GEOHAB

Marine Geological and Biological Habitat Mapping

Seventh International Symposium
May 3rd to 6th, 2006

Agenda and Abstracts

Theme: Regional Marine Habitat Mapping Influencing Marine Policy and Resource Development

Hosted by the British Geological Survey, Edinburgh, Scotland, UNITED KINGDOM

Contents

Convenors

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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Introduction

On behalf of the British Geological Survey (BGS), the Centre for Fisheries and Aquaculture Services (CEFAS) and the National Oceanography Centre, Southampton (NOCS), we would like to welcome you to the Seventh International GeoHab Conference in Edinburgh.

GeoHab (Marine Geological and Biological Habitat Mapping) was established in 2001 to bring together scientists from around the world working on the development of new thematic maps linking acoustic mapping and geological sampling to marine biology in a Geographic Information System environment to underpin sustainable ocean management. The representatives from 14 countries attending this year's conference demonstrate that GeoHab continues to be an international forum. Previous meetings have been held in Norway, Canada, USA, Australia and Ireland and we are pleased to host this third meeting in Europe and the first to be held in the United Kingdom. The focus of the GeoHab meetings is to:

- Maintain awareness of technological developments and survey standards
- Develop new thematic maps useful for fisheries management, biodiversity management and the assessment of future Marine Protected Areas (MPAs)
- Encourage standardisation of maps through the creation of a habitat mapping glossary and building links to marine mapping agencies worldwide
- Apply and evaluate habitat classification systems using real-world examples

This year the theme of our conference is 'Regional Marine Habitat Mapping Influencing Marine Policy and Resource Development'. It is an appropriate theme for a meeting held in the United Kingdom as the Department for Environment, Food and Rural Affairs (DEFRA) are currently preparing a Marine Bill for introduction to the UK Parliament. The Bill is aimed at delivering the UK Government's vision of clean, healthy, safe, productive and biologically diverse oceans and seas. It will put in place a better system for delivering sustainable development of the marine and coastal environment and will address both the use and protection of our marine resources. A public consultation on the Marine Bill is open until 23 June 2006.

The Marine Bill consultation process covers four main themes, a Marine Spatial Planning (MSP) system to provide a framework for managing activities in the marine area; the reform of marine licensing regimes; how to take Marine Nature Conservation proposals for the effective delivery of a network of MPAs and a potential new Marine Management Organisation (MMO).

The development of a UK Marine Bill is set against a background of the European Commission's ambitious strategy to protect the marine environment across Europe. The proposed Thematic Strategy on the Protection and Conservation of the Marine Environment aims to achieve good environmental status of the EU's marine waters by 2021 and to protect the resource base upon which marine-related economic and social activities depend. The Marine Strategy will constitute the environmental pillar of the future maritime policy the European Commission is working on, designed to achieve the full economic potential of oceans and seas in harmony with the marine environment.

A Marine Strategy Directive will establish European Marine Regions on the basis of geographical and environmental criteria. Each Member State within a Marine Region, will be required to develop Marine Strategies for its marine waters that contain a detailed assessment of the state of the environment, a definition of "good environmental status" at

regional level and the establishment of clear environmental targets and monitoring programmes.

As the meeting is being held in Scotland, it is also appropriate to mention that the Scottish Executive is also very active in implementing marine policies based on a consultation carried out in 2004 on a strategy for the long-term sustainability of Scotland's coasts and seas. Key elements of the strategy published in August 2005 include the need for sustainable environment, communities and industries as well as sound science to develop better-integrated relevant scientific data on natural processes, and a better understanding of the marine environment.

Clearly the strategies that are being pursued at European, UK and devolved level of Government include topics that the participants of GeoHab 2006 can contribute to. The timing of this conference can help to focus on the issues that are relevant to the Marine Bill as well as provide an opportunity to hear about experiences in marine policy and resource development from our colleagues in other countries.

The GeoHab Conference is just one part of a series of events that bring together international scientists working in the area of seabed classification. On Tuesday 2nd May a workshop on Acoustic Seabed Classification was held at the BGS office in Edinburgh, in association with the Quester Tangent Corporation, Canada. Following the GeoHab Conference there will be a technical meeting of the MESH (Mapping European Seabed Habitats) project also hosted by BGS in Edinburgh, to ensure that the project deliverables remain on track. MESH is an international marine habitat mapping programme that started in spring 2004 and will last for 3 years. A consortium of 12 partners across the UK, Ireland, the Netherlands, Belgium and France gained financial support from the EU INTERREG IIIB fund for this international programme. MESH aims to produce seabed habitat maps for north-west Europe and develop international standards and protocols for seabed mapping studies. The end products will be a meta database of mapping studies, a web-delivered Geographic Information System (GIS) showing the habitat maps, guidance for marine habitat mapping including protocols and standards, a report describing case histories of habitat mapping, a stakeholder database and an international conference with published proceedings.

The Organising Committee of GeoHab 2006 would like to thank you for attending these events. We hope you have an enjoyable stay in Edinburgh and that you find the events to be stimulating and informative.

Alan Stevenson and Heather Stewart

Organising Committee

This year's Organising Committee comprises:

Siân Boyd	(The Centre for Environment, Fisheries and Aquaculture Science, UK)
Kim Conway	(Geological Survey of Canada, Canada)
Gary Greene	(Moss Landing Marine Laboratories, USA)
Anthony Grehan	(Marine Institute, Galway, Ireland)
Peter Harris	(Geoscience Australia, Australia)
Alan Stevenson	(British Geological Survey, UK)
Heather Stewart	(British Geological Survey, UK)
Terje Thorsnes	(Norwegian Geological Survey, Norway)
Brian Todd	(Geological Survey of Canada, Canada)
Phil Weaver	(National Oceanography Centre, Southampton, UK)

Acknowledgements

The Organising Committee would like to give special thanks to the following:

- The conference sponsors: British Geological Survey, the Centre for Environment, Fisheries and Aquaculture Science and the National Oceanography Centre, Southampton.

- Bill Gilmour at Fugro Pelagos Inc. for sponsoring the Ice Breaker event.

- The session chairpersons.

- Terje Thorsnes and his colleagues at the Norwegian Geological Survey for web support.

- Rosalind Garton at St Andrews University for leading the field excursion on the 6th May.

- The staff at the Apex International Hotel.

Agenda

Apex Suite at the Apex International Hotel

WEDNESDAY, MAY 3RD 2006

08:30-09:00	Registration	
09:00-09:05	*Opening Remarks*	***Alan Stevenson***
09:05-09:20	*Welcome and Introduction*	***David Falvey**, Director – British Geological Survey*
09:20-10:10	*Keynote Presentations* *Chair – **Robert Gatliff (British Geological Survey)***	
09:20-09:45	UK Marine Policy: The evidence needed for an ecosystem-based approach.	***Beth Greenaway**, Marine Science and Monitoring Policy Advisor – DEFRA*
09:45-10:10	Regional Implementation of the US Ocean Action Plan	***Margaret Davidson**, Director – NOAA Coastal Services Centre*
10:10-10:35	National Marine Mapping Strategies in Canada, how effective are we in influencing marine policy and resource development?	***R. A. Pickrill**, Program Manager, Geoscience for Oceans Management Program – Geological Survey of Canada*
10:35-10:50	Coffee Break	
10:50-12:30	*Ocean Policy and Resource Management* *Chair – **Siân Boyd (CEFAS, UK)***	
10:50-11:10	Ecosystem orientated seabed mapping in the Norwegian MAREANO programme – physiotype and habitat maps in ocean management.	***Terje Thorsnes**, Ole Jørgen Lønne, Trond Skyseth and Connie Solberg*
11:10-11:30	The Irish Sea Marine Aggregates Initiative (IMAGIN): scoping the potential development of a resource through multidisciplinary seabed mapping.	*Gerry Sutton and **Max Kozachenko***
11:30-11:50	California Coastal and Marine Habitat Initiative – an approach to large-scale habitat mapping and some considerations, specifications and recommendations for implementation.	***Bill Gilmour** and Jerry Wilson*
11:50-12:10	Highlights from the first year of the HERMES project.	***Phil Weaver***
12:10-12:30	Geomorphic classification of marine benthic bioregions: application to a national marine bioregionalisation of Australia.	***Andrew Heap**, Peter Harris, Alan Hinde and Murray Woods*
12:30-13:30	Buffet lunch and Posters	
13:30-15:10	*Regional Habitat Mapping Studies (Session 1)* *Chair – **Brian Todd (Geological Survey of Canada)***	
13:30-13:50	Habitat mapping for conservation and management of the Southern Irish Sea.	*K Ramsay, **K. A. Robinson,** C Lindenbaum,*

		J Wilson, F McBreen, A Wheeler, K van Landeghem, A Mackie, T Derbyshire, N Mitchell and F O'Beirn
13:50-14:10	Multibeam acquisition in the Irish Sea: applications for habitats research.	***K. van Landeghem**, A Wheeler and N Mitchell*
14:10-14:30	UKSeaMap: The mapping of the marine seabed and water column features of UK seas.	*David Connor, Paul Gilliland, Neil Golding, Paul Robinson and **Dylan Todd***
14:30-14:50	Surface-mounted multibeam mapping of the deep-water Seamounts and Banks west of the United Kingdom: its use as a tool for process studies and habitat identification and comparisons with deep-towed sonar results.	***Colin L. Jacobs** and Peter M Hunter*
14:50-15:10	Overview of habitats found on the seamounts and banks to the West of the UK during the SEA 7 survey 2005.	***Bhavani Narayanaswamy**, Kerry Howell, Colin Jacobs, David Hughes, Jaime Davies and Murray Roberts*
15:10-15:40	Coffee Break	
15:40-17:20	*Regional Habitat Mapping Studies (Session 2)* *Chair – **Phil Weaver (National Oceanography Centre, Southampton)***	
15:40-16:00	The use of mapping techniques for identifying and evaluating *Sabellaria spinulosa* 'reef' habitats in UK waters.	***D. Limpenny**, R Foster-Smith, K Vanstaen, J Eggleton, W Meadows, S Boyd and T Edwards*
16:00-16:20	The Outer Bristol Channel Marine Habitat Study: an integrated interdisciplinary project with strong educational outreach.	***A. S. Y. Mackie**, J.W.C. James, T. Darbyshire, S. Philpott, K. Mortimer, A. Morando, G.O. Jenkins, L. Murphy and C. Poulton*
16:20-16:40	Marine habitat mapping – results from the Archipelago Sea, northern Baltic Sea.	***A. T. Kotilainen**, A M Reijonen, U Alanen, A Hirvonen, A Laine, J Leinikki, P Oulasvirta, T Suominen, P Vahteri J H Andersen, J Ekebom, J O Leth, G Lindeberg, S Neuvonen, M Nyman, A Nöjd, H Piekäinen and J Reker*
16:40-17:00	High resolution sea bottom survey of the Oslofjord, Norway – usual suspects and unexpected encounters.	***Aivo Lepland**, Reidulv Bøe, Heidi Olsen, Aave Lepland and Oddbjørn Totland*
18:00-20:00	Ice Breaker Hosted By Fugro Pelagos Inc. *Metro Bar, Apex International Hotel*	FUGRO Fugro Pelagos, Inc.

THURSDAY, MAY 4TH 2006

09:10-12:00	*Anthropogenic Impact and Habitat Mapping* *Chair – **Kim Conway (Geological Survey of Canada)***	
09:10-09:30	The Eastern English Channel Marine Habitat Map: supporting the sustainable management of offshore resources.	***J.W.C. James**, S. Philpott, D.S. Limpenny, A. Morando, R.A. Coggan, E. Bee, S.N.R. Birchenough, J. Robinson, S.E. Boyd, C. Johnston and B V Blyth-Skyrme*
09:30-09:50	Scale issues in ground-truthing the large-scale habitat map of the eastern English Channel.	***Roger A. Coggan**, Silvana N.R. Birchenough, Jamie Robinson, David S. Limpenny and Siân E. Boyd*
09:50-10:10	Natural and anthropogenic analogues for modeling seabed development scenarios.	***Richard Holmes**, Ceri James and David Tappin*
10:10-10:30	*Modiolus* bioherms in the Irish Sea: surveying and management challenges of a range of mussel bed types.	***E. I. S. Rees**, C Lindenbaum, J Bennell, W G Sanderson and T J Holt*
10:30-11:00	Coffee Break	
11:00:12:00	*GIS and Data Processing / Analysis* *Chair – **Ceri James (British Geological Survey)***	
11:00-11:20	Nearshore benthic habitat GIS for the Channel Islands National Marine Sanctuary and Southern California State Fisheries Reserves.	***Guy Cochrane***
11:20-11:40	Construction of potential marine benthic habitat maps in GIS for end users: a regional resources management tool.	***H. Gary Greene**, Victoria M. O'Connell, Cleo K. Brylinsky, Joseph J. Bizzarro and Holly L. Lopez*
11:40-12:00	Typology of the sea floor of the North and Baltic seas by means of geostatistical and multivariate statistical methods.	*W. Schröder, **R. Pesch** and H. Pehlke*
12:00-12:40	Buffet lunch and Posters	
12:40-14:40	*Habitat Mapping Techniques (Session 1)* *Chair – **Terje Thorsnes (Norwegian Geological Survey)***	
12:40-13:00	Exploring the relationship between sidescan sonar backscatter and benthic habitat.	***C. J. Brown** and J. S. Collier*
13:00-13:20	Combined acoustic and optical methods for improved high resolution habitat classification: Sound of Harris.	***Tim J. Malthus**, Evanthia Karpouzli, Dan B. Harries and Bob Foster-Smith*
13:20-13:40	Mapping Seabed Habitats off the North Irish Coast: a range of habitats and a range of techniques.	*A. Mitchell, C. Brown, **J. White**, J. Strong, F. Fitzpatrick, D. Long and M. Service*
13:40-14:00	Predicting the potential distribution of cold-water corals at the Irish continental margin.	***Janine C. Guinan**, Margaret F. J. Wilson, Colin Brown and Anthony*

		J. Grehan
14:00-14:20	Seabed classification: a multidisciplinary approach to the mapping of deep-water coral habitats.	***Max Kozachenko*** *and Andy Wheeler*
14:20-14:40	Developing species specific habitat suitability maps in the deep sea – case studies from the Irish continental slope.	***Margaret Wilson****, Janine Guinan, Anthony Grehan, Colin Brown*
14:40-15:00	Coffee Break	
15:00-17:00	*Habitat Mapping Techniques (Session 2)* *Chair –**Anthony Grehan (National University of Ireland, Galway)***	
15:00-15:20	Multibeam backscatter data processing and mosaicing: implications for usefulness in habitat mapping.	***A. J. Mitchell****, T Le Bas, K L Howell and P Kennedy*
15:20-15:40	Are acoustic 'facies' diagnostic of benthic habitats on unconsolidated sea beds?	***Thaiënne A. G. P. van Dijk****, Ronnie A van Overmeeren and Sytze van Heteren*
15:40-16:00	Defining marine landscapes at a detailed level and their relevance in a biological context, experience from the Belgian continental shelf.	***Kristien Schelfaut****, Els Verfaillie, Steven Degraer & Vera Van Lancker*
16:00-16:20	Bathymetric data for mapping of seabed features and habitats. Scale relations based on tests off the coast of western Norway.	*Lars Erikstad,* ***Oddvar Longva****, Trine Bekkby, Eli Rinde, Vegar Bakkestuen, Ole Christensen, Martin Isæus and Kjell-Magnus Norderhaug*
16:20-16:40	Regionalisations of the Australian coastal and marine environment: a geophysical perspective.	***R. Porter-Smith*** *and V. Lyne*
16:40-17:00	Application of a demersal regionalisation framework to assess faunal structuring on Australia's continental shelf and slope and their relationship to deepwater geophysical properties.	*Peter Last,* ***Vincent Lyne****, Rick Smith, Gordon Yearsley, Martin Gomon, Donna Hayes, Daniel Gledhill, Tony Rees and William White*
19:00-22:00	GeoHab 2006 Dinner *Heights Restaurant, Apex International*	

FRIDAY, MAY 5TH 2006

09:00-10:40	*Classification of Habitats* *Chair – **Gary Greene (Moss Landing Marine Laboratories, USA)***	
09:00-09:20	Report from the Quester Tangent workshop on the Acoustic Seabed Classification Workshop hosted at the British Geological Survey on the 2nd May.	***Glenda Rathwell***
09:20-09:40	Testing the Coastal/Marine Ecological Classification Structure in the Columbia River Estuary.	***Nancy Wright**, Katherine Nielsen and Michael Rink*
09:40-10:00	Benthic Habitat Classification for Rockfish stock assessment in Juan Perez Sound.	***Chris Grandin***
10:00-10:20	Development and application of a pelagic regionalisation for Australia's Marine Jurisdiction.	*Vincent Lyne, **Donna Hayes**, Rick Smith and Peter Last*
10:20-10:40	Physical surrogates for marine benthic habitats in the Gulf of Carpathia, northern Australia.	***Alexandra Post**, Ted J. Wassenberg and Vicki Passlow*
10:40-12:30	Coffee Break and Poster Session	
11:30-12:30	GeoHab 2007 Planning Meeting (***GeoHab Steering Committee, San Francisco Room***)	
12:30-13:20	Buffet lunch and Posters	
13:20-13:40	GeoHab Book Update	***Brian Todd** and **Gary Greene***
13:40-13:50	Plans for GeoHab 2007	***Gary Greene***
13:50-14:00	Announcement about plans for fieldtrip.	***Alan Stevenson***
14:00-14:20	Closing Remarks	***Alan Stevenson***
14:20-14:50	Coffee Break	

Poster Presentations

Poster No.	Authors	Title
1	Cleo K. Brylinsky, H. Gary Greene, and Victoria M. O'Connell	**Tectonic Development of Significant Marine Fisheries Habitats within the Queen Charlotte-Fairweather Transform Fault System, SE Alaska, USA**
2	Roger Coggan and Annika Mitchell	**Overview of MESH Action 2: Developing standards and protocols for marine habitat mapping**
3	K.W. Conway, J.V. Barrie, E. D. Sargent, M. Krautter and S. Cook	**Sponge reefs on the western Canadian continental shelf: multibeam survey results from Queen Charlotte and Georgia Basins**
4	Axel Ehrhold, Dominique Hamon, Brigitte Guillaumont and Jacques Populus	**The REBENT monitoring network, a spatially integrated acoustic approach to survey nearshore macrobenthic habitats: application to the Bay of Concarneau (South Brittany, France)**
5	Jan Helge Fosså, Pål B. Mortensen, John Alvsvåg and Arne Hassel	**Growth pattern of the Træna reefs off northern Norway**
6	Neil Golding, Jon Davies and Natalie Coltman	**The development of a framework for Mapping European Seabed Habitats (MESH)**
7	Anthony J. Grehan, Margaret Wilson, Janine Guinan, James O'Riordan, Sean Nolan, Levente Molnar, Edin Omerdic, Daniel Toal, R. Hill and Colin Brown	**Deep-water coral habitat mapping off the west coast of Ireland: influencing marine policy and resource development**
8	Howell, K L, Davis, J, Drewry, J, Jacobs C, Johnston C M, Narayanaswamy B E	**Deep-water habitat mapping to inform development of offshore marine protected areas: research and management working in partnership**
9	Veit Hühnerbach, Philippe Blondel and Veerle A.I. Huvenne	**How Computer-Assisted Interpretation can improve the Mapping and Monitoring of Potential Habitats in Cold-Water Coral Reef Settings**
10	Peter Hunter, Colin Jacobs, Richard Holmes and David Long	**Detailed views of Seamounts and Banks, west of Scotland.**
11	Ceri James, Andy Mackie, Sally Philpott, Ivor Rees, Gareth Jenkins, Angela Morando, Teresa Derbyshire, Kate Mortimer	**Outer Bristol Channel Marine Habitat Study**
12	Ceri James, Sally Philpott, Dave Limpenny, Angela Morando, Roger Coggan, Emma Bee, Silvana Birchenough, Jamie Robinson, Koen Vanstaen, Bryony Pearce, Charlotte Johnston, Viv	**Eastern English Channel Marine Habitat Map**

	Blyth-Skyrme	
13	Jørgen O. Leth and Zyad K. Alhamdani	**Geophysical mapping of Læsø Trindel area, Northern Kattegat, Denmark**
14	Klaus C. Leurer, Brian O'Connell, Colin Brown, Gerry Sutton and Max Kozachenko	**Seabed sediment properties from single-channel seismic profiling data**
*15	D. Limpenny, R. Foster-Smith, J. Eggleton, K. Vansteen and T. Edwards	**The use of mapping techniques for identifying and evaluating *Sabellaria spinulosa* 'reef' habitats in UK waters**
16	Greger Lindeberg	**Airborne laser bathymetry in the Stockholm archipelago, Sweden**
17	Long, D, Jacobs, C L, Narayanaswamy, B E, Roberts, J M and Howell, K L	**Cold water corals (forming carbonate mounds) on Hatton Bank**
*18	Mitchell, A.J., Le Bas, T., Howell, K.L. and Kennedy, P.	**Multibeam backscatter data processing and mosaicing: implications for usefulness in habitat mapping**
19	Johan Nyberg	**Investigation and classification of seabed substrates in Swedish shallow bank areas**
20	Alexandra L. Post, Mark A. Hemer, Donna Roberts and Phil E. O'Brien	**Life beneath the ice: A history of benthic colonisation beneath the Amery Ice Shelf, Antarctica**
*21	Ramsay, K., Robinson, K.A., Lindenbaum, C., Wilson, J., McBreen, F., Wheeler, A., van Landeghem, K., Mackie, A., Derbyshire, T., Mitchell, N. and O'Beirn, F.	**Habitat Mapping for Conservation and Management of the Southern Irish Sea**
*22	R. Porter-Smith and V. Lyne.	**Regionalisations of the Australian coastal and marine environment: A geophysical perspective**
23	Johnny Reker, Greger Lindberg, Jørgen Leth, Åsa Andersson, Jan Ekebom and Jesper H. Andersen	**Improving management efficiency of Marine Protected Areas in the Baltic Sea through mapping, modelling, outreach and zoning plans**
24	Sayago-Gil, M, Fernández-Salas, L M, Long, D, Díaz-del-Río, V, Hitchen, K and Vázquez, J T	**Geomorphological features on the western flank of Hatton Bank (NE Atlantic Ocean)**
25	Kathryn M. Scanlon, Rhian Waller and Julia M. Knisel	**Deep-water Scleractinian Coral Habitats in the Madison Swanson Fishery Reserve, Northeastern Gulf of Mexico, USA**

* See Abstract in Oral Presentation Section

*26	Gerry Sutton and Max Kozachenko	**The Irish Sea Marine Aggregates Initiative (IMAGIN): scoping the potential development of a resource through multidisciplinary seabed mapping**
27	Brian J. Todd, Vladimir E. Kostylev and Page C. Valentine	**Mapping benthic habitats on German Bank, Gulf of Maine**
28	Valentine, Page C. and Heffron, Erin J.	**Mapping seabed habitats in the Stellwagen Bank National Marine Sanctuary, Gulf of Maine**
29	Henry Vallius	**Fishery and aquaculture in a changing archipelago, Eastern Gulf of Finland**
*30	K. Van Landeghem, A. Wheeler and N. Mitchell	**Multibeam acquisition in the Irish Sea: applications for habitats research**
31	Verfaillie E, Chapman N, Cremer J, Degraer S, Dijkman E, Foster-Smith R, Golding N, Hamdi A, Long D, Meleder V, Mitchell A, Populus J, Schelfaut K' Service M, Sotheran I, Todd D, Van Der Wal J, Van Gessel S, Van Heteren S, Van Lancker V, Vanstaen K, White J and Willems W	**Overview of MESH Action 4: Predictive modelling tools as an aid for the broad- and fine-scale mapping of European seabed habitats**
32	Verfaillie Els, Foster-Smith, Bob,Van Lancker Vera	**Analysis of bathymetrical derived features on the Belgian continental shelf as a support for marine habitat mapping**
33	P.P.E. Weaver and the HERMES Consortium	**HERMES: Hotspot Ecosystem Research on the Margins of European Seas**
34	C K Wilson, A McHattie, M S Stoker and A Stevenson	**Comparison of geological and biotope maps of the Summer Isles region, north-west Scotland**

* See Abstract in Oral Presentation Section

GeoHab Fieldtrip to St Andrews

SATURDAY 6TH MAY 2006

This trip will include a coastal walk examining the interesting biology of tidal rock-pools and the fascinating geology of the St Andrews Coast. The trip will also include time to explore St Andrews' historic town centre (although perhaps not enough time to fit in a round of golf on the famous Old Course!). Particular items of interest are recent landslips, sea stacks, the Saddleback Anticline and the Rock and Spindle, an ancient volcanic vent with radiating columns of basalt.

Sturdy, good footwear is needed and waterproofs should be taken in case of inclement weather!

Trip Leaders:

Rosalind Garton (St Andrews University)

Alan Stevenson (British Geological Survey)

Itinerary:

08:00	Meet bus at the Apex International in the Grassmarket.
09:40	Arrive St Andrews for guided coastal walk – view tide pools and geological features.
12:00	Lunch at the St Andrews Bay Golf Resort Clubhouse.
13:00	Continue trip into historic town of St Andrews.
15:45	Depart St Andrews.
17:00	Arrive Forth Bridges
17:30	Depart Forth Bridges.
18:00 (approx)	Arrive at Grassmarket, Edinburgh.

GeoHab 2006
Oral Presentation Abstracts

Exploring the relationship between sidescan sonar backscatter and benthic habitat

Brown, C.J.[1] and Collier, J.S.[2]

[1]University of Ulster, Northern Ireland
[2]Imperial College London
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The Loch Linnhe Artificial Reef is currently under construction off the west coast of Scotland. In 2003, a sidescan sonar survey of the reef site and surrounding area was conducted to characterise the benthic habitats. The relationship between acoustic backscatter and benthic assemblage has since been examined using the high-resolution sidescan sonar data and 21 benthic ground-truthing grab samples from the survey site. The processed sidescan sonar data were analysed by forming histograms of pixels extracted from a 20 m^2 box around each of the ground-truthing sites. Benthic assemblage structure and particle grain size data were measured from each of the grab samples. The ground-truthing stations were divided into three groups using multivariate statistical techniques based on their backscatter properties. Benthic assemblage structure was found to be significantly distinct between the high and low, and the medium and low backscatter stations. There was a low-moderate but significant correlation between the multivariate patterns of acoustic backscatter, benthic assemblage structure, and particle size distribution for the 21 sampling stations. The results indicate that analysis of acoustic backscatter data could be used in future surveys to map the spatial distribution of benthic assemblages with minimal ground-truthing.

Nearshore Benthic Habitat GIS for the Channel Islands National Marine Sanctuary and Southern California State Fisheries Reserves

Guy R. Cochrane

USGS Coastal and Marine Geology Program
Email: gcochrane@usgs.gov

The nearshore benthic habitat of the Santa Barbara coast and Channel Islands supports diverse marine life that is commercially, recreationally, and intrinsically valuable. Some of these resources are known to be endangered including a variety of rockfish species and the white abalone. Agencies of the state of California and the United States have been mandated to preserve and enhance these resources. Data from sidescan sonar, bathymetry, video and dive observations, and physical samples are consolidated in a geographic information system (GIS). The GIS provides researchers and policymakers a view of the relationship among data sets to assist scientific research and to help with economic and social policy-making decisions regarding this protected environment. With this data areas covered by thin sediment can be resolved. Without it, thicknesses of sediment on the order of 10 meters can not be resolved and estimates of rocky seafloor are exaggerated. A study area north of Anacapa Island in Southern California interpreted as a large rocky area after mapping with low resolution geologic framework seismic systems was found to have exposed rocky bottom in only 10% of the area when mapped with high resolution sonar. The area of rock was estimated using video-supervised maximum likelihood classification of the sonar data and derivatives of the data calculated from gray level co-occurance matrices. An independent sample data set was used to assess accuracy of the classified image. The classification of soft bottom was found to be approximately 90% accurate. Two general types of rock exposure are observed, sparse linear outcrops from layered sedimentary rocks and more massive rounded outcrop areas from volcanic rocks. South of point Arguello 80% of the shelf seafloor is underlain by sedimentary rock units which may result in less exposed rocky reef habitat than other sections of coast if they are predominantly volcanic. The percentage of exposed rock in volcanic areas exceeded that of sedimentary rock areas by a factor of 5 in the study area north of Anacapa Island.

Scale issues in ground-truthing the large-scale habitat map of the eastern English Channel.

Roger A. Coggan[1], Silvana N.R. Birchenough[1], Jamie Robinson[2], David S. Limpenny[1] and Siân E. Boyd[1]

[1]The Centre for Environment, Fisheries and Aquaculture Science (Cefas), Essex, UK
[2]Marine Ecological Surveys Limited, Bath, UK
Email: r.a.coggan@cefas.co.uk

The eastern English Channel contains a substantial area of potential aggregate resource. An industry consortium has undertaken a Regional Environmental Assessment (REA) covering a patchwork of aggregate prospecting areas (red polygons in Figure 1). Our survey was designed to place this REA in a wider spatial context to help assess the environmental significance of any potential impacts from commercial aggregate extraction over the broader region of the eastern English Channel. A geophysical survey grid provided 'acoustic corridors' of multibeam bathymetry data and sidescan sonar coverage over the survey area, and these data were used to target subsequent ground-truth stations. Three ground-truth sampling techniques were employed, namely grabs, trawls and video sledge transects. This paper will present preliminary result of the ground-truth sampling and examine scale issues relating to the value of these techniques when applied to verifying broad scale acoustic surveys. The utility of this survey design for underpinning policy decisions relating to the marine environment and resource development will be discussed.

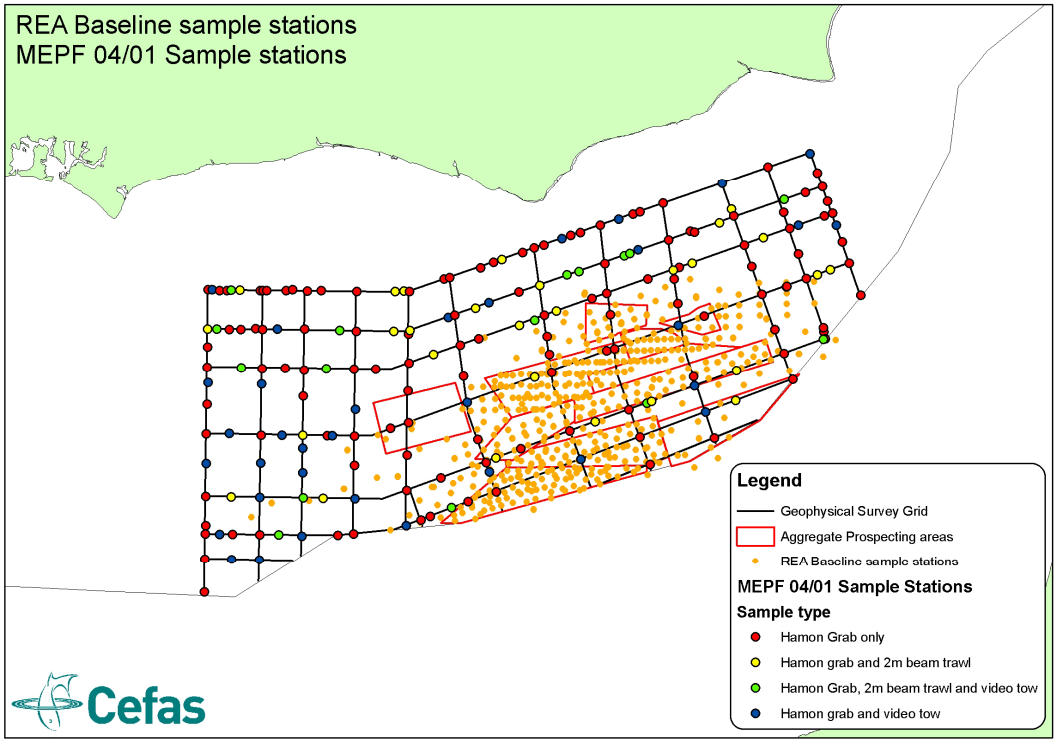

***Figure 1**. Survey grid and ground-truth sampling stations in the eastern English Channel, relative to the aggregate prospecting areas and REA sampling stations.*

UKSeaMap: The mapping of the marine seabed and water column features of UK seas

David Connor[1], Paul Gilliland[2], Neil Golding[1], Paul Robinson[1] and **Dylan Todd[1]**

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There have been a number of recent studies demonstrating the value of using geological, physical and hydrographic data to produce broad-scale ecologically-relevant habitat maps for the marine environment in the absence of detailed biological data (e.g. Roff & Taylor, 2000; Roff *et al*, 2003). The 'marine landscape' concept, initially developed in Canada by Roff and Taylor (2000), was later adapted for UK waters in the Irish Sea Pilot project (Golding *et al.* 2004; Vincent *et al*, 2004). Having proved the concept in a UK context, the approach is now being extended to the UK Continental Shelf (UKCS), under the "UKSeaMap" project.

UKSeaMap is a multi-partner project which aims to produce simple broad-scale maps of the seabed and water column features of the UKCS. The project commenced in May 2005 and is due for completion in June 2006, with results to be disseminated using the project website (http://www.jncc.gov.uk/page-2117). This paper will describe how the methodology originally used by Golding *et al* (2004) has been further developed and refined to allow the marine landscape classification to be extended to the wider UKCS sea area.

Environmental datasets were gathered from a variety of sources which have variously used modelling, remote sensing and direct sampling to provide the initial datasets. The seabed analysis utilised datasets on: surficial seabed substrata, depth and derived slope, bottom temperature, light attenuation, maximum wave base and maximum near-bed stress caused by tide. There has been a careful review of the purpose of each dataset as it is important in defining seabed types and the number of categories within each, to lead to a meaningful and manageable number of seabed types. Coastal physiographic features were also identified and mapped.

A supervised classification method was used to draw together the geological, physical and hydrographic datasets to generate and map, at the time of writing, 35 marine seabed types and 11 coastal physiographic features.

For water column features the aim was to create seasonal maps for the UK seas, based on the following seasons: Winter – December, January and February, Spring – March, April and May, Summer – June, July and August and Autumn – September, October and November. A number of hydrographic datasets were obtained from the Proudman Oceanographic Laboratory (POL), of which the following were used in the final analysis to define water column types: Surface salinity, Surface to bed temperature difference (modelled data) and Frontal probability (modelled data). Four maps were produced for the water column features, in order to reflect seasonal variability in the environment.

The final step in the methodology will involve validating the draft maps using biological information, to test the ecological validity of the maps derived from the modelling process.

The broadscale maps will provide an essential layer of spatial information to support more effective management of our marine resources and to help implement national and international commitments to protect the environment. They will also provide a more informed basis on which to design future spatially-based research and survey programmes.

The outputs and methodology are also feeding into a wider project 'Mapping European Seabed Habitats'.

References:

Roff, J.C., & Taylor, M.E. 2000. Viewpoint; *National frameworks for marine conservation a hierarchical geophysical approach.* Aquatic Conserv: Mar. freshw. Ecosyst. 10: 209-223.

Roff, J.C., Taylor, M.E & Laughren, J. 2003. *Geophysical approaches to the classification, delineation and monitoring of marine habitats and their communities*. Aquatic Conserv: Mar. Freshw. Ecosyst. 13: 77-90.

Golding, N., Vincent, M.A., & Connor, D.W. 2004. Irish Sea Pilot - a Marine Landscape Classification for the Irish Sea, JNCC Report 346

Vincent, M.A., Atkins, S.M., Lumb, C.M., Golding, N., Lieberknecht, L.M. and Webster, M. 2004. *Marine nature conservation and sustainable development - the Irish Sea Pilot.* Report to Defra by the Joint Nature Conservation Committee, Peterborough.

Are acoustic 'facies' diagnostic of benthic habitats on unconsolidated sea beds?

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The use of acoustic geophysical methods makes marine habitat mapping significantly more efficient. However, diagnostic backscatter signals and textures are not yet definite. Previous research in different seas has pointed out that backscatter intensities and patterns may allow for the recognition of different benthic colonies. However, in the interpretation, the distinction from the effects of sediment characteristics and morphology is still difficult.

As a test for the applicability of side scan sonar images for habitat mapping, we investigated several sites in the North Sea and its Dutch estuaries to find out whether acoustic 'facies' on sonograms are diagnostic for benthic habitats on sedimentary sea beds. We combined sidescan sonar and multibeam echo sounding measurements with box core samples of macrobenthos and sea bed sediments. We analysed the qualitative (mosaics of) sonograms as well as the digital backscatter intensity, highlighting intensities exceeding a certain level. Results show that biotopes which cause a high bed roughness, such as oyster, mussel and razorblade colonies, are well detectable on sonograms by their high backscatter intensity (Figure 1). Facies of other benthic colonies, such as protruding worm colonies, are more subtle, but may still be recognised by the mottling intensity on the sonograms and vague (biologically-altered) morphologic patterns in the far ranges of sonograms (Figure 2). Analysing the digital backscatter signals of the latter may help to recognise patterns specific to benthic colonies.

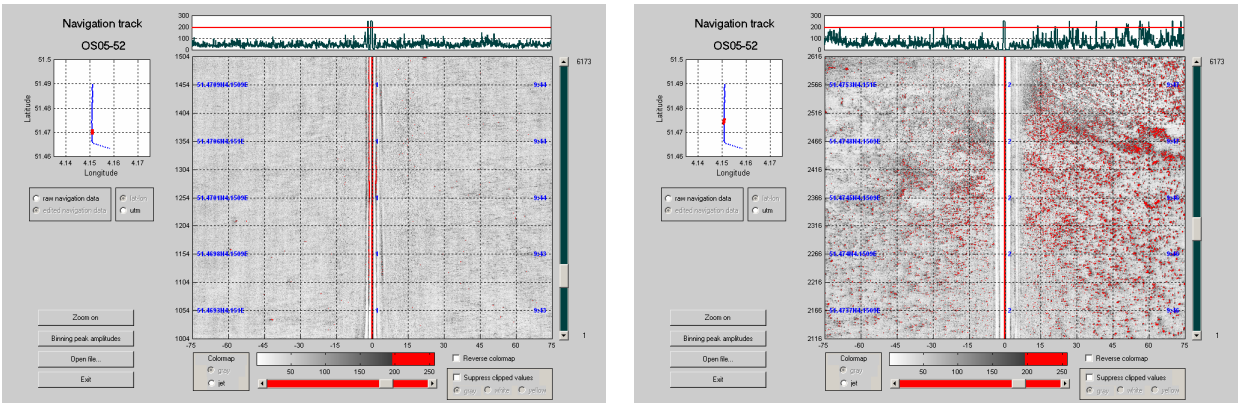

Figure 1: *Details of a sidescan sonar track across a (Japanese) oyster bank (Crassostrea gigas) in the Eastern Scheldt estuary. Strong backscatter is highlighted by colour coding above a chosen threshold. The sonogram on the left gives an example of a void area, whereas the one on the right illustrates the pattern of an oyster colony. The backscatter signal of one ping and the chosen setting of the threshold are given in the diagrams at the top.*

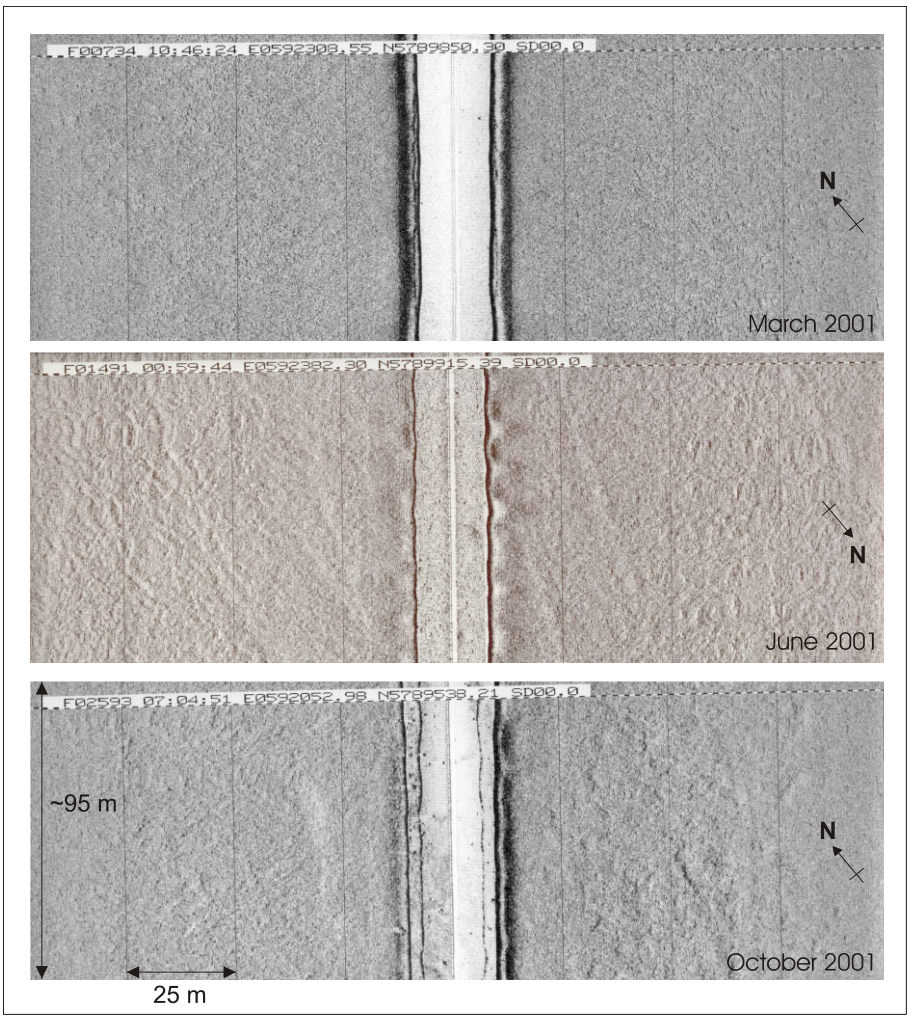

Figure 2: *Sonograms of the lower shoreface near Noordwijk, Netherlands, of March, June and October 2001. The homogeneous grainy pattern in March corresponds to a total number of individuals of 82 per sample (dominated by crustacea (Urothoe poseidonis)), and the mottled pattern in October to a total number of 707 individuals per sample (dominated by Annelida (Laonice bahuniensis and Spio goniocephala) and razorblades (Ensis americanus)).*

Very recently (Jan. 2006), we collected multibeam and sidescan sonar measurements and box core samples in combination with seismic data of Knudsen and ORE sub-bottom profilers, in order to test whether buried benthic species are better distinguishable with penetrating acoustics. We intend to present you those results.

This work shows that some benthic habitats are well distinguishable and other are extremely subtle on side scan sonar images of unconsolidated sea beds. The sonar facies and the comparison of side scan sonar and seismic data acquisition techniques contribute to both the methodology of and the facies recognition in marine habitat mapping, using acoustic techniques.

Acknowledgements
All data were collected in collaboration with the Directorate North Sea, Dutch Public Works and Water Management (DNZ-RWS) aboard the Ms. *Arca* and Ms. *Zirfaea*. Benthos samples were analysed by TNO-Environment.

Bathymetric data for mapping of seabed features and habitats. Scale relations based on tests off the coast of western Norway.

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The presentation is linked to three different projects, all with the aim to model habitats. A national project to provide basic data for habitat mapping covering the whole length of the Norwegian coast (financed by the Directorate for Nature Management and the Directorate for Fisheries) uses a standard bathymetric dataset with 50 m resolution interpolated from depth contours (0, 5, 10, 20, 30, 40, 50, 100, 150, 200m etc). The project Marmodell (financed by the Norwegian Research Council) uses the same dataset, but in parts validated by bathymetric data with resolution down to 1m, acquired by the NGU ship SEISMA. The last project financed by Norwegian Defence Estates Agency cover larger areas and is based on multibeam echo sounder data acquired by Norwegian Hydrographic Service.

The multibeam data was converted into grids with resolution 10, 25 and 50 meters and compared with the standard bathymetric model. The comparison has been done numerically comparing depth values as well as comparing the ability to distinguish seabed features. The numerical comparisons were done by comparing 4000 random single multibeam measurements with the different bathymetric models. The mean value of the standard bathymetric model was 5.2 metres above the multibeam readings, probably due to procedures securing navigation security. Standard deviation was 10.5 metres. For the two models based on multibeam data the mean value was near zero and the standard deviation increased from 2.1 metres (10m resolution) to 2.8 (25 metres) and 4.7 metres (50 metres).

All models based on the multibeam data revealed the same structures on the seabed which includes iceberg scouring marks, moraines and fluted surfaces. For the 50 meter dataset, the quality of the interpretation was however significantly lower than for the two others. The standard bathymetric model did not obtain a basis for this sort of detailed seabed feature interpretation, especially in the deep waters where contour intervals in the primary dataset has a resolution of 50 metres.

California Coastal and Marine Habitat Initiative – an approach to large-scale habitat mapping and some considerations, specifications and recommendations for implementation.

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The paper will primarily present a summary of the recent Marine Mapping Planning Workshop held in Monterey Bay in December 2005. The goal of the project was to create a strategic plan for completing the mapping for all seafloor habitats within California State Waters. The objectives were to co-ordinate efforts by all organizations involved in habitat mapping, create a summary of existing holdings, prioritize new areas and recommend minimum standards for survey specifications, level of data interpretation and map product creation. A three-tier process for map product generation as recommended by USGS will also be presented.

The debate about where to focus financial resources will be discussed and the consensus on minimum levels of data acquisition, level of interpretation, metadata and dissemination furnished.

The format of the first Request For Proposals under the Marine Habitat Initiative will be described and the preliminary concept behind the formation of a Consortium for Integrated Marine Geologic and Benthic Habitat mapping will be presented.

Benthic Habitat Classification for Rockfish Stock Assessment in Juan Perez Sound

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New non-intrusive methods using visual observations and benthic habitat classification have been developed to assess rockfish abundance. Expanding on methods developed by the Department of Geosciences at Oregon State University and NOAA Coastal Services Center, high resolution multibeam bathymetry and its derivatives including rugosity, slope, and two bathymetric position indices (BPI) were used in conjunction with backscatter to non-subjectively classify likely rockfish habitat in Juan Perez sound, British Columbia, Canada.

Development of the classifier included the use of maximum likelihood to determine BPI zones, and Principal Components Analysis to remove correlation among bathymetry and its derivatives. Visual fish observations from a submersible survey collected by line transect methods were used to create Probability of Detection Functions (PDFs) for the estimation of fish density by benthic habitat zone for Quillback rockfish and other abundant species. These densities were then applied to each habitat zone to estimate abundance. The benthic habitat classifier we have developed can be used to estimate abundance for any area covered by high-resolution multibeam bathymetry and backscatter.

Construction of Potential Marine Benthic Habitat Maps in GIS for End Users: A Regional Resources Management Tool

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Geographic Information Systems (GIS) are powerful tools that facilitate the creation of marine benthic habitat maps that can be used by fisheries biologists and marine resources managers. State-of-the-art seafloor mapping systems such as multibeam bathymetry, backscatter, and side-scan sonar tools provide excellent data that can be interpreted into marine habitat and other derivative or thematic maps using GIS. However, sometimes the presentation of many different attributes in a GIS map can be confusing and complex to an end user. Therefore, we focus on those components of the seafloor that are considered critical to the understanding and mapping of regional marine benthic habitats and to the appraisal of other resources such as aggregates for construction, sand for beach replenishment, and kelp for commercial harvest. We present examples of methodologies and products that have been developed for fisheries management purposes and resultant thematic maps that can be used for the evaluation of multiple marine resources and hazards. Specific attributes such as location, depth, substrate type, and seafloor induration (hardness), relief, complexity (rugosity, ruggedness), and dynamic conditions are emphasized as minimal critical components needed in any regional habitat-mapping project. The use of resolution and scale is often ambiguous in habitat mapping and these parameters need to be well defined. The implementation of a standard marine benthic habitat classification scheme that includes the above components in an easily retrievable GIS form is encouraged.

Predicting the potential distribution of cold-water corals at the Irish continental margin

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A growing interest in cold-water coral habitats in the northeast Atlantic and elsewhere has motivated numerous surveys collecting geophysical and underwater video data. The occurrence of coral species, in particular *Lophelia pertusa*, at target locations along the Irish continental margin has been well documented but the full extent of the species' distribution remains largely unknown. Seafloor topography and oceanographic conditions have been cited as important environmental factors required for corals to maintain their ecological range. Using species occurrence records (partially derived from new ROV video data), bathymetry data acquired during the Irish National Seabed Survey and predictions of oceanographic parameters derived from models, we describe how this information can help to predict the potential distribution of cold-water coral species.

Models identifying species potential distribution are largely determined by the type of available information. In this study we are testing the utility of an ecological niche modelling program, *Genetic Algorithm for Rule-Set Prediction* (GARP). This approach relies on the prediction of species presence from known environmental parameters. The algorithm combines several rule-sets which evolve through a machine learning artificial-intelligence-based approach so that the model achieves a greater predictive ability. Initially the model has been tested at a site scale (< 10 km^2) over carbonate mounds in the Rockall Trough and is being applied to a regional scale over the Irish continental shelf. The stochastic nature of GARP combined with the under-determined nature of the problem means that multiple solutions for the spatial distribution of species are produced for evaluation. In this study a minimum of 20 models were created for each study. Optimum models were evaluated based on intrinsic and extrinsic measures of omission and commission error.

We will present examples of using a genetic algorithm to predict potential habitat for cold-water coral. The technique may prove useful in preliminary conservation assessments and the planning of future mapping surveys.

Acknowledgements
This work is funded by the National University of Ireland, Galway's Marine Science Research Project 3.2 'Deep Ocean Habitat Mapping Using a Remotely Operated Vehicle' under the Irish Higher Education Authority Programme for Research in Third Level Institutions, Cycle 3. The authors would like to thank the Geological Survey of Ireland for use of the Irish National Seabed Survey dataset.

Geomorphic classification of marine benthic bioregions: application to a national marine bioregionalisation of Australia

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For the first time, the distribution of seabed geomorphic features has been systematically mapped over a large part of the Australian continental margin. The outlines of a total of 21 different types of geomorphic features were mapped over >9.0 million km^2 using a 250 m spatial resolution bathymetry grid generated by Geoscience Australia. The continental shelf is >1.9 million km^2 (21.91%), the slope >4.0 million km^2 (45.02%), and the abyssal plain/deep ocean floor >2.8 million km^2 (31.99%). The continental rise covers 97,100 km^2 or 1.08% of the margin. Plateaus are the most abundant geomorphic feature on the margin and cover 1.49 million km^2 or 16.51%, followed by basins (714,000 km^2; 7.92%), and terraces (577,700 km^2; 6.41%), with the remaining 14 types each making up <5%. Reefs, which total 4,923 individual features (47,900 km^2; 0.53%), are the most numerous type of geomorphic feature, due to the large number of individual coral reefs of the Great Barrier Reef. The 21 geomorphic features were clustered into 14 geomorphic unit types for application to environmental management. The geomorphic units represent regions of similar geomorphology and are inferred to capture broad patterns in benthic marine habitat distributions. These data form the basis of the National Benthic Marine Bioregionalisation of Australia, a federal government project to describe the biodiversity of Australia's seabed, and are being used to identify and define Australia's suite of marine protected areas.

Natural and anthropogenic analogues for modeling seabed development scenarios

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[2]British Geological Survey, Keyworth

Exploration and environmental monitoring of the United Kingdom Continental Shelf (UKCS) has proceeded at a rapid rate and has been stimulated by the frequency and regularity of licensing rounds, consents and permits for oil and gas extraction in hydrocarbons provinces, development of telecommunication and power cable routes, fisheries and the exploitation of sand and gravel resources. Since 2000, the UKCS hydrocarbon energy licensing rounds have been preceded by Department of Trade and Industry Strategic Environmental Assessments (SEAs), as required under the European Union Directives. World-class wind, wave and tidal energy prospects also occur within a United Kingdom Renewable Energy Zone extending to 200 nautical miles offshore. High-quality seabed physiographical, sediment textural and biota data are therefore also required in this zone to understand and monitor seabed processes and habitats. Very importantly, the results from surveys of pre-development natural and anthropogenic seabed features can provide powerful observation-based geological models and data for the calibration of quantitative numerical models.

Some of the newest and most exciting geological data and interpretations into seabed function result from the regional studies of the seabed in areas of tidal, wave and offshore wind energy prospects. Areas with developed or potential offshore renewable energy prospects are now visible from land, they are in less than 50m water depth, they are adjacent to demand or existing power distribution infrastructure and may have potential for conflict with existing users or for altering existing ecosystems. Renewable energy prospects are commonly associated with natural features including headlands, archipelagos, islands, estuaries and submarine banks. A relatively high proportion of wrecks are also found in areas that are close to harbours or exposed to strong tides, wind and tides. Detailed studies around natural and anthropogenic features are presented in relation to existing seabed properties, predictions of sediment transport and deposition, temporal seabed variability and what the natural seabed environment indicates may happen if structures are placed on the seabed for renewable energy.

Surface-mounted multibeam mapping of the deep-water Seamounts and Banks west of the United Kingdom: its use as a tool for process studies and habitat identification and comparisons with deep-towed sonar results.

Colin L Jacobs and Peter M Hunter

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Detailed mapping of Seamounts and Banks located on the deep-water continental margin to the west of the UK has recently been carried out with a view to selecting sites for high resolution investigation (high resolution sidescan sonar, photography and sampling) as part of a Strategic Environmental Assessment of Area 7. Multibeam sonar was used to construct DTM's and interpretation of the seafloor geomorphology combined with the multibeam acoustic backscatter mosaics and CHIRP sub-bottom profiles, allowed identification of recent and presently active sedimentary and oceanographic processes. However, the limitations imposed upon the multibeam system resolution by increasing water depths (cf. larger acoustic footprint), precluded detailed seafloor type delineation. We demonstrate the difference between surface-mounted and near-seabed sonar systems in terms of the resolution and briefly discuss the need for a recognised standard for Environmental Assessment and/or Habitat Delineation.

This project was funded as part of the UK Department of Trade and Industry's offshore energy Strategic Environmental Assessment programme, and we would like to thank the DTI for allowing data collected on the Kommandor Jack during 2005 to be used here. The SEA programme is funded and managed by the DTI and coordinated on their behalf by Geotek Ltd and Hartley Anderson Ltd.

The Eastern English Channel Marine Habitat Map: supporting the sustainable management of offshore resources

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This aim of the project is to provide integrated broadscale habitat maps for an extensive area within the central part of the Eastern English Channel in order to support the sustainable management of offshore resources. The maps will be based on an inter-disciplinary approach, integrating geological, geophysical and biological data and interpretations. A geophysical survey of 4000 line km utilising multibeam, high resolution multipulse sidescan and boomer sub-bottom has been completed. From an initial interpretation of the geophysics a ground truthing survey was planned and completed with grabs, trawls and video. The driver is the discovery of substantial aggregate resources in this area and the requirement to manage the sustainable development of this resource and minimise potential impacts. The area of resource needs to be assessed within the broader context of the Eastern English Channel. The UK government wishes to promote effective stewardship of the marine environment through a policy of integrated management, balancing the requirements for development with nature conservation and legislation. The implementation of the EU Habitats directive requires a significant knowledge of the nature of the sea bed and the project will act as a demonstrator for the mapping methodologies which are required for effective implementation.

Marine habitat mapping – results from the Archipelago Sea, northern Baltic Sea

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Jesper H. Andersen[6], Jan Ekebom[7], Jørgen O. Leth[8], Greger Lindeberg[9], Samuli Neuvonen[10], Madeleine Nyman[10], Anna-Leena Nöjd[10], Henna Piekäinen[10], Johnny Reker[6]

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The world oceans and seas, as well as their seafloors, have been explored for decades. However, our knowledge from these is still limited. This is valid also for the Baltic Sea, one of the largest brackish water bodies in the world, where e.g. information on the state and distribution of geo- and biodiversity is scattered and insufficient in many places. Existing data is not adequate in planning and implementing effective management solutions for sustainable use of marine resources and protection of the Baltic Sea's unique natural heritage. Due to increased activities (like marine traffic) in the marine and coastal areas this lack of information is problematic. This has been acknowledged in several national and international connections (EC Directives, HELCOM recommendations), which emphasise the importance of deepening our knowledge of marine environment.

We show preliminary results of marine habitat mapping project (VALKO) from the Archipelago Sea, northern Baltic Sea. The VALKO -project is part of the Finnish Inventory Programme for the Underwater Marine Environment (VELMU). The main aim of the VALKO project is to develop a collaboration model for the implementation of the field inventories. Marine habitat mapping in the Archipelago Sea is also the focus of the Interreg III B co-funded BALANCE –project, and is one of the pilot study areas in the BALANCE (http://www.balance-eu.org/). BALANCE -project will provide information and tools for trans-national spatial planning in the Baltic Sea region. The environment of the Archipelago Sea pilot area is very diverse. It includes coastal area, an archipelago of more than 22 000 islands and open sea areas. This sea area includes the largest diversity of both biotopes and species along the Finnish coastal zone; therefore it is optimal for testing and developing inventory methods.

Harmonization of survey methodology and data classification is an essential part of the project in national (VALKO) and especially in international level (BALANCE). Methods used to collect information on marine environment include metadata collection, remote sensing methods (e.g. aerial photographs), acoustic-seismic methods (e.g. echo-sounding, side scan sonar) and sediment sampling. Biological observations were made using underwater video and photography, diving observations and sampling. Modelling is used to provide information on both biotic and abiotic elements (e.g. marine landscape). During VALKO project distributed GIS service was tested and proved effective method for data delivery. The multinational BALANCE project is also using similar method for data delivery (http://maps.sgu.se/Portal/).

Seabed classification: a multidisciplinary approach to the mapping of deep-water coral habitats

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This presentation demonstrates a multidisciplinary approach to the mapping of deep-water coral reef habitats on the Atlantic European margin. It shows how through the use of the remotely sensed geophysical methods, in conjunction with groundtruthing ROV (Remote Operated Vehicle) video surveys, seabed sampling, and subsequent GIS (Geographical Information System) data integration, it is feasible to efficiently assess the current state of deep-water coral reefs and perform detailed geo-biological seabed classification of their environment. The undertaken approach is demonstrated on the example of detailed investigation of the Belgica Mounds (deep-water coral carbonate mounds rising up to 200m above seabed) in the eastern Porcupine Seabight, North East Atlantic (Figure 1).

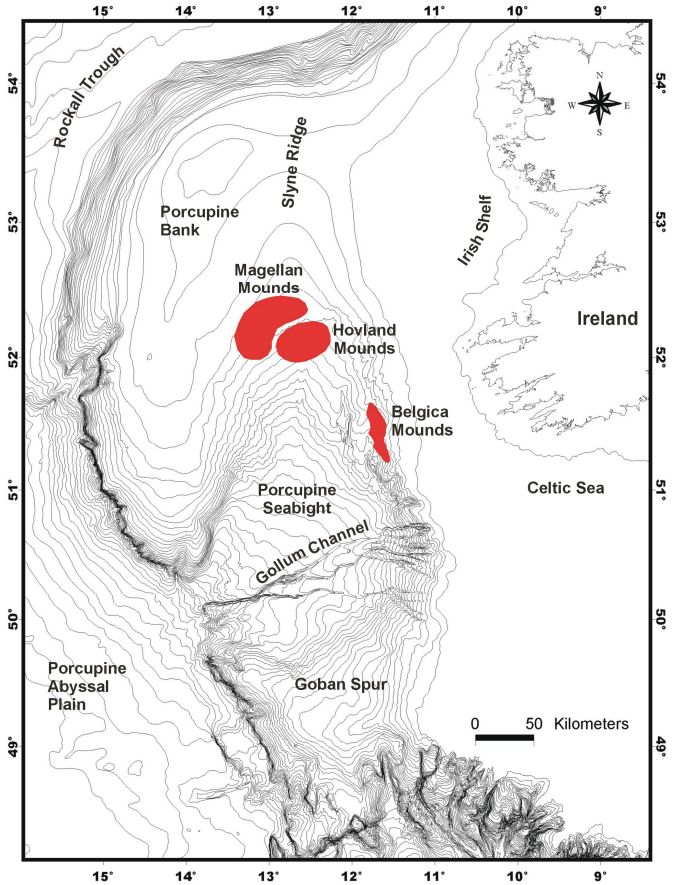

Figure 1: *Location map of the Porcupine Seabight study area, showing location of the Belgica, Hovland and Magellan coral mound provinces. Bathymetric contours are drawn at 100m intervals (source: GEBCO-97).*

In general terms, the undertaken approach can be characterised as mapping from low to high resolution. The multibeam mapping allowed the establishment of the overall seabed morphology of the study area and helped in planning of the higher resolution surveys. The 30kHz TOBI side-scan sonar mapping facilitated a generalised seabed classification in terms of seabed processes, near-bottom current and sediment pathways. The 100/410kHz

GeoAcoustic side-scan sonar and 3.5kHz sub-bottom profiler surveys have been used to provide additional detail on the seabed surface morphology, bedform distribution, currents and sediment pathways, and was used for the planning of the seabed truthing with the underwater video systems and box cores. The multibeam and 100kHz side-scan sonar integration allowed the assessment of the seabed processes from a three dimensional perspective. Finally, video truthing and seabed sampling have provided a high-resolution insight into particular aspects of the present environments of the study area. Video imagery was subject to detailed facies analysis. This was done in order to determine biotic and abiotic seabed components and hence truth the remotely sensed datasets. Facies analysis was used to emphasis changes in the coral population on the mounds, and also to define types of seabed in the off mound areas. This allowed the establishment of the current status of the carbonate mounds within the Belgica mound province (Figure 2) and produce a facies-interpretation map of the study area (Figure 3).

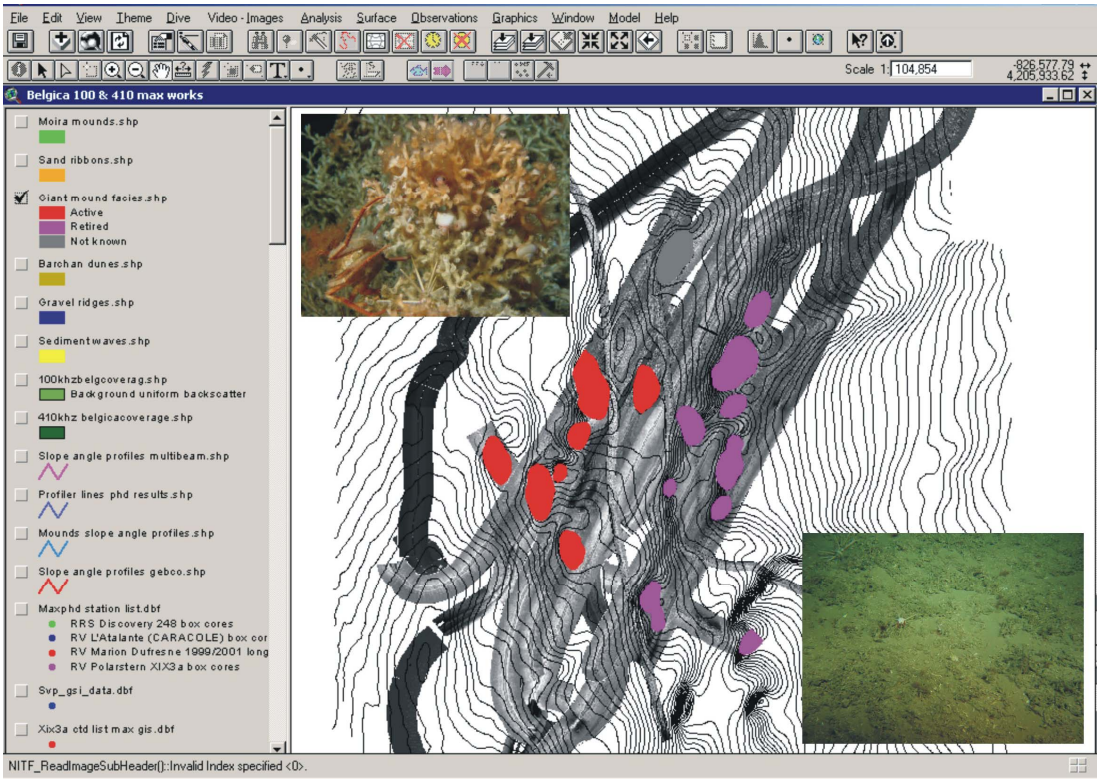

Figure 2: Screen grab from the GIS of the Belgica Mounds illustrating the division of mounds within the study area into "active" (red) and "retired" (purple) in terms of biologically driven growth. Typical video highlights characteristic for each of the mound types are also shown.

This study produced the following recommendations regarding the approach to the mapping of deep-water coral habitats:

- High-resolution side-scan sonar mapping is recommended as the main method for the planning of the video surveys and seabed sampling due to a well-established correlation between the side-scan sonar backscatter and seabed sedimentary and biological processes.

- The 3.5kHz sub-bottom profiler can be used as a predictive tool for the identification of the coral colonised mounds and, is also recommended for the planning of the groundtruthing sites. The GIS data integration performed by this study has established that there is a strong correlation between the nature of the seabed reflector imaged by 3.5kHz sub-bottom profiler and the current status of carbonate mounds: diffuse reflector is indicative of active mounds and solid reflector is indicative of retired mounds.

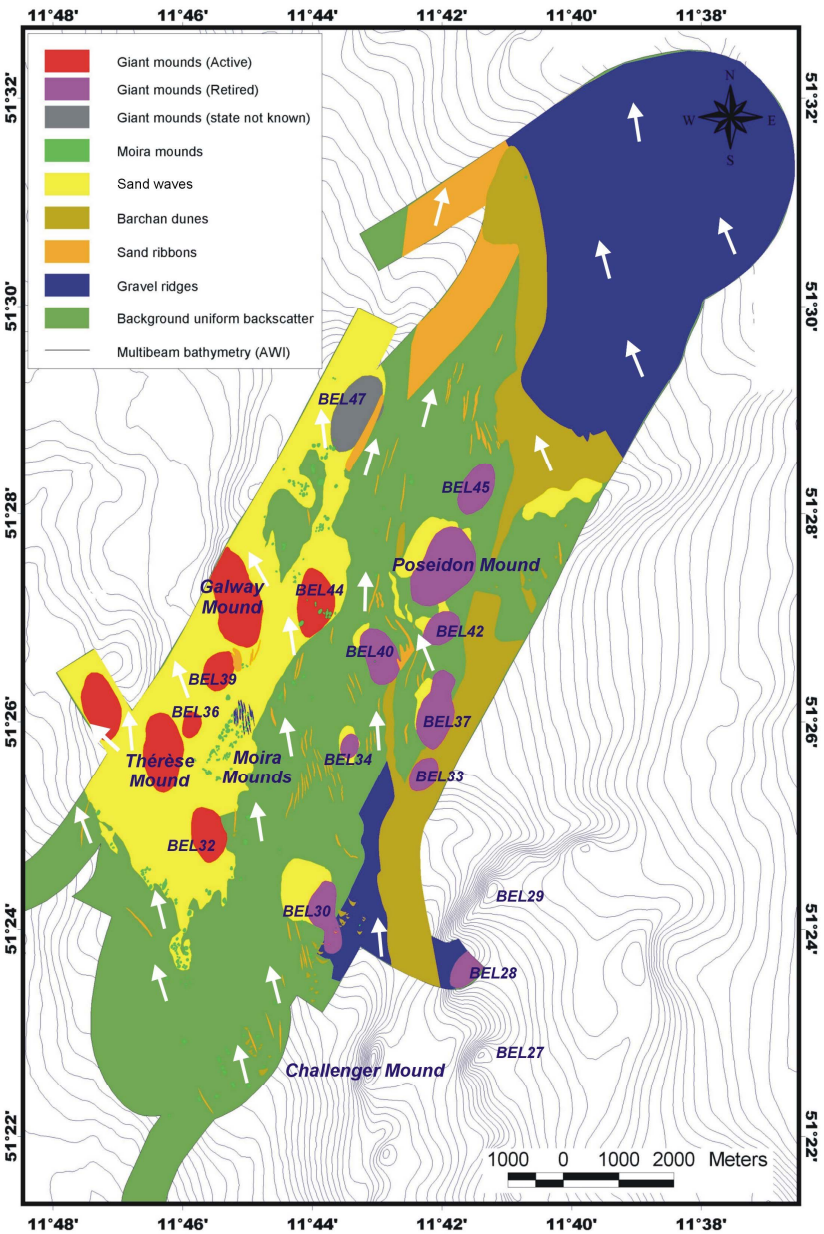

Figure 3: *Interpretation (facies) map of the Belgica Mounds study area based on the side-scan sonar, 3.5kHz sub-bottom profiler, video and sample data. White arrows indicate directions of benthic currents derived from bedform asymmetry on side-scan sonar and video imagery.*

This presentation is based on the results of the PhD study at the University College Cork, Ireland. The data collection was principally funded through EU 5th framework ECOMOUND "Environmental Controls on Mound Formation along the European Margin" (Contract number: EVK3-CT-1999-00013) and ACES "Atlantic Coral Ecosystem Study" (Contract number: EVK3-CT-1999-00008) projects. TOBI data collection was undertaken with financial support of the European Union (EASSS III programme, 'Improving Human Potential', contract HPRI-CT-1999-00047) and the Porcupine Studies Group (PSG) of the Irish Petroleum Infrastructure Programme Group 3.

Application of a demersal regionalisation framework to assess faunal structuring on Australia's continental shelf and slope and their relationship to deepwater geophysical properties

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Comprehensive biogeographic appraisals of Australia's demersal fishes are used to provide provincial and biomic demersal regionalisations of the Australian continental shelf and slope. These distributions provide a surrogate of marine faunal distributions on Australia's seafloor. We find evidence of strong provincial and biomic faunal structures with some obvious parallels between the shelf and slope patterns, as well as some marked differences. Notably, the levels of faunal complexity are less offshore in temperate Australia, but more complex on the Australian slope in the tropical Indian and Pacific Oceans, particularly off both the north-east and north-west coasts respectively.

Faunas in each of these provinces display strong patterns of bathymetric zoning into biomes. In the present study, three biomic units were identified on the continental slope, and an additional ill-defined unit on the outer continental shelf. Transition units occur between these biomes. Assemblages beyond the mid-slope could not be clearly evaluated due to a lack of data, but species confined to the deep slope flagged the existence of a lower slope biome, probably beyond 1600 m. Beyond the continental slope (ie, deeper than 2000 m), where the fauna is known to become more homogeneous, we examine the utility of geophysical surrogates.

Whilst a comprehensive assessment of biomic structure on the continental shelf is yet to be completed, regional studies reveal strong depth stratification of faunal units which appears to parallel variations in broadscale geophysical properties. Overall, our studies to date using quality controlled data on informative demersal fish demonstrate a high degree of faunal structuring at both the provincial and biomic levels on the continental shelf and slope of Australia. While our assessments of geophysical surrogates is still at an early stage, surrogacy is apparent at the biomic level on both the shelf and slope. We also expect stronger associations between fauna and appropriate geophysical properties at smaller scales.

High-resolution sea bottom survey of the Oslofjord, Norway – usual suspects and unexpected encounters

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One third of Norway's population lives in the Oslo region hence it is not surprising that the Oslofjord has been exposed to various contaminant discharges and environmental hazards. Over the past decades some areas of the fjord bottom have been rendered largely inhabitable. Complicated seabed morphology, great variability of substrates and alteration of erosion and accumulation areas call for detailed information on bathymetry, bottom types and sedimentary processes to establish sensible monitoring and conservation programs.

The Geological Survey of Norway took an initiative for a full-scale seabed-mapping programme of the inner Oslofjord in 2004. Interferometric sonars (GeoSwath by GeoAcoustics) with 125 kHz or 250 kHz transducers have been used for collecting bathymetric and backscatter data. Sediment stratigraphy and sediment thicknesses were mapped (simultaneously with GeoSwath profiling) with either TOPAS parametric sub-bottom profiler or GeoPulse boomer. The GeoSwath registrations have been gridded applying a 1m cell size. The spatial density of GeoSwath registrations allows to grid the data with even smaller cell size, but because of transitional, fluffy sediment-water interface it is often impossible to exactly define the sea bottom at the cm-scale, and therefore smaller than 1m grids appear impractical.

The bathymetric dataset reveals numerous large and small, natural and man-made sea bottom features such as bedrock ridges, dyke and fault systems, submarine slides, anchor and dredging tracks, dumping areas, shipwrecks etc. The most astonishing finding is the occurrence of hundreds of well-defined pockmarks (ca. 60 m in diameter and up to 5 m deep) that had not been reported from the Oslofjord before. Pockmarks occur typically in sediments above faults in the underlying Palaeozoic bedrock, but it is yet to be proven whether it is gas or groundwater that seeps out and forms pockmarks.

GeoSwath backscatter data integrated with bathymetry, seismic information and sediment sample characteristics allow compilation of sediment maps and interpretation of sedimentary processes (erosion, by-pass, accumulation) at the seabed. This information is used to define the depocentres in the Oslofjord that are the ultimate recipients of fine-grained sediments and associated contaminants. The environmental state of the fjord, both at present and in the past is most reliably reflected in the bottom sediments in these accumulation basins hence the control upon the depocentres and sediment transport provides an important framework for environmental assessments.

The use of mapping techniques for identifying and evaluating *Sabellaria spinulosa* 'reef' habitats in UK waters

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Biogenic structures formed by the tube-building worm *Sabellaria spinulosa* provide a habitat that allows many other associated species, including epibenthos and crevice fauna, to become established. Consequently, they are subject to the EU Habitats Directive (Annex 1) and represent a marine habitat which must be considered for protection through the designation of Special Areas of Conservation (SACs). This habitat exists in a range of forms from crusts a single individual thick to agglomerations rising several decimetres from the seabed. Human activities, such as aggregate extraction, have the potential to damage these structures and the statutory licensing of such activities seeks to protect these habitats. However, the status of this habitat in U.K. coastal waters is not well understood and the survey methods which might best identify *Sabellaria spinulosa* 'reefs' have not yet been established. This limits our ability to provide effective management and protection of this habitat.

CEFAS, in partnership with JNCC and Envision Mapping, are conducting a review of both the occurrence and the ecology of this habitat and also those survey techniques that have been used to identify it. The project is funded by Defra's Aggregate Levy Sustainability Fund, through English Nature's grants scheme. We are intending to establish the comparative effectiveness of various survey tools and approaches to identify, map and monitor the presence, extent and 'quality' of these habitats. During the first year of the project we have conducted preliminary survey work at a number of sites in the North Sea using acoustic, photographic, grabbing and trawling techniques. Early results suggest that a range of techniques will have a role to play in mapping *Sabellaria* 'reef' habitats. Further survey work is planned for 2006 and we intend to use the results from both the review process and the preliminary surveys to guide and refine our approaches.

The outcomes of the project will inform subsequent 'Best Practice Guidelines' to be produced by the JNCC.

Development and application of a pelagic regionalisation for Australia's Marine Jurisdiction

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The three-dimensional nature of the marine environment and temporal variability have posed difficult challenges in understanding and managing the pelagic (water column component) of the oceans. Apart from satellite-based plankton images, biological information lacks spatial and temporal coverage to adequately regionalize this environment, or to determine surrogate relations between geophysical properties and ecological structures and processes. Management needs and potential uses of pelagic regionalisation information is consequently also unclear because there are no synergies with terrestrially-based studies, or of regionalisations of benthic marine systems based on distributions of biota and geophysical properties of the seafloor.

We describe firstly a framework for regionalizing the pelagic marine system which relies primarily on physical properties and satellite plankton images. Three levels of the framework are described by application to Australia's Marine Jurisdiction. The first level describes the structure at the scale of the oceans. The second level describes ocean zones that appear as latitudinal bands at the surface but are three-dimensional in structure. The third level describes the energetics and variability of water masses and we present only the surface characterization at this level.

At this stage, the pelagic regionalisation of Australia is mainly being used to illustrate the complexity of the marine water column structure so it is at an early state of development compared to the benthic regionalisations reported in GeoHab 2003. However, as with the benthic regionalisation, the key aim is to determine the linkage between biological and geophysical attributes - we expect the linkage to be much stronger in pelagic than benthic systems. Our work also suggests much tighter coupling between pelagic and topographic structures than we had anticipated. This last observation suggests that a unified treatment of pelagic and benthic regionalisations should be possible. A corollary conclusion is that benthic structures may also be influenced by the pelagic environment.

The Outer Bristol Channel Marine Habitat Study: an integrated interdisciplinary project with strong educational outreach

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This three-year study (2003-2006) was based around regional habitat mapping of an area with potential for the future extraction of marine aggregates. The project utilised newly collected geological, geophysical and biological data, together with photographic and video imaging, to produce integrated sea bed habitat and biotope maps. This was achieved through the combined use of multibeam, sidescan and boomer technologies, alongside direct sampling with grabs and trawls, supplemented by underwater photography. Apart from providing modern scientific interpretations of the seabed to satisfy resource management and environmental needs, a major part of the study involved the dissemination of the data, results and recommendations to as wide an audience as possible. This has been achieved through a range of outputs including scientific reports, a touring multimedia exhibition, an innovative interactive educational CD-ROM and the development of website access. However, the most important outreach activities were delivered by a project marine education interpreter who developed and ran a workshop programme for schools suitable for use in the National Curriculum (Key stages 2-4; ages 7-16). This reached over 4500 pupils in the 2005-2006 academic year and a further 3500 people were involved through outreach sessions and events in Wales and England.

Combined acoustic and optical methods for improved high resolution habitat classification: Sound of Harris

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A range of high resolution remote sensing technologies are now available to assist in the mapping of subtidal marine habitats. Acoustic technologies offer easy deployability, independence from cloud cover problems, good depth penetration and modest cost, but give limited coverage, especially in more inaccessible shallow water areas. High resolution optical remote sensing offers spectral information with a degree of penetration into the water column and wide spatial coverage in shallow clear waters. LIDAR offers high data density for bathymetric studies, useful in the habitat classification process. However, despite evidence suggesting there are complementary benefits, there is a lack of studies on the combined use of alternative remote sensing approaches for biotope mapping. Additionally, classification accuracies can be increased though the use of structural and contextual approaches to the classification; it is well known that the determinants of variation of certain biotopes include important environmental gradients, for example, bathymetry, salinity, exposure, tidal currents and other geomorphological and hydrological gradients.

An increased knowledge of the marine biotope distribution in the Sound of Harris, Outer Hebrides is desirable in order to assess the potential impacts of any proposed future developments in the area. The paper presents the results of the combined use of remote sensing technologies for mapping biotopes in the Sound. High resolution multispectral QuicBird satellite data, multibeam acoustic data and high resolution LIDAR bathymetric data were obtained for the study. The study was complemented by a comprehensive groundtruth survey, used both to guide and test the accuracy of the classification; this survey included records acquired from 320 shore zones and 198 subtidal stations and sediment infauna samples collected from 102 locations.

A combined spectral and acoustic classification for the Sound of Harris was produced which drew on further rules based on observed variations of biotope distribution within the Sound in relation to factors such as exposure, tidal currents and water depth (extracted from the LIDAR data). This process provided greater resolution in the mapping of those biotopes which are not clearly distinguishable in terms of their spectral and acoustic characteristics. Biotopes were also combined to appropriate hierarchical levels where they occurred infrequently in the Sound or where their reflectances were spectrally similar. As a result, a total of 19 intertidal and subtidal biotopes and biotope groupings were discriminated with an overall accuracy of 75% with all classes individually discriminated to 50% accuracy or better.

The project has shown that a combined acoustic and optical approach exploits synergies in the two techniques allowing discrimination of biotopes in shallow zones using optical data where light penetration is good, combined with the accurate mapping of biotopes using acoustic data

in deeper waters where light penetration is low and where the optical datasets are of more limited utility.

Mapping Seabed Habitats off the North Irish Coast: a range of habitats and a range of techniques

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The British Geological Survey, Department of Agriculture and Rural Development, Northern Ireland and Irish Marine Institute embarked upon a joint seabed habitat mapping programme in 2004 as a component of the INTERREG IIIB Project MESH (Development of a framework for **M**apping **E**uropean **S**eabed **H**abitats). The aims; to investigate seabed habitat mapping surveying standards and processing protocols, to advise future habitat survey operations.

Survey areas were selected to provide a range of seabed features, including rock platforms, rock pinnacles, iceberg scour marks, sand waves and sand banks. Areas were targeted with multibeam echo sounder, single beam echo sounder, sidescan sonar, sub-bottom profiler, drop camera, video tow and grab samples collected for particle size analysis and replicates for benthic invertebrates.

Results from a range of seabed classification approaches using MBES backscatter, sidescan sonar and single beam AGDS will be presented with corresponding ground truthing data to assess appropriateness of methods for delimiting seafloor habitats across the different features.

Multibeam Backscatter Data Processing and Mosaicing: implications for usefulness in habitat mapping

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Five sites were surveyed offshore from the Outer Hebrides, Scotland, using a Reson SeaBat 8101™ multibeam echosounder (MBES) to examine circalittoral bedrock reefs as part of a broadscale habitat mapping effort initiated by the UK Joint Nature Conservation Committee and Scottish Natural Heritage. Ground-truthing was undertaken using a towed video sledge, drop-camera and grab sampling. For one survey area, ground-truthing sites were selected using backscatter data, while for the other areas bathymetric data guided sampling efforts. The habitat maps were constructed initially through integrating, post-processing and interpreting the bathymetric data, some associated acoustic ground discrimination system (AGDS) data and ground-truthing information.

As a follow-up exercise, the MBES backscatter data was processed and mosaiced for all the survey sites using a variety of software packages in order to find which may produce a result that would be useful in discriminating habitats. It was found that some of the mosaics could reveal an almost sidescan sonar-like image quality at a number of sites, with associated discriminatory power that would be a great aid to habitat mapping and stratification of ground-truthing. The mosaics will be presented along with corresponding ground-truthing data and habitat maps. Recommendations will be made for the data processing, incorporation and weighting of such information for habitat mapping purposes.

Overview of habitats found on the seamounts and banks to the West of the UK during the SEA 7 survey 2005

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The seamounts and banks in the NE Atlantic, situated to the West of the UK, were broadly explored for the first time in July – September 2005. This work was carried out under the Strategic Environmental Assessment Area 7 remit funded by the Department of Trade and Industry.

The first cruise was to undertake EM120/1002 multibeam (dependent on water depth), backscatter and high resolution sidescan sonar data of the seamounts and banks along transect lines that had been pre-determined. This was then interpreted for areas of potential interest e.g. iceberg ploughmarks, areas of cold water coral etc, which would then be targeted by photographic/faunal sampling during the biological DTI cruise. A Fisheries Research Services survey in collaboration with the Joint Nature Conservation Committee and the University of Plymouth sampled some of the stations that the biological DTI cruise was unable to undertake as well as adding additional stations, leading to a much greater area of the region of interest being sampled.

The results proved to be extremely interesting and the next stage is to now link the results of the physical survey with that of the biological survey and to undertake some identification and mapping of the different habitat types encountered.

National Marine Mapping Strategies in Canada, how effective are we in influencing marine policy and resource development?

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With an offshore territory of 4.6 million km^2 Canada faces many challenges in managing offshore lands. In addition, Canada recently ratified UNCLOS and under Article 76 could lay claim to a substantial additional territory on the Atlantic and Arctic margins. Rapid climate change in the Arctic and sustainable management of the fishery are providing additional stresses to resource management. Government response to these challenges has been to enact new policy (Canada's Oceans Act 1997), to develop new strategies (Canada's Ocean Strategy 2002), leading to realignment of existing research programs (Geoscience for Oceans Management in the NRCan), and to fund new programs such as Canada's Oceans Action Plan, and a 10 year program to support the Canadian UNCLOS claim. Ocean management policy and emerging management plans are founded in principles of precaution, conservation and sustainability. Seafloor maps are a foundation knowledge base upon which regional management plans are being developed. Over the last three years a national seafloor mapping program has been developed and implemented. In this paper the mapping program is described and a critique provided of our ability to influence marine policy and resource development.

Regionalisations of the Australian coastal and marine environment: A geophysical perspective

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In recent years benthic regionalisations for the Australian continental shelf have been developed using a hierarchical framework and quantitative estimates of geological, geomorphic features, oceanographic processes and biological data. Over the years methodologies have progressed from a Delphic approach to one that is quantitatively driven and therefore statistically robust. Methodologies and techniques are constantly being refined. The regionalisation process has largely been confined to investigate the hierarchical structure from a regional or mesoscale perspective and these pieced together to reflect a continental wide scale picture. Political pressure and disparity of available or relevant data have constrained the regionalisations.

The current higher level structure was determined largely from the distribution of Australia's fish species which are used as a surrogate for paleohistoric evolutionary processes that define contemporary marine and coastal ecological systems. An age old problem that recurs in debates on regionalisations is the one on the relative importance of biology, geology and oceanography in defining regional structures. We investigate in this work the geophysical approach to determining the higher level structuring of Australia's coastal and marine regions. Our aim is to compare the results of this approach with the existing biological regionalisations in order to understand the relative roles of the biogeophysical components in shaping Australia's ecological regions.

The high-level geophysical province structure is being investigated by examining the complexity of the coastline and its relationship to crustal elements of the Australian continental platform. The complexity of the coastline was calculated using fractal analysis and the results compared to various mappings of geophysical variables that control coastline formation and structure – such as tides, waves and currents. Our intention is to carry out similar analyses for the lower level so-called "biomic" structure by investigating depth based changes in geophysical properties.

Our expectation is that there will be similarities and differences in the structures obtained by the respective biophysical and geophysical approaches. It is only from such comparative studies that constructive quantitative approaches can be developed for robust regionalisations of the coastal and marine systems.

Physical surrogates for marine benthic habitats in the Gulf of Carpentaria, northern Australia

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The characterisation of benthic habitats based on the abiotic (physical and chemical) attributes of the environment remains poorly defined in the marine environment, but is becoming increasingly central in the development of marine management plans in Australia and elsewhere in the world. In this study we test this link between physical and biological datasets for the southern Gulf of Carpentaria, Australia, using a range of physical factors, including the sediment composition (grain size and carbonate content), sediment mobility, water depth and organic carbon flux. On a local scale (50 000 km^2) we find a good correlation between the abundance of benthic macrofauna and the per cent mud, very fine sand and gravel, the bulk per cent $CaCO_3$, the organic carbon flux and water depth.

To extrapolate these results across the broader scale (500 000 km^2) required for the development of marine management plans, our dataset of physical variables is reduced to grain size properties, wave energy and water depth. However, the distribution of biological and physical attributes at this broad scale indicates that water depth, sediment mobility, and mud and gravel content define distinct biological communities in northern Australia. We apply these parameters to define the likely distribution of biological communities in this region, and demonstrate the uncertainty associated with this classification.

Habitat Mapping for Conservation and Management of the Southern Irish Sea

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HABMAP is a three-year INTERREG IIIA funded seabed-mapping project covering the Southern part of the Irish Sea. It involves partners in both Wales and the Republic of Ireland. The project aims to produce a predictive biotope model for the Southern Irish Seabed, based on existing physical and biological information. The model will be validated using survey data collected during the project in order to produce GIS-based habitat maps.

Modiolus bioherms in the Irish Sea: surveying and management challenges of a range of mussel bed types

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Where Horse Mussels *Modiolus modiolus* form dense beds they can sometimes create bioherms at scales detectable by geoacoustic methods. Mussel beds are often oases of enhanced biomass and biodiversity on otherwise tide swept areas of seabed and so have importance for ecosystem based management disproportionate to their actual extent. Because they are long-lived keystone species, adding structure to the seabed and with poor resilience to disturbance, knowledge of bed locations and their condition is a priority.

The paper discusses, with examples, the range of situations in which aggregations of *Modiolus* have been found in the Irish Sea and the bedforms they create. Different types of mussel bed, occurring within various broader scale habitats, present various challenges when trying to interpret data obtained by acoustic or other methods indicating their extent, morphology and condition.

Defining marine landscapes at a detailed level and their relevance in a biological context, experience from the Belgian continental shelf

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Ever-growing usage of the marine environment raises pressure on seas and coasts, and it can be questioned whether this is sustainable on a long-term. One of the indicators is surely the status/evolution of the marine biodiversity and in that context knowledge of seafloor habitats becomes more important. Habitat mapping is a multidisciplinary task, ideally integrating a wide variety of datasets (biological, geophysical, hydrographical) for the direct mapping of habitat types. When larger areas are mapped, as in the framework of marine protection, available marine benthic data are becoming mostly variable in quality and patchy in nature. Hence, at a large scale, habitat mapping *s.s.* is not applicable. In literature, various ways have been suggested for the mapping of biologically relevant zones in the absence of sound biological data. The marine landscape approach, being a hierarchical combination of various geophysical datasets in GIS (Roff & Taylor, 2000) is now widely applied. However, mostly not enough biology data is available for validation and as such the added-value of defining marine landscapes is not clear.

Generally, marine landscape mapping is considered a broadscale approach and mostly relatively low resolution datasets are being used. This is a problem in soft substrata shelf areas where small- to medium-scale topographic features might be biologically relevant and where benthic communities are bound to the sedimentological and morphological gradient. This is the case along the sandbank-dominated Belgian shelf and therefore the marine landscape approach had to be carefully handled.

On the Belgian shelf (3600 km²), there is generally a large availability of various data including an extensive biological dataset for validation. The physical data (related to topography, sedimentology, and energy regime) has recently been compiled at a 250 m grid resolution and practically covers the whole shelf. In soft substrata, sedimentology is generally regarded the most discriminating dataset and as such the need for a detailed distribution map of the median grain-size and silt-clay percentage was high. This became available (Verfaillie *et al*.) and was used as an input for the marine landscape approach and as a direct input to habitat models.

At first, various geophysical datasets (sedimentology, absence/presence of bedforms, bed shear stress and slopes) were combined and this led to a definition of 17 landscapes. These landscapes had a clear relation with the terrain and as such they are valuable for different purposes (e.g spatial planning related to aggregate extraction, for the prediction of seabird distribution). However, the correlation with the occurrence of macrobenthic communities was somewhat blurred and the amount of landscapes seemed unmanageable. To find out the most relevant input layers, each layer was individually validated with the biology. Datasets that were considered to be biologically relevant in the first place (dune fields, maximum bed shear stress), showed little correlation to the biology and were therefore excluded from the process. In the mean time, biology-steered habitat models put forward that 70 % of the distribution of the macrobenthic communities was determined by the medium grain-size and the remainder by the silt-clay percentage. In a subsequent phase, only those two parameters were used in the

landscape approach. Five landscapes were defined and correlated for 80 % with the existing biology dataset; however the relation with the terrain is now more or less lost. Apart from the general distribution pattern, which can now be modelled in GIS, observations do learn that macrobenthic communities are bound to specific physical habitats. Further research is carried out to define which extra geophysical/hydrographical datasets and resolution is required to fine-tune the distribution pattern.

Given the availability of data and the relatively restricted dimensions of the Belgian shelf, various approaches (vector versus raster, various datasets, etc) can be trialled and from this it is aimed at proposing a most user-friendly and optimised approach. This becomes very valuable in the framework of the InterregIIIb project MESH (‘*Mapping European Seabed Habitats’*) where seabed habitat mapping at the scale of NW Europe is aimed at.

Typology of the Sea Floor of the North and the Baltic Sea by Means of Geostatistical and Multivariate Statistical Methods

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Goal. The MarGIS project intended the integration of research data by use of Geo-Information-Systems (GIS) and advanced statistical techniques to characterise, identify and map ecological provinces at the seafloor of the North Sea and the Baltic Sea. The mapping concept consisted of two working steps: At first geostatistical methods were applied to spatially extrapolate abiotic measurement data. Multivariate statistics like cluster analysis and decision trees as well as GIS-techniques were then used to derive sea floor provinces from the calculated raster maps.

Geostatistical analysis of measurement data. Originally coming from geological research and applied to estimate mineral resources and reserves (Krige 1951; Matheron 1965, 1971), geostatistics are nowadays being used in various terrestrial and marine fields of research. As far as marine research is concerned geostatistical instruments were applied by various scientific disciplines, e.g. pollution research (Poon et al. 2000), geology (Chihi et al. 2000) and biology (Harbitz & Lindstrøm 2001; Jelinski et al. 2002). The latter exhibits a multitude of examples of geostatistical applications serving the interests of various fisheries: Lembo et al. (1999) applied geostatistical techniques to map the spatial distribution of the deep-water Rose Shrimp in the central-southern Thyrrhenian Sea. Other examples relating to the abundances of certain fish species can be found in the publications of Petitgas (1997), Lembo et al. (2000) as well as Rivoirard et al. (2001). Compared to deterministic procedures like IDW (Inverse Distance Weighted Method) geostatistical methods take into account the degree of spatial autocorrelation when predicting measurements. Geostatistics can be subdivided into two working steps: variogram analysis and kriging procedures. With variogram analysis the autocorrelation structure of the underlying spatial process is at first examined and then modelled. Variogram maps can be used to detect directional dependencies or so called anisotropies in the data field. The variogram models are used to predict measurement values by chosen kriging procedures (e.g. ordinary kriging). Crossvalidation and standard error maps may furthermore give an idea of the quality of estimation.

In the project MarGIS geostatistical analyses were carried through for ecologically relevant parameters that were to serve as input variables for the preceding multivariate statistical calculations: grain size (0-20 µ, 0-63 µ, 20-63 µ und 63-2000 µ) as well as temperature, salinity, silicate, ammonium, nitrate, phosphate and dissolved oxygen measured at or near the sea floor. The geochemical measurement data were analysed with regard to three different areas of interest according to different time intervals: the Exclusive Economic Zone (EEZ) of the North Sea (four three months intervals aggregated over a six-year-period from 1995 to 2000), the entire North Sea (summer and winter months aggregated over a three year period from 1997 to 2000) and the western part of the Baltic Sea (summer and winter months aggregated over a three year period from 1995 to 2000). The degree of spatial autocorrelation was determined for all 42 measurement datasets on the basis of variogram maps introduced in the extension 'Geostatistical Analyst' of ESRI's ArcGIS 9.0. The mean distance of each measurement site to its nearest neighbour was used as the lag size and the number of lags allocated to each lag size was set so that the distance of significant autocorrelation (range) became clearly visible in the variogram window. We tested various variogram models, including different types of models, sills, ranges, and nugget effects. Crossvalidation was used as the method to compare the different models. Additionally, if the semivariances displayed

on the variogram map indicated anisotropies in the data field, different ranges for different directions (to account for anisotropies) were compared with each other. Dependent on existing spatial trends and skewed value distributions either ordinary, universal or lognormal kriging was applied to spatially extrapolate the measurement data to raster maps. The quality of estimation was documented in terms of chosen key values derived from the results of crossvalidation.

Figure 1 depicts on of 42 results of geostatistical analyses in terms of the ammonium concentrations measured at the sea floor of the North Sea in the summer months between the years of 1998 and 2000. The results of variogram analysis depicts a distinct autocorrelation structure with a low nugget-sill ratio, indicative of low small-scale variabilities as well as strong spatial dependencies of the measurement values. With the help of the variogram map anisotropies in 53.3° direction could furthermore be detected resulting in a searching ellipse in the following ordinary kriging calculations. Similar can be observed for all geostatical analyses done. For a detailed description pease refer to Pehlke (2005) and Schröder et al. (2005).

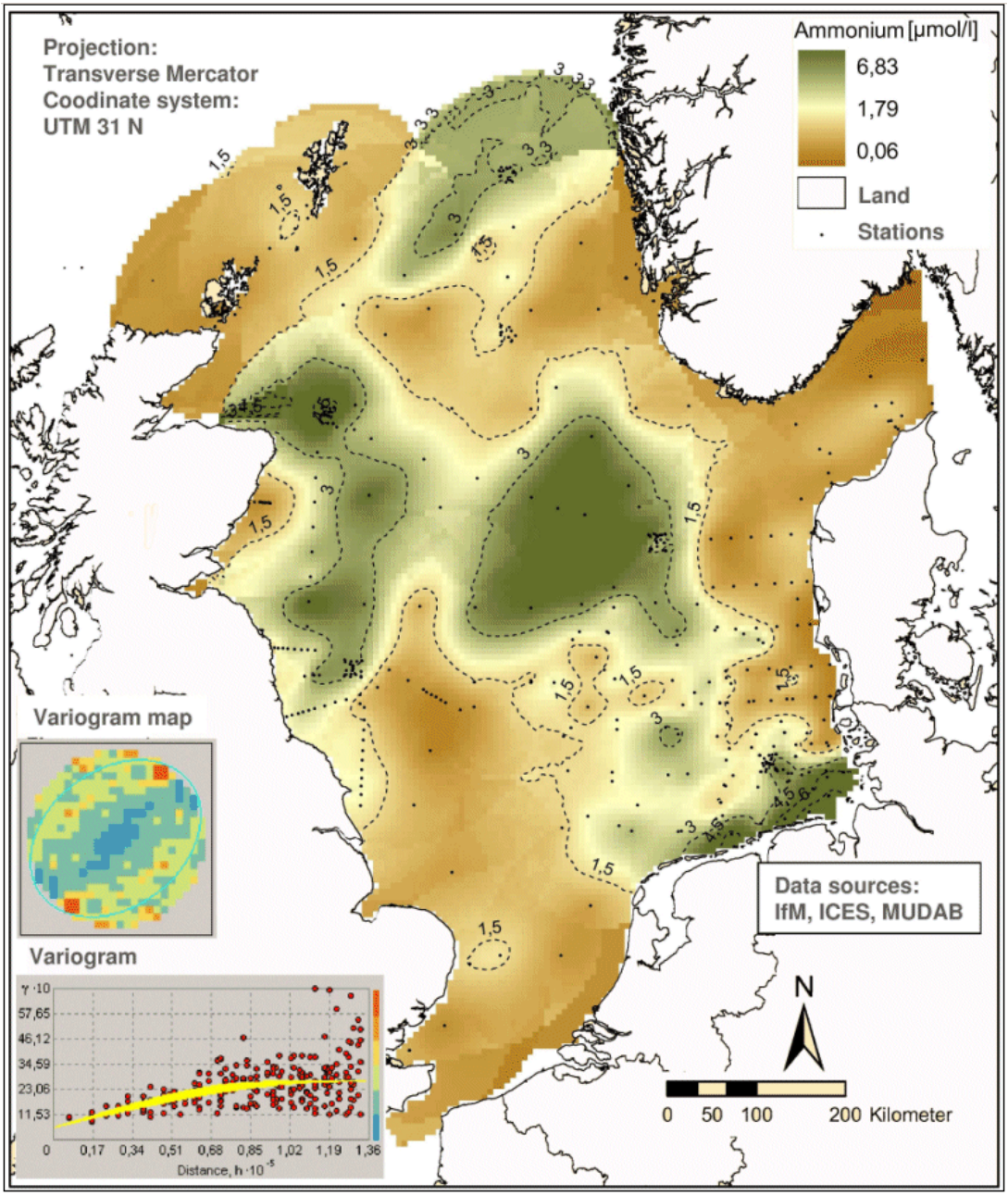

Figure 1: *Ammonium concentrations at the sea floor of the North Sea in the summer months between 1998 and 2000*

Calculation of ecological sea floor provinces. On basis of the geostatically estimated surface maps ecological sea floor provinces were calculated by means of multivariate statistical methods. For the EEZ of the North Sea as well as the entire North Sea predictive habitat mapping was performed with help of the decision tree algorithm Classification and Regression Trees (CART). Since no biotic data were availible for the Baltic Sea here cluster analysis (Ward, Kmeans) was applied to derive abiotic sea floor types.

The predictive habitat maps calculated for the EEZ of the North Sea as well as the entire North Sea rely on punctual data on eight benthic communities collected at 184 sites within the German Bight and the bordering central North Sea (Rachor & Nehmer 2003). Predictive habitat mapping can be defined as the development of a numerical or statistical model of the relationship among environmental variables (data on bottom water measurements on salinity, temperature, silicate, dissolved oxygen, phosphate and nitrate as well as on grain size ranges) and benthic communities. The model can then be applied to a geographic data base (bottom water measurements) to predictive benthic communities for those sites where data on benthic communities are missing and where only measured or geostatistically estimated data on abiotic habitat characteristics are available. The methods used for predictive mapping vary widely from statistical approaches (including geostatistics) to more complex methods, such as expert systems, and decision tree analysis (Kelly et al. 2005; Scull et al. 2003).

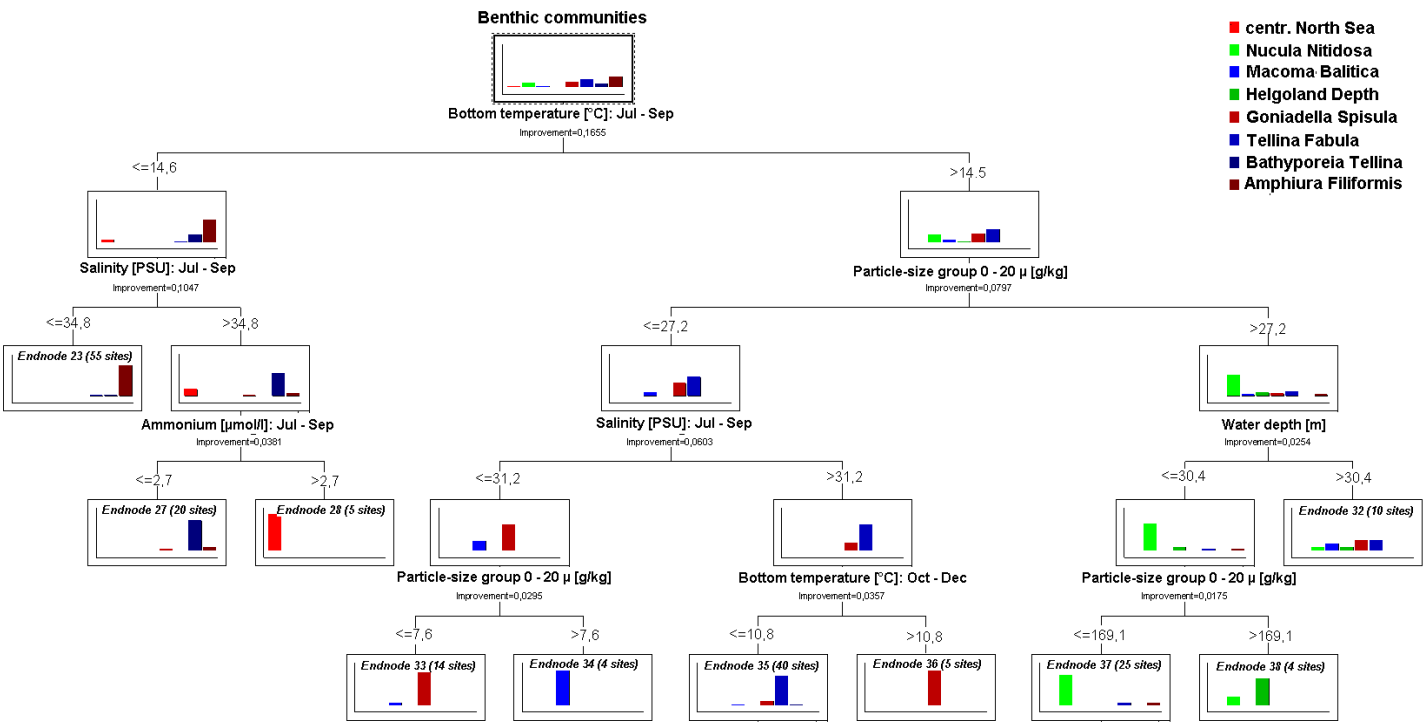

Figure 2: *Decision tree for the occurence of eight benthic communities derived by Rachor & Nehmer (2003)*

In the MarGIS project CART was applied to derive a classification model for the eight benthic communities derived by Rachor & Nehmer (2003). CART is applied in various scientific disciplines to uncover hidden structures in complex data matrices. CART is a so called tree-growing algorithm that produces decision trees to predict or classify the outcome of a certain feature (= target variable) from a given set of meaningful predictor variables (Breiman et al. 1984). A major advantage of this technique is its ability to model non-additive and non-linear relationships among input variables. In contrast to most of the classification

techniques as, e.g. cluster anlaysis or classical regression analysis, CART handles very large sets of mixed, i.e. both categorical and parametric data without prior transformation of scale dignity. The central goal of the CART-algorithm is to produce homogenic classes with respect to the features of the target varaible. Whether the target variable is of metric, ordinal or nominal scale dignity, different impurity measures exist. The Gini index is commonly used when the target variable is categorical, allthough other options exist (entropy, twoing index) (Steinberg and Colla 1995). CART does not make any assumptions on the distribution of the data and can use one explanatory variable more than once so it can work with data that might have multiple interrelations. Further CART is extremely robust with respect to special cases as outliers or rare biotopes because they will be separated as class of its own so, as such, they will no longer affect the calculation of the rest of a decision tree.

Decision trees were calculated to predict the occurrence of the benthic communities from the intersected abiotic grid data (s. above). One decision tree each was computed for two sets of predictors and time intervals: the geostatistically estimated raster data for the German EEZ of the North Sea as well as the entire North Sea. Figure 2 depicts the nodes of the decision tree for the EEZ in terms of histograms where each bar is representative for one of the eight communities. The results of the CART analysis resulted in a decision tree grown in nine binary splits leading to 10 endnodes or classes, respectively. As can be seen each decision tree starts with one root node containing all observations of the sample. By following the dendrogram from up to down it can be observed that the portion of each benthic communities increases stepwise. This leads to nine endnodes in which one of the eight communities is dominant (portion > 75%). Since each of these end nodes is defined by a set of decision rules, the tree can be applied to predict the occurrence of benthic communities at places where no such information is available. Each of the resulting spatial units may therefore be described with respect to the possibility of the occurrence of one of the eight communities. This possibility of the occurrence of each community can be derived from its percentage in the corresponding endnode. This was done for both the EEZ and the entire North Sea resulting in two different habitat maps. The habitat map of the EEZ is shown in Figure 3. All habitat classes were described with help of suitable statistical measures.

In case of the Baltic Sea no biotic data was availible in order to calculate predictive habitat maps for e.g. benthic organisms. Here the two cluster algorithms Ward and kmeans were applied to classify the geostatistically estimated grid cells in terms of abiotic sea floor provinces. The objective of such multivariate cluster procedures is to put individual objects (here grid cells) into classes (groups, clusters) referring to the similarity respectively dissimilarity of the objects´ characteristics (Backhaus et al. 2000). Unlike the CART method the derived clusters are aimed to be homogenic with respect to all input variables. The Ward algorithm is an agglomerative hierarchical cluster procedure for metric data. Hierarchical cluster procedures join together objects or clusters respectively step by step by minimisation of the increase of variance within the clusters. A major advantage of this technique is its ability to derive an adequate number of classes. The k-means cluster algorithm improves the allocation of objects to a given number of classes by minimising the deviation of all objects to the respective cluster centers. By applying both techniques to the estimated surface maps abiotic five sea floor provinces could be calculated for the western part of the Baltic Sea. All five clusters were described with respect to their abiotic characteristics (Schröder et al. 2005).

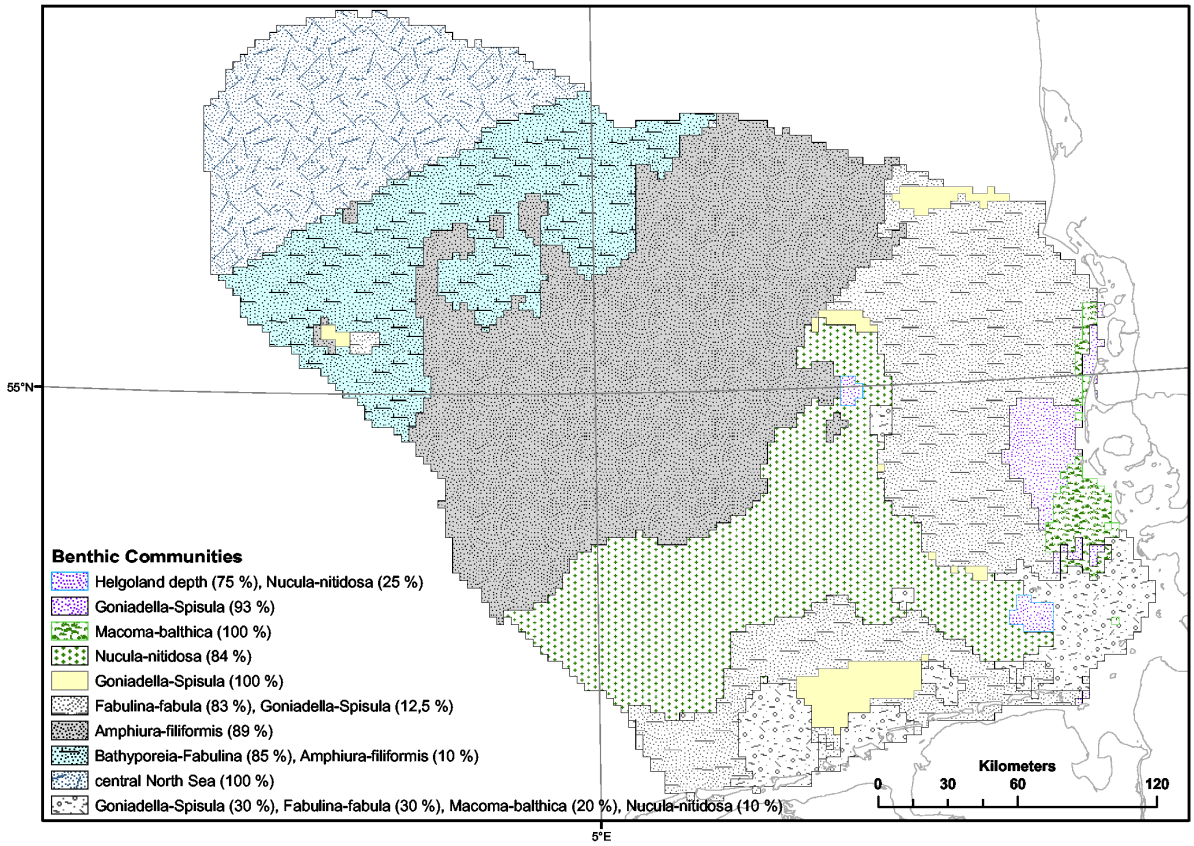

Figure 3: *Predictive benthic habitat map for the EEZ*

References

Backhaus K., Erichson B., Pinke W., Weiber R. (2000): 'Multivariate Analysemethoden. Eine anwendungsorientierte Einführung', Springer, Berlin, Heidelberg, New York, Barcelona, Honkong, London, Mailand, Paris, Singapur, Tokio.

Breiman, L., Freidman, J.H., Olshen, R.A., Stone, C.J. (1984): Classification and Regression Trees, Wadsworth.

Chihi, H., Galli, A., Ravenne, C., Tesson, M., De Marsily, G. (2000): Estimating the Depth of Stratigraphic Units from Marine Seismic Profiles Using Nonstationary Geostatistics, Natural resources research 9 (1), pp. 77-95.

Harbitz, A., Lindstrom, U. (2001): Stochastic spatial analysis of marine resources with application to minke whales (Balaenoptera acutorostrata) foraging: A synoptic case study from the southern Barents Sea, Sarsia, 86, pp. 485-501.

Jelinski, D.E., Krueger, C.C., Duffus, D.A. (2002): Geostatistical analyses of interaction between killer whales (orcinus orca) and recreational whale-watching boats, Appl. Geogr. 22, pp. 393-411.

Kelly, A., Powell, D., Riggs, R.A. (2005): Predicting potential natural vegetation in an interior northwest landscape using classification tree modeling and a GIS, Western Journal of Applied Forestry, 20 (2), pp. 117-127

Krige, D.G. (1951): A statistical approach to some basic mine evaluation problems on the witwatersrand, J. Chem. Metall. Min. Soc. S. Africa 52 (6), pp. 119-139

Lembo, G., Silecchia, T., Carbonara, P., Contegiacomo ,M., Spedicato, M.T. (1999): Localization of nursery areas of parapenaeus longirostris (Lucas 1946) in the central-southern tyrrhenian sea by geostatistics, Crustaceana. (73), pp. 39-51.

Lembo, G.; Silecchia, T.; Carbonara, P.; Spedicato, M.T. (2000): Nursery areas of Merluccius Merluccius in the Italian Seas and in the east side of the Adriatic Sea, Biol. Mar. Medit. 7 (3), pp. 98-116.

Matheron, G. (1965): Les variables régionalisées et leur estimation. Masson, Paris

Matheron, G. (1971): The theory of regionalized variables and its application. Fontainebleau.

Pehlke, H. (2005): Prädiktive Habitatkartierung für die Ausschließliche Wirtschaftszone (AWZ) der Nordsee, Diplomarbeit, Universität Vechta, Institut für Umweltwissenschaften.

Petitgas, P. (1997): Sole egg distribution in space and time characterised by a geostatistical model and its estimation variance, ICES J. Mar. Sci., J. Conseil., International Council for the Exploration of the Sea, Acad. Press. London, Bd. 54, 213-225.

Poon, K.-F., Wong, R.W.-H., Lam, M. H.-W., Yeung,H.-Y., Chiu,T. K.-T. (2000): Geostatistical modelling of the spatial distribution of sewage pollution in coastal sediments, Water Research 34 (1), pp. 99-108.

Rachor, E., Nehmer, P. (2003): Erfassung und Bewertung ökologisch wertvoller Lebensräume in der Nordsee, Abschlußbericht für das F und E-Vorhaben FKZ 899 85 310 (Bundesamt für Naturschutz), Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven.

Rivorard, J., Wieland, K. (2001): Correcting for the effect of daylight in abundance estimation of juvenile haddock (Melanogramms aeglefinus) in the north sea: an application of kriging with external drift, ICES J. Mar. Sci. 58, 1272-1285.

Schröder W, Pesch R, Pehlke H, Busch M. (2005): MarGIS - Marines Geo-Informationssystem zur Visualisierung und Typologisierung meeres-geowissenschaftlicher Daten. Teilprojekt: Flächenhafte Typologisierung des Meeresgrunds mit Hilfe geostatistischer und multivariat-statistischer Verfahren. Abschlussbericht BMBF/DFG FKZ 03F0370.

Scull, P., Franklin, J.,Chadwick O.A., McArthur, D. (2003): Predictive soil mapping: a review, Progress in Physical Geography, 27 (2), pp. 171-197

Steinberg, D., Colla, P. (1995): CART. Tree-structured Non-Parametric Data Analysis, Salford Systems San Diego, Ca.

The Irish Sea Marine Aggregates Initiative (IMAGIN): scoping the potential development of a resource through multidisciplinary seabed mapping

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The Irish Sea Marine Aggregates Initiative (IMAGIN) commenced officially in February 2005, and is a 2-year project funded under the Ireland/Wales INTERREG IIIA Community Initiative Programme 2000-2006. The overall aim of IMAGIN is to facilitate the evolution of a strategic framework within which development and exploitation of marine aggregate resources from the Irish Sea may be sustainably managed with minimum risk of impact on marine and coastal environments, ecosystems and other marine users. This is important due to the fact that economically viable on-land sources in Britain and Ireland are rapidly diminishing, therefore in order to sustain competitive economic development, alternative sources need to be found. A summary overview of the IMAGIN project will be given which demonstrates the results obtained to date from multidisciplinary seabed mapping. These findings are finally discussed in terms of their potential to assist in the development of a regional extraction policy.

The overall aim is being strongly supported by detailed geo-biological habitat mapping of study areas together with morphodynamic modelling (Figure 1). The study areas were selected on the basis of prior assessment of existing archival data (courtesy of the Geological Survey of Ireland, Irish Petroleum Affairs Division, British Geological Survey, and other online and literature sources). They were also chosen to correspond with areas of seabed that may be more appropriate than others for aggregate extraction (e.g. relatively free from interactions with infrastructure & environment) between 20m and 60m water depth contours.

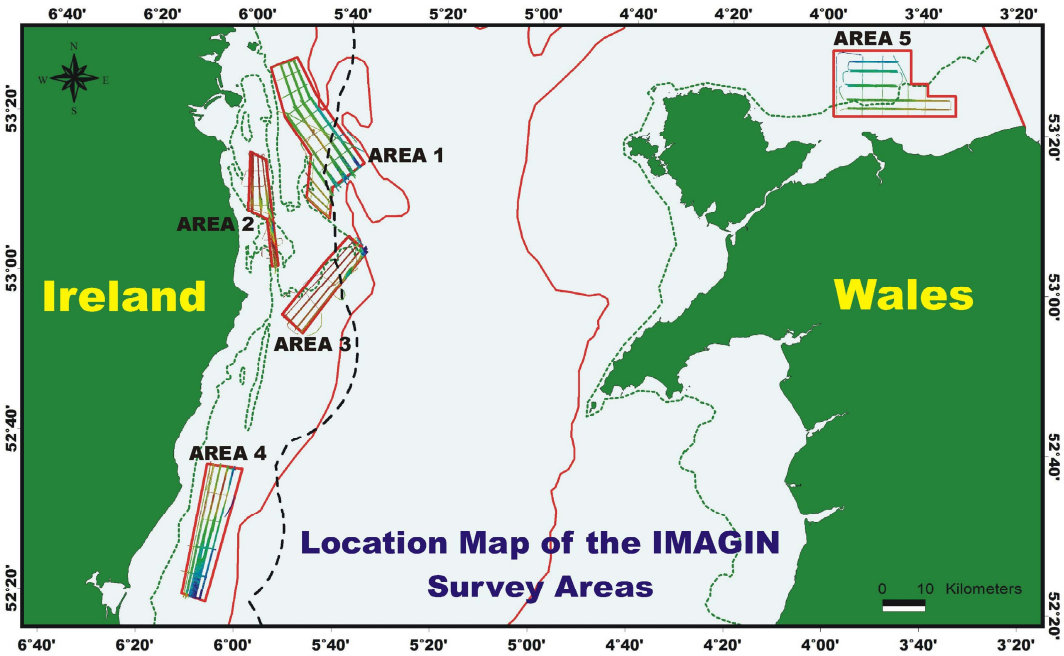

Figure 1: *Location map of the IMAGIN survey areas (Area 1 to 5). Green dashed and red solid lines correspond to 20m and 60m depth contours respectively. The dashed black line indicates the Ireland's 12-mile territorial limit.*

The general mapping approach adopted in the IMAGIN project is characterised as mapping from low to high resolution. Field surveys began with the use of remotely sensed mapping techniques such as multibeam and side-scan sonar. The initial aim was to establish overall seabed morphology, and to assist in defining the general distribution of sediment types, as well as to understand the distribution of bedforms, sediment movement and hydrodynamic patterns. Seismic profiles using Boomer and Pinger systems were also collected in order to image the sub-surface geology, and thus develop an understanding of the study areas in three-dimensions. Planning of the higher resolution (groundtruthing) surveys using underwater video imaging and seabed sampling was based on information generated in the initial acoustic mapping. The sampling was performed using a grab sampler (200 samples) and a vibro core (36 vibro cores with a total recovery of 128m of sediment). The project had also undertaken biological surveys in order to characterise, benthic, epibenthic and demersal habitats (including fisheries) in study areas 1 to 4. Detailed interpretation of the subbottom profiles has allowed initial determination superficial sediment thickness. In combination with information from vibrocore samples these interpretations are useful instruments for tentative assessment of marine aggregate resource potential.

All collected and derived datasets have been integrated within GIS (Geographical Information System) in order to simplify data management and manipulation processes, thus facilitating understanding of the geoenvironmental setting and resource potential (Figure 2).

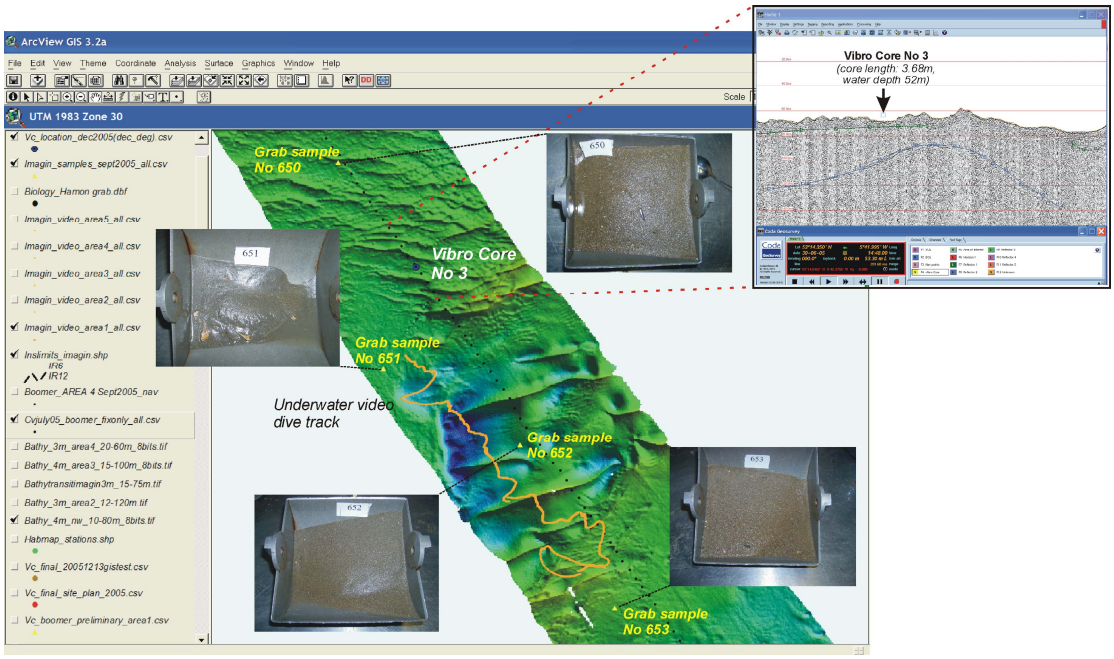

Figure 2: *Screen grab of the GIS showing the southern part of the study Area 1 (see Figure 1) with seabed surface morphology as imaged by multibeam. Boomer seismic tracks (black dotted line), underwater video transect, and showing location of the grab and vibrocore sediment samples are overlain. Upper right outset shows screen grab from CODA GeoSurvey software suite showing fragment of the Boomer line together with vibrocore location sited between adjacent sandwave crests.*

Ecosystem oriented seabed mapping in the Norwegian MAREANO programme - physiotype and habitat maps in ocean management

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Ecosystem based management of Norway's maritime areas is a high priority for the Norwegian government. In line with this, the government decided in 2005 to fund a marine mapping and documentation programme – MAREANO. The first five years of the programme is dedicated to the Lofoten and Barents Sea region, which is subject to heated political discussions regarding conservation and petroleum exploitation.

The programme is a multi-disciplinary cooperation, led by the Institute of Marine Research, and with the Geological Survey of Norway, and the Hydrographic service as active partners. In addition, the major Norwegian government institutions dealing with the marine realm are included, both in an information network, and as part of a Reference Group.

Primary end-users are management at national and regional level, oil industry, and fishery/aquaculture industry. Main products include multi-disciplinary thematic maps, underpinned by basic maps and scientific publications. A web based information system, with map services supported by text and illustrations, will be the main distribution channel for the programme (www.mareano.no - only in Norwegian so far). The vision is that this portal will be the main portal for any marine information in the future, serving a series of regional management plans.

The first data collection started in late 2005, with a multibeam bathymetry cruise from one of the areas of particular interest in the Barents Sea. All in all, the intention is to map c. 120 000 square kilometres within the first 5 years, depending on the annual funding. Building on this information, a series of maps addressing geological, biological and environmental issues will be constructed. Physiotype maps integrating morphology, sediments and other relevant physical parameters will form the basis for habitat maps integrating physical and biological information. By the end of 2006, a complete series of seabed maps will provide a corridor from the coast to open shelf, providing a first demonstrator of the knowledge to be produced.

The environmental issues will address pollution – documenting levels, processes and as far as possible, sources. Special attention will be given to natural leakages of hydrocarbons and fluids, suspected to be a natural source of PAHs into the marine environment.

In the coastal areas, thematic maps addressing ICZPM will be produced, covering particularly issues related to aquaculture. This will build upon an extensive database of multibeam data, originally collected for defence purposes.

Multibeam Acquisition in the Irish Sea: Applications for Habitats Research

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HabMap is a three-year seabed mapping project covering the southern part of the Irish Sea. The project is funded by the INTERREG IIIA programme. In the summer of 2005 data was collected during two survey cruises.

During the first cruise (June 14th-27th) Single Beam EchoSounder (SBES), MultiBeam EchoSounder (MBES) and sub-bottom profiler data was collected (Figure 1). During the second cruise (July 25th-August 8th) benthic + sediment samples, SPI footage and towed video footage was collected.

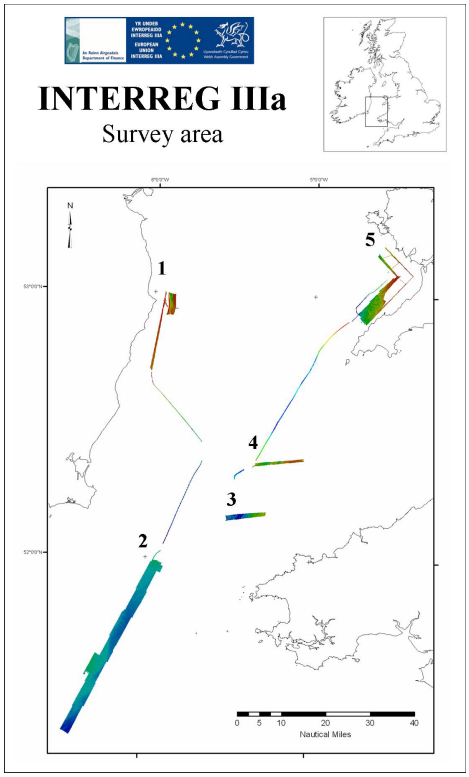

Figure 1: *MBES coverage during HabMap survey*

The backscatter values and bathymetry from the MBES data can be groundtruthed with SPI footage, sediment samples, video footage, and other data collected during previous projects. This allows interpretation of the dataset in terms of bedforms of which the classification scheme intends to capture the features relevant to both sediment transport and habitat mapping. The bedform layer created will serve as a component in the modelling exercise in which relationships between physical data and biological data will be examined. Eventually a predictive habitat map will be developed.

Highlights from the first year of the HERMES project

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The HERMES project aims to gain new insights into the biodiversity, structure, function and dynamics of ecosystems along Europe's deep-ocean margin. It represents the first major attempt to understand European deep-water ecosystems and their environment in an integrated way by bringing together expertise in biodiversity, geology, sedimentology, physical oceanography, microbiology and biogeochemistry, so that the generic relationship between biodiversity and ecosystem functioning can be understood. Study sites will extend from the Arctic to the Black Sea and include open slopes, where landslides and deep-ocean circulation affect ecosystem development, and biodiversity hotspots, such as cold seeps, cold-water coral mounds, canyons and anoxic environments, where the geosphere and hydrosphere influence the biosphere through escape of fluids, presence of gas hydrates and deep-water currents.

HERMES is now one year into its four-year programme. In this first 12 months, almost 30 major research cruises have taken place, including an IODP drilling expedition to the Porcupine coral province. The HERMES consortium has collected a huge volume of data from all study areas, and this will continue as the second year's cruise programme gets under way.

Developing species specific habitat suitability maps in the deep sea – case studies from the Irish continental slope

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Multibeam bathymetry data acquired under the Irish National Seabed Survey (INSS) have provided a good starting point for the investigation of benthic habitats on the Irish continental slope. These data have recently been complemented by detailed surveys conducted using a Remotely Operated Vehicle (ROV) at selected locations on the Irish continental slope. ROV-based fieldwork was conducted in June 2005 by researchers from the National University of Ireland, Galway, and the University of Limerick and focussed on the acquisition of detailed multibeam data and geo-referenced video.

Whilst these ROV surveys provide data on these deep sea habitats in unparalleled detail they are limited in their extent by cost and time constraints. Owing to the vast expanse of the deep sea region it is unlikely ever to become feasible to obtain this level of detailed survey in more than a small proportion of the area. Despite this managers and resource developers require ecologically relevant information across the whole region and attempts to address this gap are becoming increasingly important. Here we examine ways in which the regional multibeam data and ROV observations can be integrated to provide directly relevant information on the distribution of key fauna across a wider area, building outward from the ROV surveys.

Using multi-scale terrain analysis we have calculated quantitative descriptors of the terrain from the INSS multibeam dataset (slope, orientation, curvature, roughness etc.) These form a suite of environmental predictor variables which we have used for the development of preliminary habitat suitability models for key fauna in selected study areas. We also examine the potential for the development of site-scale habitat models on the basis of high resolution multibeam bathymetry acquired using an ROV. At this local scale these models add value to limited video observations and may contribute to our understanding of benthic ecology at spatial scales relevant to individual fauna which in turn will have implications for sustainable management.

Acknowledgements
This work is funded by the National University of Ireland, Galway's Marine Science Research Project 3.2 'Deep Ocean Habitat Mapping Using a Remotely Operated Vehicle' under the Irish Higher Education Authority Programme for Research in Third Level Institutions, Cycle 3. The authors would like to thank the Geological Survey of Ireland for use of the Irish National Seabed Survey dataset.

Testing the Coastal/Marine Ecological Classification Structure in the Columbia River Estuary

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Coastal and marine planners and conservationists have long recognized a need for a standardized habitat classification system to help develop strategies for coastal and ocean resource management. This need prompted a NOAA initiative to develop a consistent and widely applicable framework for classifying benthic habitats and water bodies including estuaries, nearshore ecosystems, and oceanic systems. The Coastal Marine Ecological Classification Standard (CMECS) is the result of combined efforts by numerous agencies and ongoing collaboration with scientific and management experts. The applicability of CMECS has been tested in the Columbia River Estuary (CRE) using new and existing data at scales appropriate for each of the 8 layers of the classification's nested hierarchical framework. Built entirely in a Geographic Information System, the CRE test of the national coastal/marine standard explores the fundamental utility and ecological validity of a geophysical classification with limiting scales, geologic and hydrologic modifiers, fully nested hierarchical habitats, and the expectation that biological communities fit within the abiotic framework. The test also includes a description of requisite software and hardware standards, GIS and data analyst skill sets, and end-user products related to the application of CMECS.

GeoHab 2006
Poster Presentation Abstracts

Tectonic Development of Significant Marine Fisheries Habitats within the Queen Charlotte-Fairweather Transform Fault System, SE Alaska, USA

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The Queen Charlotte-Fairweather (QC-FW) fault system is a major transform fault complex that is the active plate boundary between the North American and Pacific Plates in northern North America. Consequently, considerable tectonic activity occurs along this boundary including earthquakes, fault ruptures with significant seafloor displacement, and even volcanism. These geologic processes have altered the seafloor, building discrete features of rugged and high relief that are important habitats for demersal rockfishes and other biota. In 2005 we imaged a large pit crater on the QC-FW fault system using multibeam and dove on this feature using a submersible. We have previously mapped four major volcanic edifices along the faults of the QC-FW fault system using side-scan sonar and multibeam systems, ground-truthed with observations from a submersible. In addition, many fault scarps and shutterridges have been imaged and appear as ideal geological and biological habitats for rockfishes. Exposed, deformed, and differentially eroded sedimentary bedrock features provide high and variable relief on the seafloor that attract many bottomfishes. One of these volcanic features has been designated, a Marine Protected Area. Others of these volcanic features are being considered for designation as MPAs or Habitat Areas of Particular Concern (HAPC). We speculate that the identification of other tectonic features on the seafloor may be useful in the initial identification of potential HAPC because of their well-defined boundaries and diversity and abundance of organisms.

Overview of MESH Action 2: Developing standards and protocols for marine habitat mapping

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MESH is the EU funded project entitled 'Developing a Framework for Mapping European Seabed Habitats'.

Across Europe there are many different mapping initiatives undertaken by many different institutes. Each conducts surveys and produces outputs in its own way, with the result that the maps cannot easily be joined together in a seamless fashion. Action 2 of the MESH project therefore seeks to develop a common set of standards and protocols for marine habitat mapping so that future mapping initiatives at the local, regional and national scale are compatible and can be used to build integrated habitat maps across NW Europe. This poster gives an overview of this work in the four elements of the mapping process, namely the acquisition, processing, interpretation and presentation of data. It also outlines the intended final product of Action 2, 'A Guidance Framework for Habitat Mapping'

Sponge reefs on the western Canadian continental shelf: multibeam survey results from Queen Charlotte and Georgia Basins

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Multibeam surveys have revealed the form and organization of hexactinellid sponge reef complexes on the western Canadian continental shelf. Four large (> 100 km^2) reef complexes and three small complexes (< 10 km^2) have been mapped using multibeam bathymetric and backscatter data. The reefs are built by framework skeleton sponges of the Order Hexactinosida which trap clay-rich sediments resulting in a distinctive pattern of low intensity backscatter as compared to the more reflective glacial sediments of higher backscatter intensity upon which the reefs develop. The reefs are found on a relict, glacial foundation of iceberg scour marks in Queen Charlotte Basin, and fluted banks in Georgia Basin. The forms of individual reefs include isolated mounds or bioherms, coalesced mounds, ridges, flat lying meadows or biostromes, and waveform mounds. Large-scale reef complex morphology and reef distribution is variable and is inferred to be a function of the relative strength of seafloor currents that are bathymetrically constrained. The largest reefs are up to 21 m in height and are up to 9,000 years old, and the largest of the reef complexes discontinuously covers 700 km^2. The setting and orientation of each complex is well described by these new digital data which allows for the discrimination of individual reefs as small as 20 m in diameter. These maps provide the basis for the understanding of the developmental history of the reefs and their aerial extent. The reefs support a complex ecology that is unique from that of the surrounding shelf ecosystems. The reefs are also nursery habitats for juvenile rockfish, and host many other species of fish and invertebrates. However, groundfish trawling has extensively damaged this habitat in many areas and, although some reef areas have been closed to trawling, the time required for the reefs to recover from this damage is uncertain. These new data will assist sustainable fisheries management, allow accurate planning of detailed scientific studies, and offer a way to directly compare the geomorphology of reefs from different areas on the shelf.

The REBENT monitoring network, a spatially integrated acoustic approach to survey nearshore macrobenthic habitats: application to the Bay of Concarneau (South Brittany, France)

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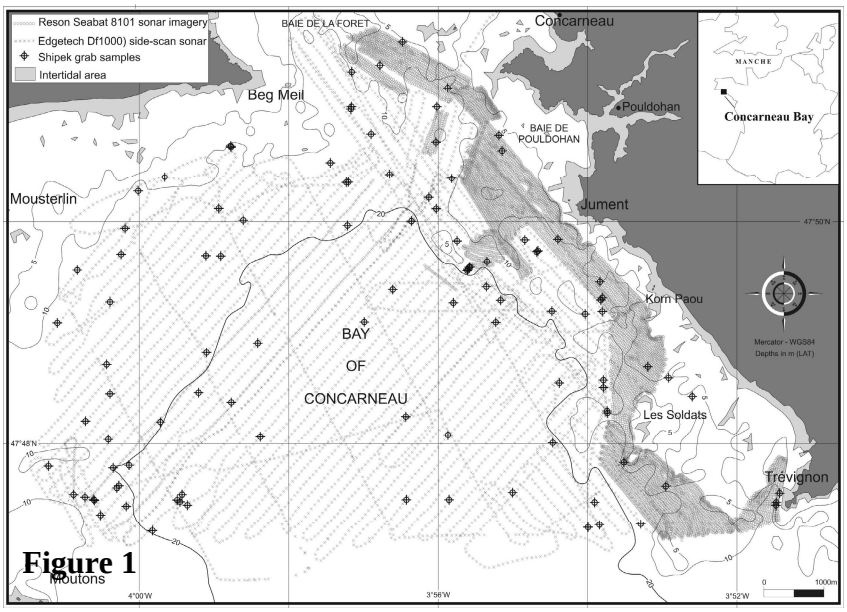

Figure 1

A 200 km^2 area in the bay of Concarneau on the South Brittany coast was surveyed acoustically using different side-scan sonars (a 100 kHz Edgetech DF1000 and a 240 kHz Reson Seabat 8101) (Figure 1). This area corresponds to a sector of the REBENT network (Guillaumont *et al.*, 2002). It was selected for its physical and biological characteristics reflecting the sedimentary heterogeneity and biological diversity of Brittany's coastal seafloors. The work presented here illustrates the methodology for mapping subtidal seabed habitats in the context of the REBENT network (www.ifremer.fr/rebent). Its aim is to define a reference state and provide regular monitoring of the French marine coastal fauna and flora from the intertidal area to water depths of about 30 metres. Before transposing the network strategy to other seafronts (Eastern Channel, Bay of Biscay and the Mediterranean) and adapting it to regional specificities, the Brittany coast was chosen as the pilot region to test protocols and standard methods for marine habitat mapping. REBENT's spatial organization is composed of various levels nested on three different scales levels, with increasingly frequent monitoring and coverage to detect changes in specific habitats (Figure 2). Backscatter mosaics were produced covering 100% of the survey area. Extensive ground-truthing was carried out involving 93 Shipek grab samples and 25 drop-down video profiles (Figure 3). From interpretation of acoustic facies, 40 biological soft bottom stations were sampled using a Hamon grab to characterise macrobenthic communities (> 2 mm). The results indicated considerable variations in the backscatter responses in relation to high densities of macrobenthic species (*Lithothamnium*, *Asterias*, *Haploops*, *Maldane*, *Ophiocomina*) and a wide variety of substratum types present within a relatively small area. Dense maerl beds were very accurately surveyed from depths of 20 to less than 5 m (LAT). Boundaries of *Haploops* communities are associated with dense small pockmarks in the centre of the bay (Figure 4).

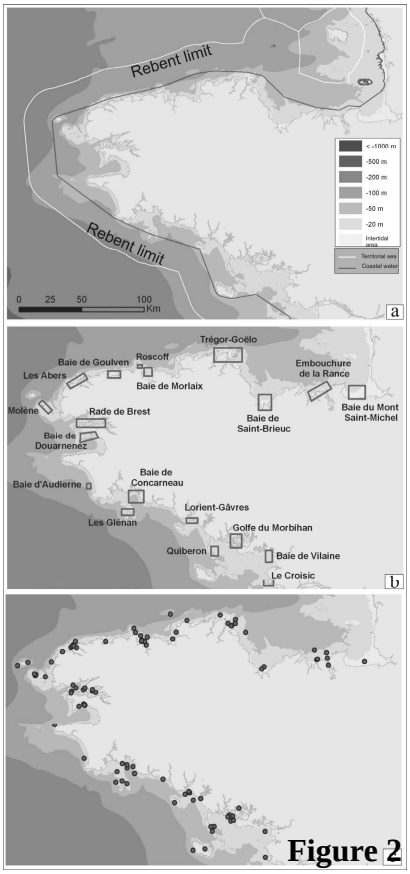

Figure 2

REFERENCES:
Guillaumont, B., Archambault, P., Bouvet, G., Hamon, D., Hily, C., Derrien-Courtel, S., Abiven, T., Grall, J., Le Hir, M., Le Loc'h F., Raffin, C., Castric-Fey, A., Berline, L., Dion, P., Ballu, S., Augris, C., Bonnot-Courtois, C., Fournier, J., Ar Gall, E., Singelin, P., Pellarin, Y., Lesage, G. 2002. Réseau Benthique (REBENT). Développement d'un pilote breton. Elaboration de l'Avant-Projet Détaillé (APD) – Phase 1. IFREMER/DEL, DIREN, Préfecture de la région Bretagne, Brest. 65 pp.

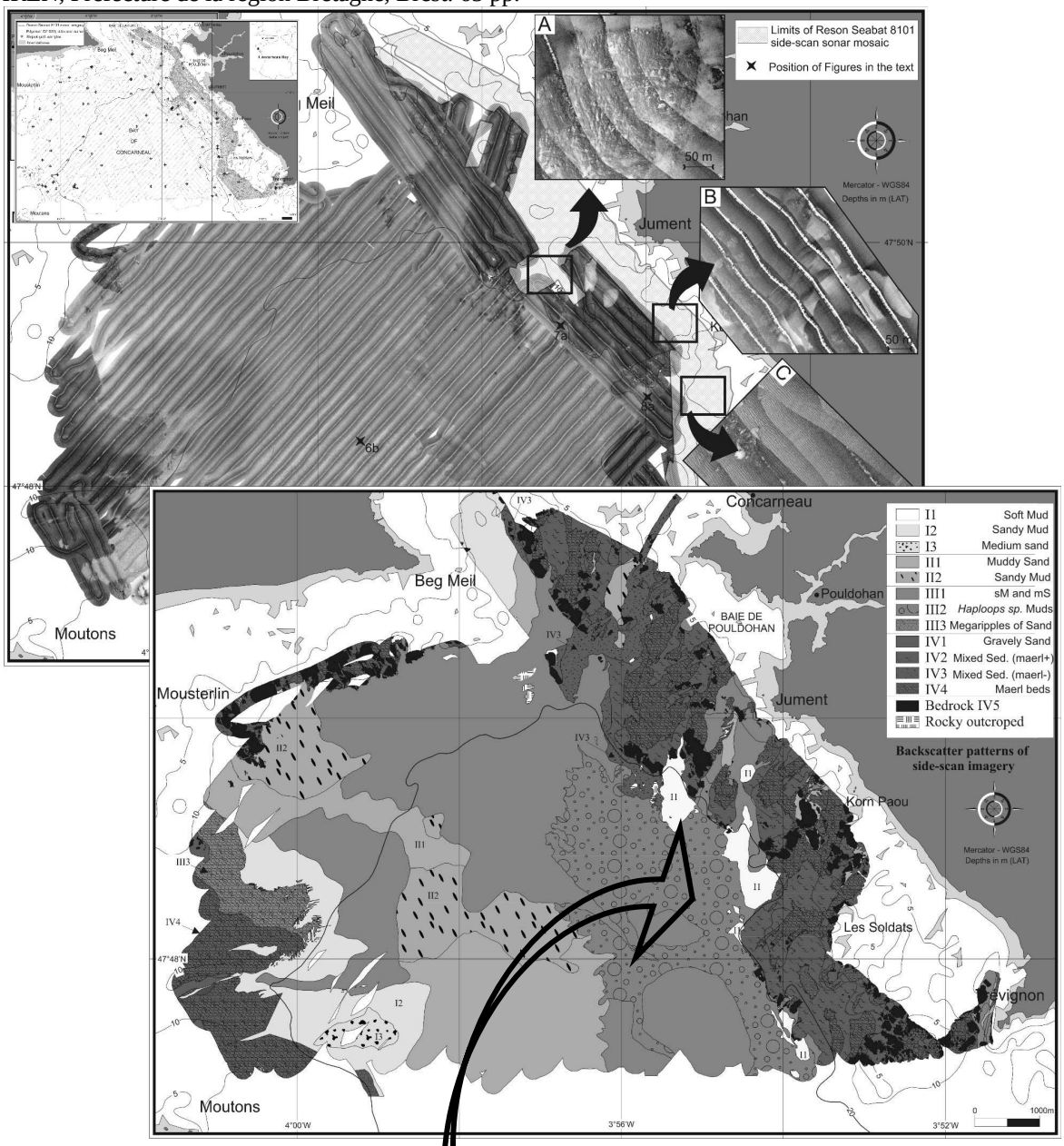

Figure 3: *Image mosaic of 100 kHz Edgetech DF1000 side-scan sonar (A, B, C : extracts of 240 kHz Reson Seabat 8101 side-scan mosaic) and backscatter patterns interpretation*

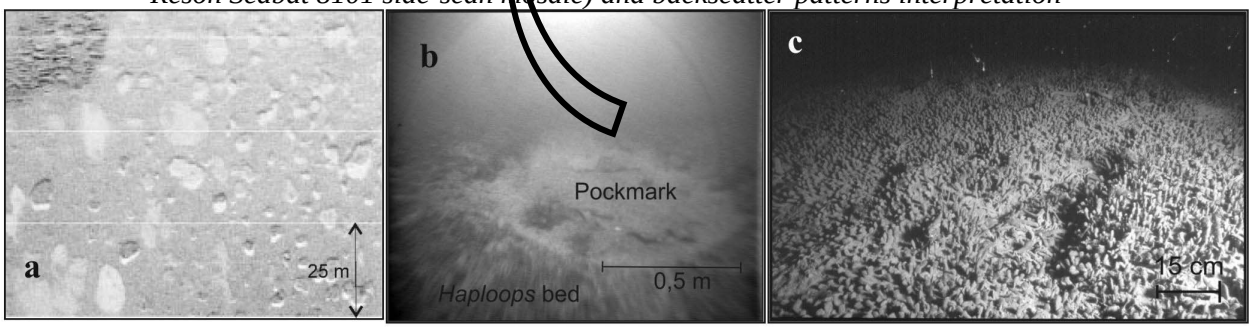

Figure 4: *Observations of Haploops sp. community at several scales (a: Edgetech DF1000 side-scan sonar image ; b: image extract from video frame ; c: diver photo Caisey©Ifremer).*

Growth pattern of the Træna reefs off northern Norway

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The main objective of this study is to map *Lophelia* reefs located in the Træna Deep off northern Norway, and describe their structure and physical environment. The study area (23 x 13 km) has a high density of reefs and was selected on the background of interpretation of multi-beam mapping. Interpretation of the bathymetry indicates that there are nearly fifteen hundred coral reefs in this area. These are similar in size (approximately 150 m long, 40 m wide) and locally orientated in the same direction. The bottom topography is characterised by glacial scour marks orientated in a WNW-ESE, but the reefs are oriented mainly E-W. There is no obvious geological explanation to the orientation of the reefs. The most obvious explanation is that the local current regime directs the growth of the corals. Internal reef structure was studied with TOPAS sub-bottom profiler, and indicated the presence of subsurface layers extending towards the east. To test if this reflects a horizontal reef growth, dead coral fragments for ageing were sampled with video-grab, at different sites along the "reef tail" at one selected reef. The physical environment was studied using current meters, ADCP, CTD and direct observation. Seventeen reefs were inspected with the ROV Aglantha. With few exceptions the elongated reefs consisted of a short live part on the up-current side ("reef head") to the east, and a longer dead "reef tail" extending down-current to the west. The orientation of the reefs fitted well with recorded current direction and observed orientation of the gorgonian *Paragorgia arborea*.

The development of a framework for Mapping European Seabed Habitats (MESH)

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Joint Nature Conservation Committee, Peterborough, UK

A consortium of 12 partners across the UK, Ireland, the Netherlands, Belgium and France gained financial support from the EU INTERREG IIIB fund for an international marine habitat mapping programme. The three year project, entitled 'Development of a framework for **M**apping **E**uropean **S**eabed **H**abitats', or MESH for short, commenced in Spring 2004 and is due to finish in Spring 2007. Funding for the project was gained from the EU INTERREG IIIB fund.

The MESH Project aims to produce seabed habitat maps for north-west Europe (see figure 1) and develop international standards and protocols for seabed mapping studies. The key work areas are:

- Generate habitat maps and metadata for north-west Europe;
- Develop standards and protocols for marine habitat mapping;
- Field surveys;
- Predictive modelling;
- Demonstrate applications of habitat maps for spatial planning and environmental management and,
- Communication and dissemination.

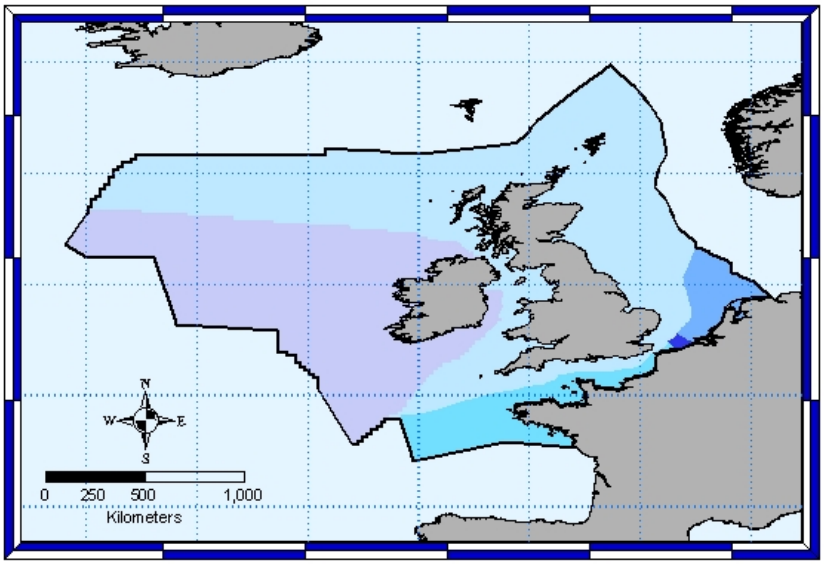

***Figure 1**: MESH project area*

The key project deliverables will include a meta-database of mapping studies, a web-delivered geographic information system (GIS) showing the habitat maps, guidance for marine habitat mapping including protocols and standards, a report describing case histories of habitat mapping, a stakeholder database and an international conference with published proceedings.

This poster will describe progress and outputs of the work area 'Generate habitat maps and metadata for north-west Europe', that is developing an online metadata catalogue, collating existing habitat maps and translating their habitat classes to a common habitat classification (EUNIS[1]) to create a unified marine habitat map for north-west Europe. The problems associated with translating habitats to the EUNIS classification will be discussed, together with the procedures that have been developed to help automate the translation process.

The main outputs of the work area are:

A *MESH Data Agreement* that helps Partners to describe any licensing, copyright or publishing restrictions associated with each dataset supplied to the project from a third party.

A series of *Data Exchange Formats (DEF)*, which were defined for each type of data used by the MESH Project. The key aspects of these DEFs were the GIS software format, the co-ordinate system and projection, and the attribute data. The Partnership settled on using ESRI shapefiles with geographic co-ordinates (Latitude, Longitude) using the WGS84 datum. Further information on these DEFs, including a downloadable description, is available on the MESH website (www.searchMESH.net).

The *online MESH metadata catalogue*, which is now available on the project website www.searchMESH.net/metadata. This metadata catalogue complies with the international standard ISO 19115[2] for metadata, and includes metadata for all habitat mapping data collated within the project; metadata has been contributed from all countries participating in the project.

Partners have supplied the first tranche of habitat maps, using the MESH DEF, for display on the MESH webGIS; a custom built mapping website based on MapServer, which is an open source development environment for building spatially-enabled internet applications. Maps from each MESH country were supplied with attributes describing their original habitat classes, and their translated classes to represent the EUNIS, OSPAR priority habitat and Annex I habitat directive types. The translation of these habitat maps from the many different classification schemes present across the MESH project area, to the common schemes, allows unified habitat maps to be presented for the MESH project area.

As these maps are being collated, there is a growing need to develop systems which allow us to display these maps clearly and consistently. To this end, data presentation standards are being developed within the MESH project for this purpose, and may include standardised symbology/ESRI stylesheets for marine habitat mapping.

The MESH project will bring together information and habitat maps from across the North West European sea area from a multitude of disparate sources to a central interactive web-based mapping system, harmonised to a standard European habitat classification scheme. This will be an essential resource for stakeholders and marine managers working towards sustainable marine resource management.

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[1] EUNIS Habitat Classification (http://eunis.eea.eu.int/habitats.jsp)

[2] ISO 19115:2003 defines the schema required for describing geographic information and services. It provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data.

Deep-water coral habitat mapping off the west coast of Ireland: influencing marine policy and resource development

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Ireland has completed swath mapping of over 450,000 sq.km of it's seafloor territories as part of the Irish National Seabed Survey (INSS). Initial map products were produced at a scale of 1:250,000 however further processing of the raw multi-beam data has revealed features hitherto unknown, with potential as cold-water coral habitat.

Here, we present preliminary results of ROV investigations of a number of these previously unexplored features found along the continental margin at depths between 600 and 1000m off the west coast of Ireland. The survey took place aboard the Celtic Explorer in June, 2005, and gathered information relating to cold-water coral occurrence, associated fauna and the extent of fisheries impacts. Trials with a ROV mounted RESON 8125 were also undertaken to assess the usefulness of combined micro-bathymetry/video surveys as a means of ground-truthing INSS data for the development of regional scale geological and biological habitat maps.

The implications of the cruise findings for coral conservation and deep-sea fisheries exploitation are discussed in the light of recent policy developments relating to sustainable marine resource development in the European Union.

Acknowledgements
This work is funded by the National University of Ireland, Galway's Marine Science Research Project 3.2 'Deep Ocean Habitat Mapping Using a Remotely Operated Vehicle' under the Irish Higher Education Authority Programme for Research in Third Level Institutions, Cycle 3. The authors would like to thank the Geological Survey of Ireland for use of the Irish National Seabed Survey dataset. This work will also contribute to the EU Fifth Framework Project: 'Hotspot Ecosystem Research on the Margins of European Seas' (HERMES) (Contract No. GOCE-CT-2005-511234-10).

Deep-water habitat mapping to inform development of offshore marine protected areas: research and management working in partnership

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Rockall Bank has been identified as an area that may meet the criteria for the establishment of offshore marine protected areas under the EU Habitats directive and the OSPAR convention. In addition, following a request from NEAFC (North East Atlantic Fisheries Commission) to ICES (International Council for the Exploration of the Sea), parts of this offshore Bank have been identified as probable areas of cold-water coral habitat and appropriate boundaries for future protected areas have been suggested/identified. In order to assess such closed/protected areas against a range of selection criteria, data on the habitats present on Rockall Bank and their distribution is vital. In August and September 2005 two survey cruises were undertaken by a range of partners under the auspices of the DTI's Strategic Environmental Assessment 7, with further data collection being carried out onboard an FRS Marine Laboratory Research survey, in collaboration with the Joint Nature Conservation Committee and the University of Plymouth. These surveys focused on identifying and mapping the diversity of habitat types present on Rockall Bank and further developing habitat classification for deep-water habitats.

How Computer-Assisted Interpretation can improve the Mapping and Monitoring of Potential Habitats in Cold-Water Coral Reef Settings

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Sidescan sonar is a useful tool for delineating and monitoring different potential habitats within a coral environment (e.g. live or dead coral reef, sediment covered reef framework, background sediments etc.), as it is relatively easy to deploy and highly cost-effective. Facies maps can then be created by visual interpretation of the imagery, but any consistency in this work relies with the human interpreter, and two people might interpret the same imagery differently.

By taking advantage of the fact that imagery, such as sidescan sonar, is best described by its texture, we use texture analysis techniques, e.g. Grey Level Co-occurrence Matrices (GLCMs), combined with supervised or unsupervised classification, for the interpretation. This method calculates statistical indices that quantify the distribution of grey levels and their spatial relationship within the image, and classifies each image pixel according to the combination of its resulting textural indices. This way, texture analysis can be a useful tool to make facies/habitat mapping from sidescan sonar easier and faster, revealing details possibly overlooked during visual interpretation.

In addition to these advantages, preliminary tests on repeated sidescan sonar surveys with variable frequencies or different systems, indicate that similar textural results are obtained and that the major features are mapped consistently in the different surveys over the same area. However, validation of details by an experienced interpreter is still necessary, and therefore visual and computer-assisted interpretation should be used as complementary tools in habitat monitoring.

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Detailed Views of Seamounts and Banks, West of Scotland

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During the summer of 2005, detailed mapping of the seamounts and banks located on the deep-water continental margin to the west of Scotland was carried out as part of a Strategic Environmental Assessment of Area 7. The surveys shown here were carried out by R.V. Kommandor Jack using a Simrad Multibeam Echosounder EM 1002. Other surveys by British Geological Survey (RRS Charles Darwin 174), British Antarctic Survey (RRS James Clark Ross 199) and IFREMER (RV Atalante 'CARTOPEP') are also shown.

The Outer Bristol Channel Marine Habitat Study

Ceri James[1], Andy Mackie[2], Sally Philpott[1], Ivor Rees[3], Gareth Jenkins[1], Angela Morando[1], Teresa Derbyshire[2] and Kate Mortimer[2]

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To inform the policy and decision making process in terms of developments in the marine environment requires knowledge of its current physical state. This includes the morphology, geology, biology and sediments of the sea bed. Such baseline information is essential for the strategic management and sustainability of the physical and biological resources, as well as the conservation of biological diversity. Further, responsible stewardship requires an understanding of the way the marine environment functions and how it might respond to human activity.

The *British Geological Survey* (BGS) and the *National Museum Wales* (NMW) have undertaken a marine habitat study with the aim of addressing the lack of regional-scale biological and geological data for the Outer Bristol Channel. This is an area that has been highlighted by planning authorities as having marine aggregate resource potential in the future. There are currently two licence applications in the area.

The study includes high resolution marine geophysical surveys combined with sediment and benthic fauna surveys. In conjunction with archive data the study aims to produce comprehensive interpretations of marine habitat, species, and biodiversity distributions within the study area.

The area covered by the study includes approximately 2400 km^2 of the sea bed from Carmarthen Bay in the north to Lundy Island 60 km to the south. Within the central part of the area the sea bed reaches depths of 50-60m. The Bristol Channel is noted for having one of the highest tidal ranges in the world.

A primary aim of the study was to gather high-resolution data on the character and nature of the sea bed through deployment of multibeam and high-speed digital sidescan systems. Combining the multibeam and sidescan data has allowed bedforms to be mapped on both a small and large-scale. Ground truthing of the geophysical data was conducted during three biological surveys and included grab sampling at 136 stations along the survey corridors, 2 m beam trawls at 11 sites and 23 camera tows for video and still images of the sea bed. These have been analysed for the invertebrate animals living on and within the sea bed sediments. Sediments from the grab samples were also analysed for particle size.

The outputs include outreach activities led by a dedicated education facilitator, a bilingual (English-Welsh) CD-ROM, a travelling exhibition, scientific reports and websites. The last mentioned include those of BGS and NMW, plus an integrated presence on the *Marine Life Information Network* (MarLIN) site.

The principal support for the study comes from the *Aggregate Levy Sustainability Fund for Wales*, administered by the Welsh Assembly Government, and the *Sustainable Land Won and Marine Dredged Aggregate Minerals Programme* of the Office of the Deputy Prime Minister. This has been augmented by funding and resources from the host organisations (BGS/NERC &NMW), together with contributions from the Crown Estate and the British Marine

Aggregate Producers Association. The Maritime and Coastguard Agency, CEMEX, Hanson Marine, UMA and Llanelli Sand Dredging have also provided data.

The Eastern English Channel Marine Habitat Map

J.W.C. James[1], S. Philpott[1], D.S. Limpenny[2], A. Morando[1], R.A. Coggan[2], E. Bee[1], S.N.R. Birchenough[2], J. Robinson[3], S.E. Boyd[2], C, Johnston[4], K, Vanstaen[2], B, Pearce[3] and V, Blyth-Skyrme[4]

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This aim of the project is to provide integrated broadscale habitat maps for an extensive area within the central part of the Eastern English Channel in order to support the sustainable management of offshore resources. The maps will be based on an inter-disciplinary approach, integrating geological, geophysical and biological data and interpretations. A geophysical survey of 4000 line km utilising multibeam, high resolution multipulse sidescan and boomer sub-bottom has been completed. From an initial interpretation of the geophysics a ground truthing survey was planned and completed with 150 grabs, 40 trawls and 40 video and still sites.

The driver for the project is the discovery of substantial aggregate resources in this area and the requirement to manage the sustainable development of this resource and minimise potential impacts. The area of resource needs to be assessed within the broader context of the Eastern English Channel. The UK government wishes to promote effective stewardship of the marine environment through a policy of integrated management, balancing the requirements for development with nature conservation and legislation. The implementation of the EU Habitats directive requires a significant knowledge of the nature of the sea bed and the project will act as a demonstrator for the mapping methodologies which are required for effective implementation.

The project is funded under the Marine Environment Protection Fund (MEPF) element of the Aggregate Levy Sustainability Fund (ALSF).

Geophysical mapping of Læsø Trindel area, Northern Kattegat, Denmark

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The area north of Læsø Island / northern Kattegat is considered to be of high importance from the marine conservation point of view. The presence of stones and vegetation on the seabed and the substrate versatility makes it a potential habitat for many marine life communities. Therefore the area was carefully studied using state of the art acoustic remote sensing systems for mapping, and diver's description, videos and still photography as a ground truth part of the study. The investigation was performed as part of the requirements of the EU-Interreg IIIB funded project BALANCE (Baltic Sea management – nature conservation and sustainable development in the marine ecosystem through spatial planning). The project started in July 2005 and has 12 partners and subcontractors from all Baltic Sea riparian countries. It is a multidisciplinary partnership where institutes of different interests were gathered to form a centre of excellence in almost all aspects of marine research, conservation and management.

A Kongsberg 3002D Multibeam echosounder and an EdgeTech DF1000 dual frequency digital sidescan sonar system were utilised in mapping acoustically the area of interest in Læsø Trindel. The high-resolution bathymetric map obtained from the Multibeam system and sidescan sonar backscatter map is both utilised to interpret the type of seabed sediments and features of the surveyed area. Experienced divers equipped with video and still cameras made transects at some selected positions in the area. The results of the diving operation were used for the validation of the remote sensing interpretation conducted earlier. These results of the remote sensing mapping and diving activities will be used to develop a habitat map of the area. This map will be used to assist implementing the measures set in place for protecting the ecosystem structure such as the Natura- 2000 Network.

Seabed sediment properties from single-channel seismic profiling data

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The transition from seawater column to sediment bed is not as clearly defined as the boundary between two elastic half-spaces. The porous nature of the sediment, its layered structure and the spatial variations of these require a more sophisticated approach when the characterisation of the seabed with acoustic methods is desired. An extended Biot-theory forward model developed at NUI Galway allows to calculate velocity and attenuation of compressional waves in a wide range of soft granular marine sediments. It considers the mechanical properties of the sediments' constituents and allows the generation of normal-incidence synthetic seismograms from multi-layered unconsolidated marine sediments. The unique relationship between the input parameters and the calculated synthetic seismogram provides the basis for a neural-network inversion scheme to extract important sediment physical properties from measured seismograms.

Preliminary application to real seismograms from 5-kHz profiling data in Galway Bay. These have provided reasonable results for sediment thickness, density, sound velocity and sediment type, the latter corroborated by sediment grab sampling. We are also interpreting similar seismic data from the Irish Sea gathered in the IMAGIN project by colleagues from the University of Cork. The sediment physical properties inferred from these data are being corroborated with physical properties measured from vibracorer sediment cores. We will demonstrate the potential for classifying seabed sediments using this approach.

Airborne laser bathymetry in the Stockholm archipelago, Sweden

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Department of Marine Geology and Geophysics, Geological Survey of Sweden

The Stockholm archipelago is a shallow water area distinguished by crystalline bedrock topography. Surveying the seabed in this area with hydro-acoustical methods is very time-consuming and not cost-effective. A minor test area in the archipelago has been surveyed with Airborne Laser Bathymetry. The surveying system, Hawkeye II, is working at a wavelength of 550 nm. Derived from this investigation were a high-resolution bathymetry together with intensity values from the backscattered signal. In this area, reliable soundings down to c. 15 meters depth were obtained. The present study aims at evaluating the potential of the methodology for mapping seabed substrate in shallow areas compared to conventional hydro-acoustical methods.

Cold water corals (forming carbonate mounds) on Hatton Bank

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Sporadic finds of the coldwater coral *Lophelia pertusa* by fishing activity on Hatton Bank in the NE Atlantic have been known for many years. These can now be linked with seismic profile and multibeam echosounder survey evidence for large mounds across the bank as video trawls and camera grabs have revealed extensive occurrences of corals. These mounds occur both on igneous bedrock highs and as units within sedimentary sequences and resemble the carbonate mounds reported elsewhere west of the British Isles. They are upto 50m in height and several 100s of metres across. A wide variety of corals have been observed including stylasterid, antipatharian, scleractinian and bamboo corals. Reefs of *Madrepora oculata* and *Lophelia pertusa* are present and support are a variety of epifauna. These sites are important and should be consider by current and any future users of the sea and seabed in this most distant part of UK waters.

Investigation and classification of seabed substrates in Swedish shallow bank areas

Johan Nyberg

Department of Marine Geology and Geophysics, Geological Survey of Sweden

Shallow banks within the Swedish Exclusive Economic Zone (EEZ) that are of interest for windpower plant establishments and also for marine protection have been investigated. Marine geological surveys were conducted by the Geological Survey of Sweden using hydroacoustical profiling (reflection seismic, Sub-bottom profiling, Side-scanning sonar) as well as ground-truthing. Marine geological maps were produced and classified using the conventional geological nomenclature and later harmonised with EUNIS substrate classification. The reclassification involved residual, EUNIS as well as mobile and non-mobile substrates. Biological investigations were later carried out based on the seabed substrates.

Life beneath the ice: A history of benthic colonisation beneath the Amery Ice Shelf, Antarctica

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Beneath the Antarctic ice shelves life is surprisingly abundant and diverse. This study documents the Holocene seabed community beneath the Amery Ice Shelf, East Antarctica, based on fossil analysis of a 47 cm long sediment core. The surface samples from this core provide evidence for a rich modern fauna, dominated by filter feeders (sponges and bryozoans), with an abundant infauna predominantly of polychaetes. Mobile detritus feeders such as benthic foraminifera and ostracods have relatively low abundance, and the abundance of planktonic organisms such as planktonic foraminifera, pteropods and diatoms is also very low in the surface sediments. Basal freezing of the ice shelf at this site indicates surface water outflow. The presence of planktonic organisms therefore implies that the surface outflow must be countered at depth by strong inflow, bringing planktonic organisms from the ice edge which is approximately 100 km to the north. The suspended organic matter and oxygen carried by the currents thereby sustains the seabed community.

The down-core assemblage reveals a succession in the colonisation of this site. The lower portion of the core (prior to ~9600 yr BP) is completely devoid of preserved fauna. The first colonisers of the site after this time were the mobile benthic organisms. Their occurrence in the core is matched by the first appearance of planktonic taxa, indicating a retreat of the ice shelf following the last glaciation to within sufficient distance to advect planktonic particles via bottom currents. The benthic infauna and filter feeders emerged during the peak abundance of the planktonic organisms, indicating their dependence on the advected food supply. The establishment and increase in the infauna and filter feeders is associated with a decline in the abundance of mobile benthic organisms, suggesting greater competition for the food source.

The nature of this species succession reveals the delicate balance of the sub-ice shelf ecosystem. The disintegration of Antarctic ice shelves, as has happened in recent times, will have serious implications for the nature of these seabed communities due to associated changes in the organic supply.

Geomorphological features on the western flank of Hatton Bank (NE Atlantic Ocean)

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Data obtained with multibeam echosounder system and high-resolution seismic profiles (TOPAS) by *Instituto Español de Oceanografía* and high-resolution seismic profiles (Sparker) obtained by *British Geological Survey* across Hatton Bank, have been used to carry out this study.

Multibeam data reveal the setting, shape and distribution of ridges on the western slope of Hatton Bank. The ridges are segmented and extend over a distance of up to 25km. The segments range from 500m to 4km in length and have an average height of 20m (maximum 45m) with steeper north-facing slopes of up to 17º. The segments have two principal orientations (N90ºE and N67ºE). The parallel nature, and regularity, of the ridges suggests a tectonic origin. This is supported by existing sub-bottom high-resolution seismic data from adjacent areas.

The ridges influence along-slope currents and sedimentation causing ponding of sediments. They also provide a topographic high to be exploited by cold-water corals (*Lophelia pertusa*), some of which have been recovered from the area, and constrain the trawling activities of deep-water fishing fleets.

The ridges of tectonic origin contrast with those of a constructional form found on the top and eastern flank of Hatton Bank, which may be of carbonate origin within the sedimentary sequence that overlies the widespread Cenozoic volcanics.

The ridges and ponded sediments create a range of diverse sea-floor habitats that remains to be surveyed in detail.

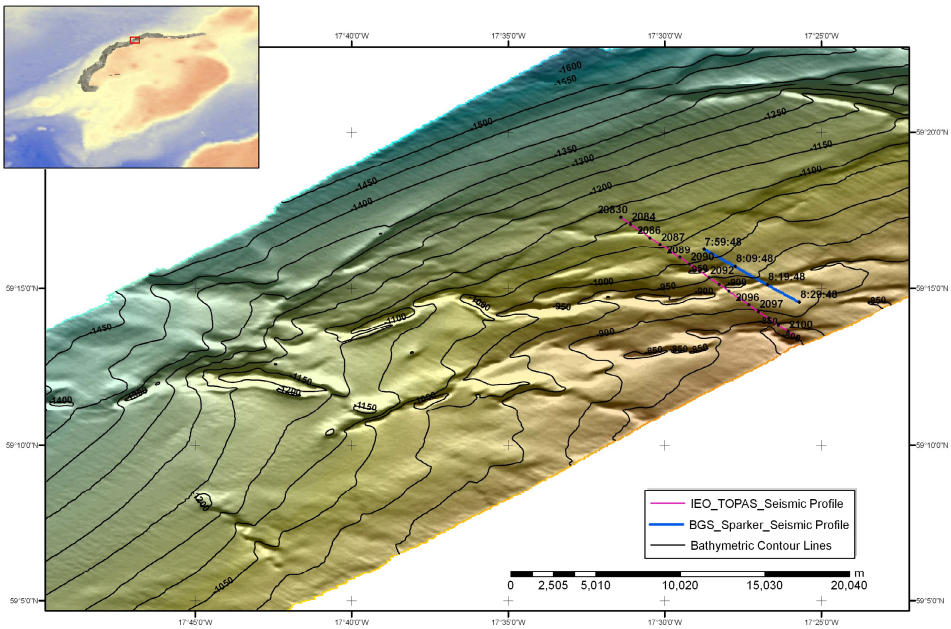

Figure.1. Multibeam data showing ridges and main trends.

Deep-water Scleractinian Coral Habitats in the Madison Swanson Fishery Reserve, Northeastern Gulf of Mexico, USA

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The Madison Swanson Fishery Reserve (MadSwan) is a marine protected area near the edge of the West Florida Shelf in the northeastern Gulf of Mexico, 100 km south of Panama City, Florida. In 2000 the U.S. Geological Survey (USGS), in collaboration with the National Oceanic and Atmospheric Administration (NOAA) and Florida State University, began a mapping study of the approximately 20 km by 20 km area, primarily focused on the inter-relationships between the seafloor geology and grouper spawning habitats. Those same data are being reexamined for deep-water coral occurrences, which will be added to a geographic database of deep-water corals being developed by USGS and NOAA. Deep-water corals are fragile and slow-growing, making them vulnerable to disturbance by human activities such as trawling, laying pipelines, and drilling wells. As trawling has moved into deeper and deeper waters, interest in protecting deep-water corals has grown rapidly because they provide complex habitat utilized by other organisms, show promise in pharmaceutical applications, and are in danger of being destroyed before they are well understood. By mapping the distribution of deep-water corals in a small protected area and understanding their associations with seafloor geology, we hope to be able to accurately predict where they are likely to occur on the broad scale.

The surficial seafloor geology of the 400 km^2 MadSwan area was mapped using a combination of sidescan-sonar imagery and multibeam bathymetry data; interpretation was supported by sediment grab samples, video, and still photographs. Rock samples were also obtained from several sites by SCUBA divers using mixed-gas gear designed for greater water depths. At least four distinct types of seafloor are common in the study area: fine-grained unconsolidated sediment, medium to coarse-grained unconsolidated sediment, low-relief hard bottom, and high-relief hard bottom. Deep-water scleractinian corals were observed exclusively in the high-relief hard-bottom areas.

In the MadSwan area, high-relief hard bottom is characterized by either carbonate pinnacles or sandstone ledges. The carbonate pinnacles occur near the shelf edge between 70 and 80 m water depth and rise as much as 5 m above the surrounding seafloor. Pinnacle outcrops are highly irregular with numerous arches, holes and overhangs. The carbonate rock is composed of well-cemented shells, coral, and other carbonate material that has been extensively bored by organisms or dissolved, leaving a very rugose surface. The sandstone ledges occur in about 65 to 75 meters of water, about 5 to 10 km landward of the shelf edge. These massive rock outcrops are more than 6 km in length and up to 15 m high. Bedding shows differential erosion and the rock is orthogonally jointed in places. Piles of large boulders, up to 2 m across, are commonly found below undercut cliffs. The well-cemented rocks contain a wide variety of terrigenous and carbonate grains, including quartz sand, shells, forams, lithoclasts, and ooids. The well-rounded grains suggest a high-energy environment of deposition, such as a beach.

The high-relief hard bottom of the MadSwan area provides habitat for at least three species of deep-water (azooxanthellate) scleractinian corals. Numerous clusters of black cup corals (exhibiting both black skeletons and black polyps) were observed; they may be a species of

solitary *Desmophyllum*. A typical cluster is a few 10's of centimeters across and contains 20 to 50 individual corallites; such clusters cover less than 10% of a rocky outcrop. Numerous pink cup corals are also present. They occur in clusters similar to the black cup corals, in small groups of 2 or 3 corallites, or as solitary individuals. They likely represent several species. Collected specimens of one type of these pink cup corals appear to be *Hoplangia durotrix*, the "carpet coral", a species also found in the North Atlantic Ocean. Neither the black *Desmophyllum* nor the pink *H. durotrix* has been previously reported in the northeastern Gulf of Mexico. In addition to the cup corals, a single colony of the branching coral *Lophelia pertusa* was seen. In the North Atlantic Ocean, *Lophelia* is known to construct large mounds and reef structures.

The black and pink cup corals and the *Lophelia pertusa* colony all occurred on the carbonate pinnacles. The only scleractinian corals observed on the sandstone ledges were pink cup corals. Several factors could contribute to this distribution of species. By plotting the locations of the deep-water coral species on our maps of substrate type and morphology, we see there is a small depth difference between the carbonate pinnacle sites (70-80 m) and the sandstone ledge sites (65–75 m). However, the pinnacles are closer to the shelf-edge where upwelling from deeper water may occur; and the pinnacles' rough surfaces and calcium carbonate composition may afford a more desirable settlement surface than the relatively smooth surfaces of the massive sandstone ledges.

Mapping benthic habitats on German Bank, Gulf of Maine

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The interdisciplinary scientific field of benthic habitat mapping has been successfully developed and applied in Canada to provide the knowledge base to effectively manage offshore fisheries, evaluate marine protected areas, minimize the environmental impact of offshore development, and resolve sea floor use conflicts. For example, on German Bank on the southern Scotian Shelf, benthic habitat maps are the critical underpinning of newly-opened scallop fishing grounds where the resource manager (the Government of Canada) and the fishing industry share in map development and utilization.

German Bank is located on the Scotian Shelf off southern Nova Scotia at the entrance to the Gulf of Maine. The Scotian Shelf is a formerly glaciated continental margin characterized by an inner shelf which is the offshore continuation of the prominent Maritime peneplain on the adjacent land. The geomorphology of the inner shelf constituting German Bank is dominated by moraines, drumlins and by outcropping bedrock that has been modified by glacial erosion. German Bank was sculpted by the advance and retreat of North American continental ice sheets during the Quaternary Period. The last ice sheet advance culminated in the Gulf of Maine region at approximately 20 000 ^{14}C yr B.P. (20 ka); ice front retreat and glaciomarine deposition began as early as 18 ka with grounded ice absent from the Gulf of Maine by approximately 14 ka.

Multibeam bathymetric data were collected over 5320 km^2 of German Bank using a Simrad Subsea EM1000 multibeam bathymetric survey system (95 kHz) with 60 beams. The multibeam bathymetric data are presented at 5 m/pixel horizontal resolution. Multibeam backscatter intensity represents the relative hardness of the seabed and thus provides a rudimentary map of the distribution of sea floor sediment type. To complement the multibeam sonar data, we collected high-resolution geophysical profiles to elucidate geological structure below the seabed, and Simrad MS992 sidescan sonar (120 and 330 kHz) imagery to show the distribution and morphological details of large-scale features and bottom types. Other groundtruthing includes sea floor sediment samples collected using a 0.75 m^3 grab sampler and high-resolution sea floor imagery using Campod, an instrumented tripod equipped with video and still cameras.

Much of the surface of German Bank naturally subdivides into discrete regions characterized by a dominant geomorphic feature derived from glacial and/or postglacial processes. Each region is a habitat mosaic (often composed of more complex and less complex parts) that can be recognized over a large area. Within each habitat, substrates can vary in hardness, roughness and mobility. Four example regions are mapped in detail in this poster.

Postglacial sand sheet – The substrate is mobile, fine-grained sand on pebble gravel and is characterized by patches of amphipod or polychaete tubes and current ripples. Megafauna include the dominant burrowing anemone (*Cerianthus borealis*) and shrimp (*Pandalus* sp.), and less common Jonah crabs (*Cancer* sp.) and hermit crabs (*Pagurus* sp.). Groundfish include hake (*Urophycis* sp.), monkfish, and flatfish.

Bedrock outcrop – This region is a mosaic of two habitat types. (1) Immobile gravel (pebbles, cobbles, boulders) on rock is characterized by fauna that include a variety of encrusting and erect sponges, sea stars (*Asterias* sp., *Crossaster papposus*, *Solaster endeca*, *Hippasteria phrygiana*), tunicates (*Boltenia ovifera*), soft corals (*Gersemia* sp.), and groundfish. (2) Immobile coarse-grained sand on pebble gravel in fracture valleys within the bedrock region is characterized by calcareous polychaete tubeworms (*Filograna implexa*), sponges, sea stars (*Asterias* sp., *Crossaster* sp., and *Hippasteria* sp.), and shell beds containing aggregations of horse mussels (*Modiolus modiolus*).

Moraine fields – This region is a mosaic of two habitat types. (1) On the moraine ridges, immobile cobble and boulder gravel in muddy sandy pebble gravel is overgrown with hydrozoa and bryozoa mats, erect and encrusting sponges, anemones, and calcareous polychaete tubeworms. (2) In the inter-moraine areas, immobile muddy sand on pebble gravel is characterized by a crab (*Hyas aranaeus*), a sea urchin (*Strongylocentrotus* sp.), flatfish, other groundfish species, and sea scallops (*Placopecten magellanicus*).

Drumlin fields – This region is a mosaic of two habitat types. (1) The drumlins are characterized by alternating patches of immobile cobble and boulder gravel in gravelly sand and by gravelly coarse-grained sand. Anemones, a sea star (*Asterias* sp.), groundfish, lobster, and abundant erect and encrusting sponges (*Halichondria panicea*) are present. (2) Inter-drumlin areas are characterized by immobile substrate of coarse-grained sand on pebble gravel. Groundfish, lobster, Jonah crab (*Cancer* sp.), and scallops (*Placopecten magellanicus*) are present.

Mapping seabed habitats in the Stellwagen Bank National Marine Sanctuary, Gulf of Maine

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The seabed of the Stellwagen Bank National Marine Sanctuary (SBNMS) in the western Gulf of Maine is a complex of geomorphic features and substrate types that owe their origin to sculpting by glacial ice movement, erosion and deposition of sediments during ice melting and sea level rise, and reworking by modern currents. During the past 10 years, regional topography and surficial seabed features have been mapped in great detail based on multibeam echo sounder imagery and on extensive groundtruthing with video and photographic imagery and geological and biological sampling. With the development of a new seabed classification scheme, it is now possible to map habitats based on substrate texture, seabed dynamics, the complexity of physical and biological structures on the seabed, and fauna. This approach has been applied to an area of the SBNMS that contains shallow and deep banks (35 and 90 m water depth) and deep basins (180 m), where sediment textures range from boulder ridges to muddy sand, and where substrates are immobile and(or) seasonally mobile.

The mapped area is Quadrangle 6, one of eighteen quadrangles that constitute the SBNMS region. The quadrangle is approximately 13 x 16 km in size, covering 208 km^2, and sea floor depth ranges from 35 m to 180 m. The seabed was imaged at a horizontal resolution of 10 m using a Simrad Subsea (www.kongsberg-simrad.com) EM 1000 multibeam echo sounder that was permanently installed in the hull of the *Frederick G. Creed*, a SWATH (small waterplane area twin hull) vessel operated by the Canadian Hydrographic Service. The EM 1000 operated at a frequency of 95 kHz, and when operating in water depths between 5 and 200 m, it produced 60 aimed beams spaced at intervals of 2.5 degrees, thus giving a total beam width of 150 degrees (75 degrees to each side of the vessel) which insonified a strip of sea floor measuring in width approximately 7.5 times the water depth.

Multibeam bathymetry is the basis for topographic and geomorphologic interpretations. Multibeam backscatter imagery is an indicator of seabed hardness and roughness. Sediment grain size analyses allow the mapping of sediment texture. Video and photographic imagery provide the basis for visual interpretation of the seabed surface in terms of sediment texture and layering, physical and biological structures, sediment movement, and major faunal elements. Using these data, we compiled three interpretive maps of the quadrangle at a scale of 1:25,000 that show 1) seabed geology, 2) sediment dynamics, and 3) habitats.

The description of seabed texture based on grain size analysis is improved by re-defining some traditional sediment size classes. Within the gravel category, which includes classes of granules, pebbles, cobbles, and boulders (Folk, 1974; Wentworth, 1922), granules (2 to <4 mm; -1 phi) and fine pebbles (4 to <8 mm; -2 phi) are moved to the very coarse sand class. This change increases the smallest particle of gravel from a diameter of 2 mm to 8 mm and larger. The reason for the change is that biologists generally interpret the term “gravel” to represent particles of “pebble” size and larger that contribute to the roughness of the seabed and are suitable for attachment by sponges, soft corals, anemones, and other epifaunal species. Sediments dominated by granules and fine pebbles in the 2 to <8 mm size range generally do not exhibit these characteristics; and for the purposes of these interpretive maps, they are classified as sand, not gravel.

The habitats of Quadrangle 6 lie on the southeastern margin of Stellwagen Bank, on several nearby banks (Ninety Meter Banks), and in interbank basins. Habitats have been classified by applying the principals of the Northeastern North America Marine Sublittoral Habitat Classification scheme (Valentine, Todd, and Kostylev, 2005). The mapped area deepens from west to east. The upper eastern flank of Stellwagen Bank (35-65 m) is a habitat of seasonally mobile coarse-grained sand formed into large ripples by storm currents. It is bounded to the east by a transitional habitat (45-55 m) of immobile gravel in mobile rippled sand that gives way, as water depth increases, to an immobile gravel habitat with boulder ridges (50-75 m). Eastward, in deeper water along the bank's lower flank (70-90 m), immobile muddy coarse-grained sand deposits represent a drowned shoreline. The Ninety Meter Banks are covered by immobile gravel with boulder ridges (90-120 m) and are separated by deep basins (to 180 m) of immobile muddy sand. Video imagery of the seabed indicates that biological diversity, and physical and biological structural complexity are highest on gravel-clad banks and lowest in deep muddy basins.

References

Folk, R.L., 1974, The petrology of sedimentary rocks: Austin, Tex., Hemphill Publishing Co., 182 p.

Wentworth, C.K., 1922, A scale of grade and class terms for clastic sediments: Journal of Geology, v. 30, p. 377-392.

Valentine, P.C., Todd, B.J., and Kostylev, V.E., 2005, Classification of marine sublittoral habitats, with application to the northeastern North America region: *in* P.W. Barnes and J.P. Thomas, editors, Benthic habitats and the effects of fishing: American Fisheries Society Symposium 41, Bethesda, Maryland, p. 183-200.

Fishery and aquaculture in a changing archipelago, Eastern Gulf of Finland

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The archipelago of the Eastern Gulf of Finland is a mosaic of islands of different size and shape separated by rather shallow waters. It is an area where fishing has old traditions but today aquaculture is partly replacing fishery as source of livelihood for the few people who still manage to live in the archipelago. The marine environment has changed considerably during the last decades, affecting fish stocks and aquaculture seriously. Since the late 1950 the sea area has been largely polluted by heavy metals and organic toxicants. These elements have been partly stored in the sediment column of the area, but as there are very important commercial ports in the area, dredging of shipping routes have occasionally released harmful elements into the hydrosphere. Unfortunately also the profound algal blooms during the last hot summers have released toxic compounds into the water column. Animals living on hard bottoms are only affected by elements released to the water column while those living on soft bottoms are also affected by the harmful elements that have been buried into the sedimentary column. The health of marine organisms as well as humans along the coast and in the archipelago is thus dependent on a combination of different factors. Such are sediment and water chemistry, bathymetry, bottom gradients, geology, and biology. When these are well enough understood, and necessary measures are taken, the quality of living of both humans and animals will increase.

Overview of MESH Action 4: Predictive modelling tools as an aid for the broad- and fine-scale mapping of European seabed habitats

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MESH Action 4 aims to model the occurrence of seabed habitats, related to both soft substrata and rocky habitats. In general biological data are scarce or not available; as such the prediction of the occurrence of seabed habitats heavily relies on the correlation between environmental variables and biological data. MESH Action 4 consists of different initiatives, taking place at different scales. The key aims are to produce a broadscale predicted habitat map of the MESH study area at EUNIS level 3, marine landscape maps at a regional scale and detailed habitat modelling for specific species and habitats.

- A broadscale (approximately 2 km grid resolution) predicted EUNIS[3] habitat map for the MESH study area will be produced, complimenting the more detailed EUNIS habitat maps produced under Action 1 (see separate GeoHAB poster of Golding *et al.*). Datasets to be used for this include seabed sediments, bathymetry, wave-base depth, light attenuation and a proxy for energy (this may include wave exposure and tidal stream strength at a later date). This will link with the Habitat Matching Programme (HMP) also being developed under MESH Action 4. The HMP is a suite of algorithms that together, predict the most likely EUNIS habitat type for a seabed sample with physical environmental data and biological taxon data. The planned outputs will be a single predictive map for the whole MESH area (assuming detailed data are available for all areas) and descriptive models for EUNIS Level 4.

- The concept of Marine Landscapes was firstly proposed by Roff & Taylor (2000) and enables the production of habitat maps where biological data are scarce, based solely upon geophysical data deemed important in influencing biology and ecology. This methodology uses biological data passively, as a validation tool for the geophysical mapping. Regional marine landscape maps are planned by all MESH countries, and have to date been produced by the UK and Belgium. Geological and physical datasets include topography (slope/bedforms), seabed sediments, bathymetry, maximum near-bed stress, light attenuation, maximum wave-base and bottom temperature. For the Belgian continental shelf a Marine Landscape map is presented by Schelfaut *et al.* (see separate GeoHAB

[3] EUNIS Habitat Classification (http://eunis.eea.eu.int/habitats.jsp)

presentation). The UK marine landscapes project (UKSeaMap) will be presented by Todd *et al.* (see separate GeoHAB presentation). Other countries are gathering the physical datasets necessary for the landscape modelling.

- On a detailed scale, a number of case studies will be presented, related both to intertidal and subtidal coastal shelf environments. In Belgium, probability maps of macrobenthic communities are created, based on full-coverage information of the median grain-size, the silt-clay percentage and the known relationships with the macrobenthic communities. Those maps have been translated into EUNIS level 5 maps. Those physical datasets are also an input for single species predictive modelling, aiming at developing the most optimal modelling methodology for the prediction of keystone species on the Belgian continental shelf and eventually the whole North Sea. Furthermore, a detailed analysis of bathymetrical derived features was completed, to facilitate and automate geomorphological analysis in the context of marine habitat mapping (a transnational initiative between Belgium and the UK: see separate GeoHAB poster of Verfaillie *et al.*). In Northern Ireland, new multibeam data has been acquired over maerl beds off the Antrim coast and will be used in conjunction with other datasets to model the habitat requirements for maerl in this region.. The occurrence of biogenic reefs of the honeycomb worm Sabellaria spinolosa in the Moray Firth area (UK) is being modelled based on a cross-scale GIS cartographic model and regression analysis modelling.
  A transnational initiative between Belgium, the Netherlands and the UK focuses on the production of a high-quality sedimentological map of the southern North Sea, based on advanced geostatistical techniques. This will serve as an input to more detailed habitat modelling.

References

Roff, J.C., Taylor, M.E., 2000. Viewpoint: National frameworks for marine conservation – a hierarchical geophysical approach. Aquatic conservation and freshwater ecosystems, 10, 209-223.

Analysis of bathymetrical derived features on the Belgian continental shelf as a support for marine habitat mapping

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Applications of terrain analysis are mostly found in a land-related geomorphological and ecological context (e.g. fire risk analysis, land management, habitat mapping of species in mountainous areas). In the context of marine habitat mapping, it becomes more and more important as topographic features are assumed to be important possible habitats for marine organisms.

A 2 meter resolution multibeam dataset with both bathymetry and backscatter data of the Westhinder sandbank on the Belgian continental shelf was analyzed, together with sedimentological grab samples. The bathymetry was available as a digital terrain model, allowing to calculate topographic derivatives in GIS. For this study, the following derivatives were calculated: slope, aspect (direction of slope), bathymetric position index or BPI (measure of where a location with a defined elevation is relative to the overall landscape) and rugosity (topographic roughness with a surface area to planar area ratio). The combination and 3D visualization of all of these layers already contributes a lot to the physical understanding of the area. Submarine bedforms (with a spacing between 10-100 m and a height between 0.4-3 m) with their crests, depressions, slopes and flats can easily be recognized and automatically demarcated using a combination of the BPI and slope indices. This is very useful for an automated detection of sediment transport pathways. Moreover, very-high resolution observations have shown that some habitats are closely related to well defined zonations of the terrain. Since those habitats represent the most rich and diverse macrobenthic communities, an automated detection of such zones is extremely interesting from a planning/ conservation perspective. Furthermore, the indices will be tested towards their ability to serve as input parameter for physical and biological models (e.g. rugosity as an input parameter for sand transport or biological models).

The calculation of the terrain analysis depends a lot on scale, since different images are obtained using different search radii. Small scale structures such as ripples will require other search radii than large scale structures such as large dunes. A series of residuals of filters with varying window sizes revealing different scale features has been tested and compiled to an isocluster unsupervised classification map resulting in a combined map of different scale features.

HERMES: Hotspot Ecosystem Research on the Margins of European Seas

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HERMES is designed to gain new insights into the biodiversity, structure, function and dynamics of ecosystems along Europe's deep-ocean margin. It represents the first major attempt to understand European deep-water ecosystems and their environment in an integrated way by bringing together expertise in biodiversity, geology, sedimentology, physical oceanography, microbiology and biogeochemistry, so that the generic relationship between biodiversity and ecosystem functioning can be understood. Study sites will extend from the Arctic to the Black Sea and include open slopes, where landslides and deep-ocean circulation affect ecosystem development, and biodiversity hotspots, such as cold seeps, cold-water coral mounds, canyons and anoxic environments, where the geosphere and hydrosphere influence the biosphere through escape of fluids, presence of gas hydrates and deep-water currents. These important systems require urgent study because of their possible biological fragility, unique genetic resources, global relevance to carbon cycling and possible susceptibility to global change and man-made disturbances. Past changes, including catastrophic events, will be assessed using sediment archives. We will make estimates of the flow rates of methane from the geosphere and calculate how much is utilised by benthic communities, leaving the residual contribution to reach the atmosphere as a greenhouse gas. HERMES will enable forecasting of biodiversity change in relation to natural and man-made environmental changes by developing the first comprehensive pan-European margin Geographic Information System. This will provide a framework for integrating science, environmental modelling and socio-economic indicators in ecosystem management. The results will underpin the development of a comprehensive European Ocean and Seas Integrated Governance Policy enabling risk assessment, management, conservation and rehabilitation options for margin ecosystems to be identified.

HERMES is now one year into its four-year programme. In this first 12 months, almost 30 major research cruises have taken place, including an IODP drilling expedition to the Porcupine coral province. The HERMES consortium has collected a huge volume of data from all study areas, and this will continue as the second year's cruise programme gets under way. As well as being stored in the secure archive facilities of the PANGAEA database in Germany, all data from HERMES cruises are integrated into a pan-European GIS system which will shortly be up and running via a web interface. This system will provide a convenient and efficient way for the consortium to visualise data, plan field strategies and aid interpretation.

An innovative aspect of the HERMES programme which has recently got underway is the interaction between HERMES science and end-users. The HERMES Policy Panel and its subsidiary 'working group', the Science Implementation Panel, has recently been established. The members of the SIP will review our work each year and make recommendations and comments on the direction of the work in the coming months, providing a clear and direct link between research, industry and other end-users such as conservation and monitoring groups.

The scope of the HERMES project is huge, and as such involves experts from all areas of marine science. A key aspect of the programme is provision of high-quality training for students and young researchers, from undergraduates to post-doctoral research fellows. Some 50 students have already taken part in a dedicated Training-Through-Research cruise on board

the RV Professor Logachev during summer 2005, and a week-long workshop in Bremen in January 2006 provided multidisciplinary training for 30 young researchers.

For more information on the HERMES project, please visit our website at http://www.eu-hermes.net

Comparison Of Geological and Biotope Maps Summer Isles Region, NW Scotland

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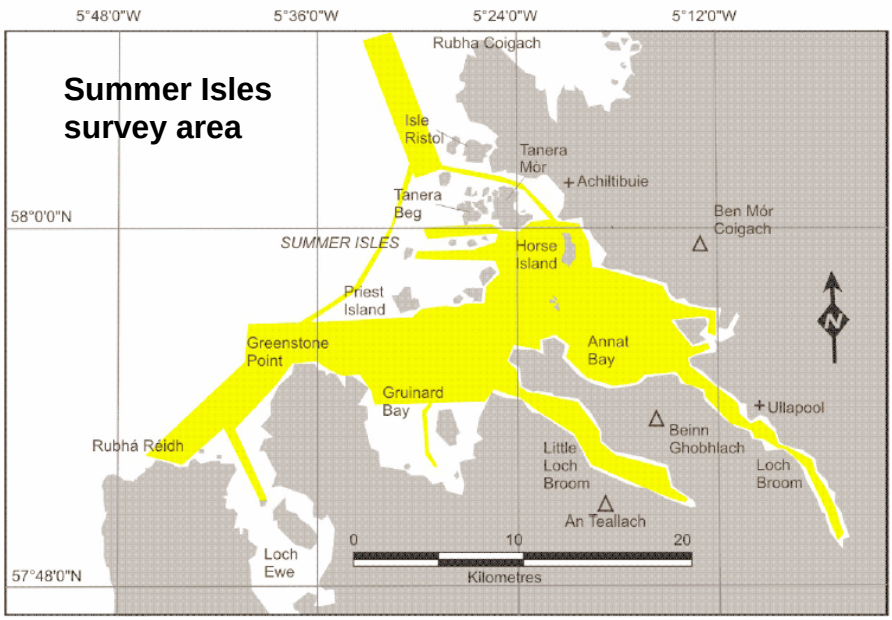
Being able to represent the spatial distribution of an infinitely complex and changing natural environment is no mean feat (even with GIS). The decision as to what is a useful level of detail is of course dependent on the particular scientific goal which has to be met. Are the scales most applicable for geological maps useful for biologists? By comparing two sets of maps covering a similar area, one geological, the other biological, it is hoped that we will be able to draw some useful conclusions.

The Summer Isles are located north-west of Ullapool and Loch Broom and lie in the mouth of a larger embayment comprised of Gruinard Bay Annat Bay along with Loch Broom and Little Loch Broom. The coast around Rubha Coigach is very exposed with the waters to the east of the Summer Isles much more sheltered from the dominant wind and waves. The variation both in the tides, exposure and water depths in the area produce a broad spectrum of intertidal and subtidal habitats.

The bedrock geology of the region is dominated by Proterozoic strata belonging to the Torridon and Stoer groups. Inliers of Lewisian orthogneiss occur sporadically east of the Coigach Fault. Whilst the effect of glaciation on this region is everywhere manifest in the present-day shape and topography of the landscape, from erosional landforms such as corries, arêtes, roches moutonneés, meltwater channels to thick glacial deposits, some of the most striking landforms occur beneath the sea. Based on a recent multibeam survey carried out by BGS it has been possible to begin mapping the seabed in a new way. The resolution of the multibeam data allows for the production of a 3D surface from which landforms can be mapped and processes inferred.



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