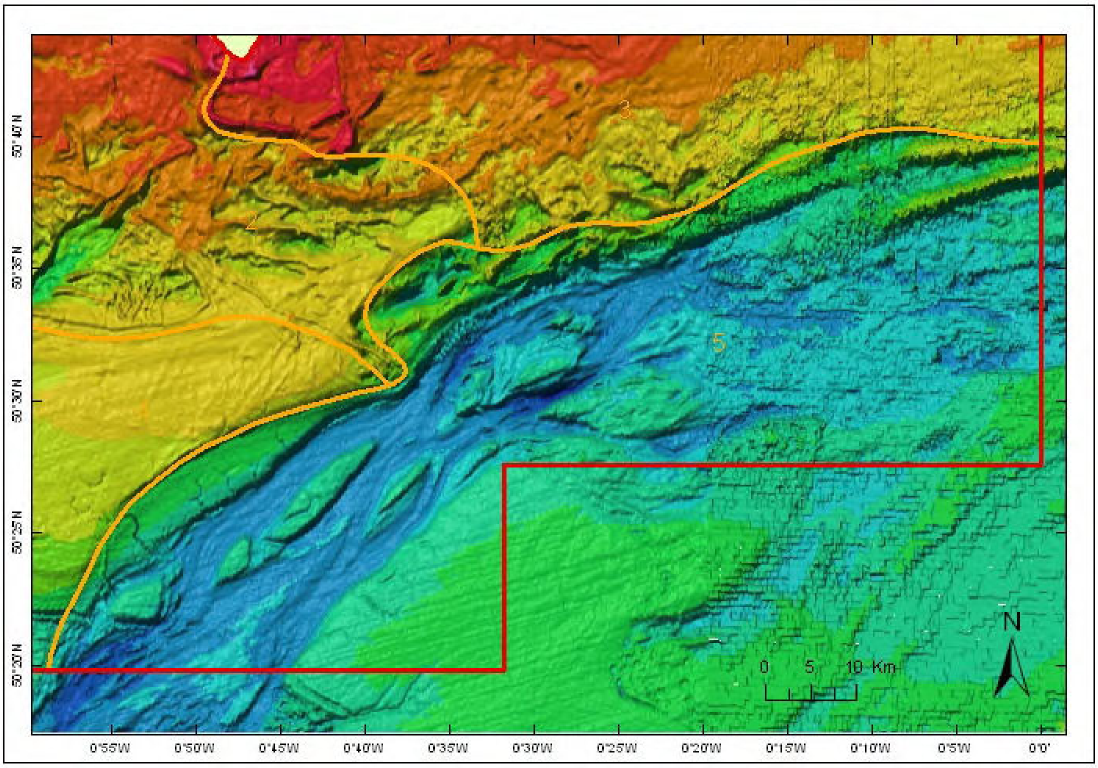


Figure 1.

A Regional Environmental Characterisation (REC) in the Central English Channel

Ceri James[1], Bryony Pearce[2], Roger Coggan[3], Stephanie Arnott[4], Jennifer Plim[1], Paul Baggaley[4], Robert Clark[5], Angela Morando[1], Jennifer Pinnion[2],

[1]British Geological Survey, Keyworth, Nottingham; [2]Marine Ecological Surveys Ltd, Bath; [3]Cefas, Lowestoft; [4]Wessex Archaeology, Salisbury; [5]Sussex Sea Fisheries Committee, Shoreham

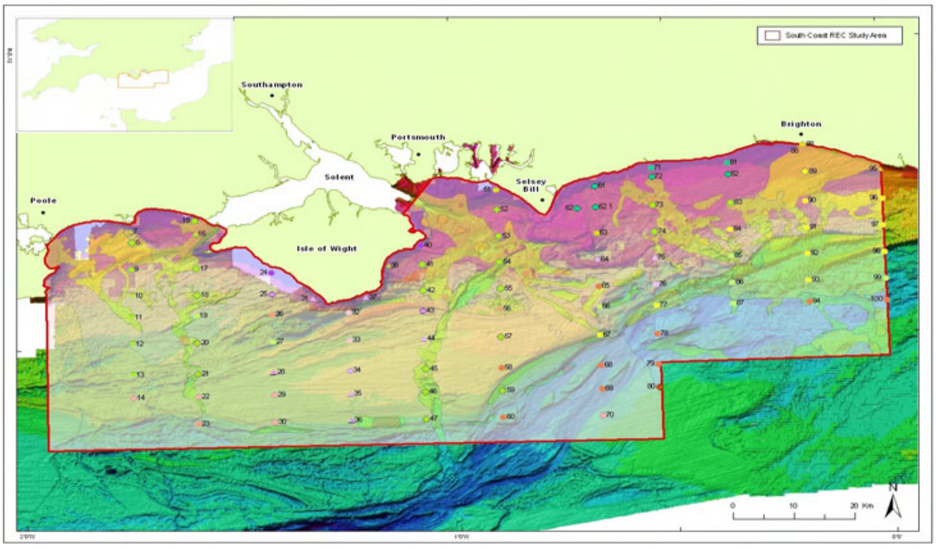


Figure 1. Modelled biotope map (EUNIS Level 3) overlaid on seabed morphology (Single beam echo sounder data © British Crown & Sea Zone Solutions Ltd. 2008.All rights reserved. Data Licence 052008.012)

There is a well established marine aggregate extraction industry in England and Wales. Research related to aggregate extraction is funded by the Marine Aggregate Levy Sustainability Fund (MALSF), derived from a tax levied on the industry. Regional Environmental Characterisation (REC) projects have been commissioned through this fund, covering strategic areas of current and future aggregate extraction in UK waters. Three of these REC projects have now been completed and a further two are underway. The objective of these projects is to develop our understanding of the seabed habitats, biological communities and archaeological assets that exist within each region, placing known impacts of aggregate extraction in a broader geographical context. The REC projects integrate new and existing geological, biological and archaeological datasets to produce comprehensive seabed maps which can be used in marine planning. The five areas currently covered by the REC programme are the Eastern English Channel, the South Coast, the Outer Thames Estuary, the East Coast and the Outer Humber. For this conference we present two posters relating to the South Coast REC.

The South Coast REC surveys were commissioned in 2007 and the project was completed in March 2010. Wide ranging datasets were interpreted to characterise and map the region in terms of the following;

– Anthropogenic pressures (fishing, aggregate extraction, spoils disposal, pipelines, cables & shipping)
– Geological resources (solid geology, quaternary sediments, bedforms & surface sediments)
– Oceanographic characteristics (currents, waves and sediment transport)
– Archaeological assets (shipwrecks, aircraft and historic landscapes)
– Biological resources (fisheries, birds, mammals, sharks, macrobenthos and epibenthos)

Finally, the physical and biological datasets were combined to produce a modelled biotope map of the area, predicting the distribution of broad biotope classes on the basis of relationships identified between biological assemblages and the physical environment. More information and the final report can be found at http://www.alsf-mepf.org.uk/.

Sand wave field: The OBel Sands, Bristol Channel, U.K.

Ceri James[1,3], Andrew Mackie[2], Ivor Rees[3] Teresa Darbyshire[2] and Angela Morando[1]

[1]British Geological Survey, Keyworth, Nottingham
[2]National Museum of Wales, Cardiff
[3]School of Ocean Science, Bangor University

The OBEL Sands are an extensive area of sand waves up to 19 m high which cover an extensive area in the Outer Bristol Channel off the Welsh Coast. The sand wave field can be divided in to a northern half with a dense concentration of bedforms on a sand substrate and southern half with isolated sand waves on a coarse substrate. In both areas the sand waves are generally asymmetric in cross profile with steep west facing stoss slopes associated with the channel's ebb tides. The sand waves commonly have abundant megaripples and secondary sand waves on their slopes, these dynamic environments maintain little or no epifauna but infauna are varied. There is more diversity in the area of coarse sediment and isolated sand waves with more abundant epifauna and also some motile epifauna

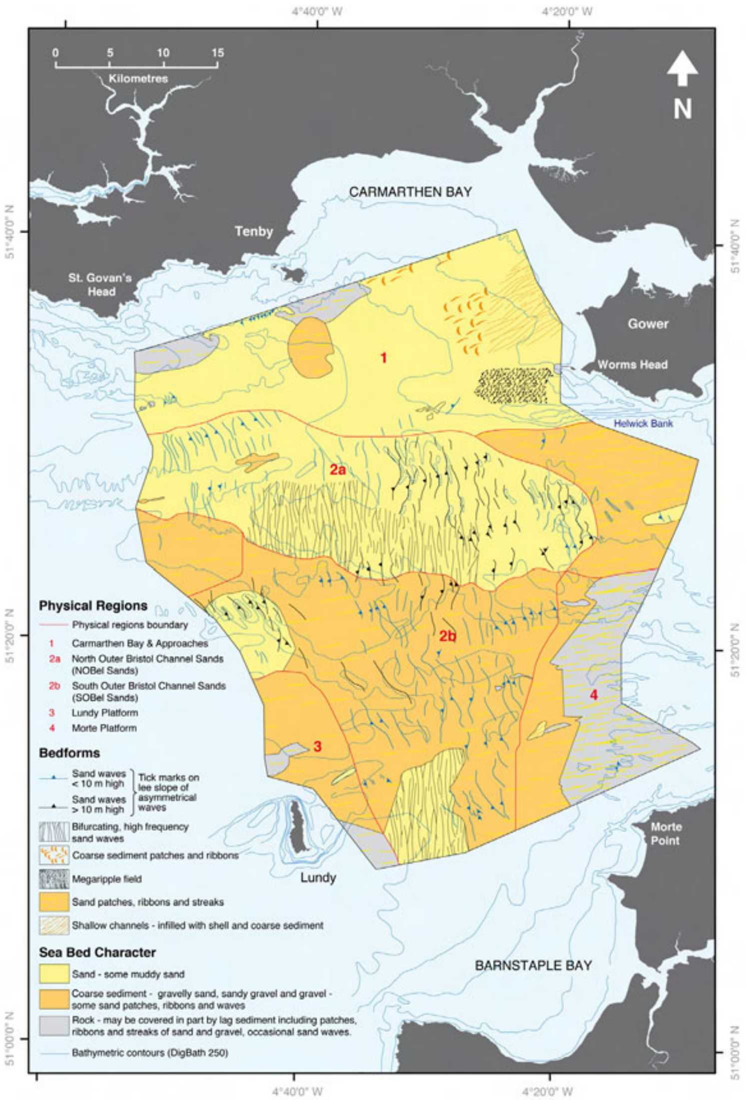


Figure 1.

Can oceanographic conditions explain species distribution patterns on the Chatham Rise and Challenger Plateau?

Kathryn Julian[1], Tanya J Compton[1], David Bowden[2], John Leathwick[3]

[1]National Institute of Water and Atmospheric Research, Hamilton, New Zealand
[2]National Institute of Water and Atmospheric Research, Wellington, New Zealand
[3]Department of Conservation, Hamilton, New Zealand

Deep-sea sediments contain a rich diversity of benthic fauna but it is often unknown which factors influence the formation and distribution of communities. It has been postulated that communities are structured by a combination of environmental factors operating at different spatial scales (e.g. water mass characteristics, current regimes and sediment grain size) that can create strict physiographic and physiological boundaries for the distribution of species. In this study we show, using boosted regression tree and generalized dissimilarity modelling, that water mass characteristics, tidal current regimes and sediment characteristics are associated with species distribution and community patterns, as well as species diversity, across the relative oligotrophic Challenger Plateau and the more eutrophic Chatham Rise. The Chatham Rise comprises a particularly interesting area, as species on the north and south slopes of the rise experience markedly different productivity and detritus influxes due to the collision of two water masses in this area (Sub Tropical and Sub Antarctic water) that results in two distinct benthic communities.

Paired ROV survey and food web study reveals invading chemosynthetic ecosystem

S. Kim Juniper[1], Catherine Stevens[2] and Anna Metaxas[3]

[1]University of Victoria, Victoria, British Columbia, Canada
[2]National Institute of Water and Atmospheric Research Ltd., Wellington, New Zealand
[3]Dalhousie University, Halifax, Nova Scotia, Canada

Several submarine volcanoes associated with intra-oceanic island arcs in the western and southern Pacific host hydrothermal activity at photic zone depths. There, the presence of two distinct sources of primary productivity (chemosynthetic and photosynthetic) and their associated benthos, creates potential for unusual ecological interactions. A multi-beam bathymetry survey of East Diamante submarine volcano in the Mariana Arc revealed a summit near 165 m depth, well within the lower photic zone. After a CTD tow-yo survey confirmed that the volcano was hydrothermally active, an ROV dive program was undertaken in 2004 and 2005. These dives discovered a 350 m deep hydrothermal chimney field, plus a zone of diffuse venting that extended up to depths where there was visible light. We report here on analysis of sensor data, samples and imagery collected by the ROVs *ROPOS* and *Jason II*. Our primary objective was to understand interactions between hydrothermal vent and non-vent benthic organisms in the lower photic zone.

ROV video records and Eh sensor data revealed that the area of diffuse venting began at 300 m and extended upslope to 190 m. Within this zone, chemosynthetic microbial mats covered most substratum surfaces. Overgrowth of coralline algae and soft corals by the microbial mats and discontinuous colonization by vent fauna suggested a recent activation of hydrothermal venting. Stable isotope and lipid biomarker analysis of faunal tissues revealed that vent and non-vent organisms at some locations were utilizing both chemosynthetic and photosynthetic food sources. At other sites, a single food source dominated faunal diets.

We discuss the combining of survey and food web studies to understanding other situations where a shifting trophic base may produce notable changes in benthic community structure within the same physical habitat.

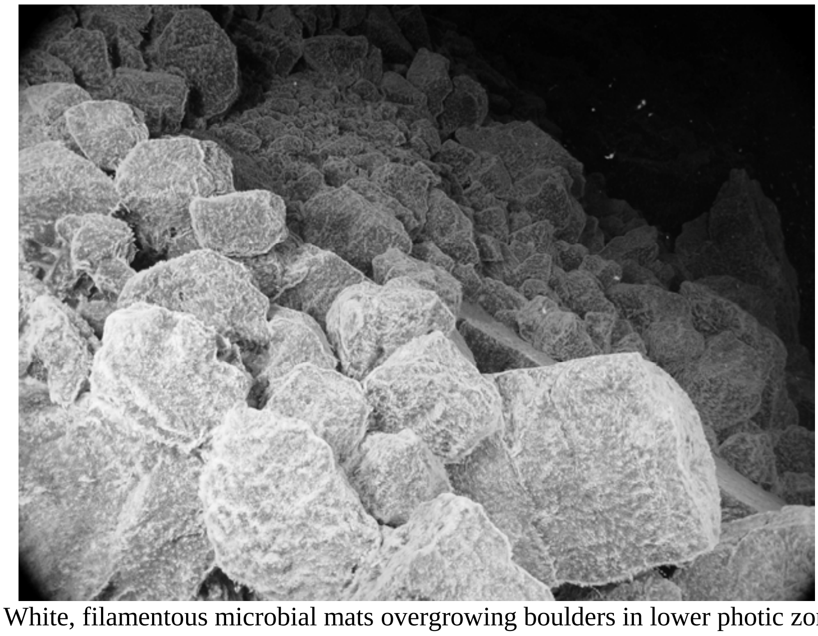


Figure 1. White, filamentous microbial mats overgrowing boulders in lower photic zone (200m), East Diamante submarine volcano, Mariana Arc.

EMODNET GEOLOGY: Combining and harmonising sea-bed sediment information

Anu Kaskela[1], Aarno Kotilainen[1], Ulla Alanen[1], Alan Stevenson[2], Rhys Cooper[2], Sophie Green[2], Ingemar Cato[3], Ola Hallberg[3], Liv Plassen[4], Terje Thorsnes[4], Jørgen Leth[5], Sten Suuroja[6], Inara Nulle[7], Tatjana Shadrina[7], Leonora Gelumbauskite[8], Algimantas Grigelis[8], Szymon Uscinowicz[9], Wojciech Jeglinski[9], Piotr Przezdziecki[9], Annemiek Vink[10], Manfred Zeiler[11],Sytze van Heteren[12], Vera Van Lancker[13], Fabien Paquet[14], David Hardy[15], Koenraad Verbruggen[15]

[1]Geological Survey of Finland (GTK), Corresponding author: anu.kaskela@gtk.fi
[2]Natural Environment Research Council – British Geological Survey (NERC-BGS)
[3]Geological Survey of Sweden (SGU)
[4]Geological Survey of Norway (NGU)
[5]Geological Survey of Denmark and Greenland (GEUS)
[6]Geological Survey of Estonia (EGK)
[7]Latvian Environment, Geology, and Meteorology Centre (LEGMC)
[8]Lithuanian Institute of Geology and Geography (LIGG)
[9]Polish Geological Institute – National Research Institute (PGI)
[10]Bundesanstalt fur Geowissenschaften und Rohstoffe (BGR)
[11]The Bundesamt für Seeschifffahrt und Hydrographie, Germany (BSH)
[12] Geological Survey of the Netherlands (TNO)
[13]Royal Belgian Institute of Natural Sciences – Geological Survey of Belgium (GSB)
[14]Bureau de Recherches Geologiques et Minieres, France (BRGM)
[15]Geological Survey of Ireland (GSI)

There is lack of comparable data across all European seas, which presents an obstacle for pan-European marine assessments. To address this problem, the marine departments of the geological surveys of Europe have come together to implement the EMODNET-Geology project. EMODNET-Geology (2009-2012) is one of the European Marine Observation and Data Network projects and it is funded by EU Commission. NERC/BGS coordinates the EMODNET-Geology project that has 14 partners in 14 European countries. The project will compile geological information from the study area covering the Baltic Sea, Greater North Sea and Celtic Sea.

One of The EMODNET-Geology work packages will compile the first full-coverage sea-bed substrate map for the study area at a scale of 1:1 million. The purpose is to harmonize existing substrate classifications taking into account the variety of regional contexts and presenting the datasets into the most appropriate scheme for integration with hydrographic, chemical and biological studies. The output will be a substrate layer (GIS) to be delivered in OneGeology –Europe portal. The project will not only deliver digital information on substrate distribution, but will also highlight data gaps and deficiencies, for example on areas where national substrate interpretations are based on low-resolution data which in turn creates difficulties for planning, exploitation and preservation.

The project partners have started to collate various local and regional substrate maps and have merged those to form a full-coverage sea-bed substrate map for the whole study area. The map includes an index map that identifies initial data layer patches and provides information on metadata: variation in remote observation, interpretation and ground-truthing methods. The current map is collated from 208 separate sea-bed substrate maps. Where necessary, the existing substrate classifications were translated to a scheme that is supported by EUNIS. This EMODNET reclassification scheme consists of four substrate classes defined on the basis of the modified Folk triangle (mud to sandy mud; sand to muddy sand; coarse sediment; mixed sediment) and three additional substrate classes (boulder, diamicton, rock). The sea-bed sediment map for the study area will be available at the end of the EMODNET-Geology phase 1 (July 2010). Next phases include testing and monitoring of the substrate layer and upgrading it.

A system for mapping nearshore, marine habitats on a tight budget

Kelly C. Kingon

Florida State University, Tallahassee, Florida, U.S.A

Unlike the terrestrial environment where detailed base maps are readily available, maps of the ocean are sparse and those that are available usually lack the necessary level of detail. Marine researchers, therefore, are usually forced to do the mapping themselves or to develop a random or systematic sampling scheme that can be costly and reveal little data on the targeted habitat or species. A relatively inexpensive, new product that is commercially available may help researchers with limited funding create the detailed maps that they need. This system, distributed by Humminbird for fishermen, records sidescan imagery, bathymetry data, and GPS coordinates simultaneously and can be purchased for under $2000. It is extremely user friendly, compact, and easy to install. The Humminbird system can locate specific geologic features or habitat types as well as schools of fishes and other large marine animals. The advantages of this particular system are 1) the additional sidescan component and 2) the ability to record all the imagery, maps, and coordinates on to a SD card. The recorded data can then be downloaded on to a computer and converted into a more usable format using a free Humminbird program. My main objective was to collect georeferenced imagery using the Humminbird that could be incorporated into ArcGIS to create accurate habitat maps. I am still searching for a free program that converts the files into a format that can be easily incorporated into ArcGIS, but for now there are sidescan sonar data processing packages that can do this, however, these can be quite expensive. During preliminary trials with the Humminbird, I mapped several artificial reefs and hardbottom habitats that were verified with dive surveys. I was very pleased with the results but have a few suggestions for future mapping efforts. To create georeferenced imagery, it is best to record one parallel transect at a time, i.e. by starting the recording at the beginning of each transect and stopping it at the end. This greatly reduces the amount of post-processing that is necessary and makes the imagery much easier to deal with since they are in separate image rows instead of a single large image. Mapping should also be completed on calm days unless a large, stable vessel is available to eliminate the effects of waves on the imagery. This Humminbird system has great potential and I plan to continue using it for my research.

Geoacoustic mapping of cold seep habitats along the Hikurangi margin, New Zealand

Ingo Klaucke[1], Andrew T. Jones[2], Wilhelm Weinrebe[1], David Bowden[3] and C. Jörg Petersen[1]

[1]IFM-GEOMAR, Kiel, Germany
[2]Geoscience Australia, Canberra, Australia
[3]NIWA, Wellington, New Zealand

Based on shipborne bathymetry and deep-towed 75 kHz sidescan sonar data a large number of cold seeps have been mapped along the Hikurangi margin, New Zealand. The 75 kHz sidescan sonar data have been processed for a pixel size of 1 metre allowing to image even small features of the seafloor. Cold seeps along the Hikurangi margin cluster in several areas and are generally associated with accretionary ridges. Two of these areas (Opouawe Bank and Uruti Ridge) have been studied in more detail using a towed video sled. The sidescan sonar data generally show low to medium backscatter intensity over most of the seafloor. These areas correlate with muddy seafloor lacking distinctive features. Only small patches that are up to a few hundred metres across show increased backscatter intensity and some even indicate small-scale relief through alternations of high backscatter and shadows. As expected there is a good correlation between high backscatter intensity and the presence of carbonates at the seafloor. Several of the seeps are currently active as indicated by gas bubble plumes in the water column. However, these gas plumes are highly variable in time and space. Outcrops of gas hydrates have not been found although the studied cold seeps are located within the gas hydrate stability zone.

Live chemosynthetic biotic assemblages, including siboglinid tube worms, vesicomyid clams, bathymodiolin mussels, and bacterial mats, were observed at the seeps. Cold-water corals were the most conspicuous biota of the cold-water reef but widespread vesicomyid clam shells indicated past seep activity at all sites. Two seeps sites on Uruti Ridge are of particular interest as they show qualitatively similar backscatter facies but contain different biological communities. One site is dominated by corals thus forming a cold-water reef while the other is dominated by tubeworms and vesicomyid clams, i.e. typical cold seep facies. This difference is also shown by the backscatter histograms of the two sites with the seep structures containing a larger proportion of high backscatter intensities (Fig. 1). The correlation between strong backscatter features in sidescan sonar images and seep-related seabed features is a powerful tool for seep exploration, but differentiating the acoustic features as either modern or relict seeps requires judicial analysis and is most effective when supported by visual observations.

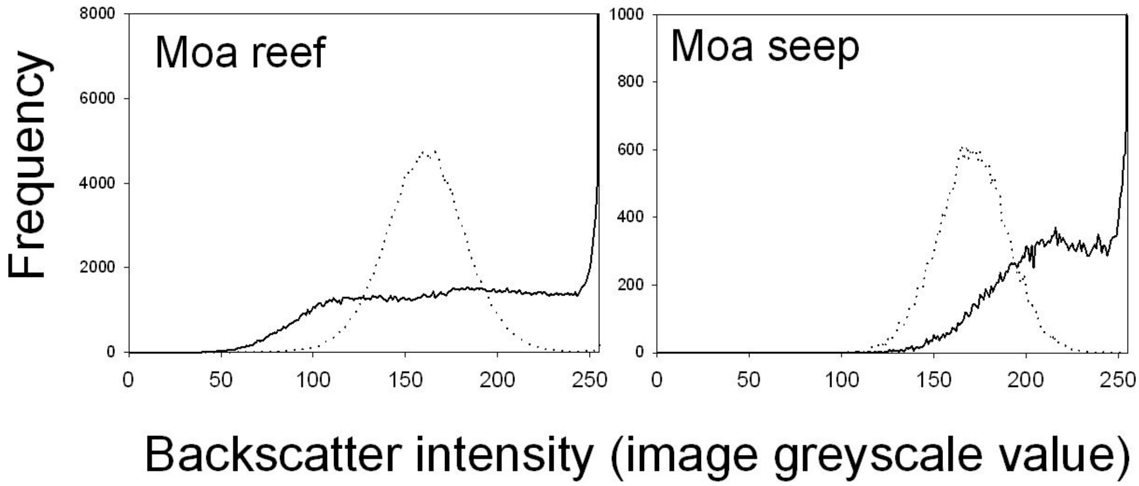


Figure 1.

National mapping of deepwater biotopes based on multi-beam acoustics

Rudy J. Kloser[1], Gordon Keith[1] and Mathew Sherlock[1]

[1] CSIRO Marine Research, P.O. Box 1538, Hobart, 7001 Tasmania

A program to map the deepwater biotopes of the Australian EEZ is underway based on fine scale acoustic multi-beam echo sounder (MBES) mapping and a newly developed benthic, optical, acoustic grab sampler (BOAGS). Data are collected on specific research voyages as well as utilising transit voyages between ports. These MBES data and associated physical and optical sensing are an important input into assessing assets (e.g. canyons, terraces, banks, seamounts) for regional marine planning, informing the placement of marine protected areas and fisheries spatial management. The acoustic data provide detailed (20 to 50 m grid) bathymetric and inferred substrate information that can be used with other co-variates to predict macro faunal functional groups based on physical and optical "ground truthing". A consistent approach of interpreting ecological hard and soft substrate based on the acoustic backscatter that maximises the spatial resolution whilst minimises sources of error was developed and applied. This consistent nationally applied acoustic backscatter processing method is highly correlated with visual and physical sampling of the seabed as well as mega fauna diversity. Mega fauna diversity of 6 taxon grouping ~2000 species is highly correlated to both the seabed hardness and the depth of sampling. Nested within a hierarchical classification scheme estimates of seabed hardness are derived for catchments, specific geological features (canyons, seamounts) and MPA's. Based on this work we propose that seabed hardness as derived from multi-beam acoustics should be included in regional marine planning processes at a number of scales from regional mapping at the 100's km scale to the 10's m to 1 km scale for final MPA placement and fisheries spatial management.

Figure 1. Benthic Observation and Grab System

Seabed habitats of the Beaufort Sea Shelf (Canadian Arctic)

Vladimir E. Kostylev, Kerstin Jerosch, Steve Blasco

Geological Survey of Canada, Dartmouth, Nova Scotia, Canada

Properties of benthic habitat and consequently spatial distribution of benthic invertebrates in the Canadian Beaufort Sea environment is influenced by presence and dynamics of sea ice and by the outflow of Mackenzie River. These two processes influence benthic ecosystems by modifying suitability and stability of bottom substrates, influencing oceanographic regime (e.g., water temperature and salinity gradients) and limiting availability of food. Ice cover also limits primary productivity of the area, by attenuating light penetration in colder months of the year. It is likely that the benthos in the Eastern Beaufort is dependent on autochtonous production that is not very closely coupled with primary production in the overlying water column. Ice mechanically disturbs the sea bed, destroying benthic habitats, and when melting, alters salinity and structure of water column. The suspended sediment brought by Mackenzie River increases water turbidity further limiting light penetration through water column, and is deposited on the sea bed thus altering sediment texture. As a consequence of these processes there are two major gradients in the distribution of benthic communities on the Beaufort shelf: the onshore-offshore gradient is driven largely by the ice scouring, water salinity and water depth, and the West to East gradient – by productivity and substrate texture.

Glacial coastal formations, western Finland

Aarno Kotilainen[1], Anu Kaskela[1], Saara Bäck[2], Jouni Leinikki[3]

[1]Geological Survey of Finland (GTK), P.O. Box 96, FIN-02151 Espoo, Finland
[2]Ministry of Environment, P.O.Box 35, FI 00023 Government, Finland
[3]Alleco Oy, Mekaanikonkatu 3,00810 Helsinki, Finland

The Kvarken Archipelago is located in the glaciated epicontinental basin, the Baltic Sea. The Kvarken Archipelago is very shallow (0-25 m) and shoaly, with ~7000 islands and islets. Glacioisotatic land uplift rate of is ~8.0-8.5 mm/year. The sea freezes yearly, and the annual mean temperature is +3.4 ºC. The salinity varies between 3 -6 ‰. The seafloor of this area consists mainly of till (~70%). The boulder-rich De Geer moraines are the most characteristic geomorphic features within the area (Figure 1) creating a unique submarine landscape. Because the area is a transition zone of salinity levels at critical levels to both marine and limnetic species, the diversity of marine life is poor. The local bladder wrack, Fucus radicans is characteristic to hard bottoms in the shallow areas with salinity up to 4.5 ‰. The Kvarken Archipelago was included on UNESCO World Heritage List in 2006.

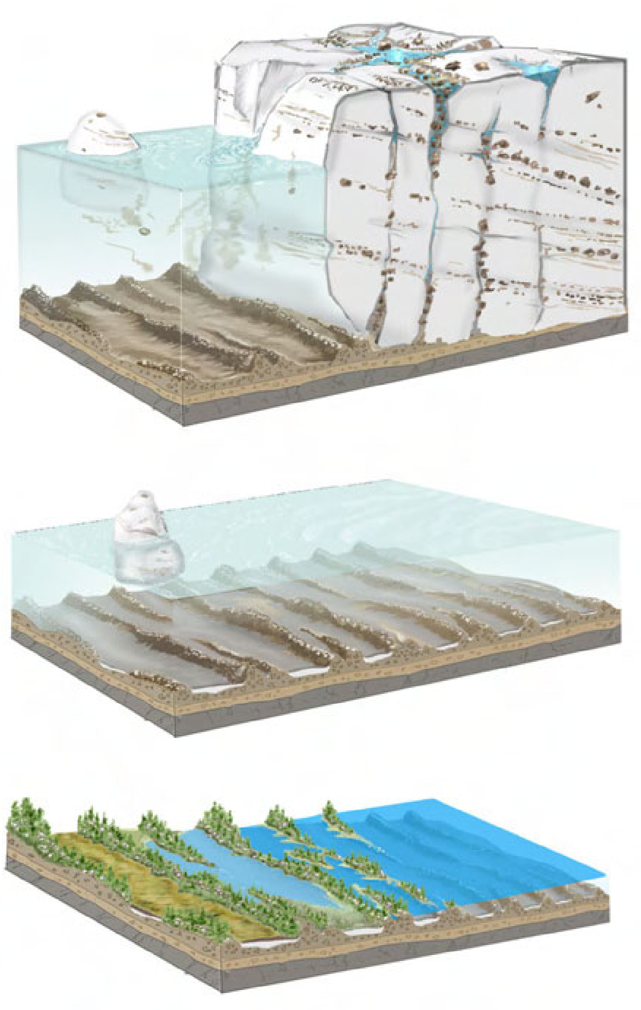


Figure 1. The suggested formation of De Geer moraines (Drawings: Harri Kutvonen,GTK). Figure modified after Breilin et al. 2005.

ZoNéCo: a multidisciplinary approach to Marine Habitats in New Caledonia

Y. Lafoy[1], A. Rivaton[2] and D. Buisson[3]

[1] Office of Regional Cooperation and External Relations, BP M2 – 98849 Nouméa Cedex, Nouvelle-Calédonie
Currently posted at NIWA, New Zealand

[2] Agence de Développement économique de la Nouvelle-Calédonie (ADECAL), BP 2384 98846 Nouméa, Nouvelle-Calédonie

[3] Direction des Technologies et des services de l'information (DTSI), 127, rue A. Daly, Ouémo, 98800 Nouméa, Nouvelle-Calédonie

In 1993 the ZoNéCo programme (for "*Zone économique de Nouvelle-Calédonie*") was launched in New Caledonia to open new avenues for both economic development and sound EEZ governance. The programme's goals fit into the Pacific Islands Regional Ocean Policy (PIROP) (http://www.spc.int), approved by Pacific Island Forum leaders in 2002, and that represents the first policy ever in terms of a regionalized approach to ocean management.

In New Caledonia, nine surveys have focused at investigating deep sea, mega-scale habitats within the framework of the ZoNéCo programme in the last fifteen years. Six seafloor mapping, geophysics and physical oceanography cruises were conducted aboard Ifremer's R/V *L'Atalante*, followed by three related exploratory fishing surveys in order to survey potential sites of interest for fishery resources. Those nine surveys have swath-mapped, imaged, and sampled (down to water depths of 2,500 m.) an area of about 500,000 sq. km, i.e. about 35% of New Caledonia's EEZ. Since 1999, in addition to the offshore surveys, the ZoNéCo Programme has been focusing on:

- understanding relationships between Tuna resources and the marine environment variability;
- gathering remote sensing data for Habitat mapping;
- an ecosystem approach on coastal reef fisheries, to understand relationships between fishing resource and fishing communities;
- deploying Acoustic Ground Discrimination system (AGDS) within the Lagoons.

Since July 2008, following the registration of the New Caledonia Lagoons as an UNESCO's World Heritage site (2nd world's largest lagoon), research works have focused on assessing the diversity of the Coral reefs and their associated ecosystems. Since 2004, the Coral Reef Mapping project for the Pacific Ocean Islands has systematically mapped Coral reefs using Landsat 7 images, providing a unique, consistent, and rich (180 classes of reefs) geomorphological classification scheme.

Marine Habitat maps are still needed offshore and nearshore in New Caledonia in terms of:
- **ground-truthing**, through sampling surveys, the potential non-living and living resource targets identified from seafloor-type interpretation of the swath-mapping surveys;
- **Marine protected areas (MPAs)** as MPAs play an important role in providing a refuge for biodiversity as mentioned in the 10 year Strategy set forth in Durban (SA, 2003);
- **protecting** and **spatial planning** of **the marine environment**, to allow users and managers to promote an ecosystem-based approach to management by using an appropriate Decision Support System (DSS) approach as stressed at the 3rd France-Oceania Summit (Noumea, July 31st, 2009);
- setting up **monitoring and surveillance** actions, to assess the state of the marine environment by establishing programmes which sample across the range of ecological features;
- **planning advice to industry**, to assess whether specific industries, such as open cast nickel mining and prawn farming, have impacts on particular types of habitat.

The Cook Strait canyon, New Zealand: A large bedrock canyon system in a tectonically active environment.

Geoffroy Lamarche, Ashley Rowden, Joshu J. Mountjoy, Anne-Laure Verdier

NIWA, Wellington, New Zealand

The Cook Strait canyon system is a deeply incised bedrock canyon system in south-eastern Cook Strait, the seaway separating the North and South islands of New Zealand between 41 and 42° south. The multi-branched canyon system cuts more than 40 km laterally into the continental shelf, where the head area of the canyon reaches water depths of less than 150 m, and exits to the Hikurangi Trough in water depths of more than 2700 m. Numerous other canyons occur on the adjacent continental slope. The highly sculptured geomorphology of the canyon walls reflects a tidally dominated seaway, with tides in the Tasman Sea and Pacific Ocean almost completely out of phase, and intense seismo-tectonic activity associated with its location on the active Pacific-Australia plate boundary.

In this case study of deep-sea canyons for the "GeoHab Atlas of geomorphic features as benthic habitat" we analyse a ~4,500 km^2 area of seafloor that includes the Cook Strait canyon system itself (~1800 km^2), adjacent canyons on the continental slope, and contrasting areas of continental shelf around the upper canyon. The study area is fully covered with Simrad EM300 multibeam sonar data. Approximately 250 sediment samples and over 150 biological samples were collected, and ~500 benthic taxa recorded within the area from seabed images and direct samples (Figure 1). Derivative spatially continuous datasets include geomorphic mapping, quantitative backscatter analysis and sediment distribution. Together these datasets enable a comprehensive spatial analysis of geomorphic-sedimentary-biologic relationships to characterise the geo-habitat and benthic biodiversity of large-scale, bedrock-incised submarine canyon systems.

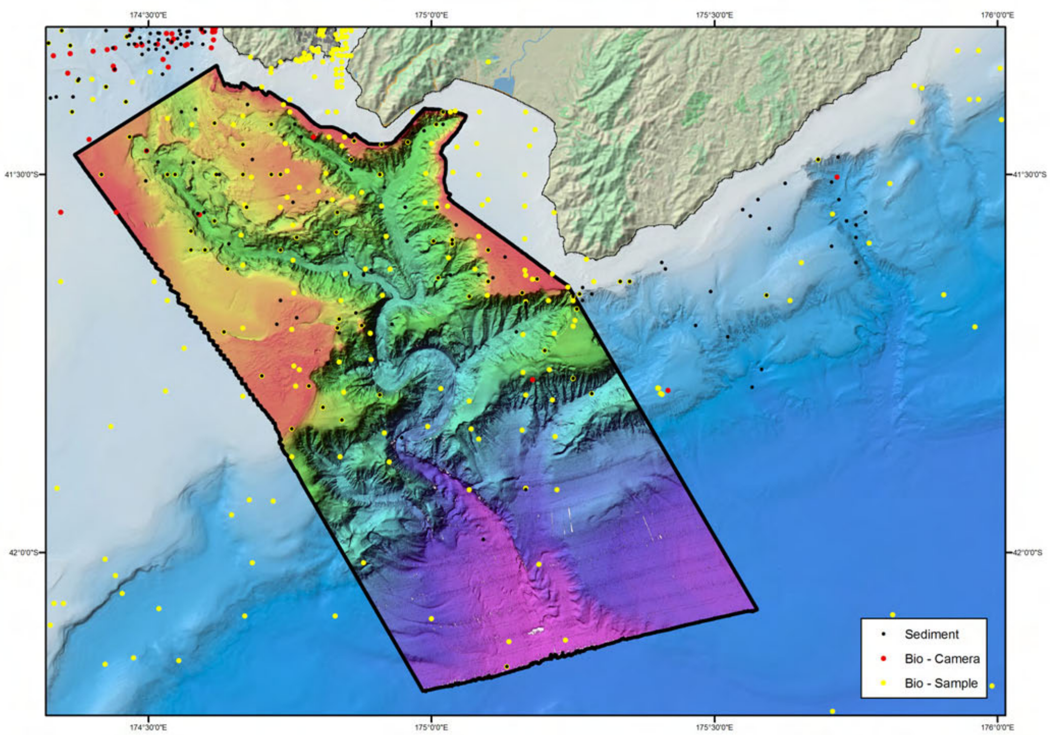


Figure 1. The Cook Strait canyon system, the study area is outlined in black. Sediment and biological sample sites are shown as points. The study area has complete Simrad EM300 multibeam bathymetric coverage.

Unsupervised deep water seafloor classification using object-based image analysis of backscatter and bathymetry data in Cook Strait, New Zealand

Geoffroy Lamarche[1], Vanessa Lucieer[2], Xavier Lurton[3,] Anne-Laure Verdier[1]
and Melanie Herrmann[4]

[1] NIWA, Private Bag 14-901, Wellington, 6041, NZ.
[2] Univ. of Tasmania, Priv. Bag 49, Hobart, Tasmania 7001
[3] IFREMER, BP.70, 29280 Plouzané, France

We developed a three-step approach to map the seafloor substrates and habitats over the tidally dominated Cook Strait, New Zealand using a comprehensive EM300 multibeam echo-sounder. Processing of the backscatter, undertaken using the SonarScope® software includes signal calibration, specular reflection compensation and speckle noise filtering aimed at attenuating the effects of recording equipment, seafloor topography, and the water column. The Backscatter Strength (BS) response as a function of the signal seafloor incidence angle also provides information of the sediment grain size, interface roughness and volume scattering and can provide a reliable first-order interpretation of the substrate composition.

We generated a fuzzy c-means (FCM) classification map from the results of the grain size analysis of 260 seafloor samples over the region. FCM methods define the optimal number of substrate classes that are overlapping and can be mapped in geographic space. The FCM method also produces uncertainty results which are related to class attribution and/or transition zones between sediment classes. In combination with object-oriented texture-based segmentation this classification method is a useful tool for identifying biotopes on the seafloor.

The results provide an improved understanding of the utility of different marine biophysical variables as surrogates for benthic habitats, and promote the use of spatial uncertainty techniques to assess the application of these methods for biodiversity assessment.

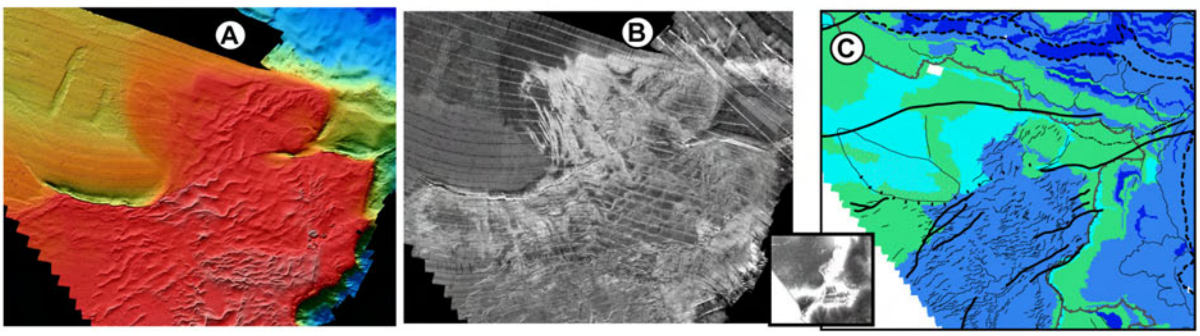


Figure 1. A: Log of bathymetry over the continental shelf in Cook Strait; B: Compensated backscatter; C: Classification map with superimposed structural interpretation. Insert is confusion index from Fuzzy C-mean analysis. White is high uncertainty, black is low uncertainty.

Relationships between seabed assemblages in the Gulf of Maine and their physical environment using Random Forests

Peter Lawton[1], Stephen J. Smith[1], Lewis S. Incze[2], Michelle E. Greenlaw[1], Nicholas H. Wolff[2], Jessica Sameoto[1], Roland Pitcher[3], Nick Ellis[3]

[1]Fisheries and Oceans, Canada
[2] University of Southern Maine, USA
[3] Commonwealth Scientific and Industrial Research Organisation, Australia

The distribution and abundance of marine species and assemblages is of fundamental interest to science and of considerable importance to management and conservation. For most marine species, such information is severely lacking, partly due to the great expense and time required for biological surveys. This has created an interest in determining the extent to which physical environmental variables can be used as surrogates for biological variables. However, a prerequisite to using physical environmental variables as surrogates is gaining general understanding of the importance and influence each physical variable has on biological communities. As a contribution to the synthesis phase of the International Census of Marine Life (CoML), we aim to contribute by characterizing the major bio-physical relationships of benthic community data from different/contrasting biogeographic regions and different gear types. We have analyzed benthic mesoscale datasets from shelf biogeographic regions in tropical Australia and Gulf of Mexico, and temperate Gulf of Maine areas using a modified version of Random Forests (a bootstrapped randomized classification/regression tree method). Each region has collated broad-scale biological survey datasets comprised of site-by-species abundance data from trawls, benthic sleds, and grabs/cores, as well as site-by-physical datasets comprised of available physiographic variables thought to be important for influencing marine distributions. The modified Random Forest analysis collates split points from regression trees and change in deviance information for each species and physical variable. Results are expressed as cumulative frequency distributions of splits, weighted by deviance, summed over multiple species within different levels of aggregation. These distributions thus represent patterns of biological (change) response along gradients for each physical variable. The outputs: (1) summarize the extent to which physical surrogates may explain biological patterns; (2) rank the importance of physical variables for structuring biological patterns; (3) examine common biological responses to their gradients; and (4) identify critical values for each physical variable that correspond to 'threshold' changes in biological patterns; where “biological patterns” may be many individual species, multi-species assemblages, and some diversity attributes. This method has the potential to: (1) yield a robust method to compare across surveys using disparate sampling and tools; (2) contribute to understanding of ecological drivers in the marine environment; (3) provide information to facilitate design of future biodiversity sampling programs and (4) assist in first order seabed characterisation in data poor situations (e.g. for spatial planning, effective ecosystem based management and conservation planning). This talk focuses on the results emerging from analyses of Gulf of Maine datasets.

Diversity in benthic habitats and sediments at Great Barrier Island, New Zealand

Tuan Meng Lee[1], Kala Sivaguru[2], Roger Grace[2], Timothy J. Langlois[1], Mark J. Costello[1]

[1]Leigh Marine Laboratory, University of Auckland, New Zealand
[2]Department of Conservation Auckland Conservancy

Mapping of benthic habitats is increasingly used to identify characteristics of marine environments. This information can inform resource management plans such as marine protected areas. In this study, the distribution of seabed habitats northeast Great Barrier Island to the 12 nmi limit of was mapped using underwater video. A large Marine Reserve had been proposed in this area but not established. The habitat and sediment of 46 deepwater survey sites were used to ground truth the map .The overall accuracy of the map was 80%, with the greatest accuracy (86%) for the most extensive habitat, mud.

Five major sediment types (mud, pebble, rocks, rubble and sand) were identified. The deeper waters (>100 m) were dominated by a muddy bottom. Video analysis identified some areas that had interspersed boulders, which formed ledges and cliffs. Waters between 85 m – 100 m were still primarily dominated by a muddy bottom, but interspersed areas of coquina shells, rubble and boulders were common. Substrates found shallower than 75 m were more diverse, ranging from rocks and sand to kelp and algae.

Seven benthic community types were identified and grouped by multivariate cluster analysis into four broad biotope classes (sponge-coral community, sponge-bryozoans community, kelp and algae, and undetectable). Kelp and algae was the principal habitat in water less than 40 m. In the deeper waters, where mud was prevalent, benthic organisms were undetectable. A weakness of the underwater video method was that when there were no conspicuous epibiota, as on flat muddy seabed, it was not possible to identify the biota that made up the assemblage. Where the interspersed boulders and rocks were present, however, there were sponge and coral communities visible. A total of 49 species were recorded in the deepwater survey including significant numbers of glass sponges, indeterminate black coral species, and endemic gorgonian species.

The habitats identified in the waters off Great Barrier Island are likely to be representative of similar depth ranges in northeast New Zealand. Although it is not known if these habitats are significantly influenced by fishing (e.g. trawling, trophic cascades), this study provides an initial baseline so that should the area become a Marine Reserve, any habitat change might be related to protection from fishing impacts. We recommend that a more extensive mapping study should be conducted at Great Barrier Island to enable direct and indirect effects of fishing to be better assessed.

Mapping habitat change after 30 years in a marine reserve shows how fishing can alter ecosystem structure

Kévin Leleu [1, 2 *], Brice Remy-Zephir [1, 3 *], Roger Grace [4] and Mark J. Costello [1]

[1] University of Auckland, New Zealand
[2] IFREMER Brest and Université de la Méditerranée, Centre d'Océanologie de Marseille, FRANCE
[3] Ecole Nationale des Sciences de l'Ingénieur, Brest, France
[4] Leigh, New Zealand
* The first two authors are of equal rank

Time-series studies have reported trophic cascades in land, freshwater and marine environments in many geographic areas, often as a response to harvesting of keystone species such as in fisheries. Sometimes whether a cascade has occurred, or is coincident with other environmental factors (e.g. disease), is debatable. Although suitable habitat conditions are a prerequisite for a species distribution, the spatial extent of habitats have not been mapped in these studies. Marine reserves can provide experimental, before-after and inside-outside (control-impacted), situations for assessing the impact of fishing on ecosystems. We mapped seabed habitats and their associated communities (biotopes) in New Zealand's oldest marine reserve for comparison with pre-reserve maps created about 30 years previously.

Areas grazed bare by sea urchins were entirely replaced in the centre of the reserve by kelp, or alga turf, an intermediate community between heavily grazed encrusting algae and lightly grazed kelp. While this gradient in habitat change matched the gradient of predator abundance, it also matched the extent of reef habitat area. Thus while previous studies have shown the trophic cascade phenomenon, its manifestation may also be influenced by the effect of habitat area on species' abundance, including algae, urchins, fish and spiny (or rock) lobsters.

No-take Marine Reserves provide real-world experiments that show the relative importance of species in food webs, and the consequences of fishing for ecosystems. Because these changes in ecosystem structure may continue, and will vary with environment, climate and species distributions, reserves need to be permanent and replicated geographically. Further changes may arise should the abundance of mega-predators, such as seals, cetaceans and large sharks, increase in the region, and when invasive species reach the reserve.

A geospatial approach to coral reef geomorphology

Javier Leon[1], Colin Woodroffe[1], Kevin Parnell[2] and Scott Smithers[2]

[1]University of Wollongong, Australia
[2]James Cook University, Townsville, Australia

Detailed morphometric analysis of submerged and shallow coral reefs has been effectively studied using high-resolution datasets such as multibeam sonar mapping at scales and spatial extents previously unconceived. However, in Torres Strait, northern Australia, a complex matrix of shallow and deep submerged reef platforms, together with exposed emergent platforms, restricts conventional water or land borne surveying. A continuous and dense coverage of accurate elevation measurements below and above the water level as derived from LADS, for example, is ideal for analysing this complex terrain but unfortunately such technologies are still cost-prohibited. Geospatial analysis techniques together with remote sensed data allow addressing the challenges of studying this unique environment at multiple scales and at a regional spatial extent.

This study presents two different approaches to modelling the terrain of reef platforms with different geomorphological characteristics in Torres Strait. A DTM for Warraber, an emergent planar reef platform was elaborated using a combination of traditional field survey approaches, photogrammetry and multibeam echo soundings. A DTM for Bet, a shallow submerged lagoonal platform, was elaborated using sonar-based bathymetry together with a remote-sensing approach.

Combining seaborne and terrain-based measurements, datasets have been merged and interpolated resulting in detailed DTMs for a lagoonal and a planar reef. Results show that even though planar reefs can be approached by simpler modelling techniques, lagoonal reefs exhibit variability that requires higher quality datasets to effectively model the complex terrain. The forereef and, particularly, the intertidal reef crest are critical components of the reef geomorphology. The reef crest is of particular importance as it is the most difficult feature to survey and it plays a particularly important role in reef geomorphology. The use of flexible data structures incorporating breaklines such as TINs yields the best results when approximating complex reef morphology.

Making Technology Transparent -
A key to better science is spending more time studying the data than collecting it.

Francois Leroy

Teledyne Benthos, Inc. – Teledyne Webb Research - North Falmouth, MA USA

When studying the origins, current state, and evolutionary trends of underwater structures or organisms, a scientist is often confronted with challenging requirements for advanced observational technologies. Although resolving such challenges is very much in line with the natural curiosity of scientists, the task can be daunting. The cost (mainly measured in time) of successfully mastering the technology generally comes at the expense of collecting the very data it is suppose to serve. Making the internal complexity of the technology transparent to the user can significantly reduce time spent for configuration, installation, commissioning and validation, leaving more time and resources for the collection of the precious data needed to conduct the science.

This presentation will explore the different methods available to technology developers, manufacturers, and software developers, which can transform a collection of sensors and instruments into a seamless assembly working together to serve the scientist instead of challenging his or her technical skills. We will look into the different levels of integration to identify where the most gain can be obtained. These levels are:

Sensors and hardware integration
Deployment and recovery hardware
Interfaces and interconnect
Data acquisition and integration
In-situ or post processing of data
Communication and global distribution

Teledyne Benthos and Teledyne Webb Research will present the work done in their engineering laboratories to move toward technology transparency and will present an overview of similar work engaged in by other manufacturers.

Producing ever more sophisticated tools to serve the scientists is a noble goal; putting the tools at the service of the scientists rather than the scientists at the service of the tools, is our task.

Improving spatial modelling of seabed sediments for biodiversity prediction: a case study from southwest Australian margin

Jin Li, Andrew D. Heap, Anna Potter, Zhi Huang and James J. Daniell

Geoscience Australia, GPO Box 378, Canberra, ACT 2601, Australia

Robust methods for generating spatially continuous data (i.e., GIS layers) from point locations of physical seabed properties are essential for accurate biodiversity prediction. For many national-scale applications, spatially continuous seabed sediment data are typically derived from sparsely and unevenly distributed point locations, particularly in the deep ocean due to the expense and practical limitations of acquiring samples. Methods for deriving spatially continuous data are usually data- and variable-specific making it difficult to select an appropriate method for any given physical seabed property. Traditionally, simple methods like inverse distance squared (IDS) have been used but in reality predictions using IDS are often associated with high prediction errors. To improve the spatial modelling of physical seabed properties, this study compared the results of a variety of different methods for deriving spatially continuous mud content data for the southwest margin of Australia (523,400 km^2) based on 177 sparsely and unevenly distributed point samples. Mud content was chosen because it plays an important role in affecting the nature and composition of marine biodiversity. For some methods, secondary variables were also used in the analysis, including: bathymetry, distance-to-coast, seabed slope, and geomorphic province (i.e., shelf, slope, etc.). Effects of sample density were also investigated. The predictive performance of the methods was assessed using a 10-fold cross validation with relative mean absolute error (RMAE) and visual examination. A combined method of random forest and ordinary kriging (RFrf) proved the most accurate for the study dataset with an RMAE up to 17% less than IDS. No threshold sample density was detected; as sample density increased so did the accuracy of the method. The RMAE of the most accurate method is about 30% lower than that of the best methods in previous publications, further highlighting the robustness of the method developed in this study. The results of this study show that significant improvements in the accuracy of the spatially continuous seabed properties can be achieved through the application of an appropriate interpolation method. The outcomes of this study can be applied to the modelling of a wide range of physical properties for improved marine biodiversity prediction.

Object based segmentation of multibeam backscatter data: methods for spatial analysis of shallow coastal seabeds, South Eastern Tasmania, Australia

Vanessa Lucieer, Nicole Hill and Neville Barrett

Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Australia

The combined use of backscatter and bathymetric data generated by multibeam echo-sounders provides a powerful tool to investigate substrate characteristics and seabed biotopes. The derived seabed classifications from these data are strongly scale dependant.

New methods to integrate both the physical and biological information at various spatial scales must be developed to be able to accurately assess the correlation of backscatter texture to substrate characteristics and seabed biotopes.

A Reson EM3002(D) 300 kHz multibeam sonar was used for sampling the south eastern coast of Tasmania in February and March 2009. The backscatter data (corrected for angular dependence) was segmented and textural signatures were developed based on different depth strata across the research site.

The *AUV Sirius*, operated by the IMOS Autonomous Underwater Vehicle facility at the University of Sydney was employed to collect fine-scale imagery over a range of depths and substrates mapped by the multibeam. Substrata, geomorphology and cover of key taxa were classified from the digital still images

We investigate different statistical algorithms to explore the patterns, relationships and correlations between the physical covariates derived from both the backscatter and bathymetry data and the biological data from the AUV. Where significant relationships existed between the two, the biological data was used to characterise the biotope classes identified in the object based image analysis.

This methodology has the potential to be applicable to other seafloor types worldwide, and will advance the research that aims to answer the fundamental questions relating to the role of high resolution acoustic data in explaining patterns in biodiversity.

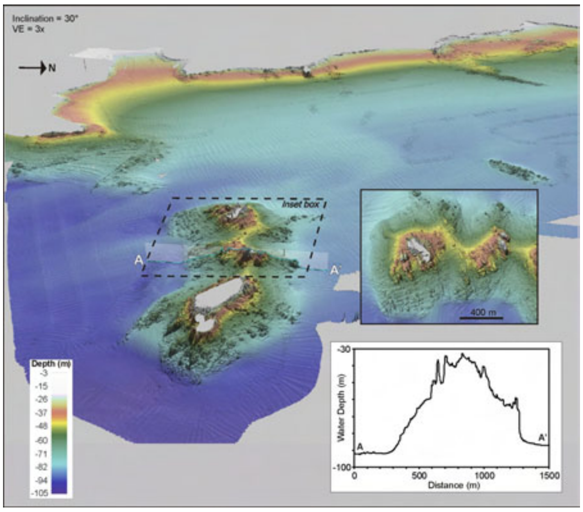


Figure 1. Perspective view and representative profile (inset) of reefs surrounding The Hippolyte Rocks located offshore from South Eastern Tasmania *(Figure courtesy of GeoScience Australia).*

Credibility of sonar Backscatter Strength measurement, modelling and inversion

Xavier Lurton and Jean-Marie Augustin

Ifremer (France)

The increasing use of multibeam echosounders in the past few years has developed along with a diversification of their application, with in particular the inversion of backscatter strength (BS) measurements to derive physical characteristics of the seafloor interface. This approach has highlighted several issues about:

- The BS quantitative measurement in isolation: what are the constraints and what is the actual reliability of the inferences?
- The backscattering phenomena model parameterised by geoacoustical models and parameters: what is available, and how appropriate are they?
- The inversion process: how best to deal with the model complexity and the number of parameters?

Ironically, many contributions dealing with experimental BS post-processing are primarily focused on the third point – which is essentially theoretical and concerned with the inversion strategy. In contrast, and despite their underpinning importance, little literature has properly addressed the first two issues. Indeed, for seafloor-mapping purposes, this fundamental understanding of the BS measured in actual at-sea conditions is far more important from a methodological point of view.

In this paper we discuss the following issues:

- The reliability of current systems for BS measurements cannot be taken for granted. The accuracy of BS levels is poor on standard industrial systems; this is shown from experimental results, which highlight either the variably of results obtained over the same area with different systems of identical or similar models, or the variations of one given system over time. The reliability of BS processing software is questionable as well, as shown on examples;
- The relevance of models commonly used in geoacoustical sonar data inversion is questionable. Backscatter modelling is usually based upon canonical assumptions (e.g., fluid sediment, isotropic roughness, homogeneous volume etc) that are normally only gross approximations of reality. Moreover, the applicability of just one model or another is not predictable considering that the data from a sonar survey are generally recorded over an unknown seafloor.
- Inversion of models with a large number of parameters raises specific difficulties: local extremums of cost functions are the most current pitfall, as well as ambiguities in solutions;
- Neither the acoustical nor the geoacoustical models are reliable enough to justify detailed conclusive statements about the seafloor properties from measured BS. An excessive confidence in modelling often goes along with underestimation of the experimental constraints and over-interpretation of the results.

The conclusions of the paper highlight that:

- Future effort should focus on sonar calibration methods to better estimate the BS physical values; this responsibility should be borne both by the manufacturers and users of sonar data.

Pragmatic models of geoacoustics and backscattering are to be developed and applied with the primary purpose of helping to *classify BS data* rather than inversion and fine characterization, which are (and possibly will stay) out of reach. Acoustic BS should be used as a basis for segmentation and classification methods and to complement *in situ* direct sampling and measurement methods.

Environmental - biological covariance in the soft sediments surrounding Lord Howe Island

Matthew McArthur, Hideyasu Shimadzu and Brendan Brooke

Geoscience Australia, Canberra, Australia

Beyond diveable depths, carrying out marine benthic ecology surveys was akin to trying to describe a rain forest from a balloon above a layer of cloud by lowering a butterfly net on a rope. Modern acoustic instruments, by allowing ecologists to interpret habitat character and patchiness, have made this analogy redundant and in April 2008 the RV Southern Surveyor sailed to Lord Howe Island to commence the first in a series of surveys to determine which environmental variables best describe benthic marine biodiversity in Australia's coastal shelf habitats by applying both new and old approaches. Mulibeam bathymetry and backscatter data, and sediment and infauna samples were collected and the resulting data matrices examined for covariance. This presentation will focus on interpreting the ecological information in light of the environmental picture arising from the sedimentology and acoustic data.

Spatial prediction of demersal fish habitat suitability from remotely-sensed observation and hydroacoustic datasets

Jacquomo Monk [1], Daniel Ierodiaconou [1], Alecia Bellgrove [1], Euan Harvey [2],
Alex Rattray[1], Laurie Laurenson [1] and Gerry Quinn [1]

[1] Deakin University, Warrnambool, Australia
[2] University of Western Australia, Perth, Australia

A fundamental step in the planning of conservation and management programs is the generation of species distribution maps and a detailed knowledge of the main environmental factors influencing their distribution. However, in countries with long and complex coastlines, such as Australia, direct observation of species is practically and economically difficult. Consequently, alternative methods are required. With the increased availability of detailed spatially-explicit remotely-sensed seafloor and observation datasets, there is potential to use this information to quantify habitat suitability for marine coastal fishes. We combine multi-beam sonar derived seafloor variables with fish observation data, obtained from remotely-operated underwater video, to compare the predictive performance of multiple presence/absence and presence-only modelling approaches. We test the predictive ability of these modelling approaches in determining potential habitat suitability of five marine coastal fishes in Victoria, southern Australia.

Modelling species distributions: the application of predicted habitat models to define demersal fish distributions

Cordelia H. Moore[1], Ben Radford[2], Euan S. Harvey[1] and Kimberly Van Niel[1]

[1]University of Western Australia, Perth, Australia
[2]Australian Institute of Marine Science, Perth, Australia

High resolution (1:25 000) hydroacoustic surveying and mapping of the benthic environment in five of Victoria's Marine National Parks has provided full coverage bathymetry, terrain data and accurate predicted benthic habitat maps for each of these parks. Here we use this information to conduct a detailed spatial analysis of the distribution of the demersal fish assemblage within one of these parks; Cape Howe Marine National Park. The research examined two statistical modelling approaches, Classification Trees and Generalised Additive Models, employed to predict species distributions. The models were investigated for their ability to identify significant species-environment relationships, and to use the environmental relationships defined to predict accurately species distributions across unsampled locations. Both statistical approaches have been demonstrated to be suited to modelling complex ecological data of this type. Generalised Additive Models have been widely applied to marine species distribution modelling and to fisheries research. However, tree based models have been applied to a lesser extent. Species distribution models were developed for 10 demersal fish species at Cape Howe Marine National Park, with environmental variables representing two scales of investigation: fine (12.5 metres) and broad (50 metres). The model providing the best predictive accuracy and deviance explained was used to predict the species distribution across the park. The Classification Trees provided the best model to define and predict 6 of the 10 the species' distributions; the remaining 4 species were better represented by the Generalised Additive Models. Of the 10 species, 8 were better represented by the broad scale variables. Environmental variables with the strongest relationship to the species distributions were: depth, relief (measured as range), reef and the Hypsometric Index (an indicator of whether the location is at a high or low point within the local neighbourhood). The research demonstrated that both statistical modelling techniques provided accurate means for predicting species distributions. In addition, it has provided a sound foundation for the monitoring of the spatial distribution of demersal fish and has enabled a more detailed understanding their spatial ecology.

Mapping habitat and biological diversity in coastal ecosystems: Bay of Islands, New Zealand

Mark Morrison[1], Scott Nodder[2], Judi Hewitt[3], Trevor Willis[4], Neville Ching[2], Don Robertson[2], Jennifer Beaumont[2], Neil Bagley[2], Andrew Swales[3], Max Gibbs[3], Els Maas[2], Steve Chiswell[2], Luca Chiaroni[3], John Mitchell[2], Alison Macdiarmid[2], David Bowden[2], Brent Wood[2], Darren Parsons[1], Wendy Nelson[2], Emma Jones[1] and the NIWA Ocean Survey 20/20 project team

[1]National Institute of Water & Atmospheric Research (NIWA), Auckland, New Zealand
[2]NIWA, Wellington, [3]NIWA, Hamilton, [4]NIWA, Nelson, New Zealand

As part of the nationally funded Ocean Survey 20/20 (OS 20/20) programme, the sea-floor habitat and biological (pelagic and benthic) diversity of the continental shelf and harbour confines of the Bay of Islands, northern New Zealand, were surveyed in 2008-10. The Bay of Islands is an iconic New Zealand tourist location, yet is host to a myriad of the common problems associated with coastal ecosystems, caused mainly by excessive sedimentation and pollution. Accordingly, the main aims of the Bay of Islands OS 20/20 project are to describe and assess the biological communities associated with different sea-floor habitat types and to describe the sediment composition, accumulation rates and sources in the Bay of Islands itself.

Multi-beam mapping of the sea-floor and a desk-top study were completed in the first phase, and integrated with side-scan sonar and aerial photographic imagery of the shallower parts of the bay. Benthic habitat diversity was determined initially qualitatively from the back-scatter response (contrast and texture), and used to plan the second phase of direct sampling. This phase was designed to establish base-line information on pelagic and benthic biodiversity in all major sub-environments, ranging from fringing mangrove forests and sea-grass meadows to shallow and deep-water rocky reefs and soft-sediment habitats. Methods used included bottom trawls for characterising demersal fish populations, Baited Underwater Video (BUV), drop and diver cameras, camera transects (still and video) using NIWA's Deep Towed Imagery System (DTIS) and Dropped Underwater Video (DUV), and epibenthic sleds for epifauna/epiflora and multi-core sampling for infaunal animals (bacteria, meiofauna, macro-infauna). Environmental data on the physical structure and circulation in the bay was collected using Conductivity-Temperature-Depth (CTD) sensors, wave and tide gauges and drifting, drogued GPS buoys to be used in later numerical hydrodynamic modelling studies. Water samples were also collected for pelagic organisms (bacteria and phytoplankton) and for information on nutrient, suspended particulate and heavy metal concentrations. Rates and sites of sediment accumulation were determined using geophysical surveying techniques (high-resolution sub-bottom profiling) and radio-nuclide dating of sediment cores (^{210}Pb, ^{137}Cs, ^{7}Be, ^{14}C). The source of sediment deposited in the bay was estimated using compound-specific stable isotope methods that isotopically fingerprint various terrigenous source materials and tracks their dispersal into the marine environment. Initial results from this comprehensive survey of a coastal and continental shelf ecosystem will be presented, outlining the main findings from the study.

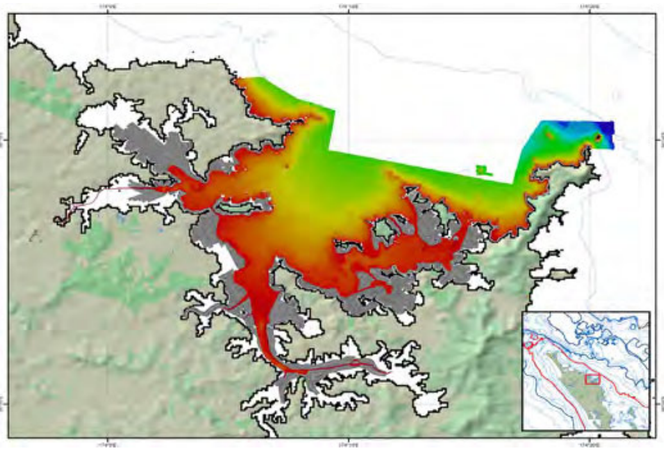


Figure 1. Bay of Islands multibeam & side-scan coverage

Large canyon-channel complexes from the west coast South Island of New Zealand show contrasting morphologies and habitat for benthic invertebrate fauna

Helen Neil[1], Alan Orpin[1], Scott Nodder[1], Ashley Rowden[1], Fabio de Leo[2], John Mitchell[1], Clark Alexander[3], Steve Kuehl[4]

[1]NIWA, Wellington, New Zealand
[2] SOEST, University of Hawaii at Monoa, Hawaii
[3]Skidaway Institute of Oceanography, Savannah, Georgia, USA
[4]Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, USA

Large submarine canyons form prominent geomorphic features that incise the continental margin. Not only do they provide conduits for off-shelf escape of terrestrially-derived material to the deep ocean, their complex morphology provides distinctive habitats for benthic communities. The west coast, South Island supports two large canyon-channel complexes fed by steep, short-reach rivers that carry ~30% of New Zealand's total riverine contribution to the sea, and form important point-sources of land-derived nutrients and bio-active material.

Recently acquired multibeam bathymetric mapping shows four principal canyon–channel complexes make up the Hokitika/Cook canyon system, which extends at least 700 km offshore and falls vertically >3000 m. Here, channels are locally entrenched up to 1000 m into the continental slope. Two of these conduits have aggraded and built levees with sea-level rise, fed by river discharge and littoral drift where they cross the shelf and upper slope. The upper reaches of the complex are up to 28 km wide and comprise numerous v-shaped canyons feeding into multiple, sinuous and migrating channels. In contrast, the lower reaches of the channels are incised, erosional and narrow. The channel confluences are marked by hanging valleys, indicating that the Cook Channel is either the distributary system that has sustained the latest and/or at least the largest avulsive event. Dependant on location, sediments within this channel-levee system range from well-sorted, mica-rich silts and sands to coarser turbidite deposits and last glacial gravels.

In contrast, the Moeraki/Waiatoto complex to the south extends offshore to >4000 m water depth, with a primary channel (Moeraki) that is flat-bottomed and steep-sided, incised 500-800 m into the slope, and considerably larger at 5 km-wide. This primary channel is fed by three near-shore canyons, and sediments within the channel-levee complex are mainly coarse sands and gravels to well-sorted, mica-rich silts, respectively. Similarly, the Waiatoto canyon system is fed by at least four near-shore canyons at its head as well as by gravel-rich, glacial outwash fans at its shoreward flank. The Moeraki Canyon feeds into the Milford Basin and eventually the Haast Channel. The Moeraki/Waiatoto systems merge to form a single, entrenched, north-westerly trending channel that continues onto the abyssal plain.

Radiochemical accumulation rate data shows high sedimentation in intra-canyon slope areas, whereas along the canyon axes slow sedimentation and persistent erosion occurs. Regionally sediment accumulation rates increase five-fold between the northerly Hokitika/Cook system and Moeraki/Waiatoto to the south. Organic carbon data show that, contrary to expectations, higher amounts of more labile organic material are found at the intra-canyon continental slope sites, although additional sampling is required to fully characterise the system. Results from studies of seabed communities of canyon and slope environments (including Kaikoura Canyon, northeast coast of the South Island) indicate that habitat complexity and the availability of labile organic matter has a dramatic impact on abundance, diversity, and distribution of benthic invertebrate fauna within and among the canyons, and nearby slope areas.

Inherited Geomorphology as a Control of Shallow Marine Habitats: Carnarvon Shelf, Western Australia

Scott Nichol and Brendan Brooke

Geoscience Australia, Canberra, Australia

New high resolution multibeam sonar mapping of the Carnarvon continental shelf, central Western Australia, reveals a complex morphology of coral reefs, ridges and sandy seabed. This paper focuses on a 280 km^2 mapped area offshore from Point Cloates (22.72^o S, 113.65^o E), seaward of Ningaloo Reef World Heritage Area. Here the inner- to mid-shelf boundary is defined by a 20 m high shore-parallel ridge that extends 15 km in 60 m water depth. In profile, this ridge preserves the largely unaltered form of a beach and foredune system. We interpret this to be a drowned shoreline formed during a sea-level stillstand approximately 12 – 13 ka BP. Landward of the drowned shoreline, the inner shelf is covered by hundreds of small interconnected patch reefs (bommies) up to 5 m high and a series of linear ridges up to 1.5 km long and 16 m high. The patch reefs are scattered but the ridges are uniformly oriented to the north-northeast and several ridges converge at their landward limit. On the basis of their shape and alignment, which is coincident with the prevailing wind direction for this coast, these ridges are interpreted as relict parabolic dunes. The preservation of these dunes is attributed to cementation of calcareous sands to form aeolianite, prior to the marine transgression. Underwater photography and seabed sampling shows that these ridges and patch reefs now provide habitat for dense coral and sponge communities, whereas the surrounding seafloor is characterised by rippled to flat, fine to medium sand with relatively low densities of epibenthic organisms. Similarly, the mid-shelf and outer-shelf are mostly sediment covered with low benthos abundance. Low profile ridges occur on the outer shelf and are also interpreted as partially preserved relict shorelines. Clearly, the antecedent geomorphology of this shelf, inherited from a period of lower sea levels, exerts a strong control on the distribution and abundance of marine benthos today. This study demonstrates the value of detailed geomorphic mapping as a physical surrogate for defining marine habitats and for informing the design of marine protected areas.

Marine habitat mapping ground truth: testing the position accuracy of a geo-localization system used for *in-situ* sampling against an acoustic USBL device

A. Norro *[1], K. Degrendele[2], W. Versteeg[3], J. Vercruysse[3] and M. Roche[2]

[1] MUMM, Royal Belgian Institute for Natural Sciences, Gulledelle 100, B-1200. Bruxelles
[2] Belgian FPS Economy, avenue du Roi Albert II, 16, B-1000 Bruxelles
[3]RCMG, University Gent, Krijgslaan, 281, S8, B-9000 Gent

Ground truth is widely used to assess confidence on marine habitat maps. Data collection on the field need to have a better and better accuracy in order to cope with the new standard of maps realized using modern multibeam echo sounding.

In this context, a Global Positioning System (GPS) buoy towed system is used by scientific diver for the geo-localization of sea bed video image and *in-situ* measurement like sand thickness. This paper describes the experiment that was set-up for testing the accuracy of that low cost, easy to deploy and Platte form independent system against a state of the art Ultra Short BaseLine (USBL) underwater localization acoustic system IXSEA-GAPS.Aiming to reduce the known impact of bubble on the acoustic signal, two closed circuit rebreather (CCR) dives were realized in 2009 in real condition on the Belgian North Sea continental plate from the RV Belgica. Time is used to synchronize all measurements and the video images.

That experiment showed despite the high level of noise observed on the acoustic signal (attributed to high incidence angle due to the geometry of the experiment) that the GPS buoy system is providing in real field condition featuring strong tidal current, waves and depth ranging from 12 to 45m a position that is always within 5m of the position provided by the state of the art USBL localization system.

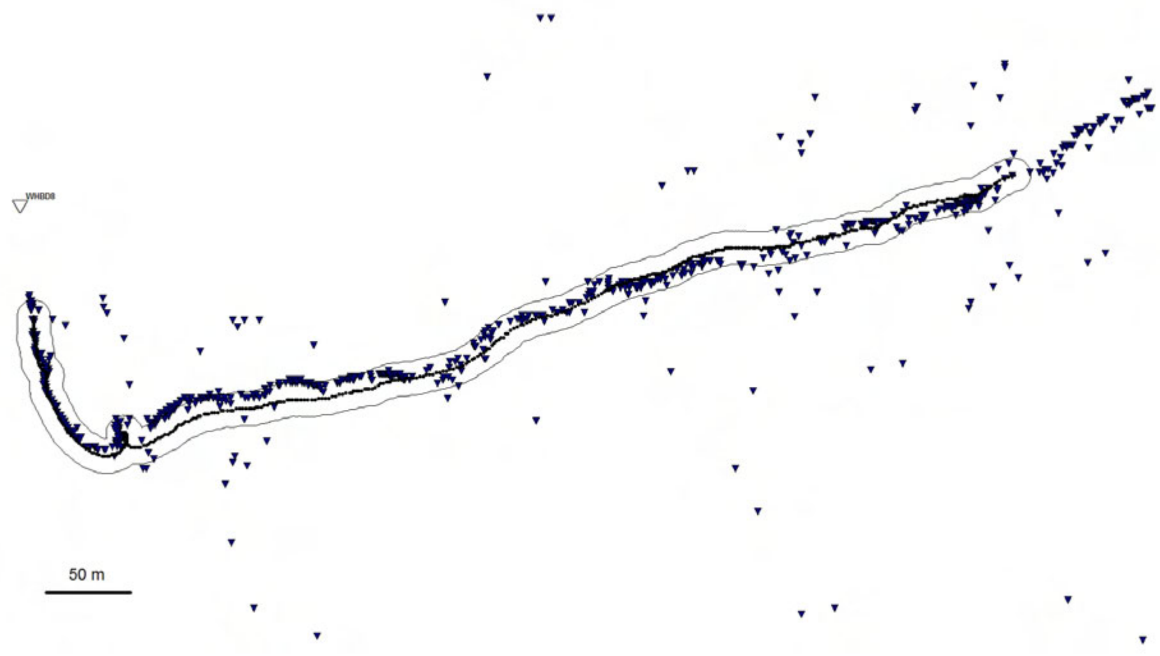


Figure 1. Comparison between black bold line (GPS track) and triangles (acoustic positions). Hair lines are buffer of 10 m on GPS track. Noise on acoustic positions, see text.

Wellington South Coast and Spirits Bay Portfolios: Presenting Habitat Mapping to Stakeholders

Arne Pallentin[1], Ian C. Wright[2], Kevin Mackay[1]

[1]National Institute of Water and Atmospheric Research Ltd. (NIWA), Wellington, New Zealand
[2]National Oceanography Centre, Southampton, European Way, SO14 3ZH, United Kingdom

Results of habitat mapping are commonly presented in reports, often as large scale figures on A4, at best A3 pages. Usually these don't pay credit to the detail often included in the underlying datasets.

In an effort to present these datasets in a more impressive way, NIWA's ocean geology group devised a set of portfolios of A2 size maps presenting early habitat mapping efforts on the Wellington South Coast and at Spirits Bay in a 'show case' publication. These portfolios have been used to present habitat mapping potential to stakeholders in local and national government, as well as science foundations.

The Wellington South Coast Portfolio was also used to support the case for the Taputeranga Marine Reserve which since has been gazetted. The data shown are also used by the Department of Conservation and the Centre for Marine Environmental & Economic Research at Victoria University Wellington to plan their respective sampling and monitoring efforts.

The Spirits Bay Portfolio additionally focuses on the comparison between backscatter data acquired by a Kongsberg EM3000D and simultaneously collected side-scan-sonar data (C-Max CM2, 102/325KHz).

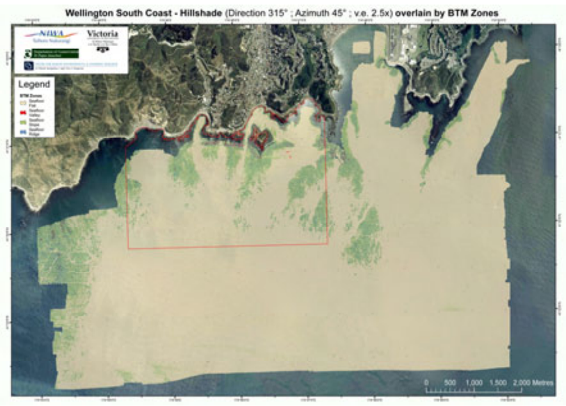


Figure 1. Wellington South Coast BTM classes

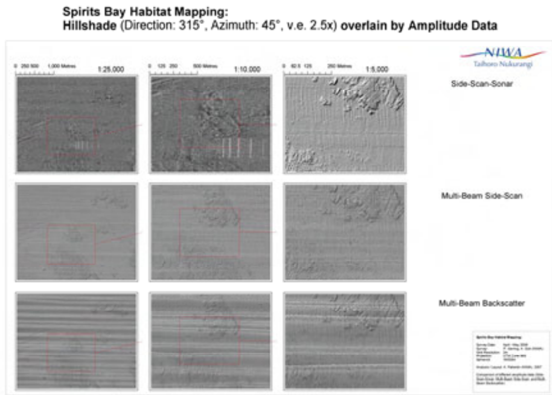


Figure 2. Spirits Bay Amplitude data

The alkaline hydrothermal field of the Prony Bay, Southern New Caledonia

Bernard Pelletier[1] and Claude E. Payri[2]

[1]UMR Géoazur – IRD, BP A5 Nouméa New Caledonia
[2]UR Coréus2 – IRD, BP A5 Nouméa, New Caledonia

New Caledonian hydrothermal springs have been known since the 1900s and the Prony hydrothermal spire was discovered in 1975. The significance and extension of the Prony hydothermal activity were newly revealed during 2004 and 2005 R/V Alis cruises. Multibeam mapping of the Prony Bay revealed a field of a few meter-high domes and pinnacles, at a depth of 50 to 60 m sometimes located on 200 meter-wide and a few meter-deep circular depressions. SCUBA prospecting revealed active chimneys composed of calcium carbonate and magnesium hydroxide material, delivering uncoloured and low temperature fluid which may allow development of microbial communities and prebiotic molecules. Numerous organisms, including alcyonarians, azooxanthellate scleractinians, sponges, crustaceans, fishes, and encrusting red calcareous algae, colonized the chimneys under extreme sedimentation, turbidity and low irradiance condition.

The Prony site shows similarities to the Lost City alkaline hydrothermal field discovered in 2000 near the Mid-Atlantic Ridge, such as high pH, deposit of CaC03 and Mg Hydroxyde and peridotitic substratum and the fact that they probably derived from hydratation of the outcropping mantellic rocks. The main difference between the two sites is the geological setting: while the Lost City site is located at a depth of 800 m on an ultrabasic massif off the Mid-Atlantic Ridge axis, Prony is in a coastal environment at depths ranging from 30 to 50 m on a peridotitic nappe emplaced in the late Eocene and located in a tectonically active area.
The Prony site offers an exceptional opportunity to study and monitor an alkaline hydrothermal system using SCUBA and relatively easy and cheap logistics and allows for comparison of a coastal system with the deep Lost City site. A multidisciplinary study dealing with the geology of the substratum, the nature of the deposits and fluids, and the biodiversity and microbial diversity associated with the vents has been proposed on the submarine hydrothermal system of Prony Bay.

GIS-Mapping of Marine Benthic Habitats using Expert-based and Statistical Methodologies

Roland Pesch, Susanne Ranft, Marc Busch, Winfried Schröder

Chair of Landscape Ecology, University of Vechta, Germany

Since Germany's territorial waters and its Exclusive Economic Zones (EEZ) are increasingly influenced by economic uses data on the spatial patterns of benthic habitats are badly needed. The presentation therefore presents two approaches how this goal can be reached by applying expert based and statistical methodologies. The first study exemplifies the application of the EUNIS habitat classification system of the European Environmental Agency (EEA) on geodata available for the seafloor of the study area. Measurement data on salinity, dissolved oxygen and grain size as well as surface maps on bathymetry and sediment conditions were acquired from different national and international databases and projects and integrated into a spatial database management system. All available geodata layers were then queried according to the criteria provided by EUNIS down to the fourth level. As a result benthic habitats could be mapped within and near the EEZ for two degrees of spatial differentiation. The produced maps provide a surface covering view but it can easily be detected that different maps with different spatial extents and resolutions were considered for the classification. Furthermore, difficulties occurred when trying to classify habitats according to the EUNIS criteria. The second approach relies on statistical decision tree models and aims at predicting the occurrence of benthic communities. From bottom water measurements on salinity, temperature as well as from punctual data on grain size ranges (0-63µm, 63-2000µm) raster maps are calculated using geostatistical methods. After intersecting these raster maps with punctual data on eight benthic communities three different decision tree models were applied to predict the occurrence of these communities within the study area. Mapping benthic habitats by applying decision tree models produced scientifically reasonable results but have to be optimised in future by integrating additional data and methods.

The role of physical environmental variables in shaping seabed biodiversity patterns

Roland Pitcher[1], Nick Ellis[1], Peter Lawton[2], Stephen Smith[2], Chi-Lin Wei[3], Lew Incze[4], Michelle Greenlaw[2], Jess Sameoto[2], Nick Wolff[4], Tom Shirley[5], Gil Rowe[3]

[1] Commonwealth Scientific and Industrial Research Organisation, Australia
[2] Fisheries and Oceans Canada, Canada
[3] Texas A&M University, USA
[4] University of Southern Maine, USA
[5] Harte Research Institute, USA

Biodiversity pattern distribution information is fundamental for planning and management in the marine environment, yet is severely lacking for most marine regions — partly due to the great expense and time required for biodiversity surveys. To serve the immediate need, more readily available physical data coverages are often used as surrogates for biodiversity patterns. However, physical variables are measured on arbitrary scales unlikely to be directly relevant to biology — to make the connection, knowledge of the relationships between biological patterns and physical variables is essential. As a contribution to the synthesis phase of the International Census of Marine Life (CoML), we explored these relationships by applying a novel analysis approach, based on modification of the statistical method randomForest (a bootstrapped randomized partitioning tree method), that elucidates the shapes and magnitude of multiple species responses to as many as 30 physical gradients, including thresholds, in addition to quantifying the extent to which physical surrogates explain biological patterns and the importance of each physical variable. These responses were compared for meso-scale biological and physical datasets from contrasting shelf biogeographic regions in tropical Australia, deep Gulf of Mexico and temperate Gulf of Maine. The biological survey datasets comprised site-by-species abundance data from trawls, benthic sleds, and grabs/cores. The modified method collates split points and Δdeviance information for each physical variable from 100's of regression trees for each species. These results are expressed as cumulative distributions of splits deviance, weighted by variance explained, summed over multiple species, and represent patterns of biological compositional change response along gradients for each physical variable. We believe this approach has significant potential as a robust method of quantitatively integrating information from across multiple disparate surveys that used different sampling devices. The results show that biological compositional change is non-linear along gradients, that some variables are more important than others but this variable importance differs for different survey types and regions, and that overall the physical surrogates may explain 10-30% of biological abundance patterns (range 0-80%). This information is contributing to understanding the role of physical gradients in determining species distributions at mesoscales, provides information to facilitate design of future biodiversity sampling programs, and is having applications as "biologically-informed" transformations of the more readily available physical data to provide predictive maps of expected seabed beta diversity patterns in a way that better reflects biological patterns than physical variables alone. Further, we hope this information will focus more routine production of biologically relevant variables from the marine geological and oceanographic community.

Image-based habitat classification and analysis using generative models

Oscar Pizarro[1], Stefan Williams[1], Jamie Colquhoun[2], Cordelia Moore[2]

[1]Australian Centre for Field Robotics, University of Sydney, NSW, Australia
[2]Australian Institute of Marine Science, Perth, Western Australia

Benthic imaging Autonomous Underwater Vehicles (AUVs) can provide geo-referenced imagery with consistent altitude and illumination that is suitable for human expert analysis. However, as these platforms become part of monitoring programs, human interpretation will turn into a bottleneck in any pipeline abstracting visual data into quantitative information.

Automated object recognition has advanced over the last decade partly motivated by large collections of tagged imagery on the Internet. Simple `bag of features' approaches rely on a vocabulary of features (analogous to words in a dictionary) and represent images as a signature vector based on the frequency of occurrence of features/words. While effective, signatures and visual features are not readily interpretable by humans thus limiting automated analysis to whole-image classification (using examples) or clustering (using similarity of signatures).

To be generally useful, automated analysis should provide quantitative information at scales smaller than an image (e.g., percent cover). Promising approaches rely on hierarchical generative models to jointly describe visual features and textual labels associated to objects in the image, capturing the intuition that knowing the image class should help segment it, while knowing image labels should help classify it. In essence, hierarchical models introduce intermediate abstractions that provide structure recognisable by humans. For example, topic-based approaches model a document as a mixture of topics, with each topic a distribution of words that is learned in an unsupervised fashion. In the case of text documents it is easy to associate a theme to a topic, given its most common words. For visual data a topic will not necessarily represent a recognizable aspect of the image, since topics reflect statistical correlations and do not capture spatial proximity.

We investigate the use of hierarchical generative models such as the author-topic model and their potential to emulate human analysis. Author-topic models assume each document/image is generated by a mix of authors/benthic components, where each author/benthic component is modelled as a distribution over topics and each topic, in turn, represents a distribution over words/visual features. We show that given proper features, images tend to segment into semantically relevant components.

We present results from supervised (using human-labelled training sets) and clustering of imagery from AUV surveys of Scott Reef, Western Australia. The performance of automated classification relative to human-based visual assessment is discussed, with multibeam and 3D stereo reconstructions providing spatial context to the interpretations.

Physical controls on deep-water coral communities on the George V margin, East Antarctica

Alexandra L. Post[1], Philip E. O'Brien[1], Robin J. Beaman[2], Martin J. Riddle[3] and Laura De Santis[4]

[1]Geoscience Australia, Canberra, Australia
[2]James Cook University, Cairns, Australia
[3]Australian Antarctic Division, Hobart, Australia
[4]Instituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste, Italy

Dense coral-sponge communities on the upper continental slope at 570-950 m off George V Land, East Antarctica have been identified as 'vulnerable marine ecosystems' (VMEs) by CCAMLR and are now closed to bottom fishing. The challenge now is to understand their likely distribution on other parts of the Antarctic margin. We propose some hypotheses to explain their distribution on the George V margin.

Icebergs scour to about 500 m in this region and the lack of such disturbance is a likely factor allowing the growth of rich benthic ecosystems. In addition, the richest communities are found in the heads of canyons. The canyons in which they occur receive descending plumes of Antarctic Bottom Water formed on the George V shelf and these water masses could entrain abundant food for the benthos. The canyons harbouring rich benthos are also those that cut the shelf break. Such canyons are known sites of high productivity in other areas because of a number of oceanographic factors, including strong current flow and increased mixing with shelf waters, and the abrupt, complex topography.

These proposed mechanisms provide a framework for the identification of other areas where there is likely to be a risk of encountering such VMEs.

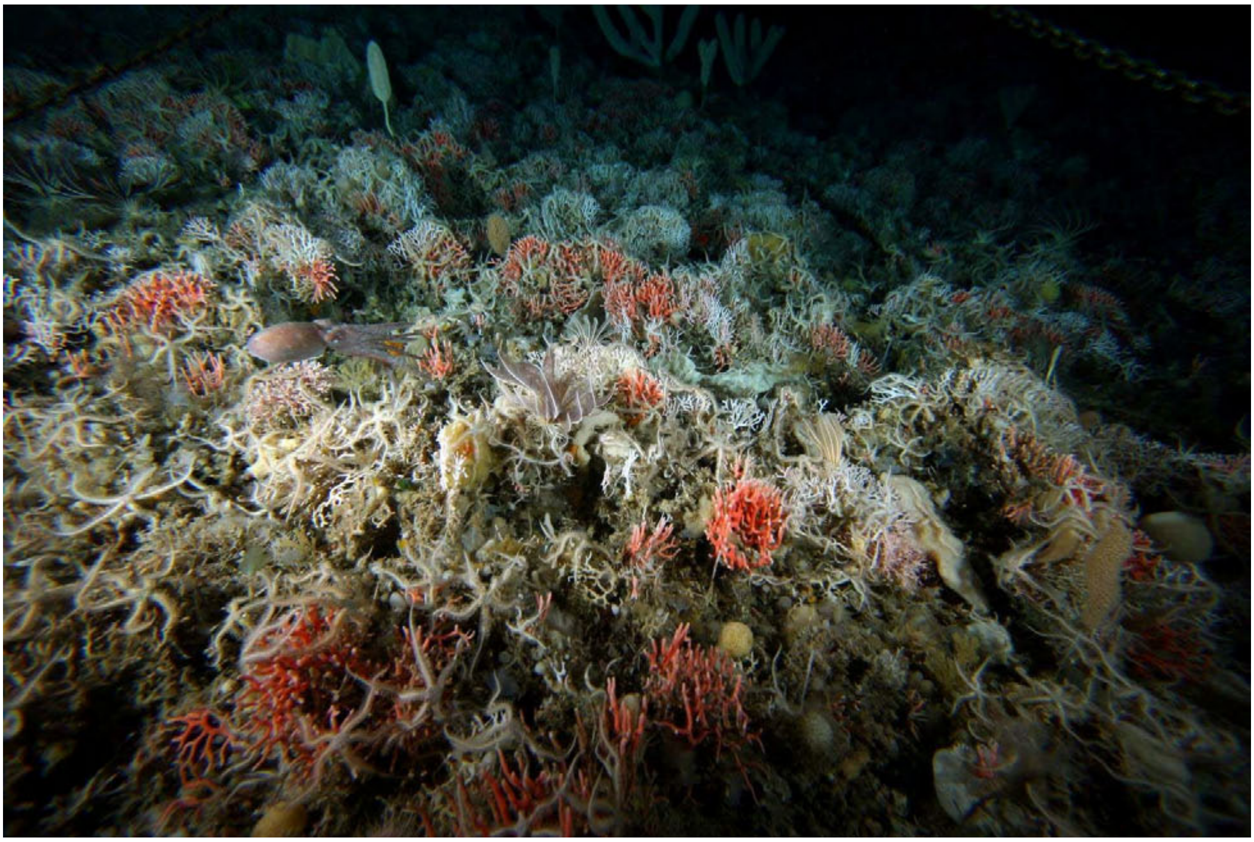


Figure 1. Dense stylasterid coral and sponge community on the George V margin

Habitats and Benthos of Vityaz Bay of Peter the Great Bay, Sea of Japan, Russian Federation

Boris V. Preobrazhensky, Vassily V. Zharikov

Laboratory of Underwater Landscape Studies, Pacific Institute of Geography,
Far Eastern Branch of Russian Academy of Sciences, Russian Federation, 690041 Vladivostok, 7, Radio st.

Vityaz bay is a secondary bay of the Peter the Great Bay of the Sea of Japan. It represents one of the most typical marine shelf aquatories of Russian Far-East. The place of origin of the whole underwater landscape studies methodology and corresponding landscape typology in Russia. The bay played the important role of the site for numerous model investigations.

Two successive main iterations of underwater landscape mapping of habitats were undertaken by the Laboratory of Underwater Landscape Studies of Pacific Institute of Geography of Russian Academy of Sciences using a complex routine of recognising, simulating and mapping of sea floor biomes. Landscaping (i.e. bentheme) methodology was developed during period of 1986 - 1996. Drawing the bentheme map allows working out the theoretically based approach to localization of objects of industrial activity in the marine environment. Planning and allocation of sites for aquaculture requires adequate knowledge of trophodynamic characteristics of habitats. According to our terminology, the habitats are named benthemes which is equivalent to the benthic geosystems. There is a whole discussion devoted to this subject published by present authors elsewhere.

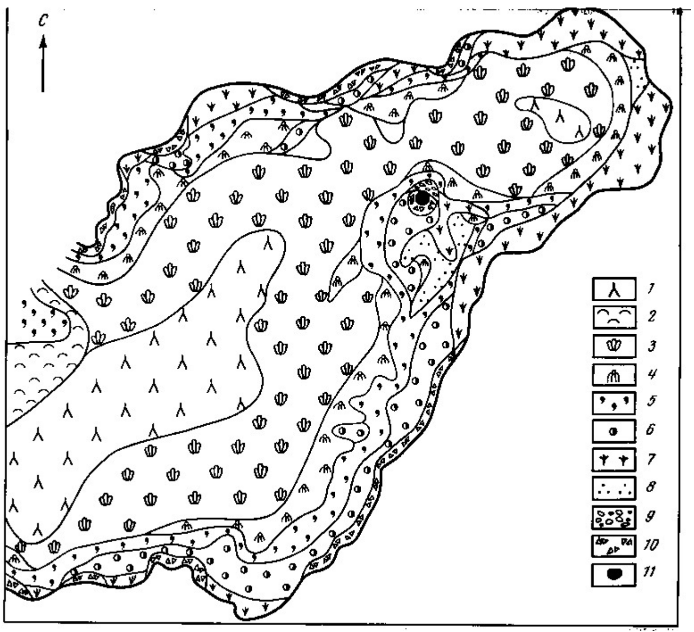


Figure 1. Bentheme map of Vityaz Bay. 1- retina; 2-metagest; 3- verrucoid; 4- scatebra; 5- conchium; 6- fractum; 7- segety; 8- arenoid; 9-pelty; 10- concisium; 11- saxosium

Specific classification and nomenclature was developed. Abridged description of main landscape facies (benthemes) of Vityaz Bay is given from shallow to the deepest ones. Landscape mapping, when it is done according to the designed guidelines, allows one to extract from benthemes the series of various maps from the same data source. Those maps derived from the map of benthemes may be relief map, seafloor steepness map, sediment, energy, maps of fauna and flora according to the species lists. Bentheme map may be used for monitoring and industrial use including the ecological expertise and allocation of places suitable for farming.

Combining multi-antenna GPS motion sensing with the Benthos C3D multi-beam to produce accurate swath bathymetry

Scott A.N. Preskett

University of Otago, Dunedin, New Zealand

The demands of modern shipping, with ever smaller Underkeel Clearances in harbours, are driving the push for more accurate and more complete bathymetry data. This has the benefit of providing better models of the underwater 'landscape' for other users interested in the benthic environment.

An L shaped array of 3 Trimble GPS antennas is used to measure (horizontal) position, heading, pitch, roll and heave, needed to compensate for vessel motion when collecting multibeam bathymetry data. Each antenna has a separate receiver, and also receives Fugro Omnistar differential corrections. One antenna is designated 'master' (recording position) and the other two form RTK baselines from it to measure horizontal and vertical angles. The array is aligned with one baseline fore and aft, the vertical measurement providing pitch, and the other baseline at 90 degrees, providing (horizontal) heading and (vertical) roll.

A static trial (nil waves or wind) conducted onboard the *Polaris II*, with a roll baseline of 3.7 metres, measured roll at 10Hz with a standard deviation of 0.07˚. With a simple process of boxcar averaging with a one second box, the standard deviation was reduced to 0.05˚. The 0.4 metre pitch baseline measured pitch at 10Hz with a standard deviation of 0.20˚. With the same boxcar averaging, the standard deviation was reduced to 0.10˚. The system was then used in conjunction with a Benthos C3D survey within Otago Harbour, with promising results.

This is the first step in ongoing research into the use of the 3 antenna motion sensing system. The intention is to be able to provide a post-processed dataset of heading, pitch, roll and heave 'at the sonar', all with associated uncertainty values needed for modern multibeam processing. The processing system should also be able to cope with spikes and gaps in the GPS data, which can happen in harbours with tall buildings, high wharves, bridges etc. The difference in using RTK corrections versus Differential GPS corrections will also be analysed.

It is hoped that with a GPS based system, bathymetric data can be easily collected in relation to the spheroid. This can be used in conjunction with RTK equipped commercial ships to provide an effective tool in Underkeel Clearance management, as well as providing data in a vertical datum comparable to land based data.

Predictive modelling of deep coral reefs using multibeam, AUV and machine classified data

Ben Radford[1], Oscar Pizarro[2], Jamie Colquhuon[1], Tim Cooper[1] ,Cordelia Moore[1], Stefan Williams[2], Mike Jakuba[2], Duncan Mercer[2], George Powell[2], Chris Davis[1], Andrew Heyward[1], Mike Sexton[3], Shoaib Burq[3]

[1]Australian Institute of Marine Science, Perth, Western Australia
[2]Australian Centre for Field Robotics, University of Sydney, New South Wales, Australia
[3] Geosciences Australia, Canberra, Australian Capital Territory

Historically, the application of remotely sensed data (such as satellite imagery and aerial photography) as a tool for mapping broad areas of coral reefs has largely been limited to reefs shallower than 30 m due to light attenuation. Recently this has changed with the introduction of hydro acoustic sensors that can collect high resolution bathymetry and autonomous underwater vehicles (AUVs), which collect high resolution optical imagery. We demonstrate when these two data sources are post-processed using a) new automated image classification techniques and b) ecological modelling methods then this synergy can provide a method for modelling and mapping living coral reef and associated major benthos down to depth of 70 meters.

We demonstrate this method using deeper coral reefs areas from south Scott Reef lagoon, Western Australia. This modelling approach involves several stages: (1) collecting and processing raw hydroacoustic multibeam bathymetric data (2) a targeted stratified sampling design, (3) acquisition of high resolution geo-referenced optical imagery (using an AUV), (4) automated image classification, (5) extensive secondary modelling on primary data, such as bathymetry, to develop spatial surfaces, which are relevant to both the physical and biotic aspects of a site, (6) integrating spatial surfaces and in situ information, (7) the development of predictive habitat models, and (8) the spatial extension of the *'in situ'* data to the unknown areas using the predictive models. These steps provide a recipe to build robust spatially explicit models of reef substrate and major benthic biotic groups. This data-method combination facilitated development of high accuracy maps of both hard coral distribution and other important biotic groups where traditional spectral remote sensing methods would fail.

Assessment of the Ecological coherence of the Baltic Sea Protected Areas by use of GIS-Methods and Available Geoinformation of Benthic Landscapes

Susanne Ranft, Roland Pesch, Winfried Schröder, Dieter Boedeker

Chair of Landscape Ecology, University of Vechta, Germany

The world's oceans today face a variety of threats and dangers resulting in severe marine environmental degradation. As a recognized powerful tool to save our oceans and sustain their vital biodiversity several international and regional conventions and political frameworks require the establishment of networks of marine protected areas (MPA). In 2003, HELCOM and the OSPAR Commissions met for the first time together in Bremen, Germany, where the environment ministers reaffirmed their commitments to establish an ecologically coherent network of well-managed marine protected areas by 2010. Within the Baltic Sea the network should be compiled of Baltic Sea Protected Areas (BSPA) in conjunction with Natura 2000 sites. To evaluate the implementation of the 2010 target this assessment was conducted with a foregoing update of the existing BSPA database, accomplished by an extensive survey asking the contracting parties for information on BSPAs within their Baltic Sea marine area. The questionnaire comprised queries on general information such as geolocation and MPA status, reasons for selection, management measures, threats to the area, and present or protected species, habitats and biotopes. In a first step an appraisal was executed specifying the retrieved information for each category in the questionnaire for all states, the HELCOM sub-regions and the Baltic Sea, respectively. Furthermore, BSPAs were aligned with Natura 2000 sites and spatial characteristic of both networks were analysed. In a next step the assessment of ecological coherence was conducted. It comprises the analysis of the four criteria to be fulfilled by a network of protected marine areas, i.e. adequacy, replication, representation and connectivity. For that purpose extensive GIS and statistical analyses were carried out using the ecologically relevant geographical data on BSPAs and Natura 2000 sites. The latter includes a map on benthic landscapes which was derived within INTERREG III B co-funded project BALANCE. Overall the assessment revealed that regardless of the good developments during the past years, the network can not yet be considered as ecologically coherent. Consequently more efforts are needed in order to meet the HECLOM 2010 target.

Mapping and modelling spatial distribution of important nature types such as kelp forest, sea grass beds and shell sand, procedures and results from a national mapping program in Norway with focus on the Skagerrak region

Eli Rinde[1], Janne Gitmark[1], Hartvig Christie[1], Wenche Eikrem[1], Heidi Olsen[2], Reidulv Bøe[2], Henning Steen[3], Torjan Bodvin[3]

[1]Norwegian Institute for Water Research (NIVA), Norway
[2]Geological Survey of Norway (NGU), Norway
[3]Institute for Marine research (IMR), Norway

In the period 2007-2010 a national programme on mapping marine biodiversity has been mapping the distribution of some selected important nature types such as kelp forest (*Laminaria hyperborea*), sea grass beds (mainly *Zostera marina*) and shell sand, in about half of the coastal municipalities in Norway. The most populated part of the coastal zone, the Skagerrak region, had high priority and was started as soon as the program was initiated. Hence, the first mapping phase is almost completed for this region. GIS modelling has been used both as a tool for field sampling and for establishing predictive models for the spatial distribution of the mapped nature types. The presentation will show the procedures for planning and performing the mapping and modelling, and the goodness of fit of the resulting distribution models. We will discuss the application of the results/models to management, including the usefulness of the methods in achieving measures for ecological reference condition and hence setting the standards for good ecological conditions.

Automated delineation of acoustic themes from Multibeam backscatter data for seafloor characterization, Tapuae Marine Reserve, NZ.

Alexandre C.G. Schimel[1], Yuri Rzhanov[2], Luciano Fonseca[3], Larry Mayer[2],
Terry R. Healy[1] and Dirk Immenga[1]

[1] Coastal Marine Group, Department of Earth & Ocean Sciences, University of Waikato, Hamilton, New Zealand
[2] Center for Coastal and Ocean Mapping, University of New Hampshire, Durham, NH 03824, USA
[3] Intergovernmental Oceanographic Commission, UNESCO, Paris, France

The importance of seafloor characterization has been steadily growing over the recent years due to an increasing interest in the mapping of seafloor habitats in a context of issues of biological sustainability. It is now generally agreed that backscatter data acquired by multibeam echosounders (MBES) and processed with automated techniques currently present the most productive approach for remote seafloor characterization. Most of these techniques are based on the principle of segmentation of a mosaic compiled after correction of the backscatter angular dependence. Some techniques, however, rely on the use of the angular dependence itself as a discriminator between seafloor types.

A methodology was developed and previously reported (Fonseca *et al.*, Geohab 2009) that mix both approaches in order to combine their respective advantages. Firstly, the mosaic is formed and segmented in small areas assumed to be acoustically homogeneous. Secondly, the segments are coalesced on the basis of their spatial proximity and similarity in angular response to a predefined set of facies obtained from a coarse segmentation of the same mosaic. The result of this process is the formation of larger homogeneous acoustic themes that are independent from the mosaic artifacts. Thirdly, a geoacoustic model for soft sediments is used to obtain estimates of average grain-size, acoustic roughness, and volume scattering from each theme’s angular response.

The two first steps can be viewed as an algorithm of segmentation of the backscatter data in both the image space and the angular-response space and therefore combine the advantage of full mosaic resolution with use of full backscatter data. This algorithm is computationally intensive but is automated and controlled by a small set of empirically chosen parameters, which allows for easy adaptation for a particular need of the researcher.

Final proof of any methodology’s validity is correlation between theoretical predictions and results of ground-truthing. In this paper the authors concentrate on such an analysis performed for a Simrad EM3000 300 kHz MBES dataset acquired in 2007 over the Tapuae Marine Reserve, in New Zealand, and a ground-truth dataset composed of underwater video footage and grab samples. The authors also introduce the latest methodology developments, which include a variation in the coalescence stage to make it independent of the facies currently used for labeling, and an extension of the delineation procedure that seamlessly incorporate available ground-truth data from grab samples or underwater video.

Habitat Mapping in Aitutaki, Cook Islands

Ashishika Sharma[1], Jens Kruger[1], Salesh Kumar[1], Chris Roelfsema[2] and Ngere George[1]

[1]Pacific Islands Applied Geoscience Commission, SOPAC
[2]University of Queensland, Australia

Atolls and low reef islands in the Pacific are complex settings as the water depths and habitats are extremely variable. The variability is due to the very environments that make up an atoll which consists of a shallow lagoon with numerous coral reefs or sandy areas, surrounded by multiple small islets and finally the deep ocean waters. Reef habitats in benthic (sea floor) environments provide tremendous economic benefits to coastal nations which rely on the aquatic wildlife as a source of food as well as a source of income from tourism.

The Pacific Islands Applied Geoscience Commission (SOPAC) applied survey techniques in Aitutaki, Cook Islands, to map reef habitats in shallow lagoon areas and geomorphological features in the surrounding ocean waters. The resultant benthic habitat map was produced using standard image processing techniques with a combination of high spatial-resolution imagery and benthic field data, for use as a base map to determine the possible impacts of changes in reef hydrodynamics resulting from increasing the size and depth of the major boating channel.

Ultimately, the SOPAC Habitat Mapping project furthers progress in ecosystem based management through the combination of habitat mapping and hydrodynamic modeling in coral reef environments.

The thematically rich marine habitat map capturing the characteristics of the marine ecosystem, with other underlying bathymetry data, was uploaded on Google earth as a means of distributing data to a wider audience.

Some issues in predicting biodiversity using spatially modelled covariates

Hideyasu Shimadzu[1], Scott D. Foster[2,3] and Ross Darnell[2,3]

[1]Geoscience Australia, Canberra, Australia
[2]CSIRO Wealth from Oceans Flagship
[3]CSIRO Mathematics, Informatics and Statistics, Australia

Investigating how biodiversity varies with the environment and predicting patterns of biodiversity have received much attention in ecological science as well as from a government management perspective. Frequently, the approach taken for the prediction is a regression type statistical model where the physical variables such as depth, %carbonate, %mud for example are covariates. However, the physical variables are not commonly measured at the same locations where the biological data were taken from. Instead, they are point predictions from spatial models which may include an extra source of uncertainty. This is almost always ignored when performing statistical analysis. It is not immediately clear what kind of effects the spatially modelled covariates will bring onto the inference of biodiversity prediction.

This talk addresses some issues on predicting biodiversity when spatially modelled covariates are used in a particular model class (Generalised Linear Models) and similar results should be available for other types of models. It appears that the primary issue is a bias of unacceptable size for the assumed statistical distribution of biodiversity. This has direct effects for the estimation of statistical models and subsequent prediction. A simulation study was performed to investigate the potential size of the bias based upon real physical and biological data sets observed from the Great Barrier Reef Lagoon.

The effects of sampling in marine surveys on biodiversity estimation

Hideyasu Shimadzu[1] and Ross Darnell[2,3]

[1]Geoscience Australia, Canberra, Australia
[2]CSIRO Wealth from Oceans Flagship
[3]CSIRO Mathematics, Informatics and Statistics, Brisbane, Australia

Scientific trawl and sled surveys are necessary tasks to understand biodiversity in marine science. Differences in the collection methods between locations and in the processing of species within a location increase the risk of bias in estimates of biodiversity. Repeat measurements under the exactly same conditions at a site are impractical.

To investigate this issue, a simple conceptual model is proposed reflecting a commonly used sampling process in marine surveys and an exploratory analysis is undertaken. The analysis is based on the observations from the Great Barrier Reef Lagoon and highlights the influence sub-sampling has on the recording of presence of species.

Geo-statistical mapping of sediment composition with application to habitat classification

David Stephens, Markus Diesing and Roger Coggan

Centre for Environment, Fisheries and Aquaculture Science (Cefas), Lowestoft, United Kingdom

Marine spatial planning and conservation both require sufficiently detailed knowledge on seabed sediments and habitats. Yet, only a few countries have so far initiated and executed large-scale seabed mapping programmes due to the involved high costs. An alternative or complementary approach in the interim would make best use of data that is currently available. Typical data sets for such a task encompass seabed sediment data, bathymetry and modelled oceanographic data. Here we describe an approach that uses such data sets from the North Sea to map seabed sediment composition and EUNIS habitats through geo-statistics. The EUNIS habitat classification system uses substrate type, energy level and photic zone to discriminate among habitat classes in the upper three levels of the classification hierarchy.

We applied a hybrid spatial prediction model to map the sediment composition of the North Sea. The approach employed both correlation with auxiliary predictors and spatial autocorrelation in prediction. The % Sand, % Mud and % Gravel values were then analysed in a GIS to classify the seabed according to EUNIS level 3 habitats.

We applied a regression-kriging approach to map the variability of the dependant variable. The predictors included bathymetry at varying resolutions, derivatives from the bathymetric digital elevation model including: slope, rugosity, curvature, aspect and the bathymetric position index. Predictors derived from oceanographic models included seabed shear stress from tides and wave base.

We created a semivariogram of the residuals from the regression model to examine its spatial structure. As spatial auto-correlation was present, simple kriging was applied to interpolate the residuals between sample points. Finally the two layers were summed to produce the final prediction layer.

There are several benefits of this coupled approach where deterministic (regression modelling) and stochastic (kriging) elements are combined, as the use of the deterministic model alone would ignore the spatial auto-correlation present in the data and using spatial interpolation alone ignores underlying trends in the data that can be explained (at least partially) by using secondary variables.

This approach also allows for a range of deterministic models such as General Additive Models or Neural Networks to be applied to explain more complex non-linear relationships between the predictors and dependant variable, the residuals of which can then be tested for spatial autocorrelation.

The results are a detailed map of predicted sediment composition of the North Sea and an associated confidence layer. The sediment composition is then applied to classify habitat types.

Comparing of Backscatter Data Over Time, Shetland, UK

Helena Strömberg

MMT, Gothenburg, Sweden

Acoustic remote sensing together with Ground truthing methods were used for marine-habitat mapping in 2008. The data were used for habitat mapping of the seafloor south of Shetland and in the Shetland near shore. During the geophysical survey multibeam data, backscatter data and side scan sonar data were collected. The ground truthing method consisted of a drop camera frame with video and still photo camera mounted. Within the survey area a set of sites were surveyed by conducting video and photo transects together with grab sampling. The survey area extended from the inner Sandsound and Weisdale Voe, southern Shetland at a depth of 25 m out to the sea south of Shetland at a depth of 80 m. The bottom substrate is highly variable from very soft sediments in the inner Voe to bedrock in the Voe entrance and sand and gravel in the outer parts. By using a Kongsberg EM3002 Multibeam echo sounder, high-resolution bathymetric data was collected. Two years later 2010 a new multibeam survey was preformed and the bathymetrical data including backscatter data were compared with the data from 2008. The aim of this study was to compare the difference between backscatter data over time. The seabed is changing over time due to hydrographical geophysical and biological processes and the accuracy of habitat mapping over time is reviewed.

Seamount habitat mapping on the Condor Bank (Azores, NE Atlantic)

Fernando Tempera[1], Eva Giacomello[1], Filipe Porteiro[1], Ana Martins[1], Igor Bashmachnikov[2], Andreia Henriques[1], José Nuno Pereira[1], Telmo Morato[1], Diana Catarino[1], Ricardo Santos[1] and Gui Menezes[1]

[1] Department of Oceanography and Fisheries, University of the Azores, Portugal
[2] Institute of Oceanography, FCUL, Lisbon, Portugal

Seamounts are some of the most ubiquitous topographic features on Earth and yet their role in the marine realm remains poorly assessed. It is well known that seamounts hold valuable fisheries resources and important habitats like coral reefs and sponge aggregations but intensive research on representative seamounts is needed to validate several ecological aspects.

The Condor seamount is a well known fishing ground located in the vicinity of the Azorean island of Faial (NE Atlantic) that has been exploited by local artisanal fishermen using bottom long-line and hand-line. Recent video surveys revealed the area supports rich deep-sea faunal communities, including cold water coral gardens.

In support of several research projects (CORALFISH, CORAZON, CONDOR, HERMIONE), the first scientific underwater seamount observatory of the Azores is being implemented on this seamount. Under this umbrella, complementary surveys with 4 different vessels and a suite of remote sensing technology (multibeam sonar, EK500, satellite imagery) and *in situ* sampling (through CTD cruises, ADCP, deployment of current meter moorings, grabs, mid-water trawls, traps and longline fishing, manned submersible, and ROVs) will focus on the area. In this scope a temporary fishing ban has already been agreed with the stakeholders to prevent interference with the surveys and the scientific equipment that is being deployed for longer periods.

The merging of data from this multidisciplinary programme creates the unique opportunity to comprehensively relate patterns and processes occurring from the sea surface down to the seafloor and increase our understanding of seamount ecological functions.

This communication will disseminate the concept and results from the observatory programme and focus on the characterization of benthic habitats based on multibeam bathymetry and CTD data, paving the way for the development of predictive habitat suitability models for benthic organisms like corals.

MAREANO – an integrated programme for marine mapping in Norway

Terje Thorsnes[1], Lene Buhl-Mortensen[2], Hanne Hodnesdal[3], Margaret Dolan[1], Pål Buhl-Mortensen[2]

[1] Geological Survey of Norway (NGU)
[2]Institute of Marine Research, Norway
[3]Norwegian Hydrographic Service

The MAREANO programme maps bathymetry, sediment composition, habitats and biotopes, biodiversity, as well as pollution in the seabed in Norwegian coastal and offshore regions. The area encompasses contintental shelf, slope and deep water zones and includes many extreme habitats including shelf-edge canyons and submarine slides.

MAREANO is coordinated by the Institute of Marine Research, in collaboration with the Geological Survey of Norway and the Norwegian Hydrographic Service. MAREANO fills knowledge gaps related to seabed conditions and biodiversity defined in The Integrated Management Plan for the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands presented by the Government in 2006. The Plan will be revised in 2010, and MAREANO will contribute to a better knowledge base for managing human activities such as fishing and oil and gas exploitation. Priority mapping areas for this phase are located along the shelf break and on the continental shelf in the western part of the mapping area. In the Management Plan, these areas are regarded as being especially ecologically important and vulnerable.

In 2010, as the first phase of MAREANO draws to a close, will deliver information about seabed characteristics and biotopes, information about the distribution of benthic fauna, communities, biological diversity and production, information about contaminants in the sediments, detailed bathymetric maps and a online database and map services collecting information on Norwegian coastal and ocean regions. We present highlights from the first phase of the MAREANO programme and look forward to future work.

For further information and results see the MAREANO website www.mareano.no .

Bay of Fundy bedform mapping: linking geomorphology with sediment transport models

Brian J. Todd, Michael Z. Li, John Shaw, Robert Prescott

Geological Survey of Canada, Dartmouth, Nova Scotia, Canada

The Bay of Fundy on the Atlantic coast of Canada has the largest tidal range in the world, reaching 17 m. Associated tidal current velocities exceeding 5 m s^{-1} are being exploited during 2009–2011 for engineering tests of turbines placed on the seabed for in-stream tidal electrical power generation. If successful, these turbine tests may lead to future installation of a full-scale tidal power system (~300 turbines) on the seafloor of the bay. Understanding the regional surficial geology is necessary for predicting sediment mobility and implications of that mobility for the design of seabed infrastructure and environmental impact in the region. In anticipation of tidal power development, the Geological Survey of Canada instituted in 2006 a regional program to map the sea floor of the Bay of Fundy (13,000 km^2) using multibeam sonar and geophysical and geological groundtruth techniques.

Interpretation has revealed that the Bay of Fundy is floored by widespread glacial deposits (till) of Wisconsinan age, 10 to 30 m thick, overlying Triassic–Jurassic bedrock. In some areas, deep channels have been eroded in glacial sediment, presumably through the action of tidal currents. Superimposed on the glacial sediments are Holocene sediments in the form of discrete sand waves up to 20 m high, fields of sand waves, and large banner banks flanking prominent headlands around the bay. Gravel megaripples occur in Minas Passage, the main erosional channel.

Tidal current data, circulation and storm driven current data, and wave information were coupled with sediment grain size data within the sediment transport model SEDTRANS. The model computed sediment transport flux and bottom shear stress. The latter was compared to bedload threshold shear stress to determine the sediment mobility frequency, or the time percentage of bedload threshold was exceeded by various processes. Sediment mobilization is dominated by the tides, reaching 30% over most of the bay and 100% in some areas. Both the maximum seabed disturbance and maximum sediment mobility occurs in Minas Passage, which is the location of in-stream tidal device deployment.

Modelled tidal flow and sediment transport patterns in the Bay of Fundy clearly reflect the distribution and geomorphology of the sand bedforms. Sediment dynamics will be measured using *in situ* instrumentation. The interpretation of the sediment mobility observations and modelling will provide information necessary for informing government management decisions regarding the use of the Bay of Fundy seabed for in-stream tidal power projects and for other competing seabed uses.

Large submarine sand wave fields on Georges Bank, Gulf of Maine, Atlantic Canada

Brian J. Todd[1], Page C. Valentine[2]

[1]Geological Survey of Canada, Dartmouth, Nova Scotia, Canada
[2]US Geological Survey, Woods Hole, Massachusetts, USA

Georges Bank is a large continental shelf feature (150 x 280 km) that rises more than 300 m above the Gulf of Maine sea floor. The Canadian part of the bank surface (~7900 km^2) ranges in depth from 38 to 200 m at the continental shelf break. The bank is mantled with a veneer of glacial debris transported during the late Pleistocene from continental areas lying to the north. These sediments were reworked by marine processes during sea level transgression and continue to be modified by the modern oceanic regime. The most prominent bedforms on Georges Bank are large, semi-mobile sand waves up to 19 m in height formed through sediment transport by strong tidal and storm currents. Well-defined bedform crest lines up to 15 km long form a complex anastomosing pattern having an overall southwest–northeast strike, which is perpendicular to the direction of dominant current flow.

Seabed habitats of the German Bank glaciated shelf, Atlantic Canada

Brian J. Todd[1], Stephen J. Smith[2], Vladimir E. Kostylev[1]

1. Geological Survey of Canada, Dartmouth, Nova Scotia, Canada
2. Fisheries and Oceans Canada, Dartmouth, Nova Scotia, Canada

An area of 5320 km^2 in water depths of 30 to 250 m has been mapped on German Bank on the southern Scotian Shelf in Atlantic Canada. The Scotian Shelf is a formerly glaciated continental margin characterized by a topographically rugged inner shelf. Bedrock is exposed at the seafloor on much of German Bank. Ice-contact sediment (till) was deposited beneath or at the margins of the ice sheet directly onto bedrock during the Wisconsinan glaciation and occurs as a widespread sediment blanket. Ice-distal glaciomarine silt overlies the older till and is primarily confined to small basins on the bank. Limited accumulations of postglacial sediments are composed of well-sorted sand, grading to rounded and subrounded gravel. Statistical analyses of benthic community structure based on seabed photographs show no difference in observed fauna between different seabed types. However, analyses of vessel monitoring systems indicate that the commercial scallop fishery occurs on ice-contact and postglacial sediment.

An Atlas of Ireland's Deep-water Seabed: the preview

Andy Wheeler[1], Boris Dorschel[1], Xavier Monteys[2] and Koen Verbruggen[2]

[1]University College Cork, Cork, Ireland. a.wheeler@ucc.ie
[2]Geological Survey of Ireland, Dublin, Ireland

Between 1999 and 2005, the Geological Survey of Ireland (GSI) with assistance from the Irish Marine Institute, during the Irish National Seabed Survey (INSS), mapped Ireland's entire deep-water seabed below 200 m water depth using multibeam echosounder (as well as additional datasets). This represents possibly the most comprehensive and extensive national seabed mapping exercises to date with 536,112 km^2 of seabed extending 1000 km west of Ireland to the Iceland Basin and as far south as the Bay of Biscay. 55 gigabytes of data (16.5 billion sounds) are now archived in the GSI and are downloadable through an on-line mapping portal at http://spatial.dcenr.gov.ie/imf/imf.jsp?site=INFOMAR.

As part of the follow-up, shallow-water mapping programme (INFOMAR), the INSS-processed MBES data has been analysed to systematically identify a variety of large-scale morphological features including: seamounts, submarine canyons, channels systems, escarpments, mounds, coral carbonate mounds and iceberg ploughmarks. To define features, a variety of spatial data routines were run and features not normally obvious were highlighted using custom projections and image enhancement.

A series of map layers with simple text have been compiled, in conjunction with groundtruthing ROV imagery, to produce an "Atlas of Ireland's Deep-water Seabed", soon to be published by Springer as the first volume in a potential series of atlases based on similar national seabed mapping programmes.

This atlas, the imagery and data are previewed here. The Atlas is divided into: an introductory section – providing the context; a thematic section - highlighting the various morphological features; and a regional section – taking a tour of the various deep-sea basins.

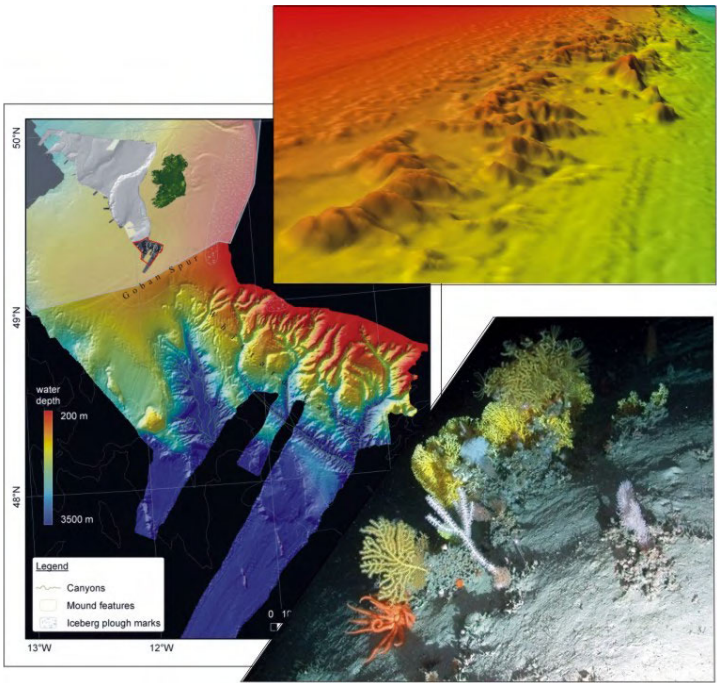


Figure 1.

Lowstand glacial landforms and fluvial systems east of Campbell Island, New Zealand

Gary Wilson[1, 2], Andrew Gorman[2], Hamish Fraser[2], Scott Preskett[3]

[1]Department of Marine Science, University of Otago, PO Box 56, Dunedin, New Zealand
[2]Department of Geology, University of Otago, PO Box 56, Dunedin, New Zealand
[3]School of Surveying, University of Otago, PO Box 56, Dunedin, New Zealand

Campbell Island is the southernmost of New Zealand's subantarctic islands, located about 600 km south of the South Island at 52.33°S, 169.09°E. While the island itself is relatively small (only 113 km^2), it represents the exposed part of a much larger (>10,000 km^2) submerged massif which rises to ~100 m towards the SE corner of the Campbell Plateau. The eastern side of the island is dissected by a series of steep sided U-shaped valleys that are assumed to be glacial in origin. Two of these valleys, Perseverance and Northeast harbours (fiords), have base levels below current sea level.

In March 2009, a detailed high-frequency seismic survey was undertaken in Perseverance and Northeast harbours and across the shallow platform on the eastern side of the Island in order to examine the floors of the fiords and adjacent shelf for evidence of glacial processes and associated sedimentation. Data were collected using the University of Otago Research Vessel *Polaris II* and included single-channel Chirp and electro-acoustic (boomer) sub-bottom imaging, and interferometricside scanning sonar (C3D). A network of ~42 lines was collected over 4 days of surveying. Unusually calm conditions allowed collection of high quality data out to the shelf edge. C3D data provided good imagery within the fiords and at the fiord mouths in water depths up to 60 m, while boomer data successfully delineated the deeper sea floor and up to 60 m beneath the sea floor. Chirp data imaged upto 20 m below the sea floor. Sediment grab samples were collected from the shelf and short (3m) piston cores were collected from inside the harbours.

The combined data-set shows that terminal moraines co-incide with the mouths of Perseverance and Notheast harbours and that the harbours give way to a now infilled v-shaped valley network that dissects the shelf. Despite subaerial exposure of the shelf at the last glacial maximum, glaciers apparently did not extend out on to the shelf. Instead the shelf was eroded by river systems presumably sourced from the glaciers which occupied the valleys on-shore. The submarine channels are now infilled with gravelly and shelly drift which also forms low-angle dune structures on the sea floor. Little or no fine grained sediment is accumulating within the harbours or on the shelf. The separation of glacial and shelf sediments at this location provides an opportunity to determine the synchroneity of polar versus mid-latiude glacial advance and retreat at the last glacial maximum.

Morphology and formation of relict coral reef on the shelf around Lord Howe Island

Colin D. Woodroffe[1], Brendan P. Brooke[2], Michelle Linklater[1], David M. Kennedy[3], Brian G. Jones[1], Cameron Buchanan[2], Richard Mleczko[2], Quan Hua[4] and Jian-xin Zhao[5]

[1]School of Earth and Environmental Sciences, University of Wollongong, NSW 2522, Australia
[2] Geoscience Australia, Canberra, ACT 2601, Australia.
[3]School of Geography Environment & Earth Sciences, Victoria University of Wellington, New Zealand
[4]Australian Nuclear Science and Technology Organisation, Menai, NSW 2234, Australia
[5]University of Queensland, St Lucia, QLD 4072, Australia

Coral reefs track sea level and are particularly sensitive to changes in climate. Reefs are threatened by global warming, with those in tropical waters experiencing increased incidences of bleaching. Although it has been suggested that reefs may extend poleward at their latitudinal limit, there has been little evidence to support this contention. In this paper, we report on a much more extensive coral reef that flourished around Lord Howe Island, which presently supports the southernmost coral reef in the Pacific. Multibeam swath mapping and sub-bottom profiling reveal an extensive reef that encircled the island, in the middle of the shelf, rising from water depths of around 50 m to 30 m, with isolated peaks reaching 23.5 m. Coring has indicated that this relict reef is composed of corals that grew between 9200 and 7100 years ago, and that the main phase of reef growth had terminated and the reef backstepped by 7000 years BP. Localised re-establishment of corals over the surface around 2500 and in the past few hundred years provides some indication that corals may be able to recolonise the relict reef and extend further in response to warmer temperatures anticipated later this century and beyond. However, this will depend on the availability of suitable substrate, as well as other environmental factors, as the relict reef is now in greater water depths than when it was most actively growing.

Modelling and Inversion of Multibeam Backscatter from a Rough Seafloor

Jiashun Yu[1], Ivor Marsh[2], Colin Brown[2] and Stuart Henrys[1]

[1]GNS Science, Wellington, New Zealand
[2]National University of Ireland, Galway, Ireland

For seafloor habitat mapping programmes, there is a need to develop innovative methods to extract seafloor physical properties from multibeam data. A key step to achieve this is to develop robust models of the physical process of multibeam backscattering, combined with an inversion scheme which can be used for quantitative determination of seafloor physical properties from vast areas of recorded multibeam data.

This poster focuses on the estimation of the seafloor roughness parameters, amplitude, correlation length, and the seafloor acoustic impedance (the product of sound velocity and density) from theoretical multibeam backscatter strength responses over realistic models of seabed bathymetry. Our backscatter forward model utilises a 2D seafloor geometry using a two-scale surface scattering mechanism based upon a random distribution of surface roughness (~mms to 10's cms) superimposed upon an undulating seafloor geometry at scales (~metres to 10's of metres) comparable with the resolution of the bathymetry acquired by commercial multibeam sonar. The seafloor geometry is assumed to be invariant in a direction perpendicular to a multibeam swath; its physical properties (roughness amplitude and correlation length, impedance) are assumed to be constant beneath the swath. The wave equation is solved using a boundary integral method and Lamber's Law for the scattering wave field from the seafloor. A suit of canonical models were used to validate amplitude variation of the synthetic data for different types of seafloors, including mud, fine-sand, sand, gravel and hard rock. A feed-forward back-propagation artificial neural network is employed to carry out the inversion. Linear regression analyses between the theoretical seafloor physical parameters and neural network predicted parameters yielded correlation coefficients of 0.98, 0.98 and 0.99 for roughness amplitude, roughness correlation length and seafloor impedance, respectively.

The approach can easily be modified to include a heterogeneous substrate and volume scattering so the remaining challenge is to reduce the computational overhead of inverting observed backscatter data acquired at frequencies > 95 kHz.

Ecosystem transformation and its eventual landscape manifestation in the aquaculture-affected Alekseeva Bay (Peter the Great Bay, Sea of Japan)

V. Zharikov, B. Preobrazhensky

Pacific Institute of Geography, FEB RAS, 7, Radio street, 690041,
Vladivostok, Russian Federation

Popov Island, a part of Archipelago of Queen Eugenia (Peter the Great Bay, Sea of Japan), composed of Permian intrusive and effusive-sedimentary complexes, with Alekseeva Bay on its north part, represents a typical for Russian Primorye semi-closed water area, during 10 years affected by aquaculture of sea-scallop and mussels. A “landscape” expression of recent structure of the ecosystem was compared with published data and mapping materials obtained during period of functioning of the aquatic farm. A whole new methods of landscape presentation of spatial structure of ecosystem was proposed and tested. The main subject of ecosystem mapping of spatial structure of the bay was the holistic presentation of facies – bentheme. Hyper-eutrophication of the bay resulted in capital transformation of entire ecosystem and its recognizable units – facies, biocenoses and benthemes in irreversible way. Shifting of limits of spatial distribution involved the communities of soft bottom. The benthemes of hard bottom stay practically intact.

The community of *C. grayanus* is still the basic one for rocky cliffs and drop-offs, but their biomass and numbers decreased. The most significant transformations are connected with increasing of number of species and biomass of green algae. Decrease in domination of *M. sarsi* can be explained by deterioration of quality of environment die to accumulation of organic matter and pollutants. Both, in shallow and in the deep parts of bay, the benthemes of protected areas undergone stronger transformation, than those in the open places with more active hydrodynamics and lesser siltation.

Retrospective analysis of changes inflicted by plantation was made with the use of original mapping routine. Hydrobiological schemes of biocenoses were compared with landscape presentation of the ecosystem and the conclusion of compatibility of biocenoses and benthemes resulted in creating accurate maps instead of rather unclear schemes of biocenoses.

A comparison of fish diversity estimates made by stereo-video systems and traps at depths ranging from 50 to 900 m

Vincent Zintzen[1], Clive Roberts[1], Andrew Stewart[1], Marti J. Anderson[2] and Euan Harvey[3]

[1] Museum of New Zealand Te Papa Tongarewa, 169 Tory Street, P.O. Box 467, Wellington, New Zealand
[2] Institute of Information and Mathematical Statistics (IIMS), Massey University, Albany Campus, Private Bag 102 904, North Shore Mail Centre, Auckland, New Zealand
[3] School of Plant Biology (Oceans Institute M470), University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009, Australia

Assessing the fish diversity in topographically complex or remote habitats is challenging, particularly in depths of 50 metres or greater. Fish behaviour and patterns of distribution, as well as sampling bias and selectivity are among the main factors leading to poor estimates of fish diversity. Recently, remotely operated video units have been developed with the objective of reducing those problems. The concurrent increase in image quality and decrease of unit costs have now made possible the simultaneous use of multiple systems. The direct result is better statistical power to detect spatial and temporal changes in the structure of fish assemblages and the relative abundances of individual species within them. As part of a larger project aiming at studying the interactions between latitude and depth on fish diversity, baited remote stereo-video systems and baited fish traps have been intensively deployed during seven days in March 2009 around White Island, Bay of Plenty, New Zealand. This station is the first of a series of seven sites programmed for the New Zealand EEZ in the coming three years. A total of 65 usable video samples and 39 fish traps were deployed at 50, 100, 300, 500, 700 and 900 m depth. Both systems were soaked for three hours and baited the same way to allow meaningful comparisons. The preliminary results obtained from the White Island station, yielding indicative information on fish diversity at different depths, will be presented.

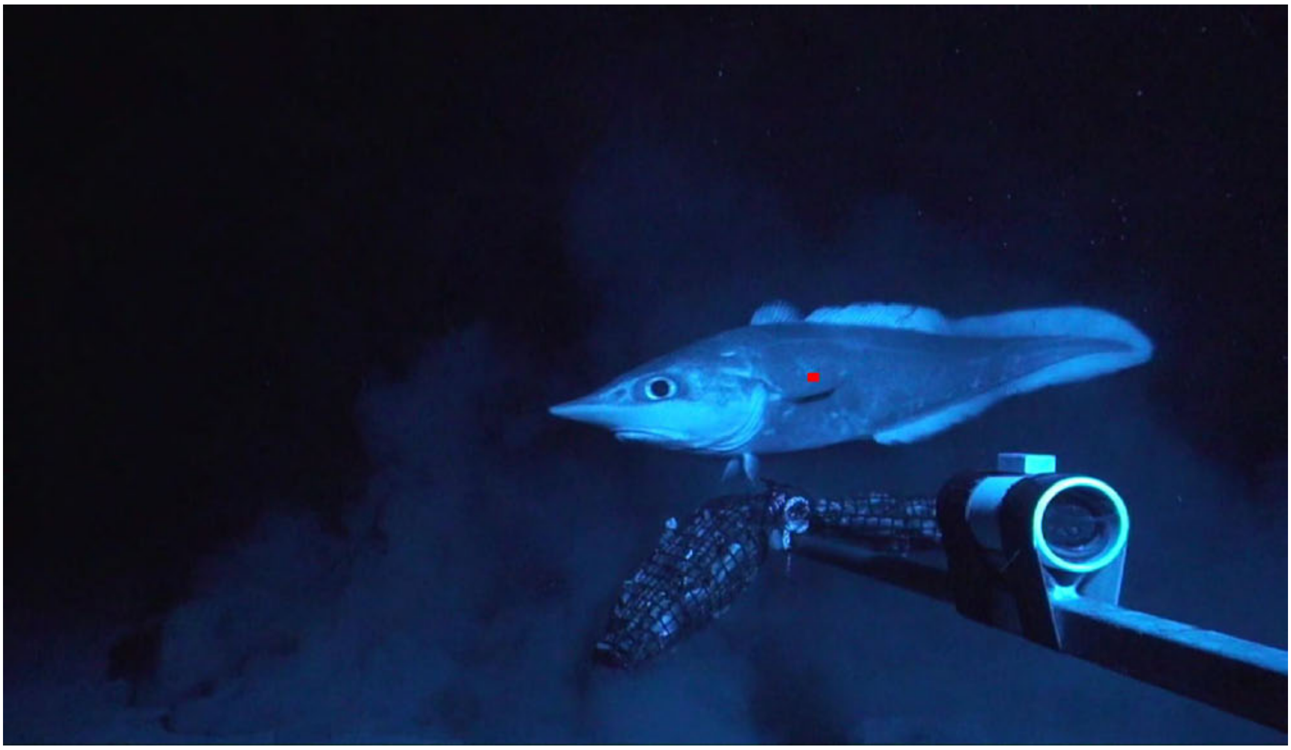
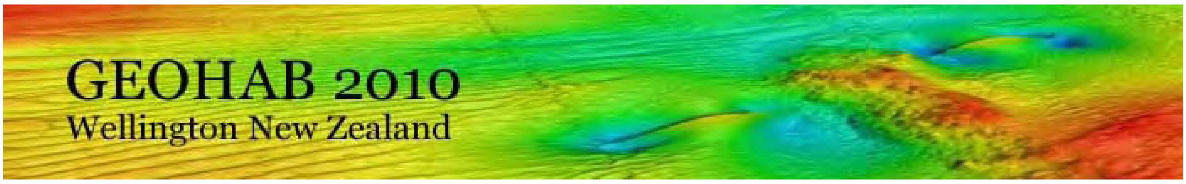


Figure 1. A still photo, extracted from a baited stereo-video system, showing the bait arm and a synchronizing diode. Species: *Trachyrincus aphyodes* (Macrouridae).
Location: White Island, Bay of Plenty, New Zealand.
Depth: 900 m

LIST OF REGISTRANTS (as of 20 April 2010)

Last Name	First Name	Organisation	Email Address
Abd Samah	Dr. Othman	International Islamic University Malaysia	oas@iiu.edu.my
Abraham	Eric	Institute of Marine Engineering, Science & Technology	eric.abraham@clear.net.nz
Allee	Rebecca	National Oceanic and Atmospheric Administration	Becky.Allee@noaa.gov
Amblas	David	GRC Geociències Marines, University of Barcelona	damblas@ub.edu
Anderson	Tara	Geoscience Australia	tara.anderson@ga.gov.au
Baird	Susan Jane	National Institute of Water & Atmospheric Research	s.baird@niwa.co.nz
Baker	Elaine	UNEP/GRID Arendal	ebaker@usyd.edu.au
Barrell	Jeffrey	Dalhousie University	jeffbarrell@dal.ca
Barrie	Vaughn	Geological Survey of Canada	vbarrie@nrcan.gc.ca
Bax	Nic	CERF Marine Biodiversity Hub	nic.bax@csiro.au
Beaman	Robin	James Cook University	robin.beaman@jcu.edu.au
Beaumont	Jenny	National Institute of Water and Atmospheric Research	j.beaumont@niwa.co.nz
Bergersen	Douglas	Acoustic Imaging Pty Ltd	dbergersen@acousticimaging.com
Bergersen	Nicole	Acoustic Imaging Pty Ltd	nbergersen@acousticimaging.com
Black	Jenny	GNS Science	j.black@gns.cri.nz
Bollard Breen	Barbara	Auckland University of Technology	bbreen@aut.ac.nz
Botha	Elizabeth	Commonwealth Science and Industrial Research Organization	elizabeth.botha@csiro.au
Bourillet	Jean-François	Ifremer	jfb@ifremer.fr
Bowden	David	National Institute of Water & Atmospheric Research	d.bowden@niwa.co.nz
Brooke	Brendan	Geoscience Australia	brendan.brooke@ga.gov.au
Bürk	Dietmar	GKSS Research Centre	dietmar.buerk@gkss.de
Byfield	Tamsen	Victoria University of Wellington	Tamsen.Byfield@vuw.ac.nz
Campbell	Norm	CSIRO	norm.campbell@westnet.com.au
Canals	Miquel	Universitat de Barcelona	miquelcanals@ub.edu
Clark	Malcolm	National Institute of Water & Atmospheric Research	m.clark@niwa.co.nz
Cochrane	Guy	United States Geological Survey	gcochrane@usgs.gov
Cogswell	Andrew	Department of Fisheries and Oceans Canada, Bedford Institute of Oceanography	Andrew.Cogswell@dfo-mpo.gc.ca
Collin	Antoine	Insular Research Center and Environment Observatory	antoinecollin1@gmail.com
Colquhoun	Jamie	Australian Institute of Marine Science	j.colquhoun@aims.gov.au
Compton	Tanya	National Institute for Water and Atmospheric Research	t.compton@niwa.co.nz
Conway	Chris	National Institute of Water and Atmospheric Research/Victoria University Welling	conwaychri@myvuw.ac.nz
Costello	Mark	University of Auckland	m.costello@auckland.ac.nz
Crandall	Jaime	Environmental Systems Research Institute	jcrandall@esri.com
Cryer	Martin	Ministry of Fisheries	cryerm@fish.govt.nz
Davy	Bryan	GNS Science	b.davy@gns.cri.nz
Davy	Chris	Victoria University Wellington	lionel.carter@vuw.ac.nz
De Mol	Ben	Parc Cientific de Barcelona/ Universitat de Barcelona	bendemol@ub.edu
Diesing	Markus	Centre for Environment, Fisheries and Aquaculture Science	markus.diesing@cefas.co.uk
Dolan	Margaret	Geological Survey of Norway	margaret.dolan@ngu.no
Downie	Anna-Leena	Finnish Environment institute	anna-leena.downie@ymparisto.fi
Downie	Ryan	CSIRO, Marine and Atmospheric research	Ryan.Downie@csiro.au
Du Preez	Cherisse	University of Victoria	cdupreez@uvic.ca
Dunstan	Piers	CSIRO Marine & Atmospheric Research	Piers.Dunstan@csiro.au
Ezhova	Elena	P.P.Shirshov Institute of oceanology, Atlantic Branch	igelinez@gmail.com
Fiorentino	Andrea	Institute for Environmental Research and Protection	andrea.fiorentino@isprambiente.it
Ford	Richard	Ministry of Fisheries	richard.ford@fish.govt.nz
Freeman	Debbie	Department of Conservation	dfreeman@doc.govt.nz
Friedman	Ariell	The Australian Centre for Field Robotics	a.friedman@cas.edu.au
Gauthier	Maeva	University of Victoria	maeva@uvic.ca
Gee	Lindsay	IVS 3D Inc.	lgee@ivs3d.com
Gitmark	Janne	Norwegian Institute for Water Research (NIVA)	janne.kim.gitmark@niva.no
Gonzalez Mirelis	Genoveva	University of Gothenburg	gegm@marecol.gu.se
Gorman	Andrew	University of Otago	andrew.gorman@otago.ac.nz
Greene	H. Gary	Moss Landing Marine Labs/Center for Habitat Studies/Tombolo	tombolo@centurytel.net
Greenlaw	Michelle	Canadian Department of Fisheries and Oceans	michelle.greenlaw@dfo-mpo.gc.ca
Greinert	Jens	Royal Netherlands Institute for Sea Research	greinert@nioz.nl
Haldin	Michael	Natural Heritage Services Finland	michael.haldin@metsa.fi
Hamylton	Sarah	Cambridge Coastal Research Unit	smh61@cam.ac.uk
Harris	Peter	Geoscience Australia	Peter.Harris@ga.gov.au
Heap	Andrew	Geoscience Australia	andrew.heap@ga.gov.au
Henrys	Stuart	Geological and Nuclear Sciences Ltd	s.henrys@gns.cri.nz
Herrmann	Melanie	Christian-Albrechts-Universität zu Kiel	psmirkmar@yahoo.de
Hewitt	Judi	National Institute of Water and Atmospheric Research	j.hewitt@niwa.co.nz
Huang	Zhi	Geoscience Australia	Zhi.Huang@ga.gov.au
Huvenne	Veerle	National Oceanography Centre, Southampton	vaih@noc.soton.ac.uk



Last Name	First Name	Organisation	Email Address
Immenga	Dirk	University Of Waikato	dirk@waikato.ac.nz
Joanne	Cathy	National Institute for Water and Atmospheric Research / Geoazur	joanne@geoazur.obs-vlfr.fr
Julian	Kathryn	National Institute of Water & Atmospheric Research Ltd	k.julian@niwa.co.nz
Juniper	Kim	University of Victoria	kjuniper@uvic.ca
Kaskela	Anu	Geological Survey of Finland	anu.kaskela@gtk.fi
Keller	Kaylene	NOAA Papahanaumokuakea Marine National Monument	kaylene.keller@noaa.gov
Keskinen	Essi	Metsähallitus / Natural Heritage Services	essi.keskinen@metsa.fi
Kingon	Kelly	Florida State University	kingon@bio.fsu.edu
Klaucke	Ingo	Leibniz Institute of Marine Sciences	iklaucke@ifm-geomar.de
Kloser	Rudy	CSIRO	rudy.kloser@csiro.au
Kobara	Shinichi	Texas A&M University	shinichi@tamu.edu
Kostylev	Vladimir	Natural Resources Canada	vkostyle@nrcan.gc.ca
Kotilainen	Aarno	Geological Survey of Finland	aarno.kotilainen@gtk.fi
Kröger	Kerstin	not associated	kerstin.kroeger@gmail.com
Lafoy	Yves	Office of Regional Cooperation & External Relations, New Caledonia	yves.lafoy@gouv.nc
Lamarche	Geoffroy	National Institute of Water and Atmospheric Research	g.lamarche@niwa.co.nz
Lee	Tuan Meng (Sonny)	University of Auckland	tlee117@aucklanduni.ac.nz
Leon	Javier	University of Wollongong	jl448@uow.edu.au
Leroy	Francois	Teledyne Marine	fleroy@teledyne.com
Li	Jin	Geoscience Australia	jin.li@ga.gov.au
Livingston	Mary	Ministry of Fisheries	mary.livingston@fish.govt.nz
Lucieer	Vanessa	University of Tasmania	vanessa.lucieer@utas.edu.au
Lurton	Xavier	IFREMER	lurton@ifremer.fr
MacDiarmid	Alison	National Institute of Water and Atmospheric Research	a.macdiarmid@niwa.co.nz
Mackay	Kevin	National Institute of Water and Atmospheric Research Ltd	k.mackay@niwa.co.nz
McArthur	Matthew	Geoscience Australia	matthew.mcarthur@ga.gov.au
Monk	Jacquomo	Deakin University	jacquomo.monk@deakin.edu.au
Moore	Cordelia	Australian Institute of Marine Science	c.moore@aims.gov.au
Morrison	Mark	National Institute of Water and Atmospheric Research	m.morrison@niwa.co.nz
Mountjoy	Joshu	National Institute of Water and Atmospheric Research Ltd	j.mountjoy@niwa.co.nz
Nichol	Scott	Geoscience Australia	scott.nichol@ga.gov.au
Nichols	Paul	Gardline Marine Sciences Pty Ltd	paul.nichols@gardline.com
Orpin	Alan	National Institute of Water and Atmospheric Research	a.orpin@niwa.co.nz
Pallentin	Arne	National Institute of Water and Atmospheric Research Ltd.	a.pallentin@niwa.co.nz
Pearce	Bryony	Marine Ecological Surveys Limited	bryony@seasurvey.co.uk
Pelletier	Bernard	South Pacific integrated Observatory - IRD	bernard.pelletier@ird.fr
Penney	Andrew	Ministry of Fisheries	andrew.penney@fish.govt.nz
Pitcher	C. Roland	CSIRO Marine & Atmospheric Research	roland.pitcher@csiro.au
Pizarro	Oscar	Australian Centre for Field Robotics, University of Sydney	o.pizarro@cas.edu.au
Preobrazhensky	Boris	Pacific Institute of Geography	prbz@mail.ru
Preskett	Scott	University of Otago	scott.preskett@surveying.otago.ac.nz
Ranft	Susanne	University of Vechta	susanne.ranft@uni-vechta.de
Rawlinson	Grant	Kongsberg Maritime Pte Ltd	grant.rawlinson@kongsberg.com
Rinde	Eli	National Institute for Water and Atmospheric Research	eli.rinde@niva.no
Rowden	Ashley	National Institute of Water & Atmospheric Research	a.rowden@niwa.co.nz
Rzhanov	Yuri	Univ. of New Hampshire CCOM/JHC	yuri.rzhanov@unh.edu
Schimel	Alexandre	University of Waikato	alex.schimel@gmail.com
Severne	Charlotte	National Institute of Water and Atmospheric Research	c.severne@niwa.co.nz
Sharma	Ashishika	Pacific Islands Applied Geoscience Commission	ashishika@sopac.org
Shimadzu	Hideyasu	Geoscience Australia	hideyasu.shimadzu@ga.gov.au
Skogen	Geir	Kongsberg Maritime	geir.flugeim.skogen@kongsberg.com
Smith	Robin	ESRI	robin_smith@esri.com
Stagpoole	Vaughan	GNS Science	v.stagpoole@gns.cri.nz
Strömberg	Helena	MMT	helena.stromberg@mmt.se
Teleberg	Jon	MMT AB	jon.teleberg@mmt.se
Tempera	Fernando	IMAR / University of the Azores	tempera@uac.pt
Todd	Brian	Geological Survey of Canada	Brian.Todd@NRCan.gc.ca
Tracey	Dianne	National Institue of Water and Atmospheric Research Ltd	d.tracey@niwa.co.nz
Verdier	Anne-Laure	National Institute of Water & Atmospheric Research	a.verdier@niwa.co.nz
Wakita	Koji	Geological Survey of Japan, AIST	koji-wakita@aist.go.jp
Wedding	Lisa	University of Hawaii/ NOAA Biogeography Branch	wedding@hawaii.edu
Wheeler	Andy	University College Cork	a.wheeler@ucc.ie
Williams	Hugh	Institute of Marine Engineering, Science & Technology	hugh.williams@clear.net.nz
Wilson	Jerry	FUGRO Pelagos	jwilson@fugro.com
Woodroffe	Colin	University of Wollongong	colin@uow.edu.au
Wright	Ian	National Oceanography Centre, Southampton	jhgo@noc.soton.ac.uk
Yu	Jiashun	GNS Science	Jiashun.Yu@gns.cri.nz
Zharikov	Vasiliy	Pacific Institute of Geography	zhar@tig.dvo.ru
Zintzen	Vincent	Museum of New Zealand Te Papa Tongarewa	vincentz@tepapa.govt.nz

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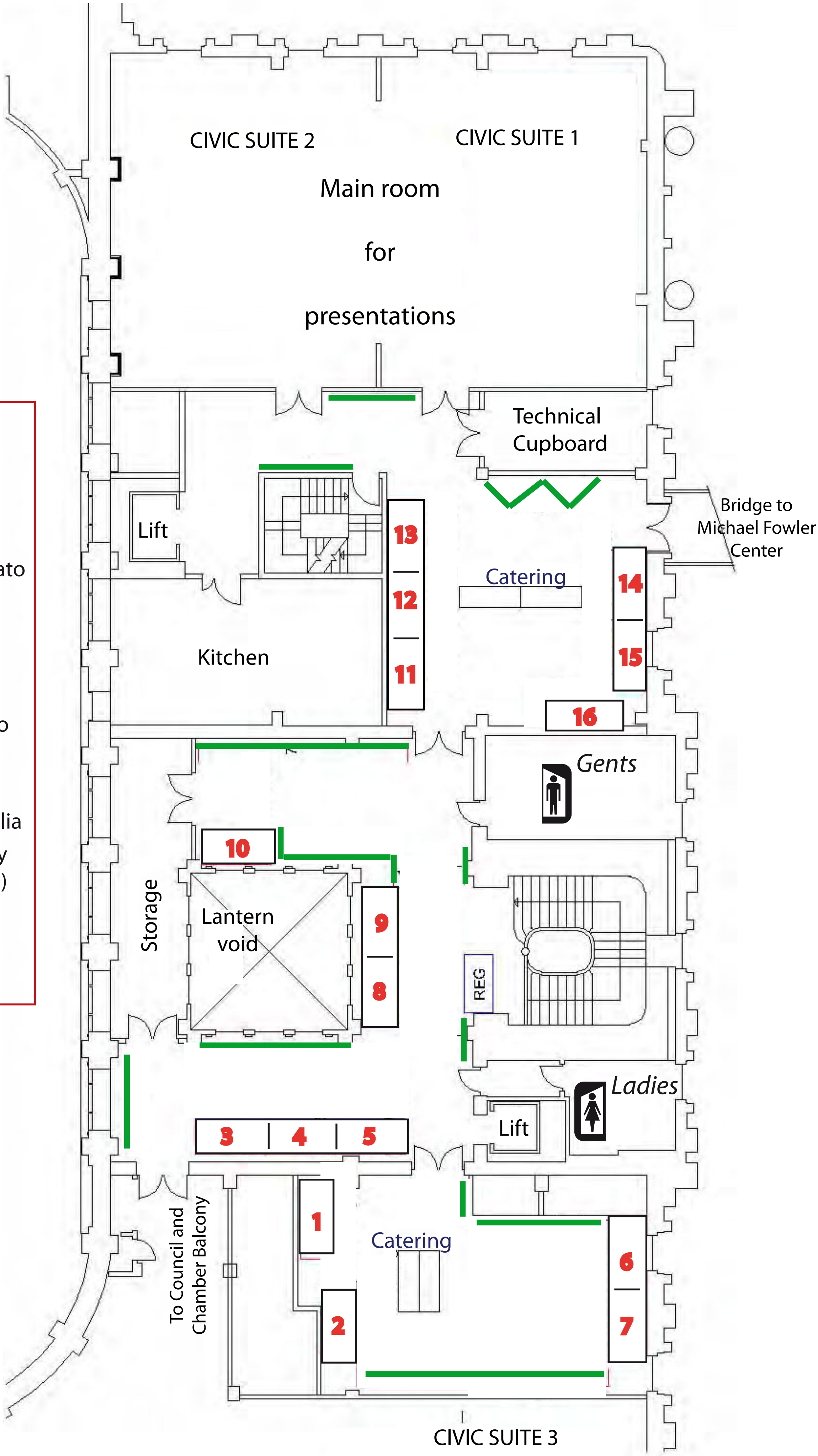

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