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Report of the Working Group on Marine Habitat Mapping (WGMHM)

31 March-4 April 2008

Horta, the Azores

ICES International Council for the Exploration of the Sea

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Contents

Executive summary **1**

1 Opening of the meeting **3**

2 Adoption of the agenda **3**

2.1 Appointment of Rapporteurs 3

3 International programmes **4**

3.1 Progress in international mapping programmes 4

3.1.1 The BALANCE programme for the Baltic Sea 6

3.1.2 The OSPAR habitat mapping programme 9

3.1.3 CHARM 12

3.1.4 HERMES 12

3.1.5 PLANOR 13

3.1.6 Developments at the European Union 14

3.1.7 EUNIS habitat classification 14

3.2 International access to metadata and habitat maps 16

3.2.1 Introduction 16

3.2.2 Web portals reviewed 16

3.2.3 Challenges 18

3.2.4 Recommendations 19

4 National programmes (National Status Reports) **20**

4.1 Belgium 20

4.2 Canada 21

4.3 Denmark 21

4.4 Finland 21

4.5 France 22

4.5.1 Bathymetry 22

4.5.2 Seabed sediments 23

4.5.3 Habitat maps 23

4.6 Germany 24

4.7 Ireland 24

4.7.1 INFOMAR 25

4.7.2 MESH 26

4.7.3 *Nephrops* 27

4.7.4 JIBS 28

4.7.5 SMARTBAY 28

4.7.6 OCEAN ENERGY 28

4.7.7 Others 29

4.8 Norway 29

4.9 Portugal 30

4.10 Spain 31

4.10.1 Introduction 32
4.10.2 Methods 32
4.10.3 Results 33
4.11 Sweden 34
4.12 UK 36
4.13 USA 37
4.14 Improving access to National Status Reports 37

5 Mapping strategies and survey techniques 38
5.1 Multibeam calibration with video 38
5.2 Bathymetric LIDAR 38
5.3 Video analysis 39
5.4 Habitat modelling techniques 39
5.4.1 Going from biological point data to full coverage maps 39
5.4.2 Spatial interpolation 40
5.4.3 Criteria analysis 40
5.4.4 Statistical modelling 41
5.4.5 A general scheme for the modelling procedure 41
5.4.6 Statistical modelling methods 43
5.4.7 Current challenges in habitat modelling 43
5.4.8 Network for marine habitat modelling 44
5.4.9 References 44
5.5 Modelling wave exposure for habitat mapping 44

6 Protocols and standards for habitat mapping 45
6.1 Guidelines for habitat mapping 45
6.2 Accuracy and confidence in habitat maps 45
6.2.1 Why assess accuracy and confidence? 45
6.2.2 Some definitions 46
6.2.3 Error propagation 46
6.2.4 Methods to estimate and visualize error/ confidence 47
6.2.5 The MESH confidence assessment tool 48
6.3 Discovery and survey/method metadata standards 49
6.3.1 Metadata for surveys and mapping techniques 50
6.3.2 Metadata for habitat maps 50

7 Uses of habitat mapping in a management context 51
7.1 Habitat mapping in ecosystem-based management 51
7.2 Habitat mapping and ICES science and advisory needs 52

8 Recommendations and Actions 52
8.1 Location for future meetings 52
8.2 Terms of Reference for 2009 meeting 53
8.3 Recommendation for a new Working Group Chair 53

9 Adoption of the Report 53

10 Close of Meeting 53

Annex 1: List of participants 55

Annex 2: WGMHM 2008 Terms of Reference 57

Annex 3: Agenda for the WGMHM 2008 meeting 60

Annex 4: Summary of the HERMES project 63

Annex 5: National Status Reports – summary table 66

Annex 6: National Status Report - Belgium 111

Annex 7: National Status Report – USA 116

Annex 8: Draft Terms of Reference for WGMHM 2009 123

Annex 9: Recommendations and actions 126

Executive summary

The Working Group on Marine Habitat Mapping (WGMHM) convened in Horta, Azores, Portugal from 1–4 April 2008 and was hosted by Fernando Tempera from the University of the Azores. The meeting was chaired by David Connor (UK) and attended by 20 delegates from 9 countries.

Key points from meeting

Two major international marine habitat mapping programmes (both co-funded by EU Interreg) had recently been completed, whilst national programmes continued to indicate the growing importance of habitat mapping to a variety of marine environmental management issues. The BALANCE project had succeeded in developing the first full coverage seabed habitat map for the Baltic Sea, together with developing pelagic habitat maps of use in fisheries management and the application of habitat mapping in spatial planning and marine protected area network design. The MESH project has compiled the first habitat maps and models for north-west Europe in the pan-European EUNIS classification system. MESH has developed a framework for international marine habitat mapping through the establishment of standard Data Exchange Formats and guidelines for habitat mapping, together with a bespoke web-based GIS application which provides a means to integrate mapping data at an international level. The increased importance of marine habitat mapping is reflected in new EU policy mechanisms, such as the Marine Strategy Framework Directive and a proposal for an Atlas of the Oceans in its Maritime Strategy.

WGMHM identified the need for improved coordination of current national and international effort to ensure the resultant maps are fully compatible and readily accessible. This requires further work to develop common or harmonised classification schemes and to make the data from national programmes, including the WGMHM National Status Reports, available via an international web portal. Initially, this should be started by making the NSR metadata available via a web portal.

International programmes

In addition to the BALANCE and MESH programmes reported above, several other international programmes are underway. Work for the OSPAR Convention to collate data for 16 habitats across the north-east Atlantic is well advanced; the data are needed to contribute to assessments on the status of these habitats and will be reported in the 2010 Quality Status Report. Reports were received on mapping activities in the FP6 HERMES project (Europe-wide) and the Interreg CHARM project (English Channel), together with details of a proposed North Sea mapping and spatial management project (PLANOR). Continued development of the European EUNIS classification was noted, including advances in the classification of habitats for the Baltic Sea region. WGMHM advocated enhanced development of common classification systems, such as EUNIS, and identified ways in which this could be achieved.

National programmes

WGMHM has continued to review national programmes, providing a valuable forum for the exchange of information, techniques and strategies. WGMHM has collated much useful information in its National Status Reports (metadata on mapping programmes) during its past meetings. Bringing these reports together and making them more widely available via a web portal was considered a valuable step in bringing the mapping studies reported by WGMHM to a wider audience.

Mapping strategies and survey techniques

WGMHM reviewed the use and range of marine habitat modelling techniques, recognising its valuable role in complementing and enhancing the more costly direct habitat mapping approach. A general scheme for developing modelling procedures was proposed, and a network of marine habitat modellers advocated. Other topics discussed included multibeam calibration using video techniques and the use of bathymetric LIDAR.

Protocols and standards for habitat mapping

A major on-line set of guidelines for marine habitat mapping had recently been released by the MESH project (www.searchMESH.net/mapping-guide). WGMHM welcomed these and identified some gaps in the available set of Recommended Operating Guidelines.

WGMHM reviewed the important topic of accuracy and confidence assessments in marine habitat maps, an issue that had received little attention until MESH developed a confidence assessment procedure. Issues about mapping error and its visualisation were discussed, together with suggested ways to further improve the MESH assessment tool.

The use of metadata at both the survey data collection stage and in the map presentation stage was examined. Consistent use of metadata was advocated, as this contributed to understanding the quality of the underlying data and the resultant maps. WGMHM agreed to trial the newly available MESH survey metadata database application and report back to WGMHM 2009 on its suitability.

Uses of habitat mapping in a management context

Recognising the importance of habitat mapping to a wide range of marine management and policy contexts (as evidenced by the many programmes reviewed in the international and national reports above) WGMHM drew upon its experience to provide comments on the draft ICES Science Plan (2009–2014). WGMHM considered more effort was needed on fishery-related impacts on the seabed and on deep-sea habitats.

1 Opening of the meeting

The Working Group on Marine Habitat Mapping (WGMHM) was convened at Horta (Azores, Portugal) from 1-4 April 2008 at the kind invitation of the Department of Oceanography and Fisheries of the University of the Azores (DOP/UAç) and IMAR, the Institute of Marine Research at the University of the Azores. The organization of the meeting was sponsored by Project MARMAC II - Knowledge, promotion and enrichment for the sustainable use of the Marine Protected Areas of Macronesia – Phase II (Interreg IIIb/FEDER).

The meeting was chaired by David Connor (UK) and was hosted by Fernando Tempera on behalf of Dr Ricardo Santos, Director of DOP. It was attended by 20 delegates from Belgium, Denmark, France, Germany, Ireland, Norway, Portugal, Sweden and the UK (Annex 1). Each participant provided a brief introduction about themselves. Apologies were received from the following WG members: Dieter Boedeker (Germany), Christopher Cogan (US), Roger Coggan (UK), Per Sand Christensen (Denmark), Jan Van Dalfsen (Netherlands), Ibon Galparsoro (Spain), Brigitte Guillaumont (France), Peter Lawton (Canada), David Limpenny (UK), Lene Buhl Mortensen (Norway), Pål Buhl Mortensen (Norway), Kjell Magnus Norderhaug (Norway), Anu Reijonen (Finland), Ricardo Santos (Portugal), Brian Todd (Canada) and Laurence Vigin (Belgium).

2 Adoption of the agenda

The Terms of Reference for the meeting were reviewed and are given in Annex 2. The Agenda and this report were structured to address each item on the ToR, set within the following theme topics, established previously by WGMHM:

- International programmes
- National programmes
- Mapping strategies and survey techniques
- Protocols and standards for habitat mapping
- Uses of habitat mapping in a management context

A draft Agenda distributed before for the meeting was discussed, adding several additional national status reports and adjusting scheduling. The adopted Agenda is given in Annex 3.

2.1 Appointment of Rapporteurs

The task of preparing the report of the meeting was shared amongst delegates as follows: Kerstin Geitner (ToR a), Fergal McGrath (ToR b), Mike Robertson (ToR c), Matt Service (ToR d/e), David Connor (ToR f), Wouter Willems (ToR g), Jacques Populus (ToR h), Ulf Bergström (ToR i) and David Connor (ToR j), and with additional contributions from individuals who made presentations.

3 International programmes

3.1 Progress in international mapping programmes

Review progress of international mapping programmes (including MESH, EEA, OSPAR, BALANCE, HERMES, CHARM) (**ToR a**)

The MESH programme for north-west Europe

David Connor (UK) described the habitat mapping project MESH (Developing a Framework for Mapping European Seabed Habitats) which was undertaken between 2004 and 2008 with co-funding from Interreg IIIb. The project's main aims were to develop a framework for marine habitat mapping in Europe and to develop the first co-ordinated seabed habitat maps for the north-west Europe region. MESH was undertaken by a consortium of twelve partners across Belgium, France, Ireland, the Netherlands and the UK. The main achievements of the project were:

- Development of an on-line catalogue of habitat mapping studies, now containing over 1000 metadata entries (www.searchMESH.net/metadata).
- Collation of over 250 habitat maps for the five MESH countries, and their conversion into a common GIS format and to a common habitat classification scheme (the European Environment Agency's EUNIS scheme).
- Development of Data Exchange Formats (DEFs) for habitat mapping and other associated types of data to facilitate rapid exchange of data between institutes and across countries.
- Development of an interactive guide to marine habitat mapping, including protocols and standards for mapping survey techniques and the interpretation of data, to promote future collection of data which are of high quality and inter-operable (allowing them to be combined with other mapping data). This includes a series of Recommended Operating Guidelines (ROGs) and survey metadata standards. This Guide was published on-line in 2007 (www.searchMESH.net/mapping-guide), with a summary report published in 2008 (Davies & Young eds. 2008[1]).
- New surveys in over 70 study areas, which have added to the available knowledge on seabed habitats, tested and evaluated survey procedures and facilitated the transnational exchange of expertise. A final survey, in the deep-water canyons in the south-west approaches to the Celtic Sea, was undertaken in summer 2007.
- Development of a series of modelling techniques and studies, from very broad scale to very fine scale, which enable the prediction of habitat distribution. As the coverage of existing habitat maps in still very patchy, and mostly confined to coastal areas, such modelling techniques can fill large gaps in mapping coverage until such times as high quality habitat surveys can be undertaken. Examples of broad-scale outputs include marine landscape maps for UK (www.jncc.gov.uk/UKSeaMap), French, Belgian and Dutch waters and a map to EUNIS levels 3 or 4 for the MESH area (Figure 3.1; www.searchMESH.net/webGIS).
- Case studies examining the use of habitat maps for a variety of management and industry needs (incorporated into the MESH Guide).

[1] Davies, J., & Young, S. (eds). 2008. *MESH guide to habitat mapping – a synopsis*. Joint Nature Conservation Committee, Peterborough.

- Dissemination of the data, reports and maps emanating from the project via the MESH web site (www.searchMESH.net) including an interactive webGIS application.
- Communication with stakeholders via newsletters, conferences and bespoke stakeholder workshops in each country, to help ensure the work undertaken meets end-user needs. A project conference held in Dublin in March 2007 was attended by over 200 delegates from 21 countries.
- An Executive Summary of the projects achievements – the MESH Blue Book[2].

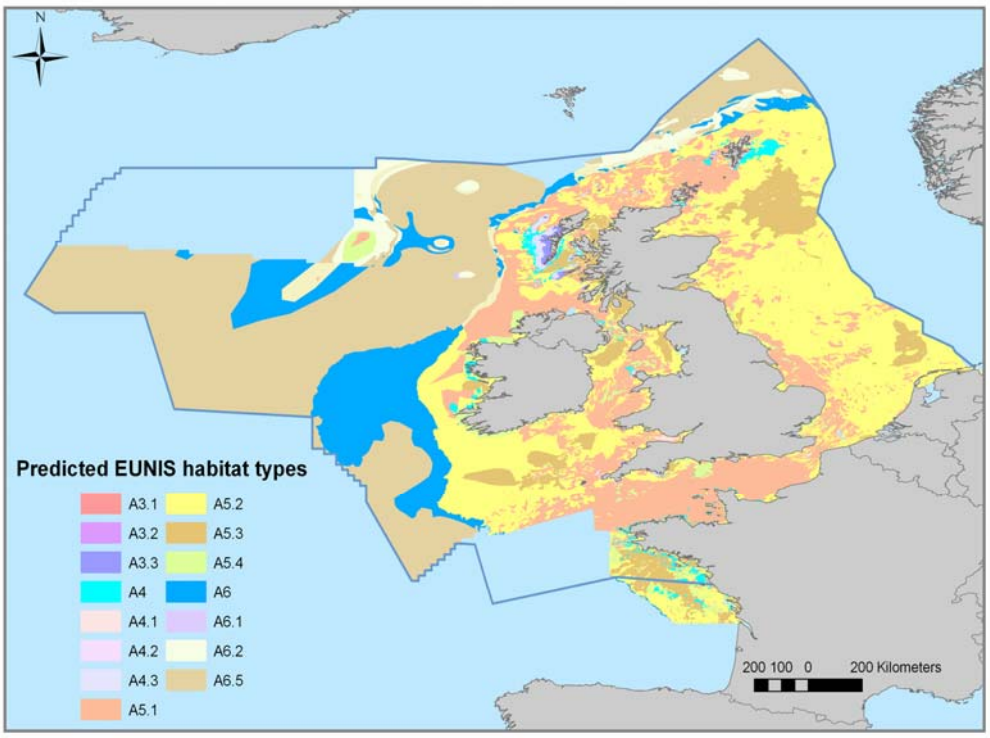

Figure 3.1: Predicted distribution of EUNIS habitats for the MESH area (MESH, 2008).

In line with the project's initial goal to develop a framework for habitat mapping in European waters, consideration was given to maintenance and development of the work beyond the formal completion of the project in early 2008. The initial plans include:

- A commitment by the Joint Nature Conservation Committee (JNCC)[3] to maintain the MESH web site and webGIS facility.
- Continued work to extend the coverage and quality of the habitat maps for UK waters, as new data become available, and to upload further data for the other MESH countries as resources permit.
- The establishment of a national Seabed Survey Working Group in early 2008 to coordinate future hydrographic, geological and biological survey work across the UK and to facilitate access to mapping data and products.

[2] MESH Partnership (2008). *The MESH Blue Book. A summary of achievements of the MESH Project*. Joint Nature Conservation Committee, Peterborough.

[3] JNCC were the Lead Partner in the MESH project.

- Exploration of further collaborative opportunities to extend the coverage of habitat maps beyond the MESH area.

3.1.1 The BALANCE programme for the Baltic Sea

Martin Isæus (Sweden) presented an overview of the BALANCE project (Baltic Sea Management – Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning). BALANCE is an INTERREG IIIB co-funded project aimed towards development of informed marine management tools for the Baltic Sea, based on spatial planning and cross-sectoral and trans-national co-operation. The project was completed in December 2007, resulting in 33 reports (www.balance-eu.org) and maps and metadata which may be explored at http://maps.sgu.se/Portal.

3.1.1.1 A marine landscape and habitat mapping in the Baltic Sea

Marine landscapes are a broad-scale classification of the marine environment based on geophysical features; they are believed to form the basis for determining the nature of biological communities.

A marine landscape map for the whole Baltic Sea region was produced, through modelling based on a number of physical data layers[4]. A major task in producing the map was to harmonise the necessary background data layers needed from various sources of data provided by all 10 participating countries. Sixty different landscape classes were defined (Figure 3.2).

In four trans-national pilot areas distributions of species and habitats were modelled. It showed that statistical modelling is a useful tool for producing basic layers for marine spatial planning. The modelling approach depends on GIS layers describing the physical environment; the quality of these is one limiting factor for modelling. For modelling vegetation, depth came out as the most useful physical factor followed by wave exposure.

3.1.1.2 3D pelagic mapping of cod habitat in the Bornholm Basin, Baltic Sea

Kerstin Geitner (Denmark) presented work on 3D-modelling of pelagic fish habitats which could be of use in dynamic fisheries closure measures (Nielsen & Kvaavik *eds*. 2007[5]). This was undertaken by the National Institute of Aquatic Resources at the Technical University of Denmark.

Introduction: Baltic cod in decline

High fishing pressure and unfavourable environmental conditions have rendered the Baltic cod population at historically low levels and the stock has in recent years been considered outside *biologically safe limits* by the International Council for the Exploration of the Sea (ICES 2007[6]).

The recruitment of cod is low due to low oxygen and salinity conditions since the mid-1980s, as a result of eutrophication and a lack of inflow of saltwater into the Baltic Sea, causing increasingly unfavourable conditions for cod reproduction, including

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[4] Al-Hamdani, Z., & Reker, J. (eds.). 2007. *Towards marine landscapes in the Baltic Sea*. Geological Survey of Denmark and Greenland, Copenhagen. (BALANCE Interim Report, no. 10).

[5] Nielsen, B., & Kvaavik, C. (eds). 2007. *Pelagic habitat mapping: A tool for area-based fisheries management in the Baltic Sea*. DTU-Aqua, Copenhagen. (BALANCE Interim Report, no. 20).

[6] ICES. 2007. *Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2007. Book 8. The Baltic Sea*. International Council for the Explorations of the Sea, Copenhagen.

oxygen-related egg mortality. In addition, increasing predation pressure on cod eggs by sprat has contributed substantially to the low cod recruitment levels. The Bornholm Basin is currently the only large, active spawning ground for cod in the Baltic Sea. On this basis, the European Commission has implemented a number of closed areas and seasons for Baltic cod fisheries, aimed at maximising the spawning success of Baltic cod.

To assist in determining optimal location, size and timing of closed areas in the Bornholm region, models and GIS visualisations have been developed to describe the location and variability, in a given year and between years, of pelagic cod habitats, including spatial and temporal dynamics of different life stages.

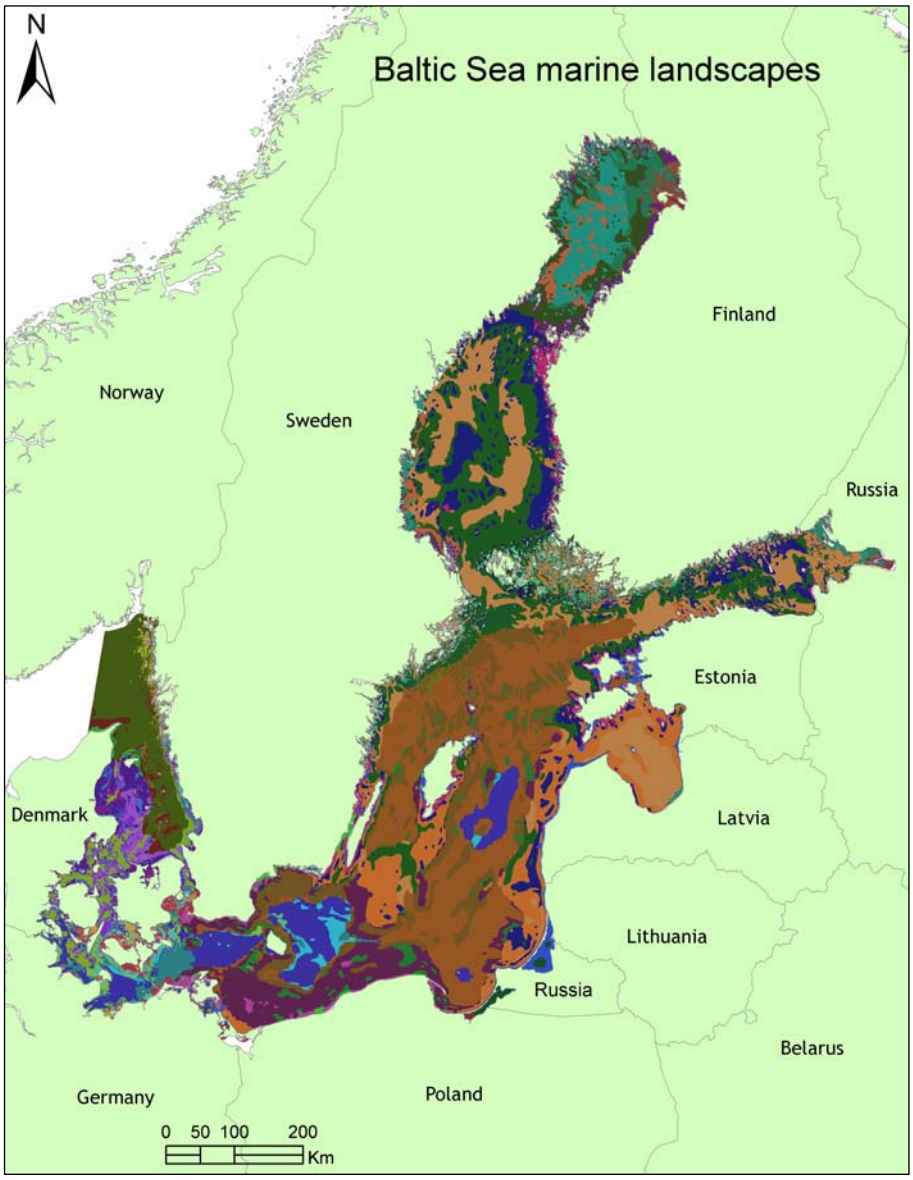

Figure 3.2: Baltic marine landscape map produced by the BALANCE project (Al-Hamdani and Reker eds. 2007).

2D-mapping of cod life stages in the Baltic Sea and Bornholm Basin

Basic 2D-visualisations of the seasonal variation of different life stages of cod were undertaken. This included different stages of cod eggs and larvae (1986–2003), distribution of adult cod based on catch per unit effort data (CPUE) from trawl surveys (1995–2005), as well as the ratio between female and male cod (1994–2005). Interpolation between sampling points was performed for the different variables to optimise the visual interpretation of data. The natural neighbour technique was used for implementing the interpolation of the sum of the different stages of cod eggs and larvae (1997–2003) as well as for the ratio between female and male cod (1994–2005).

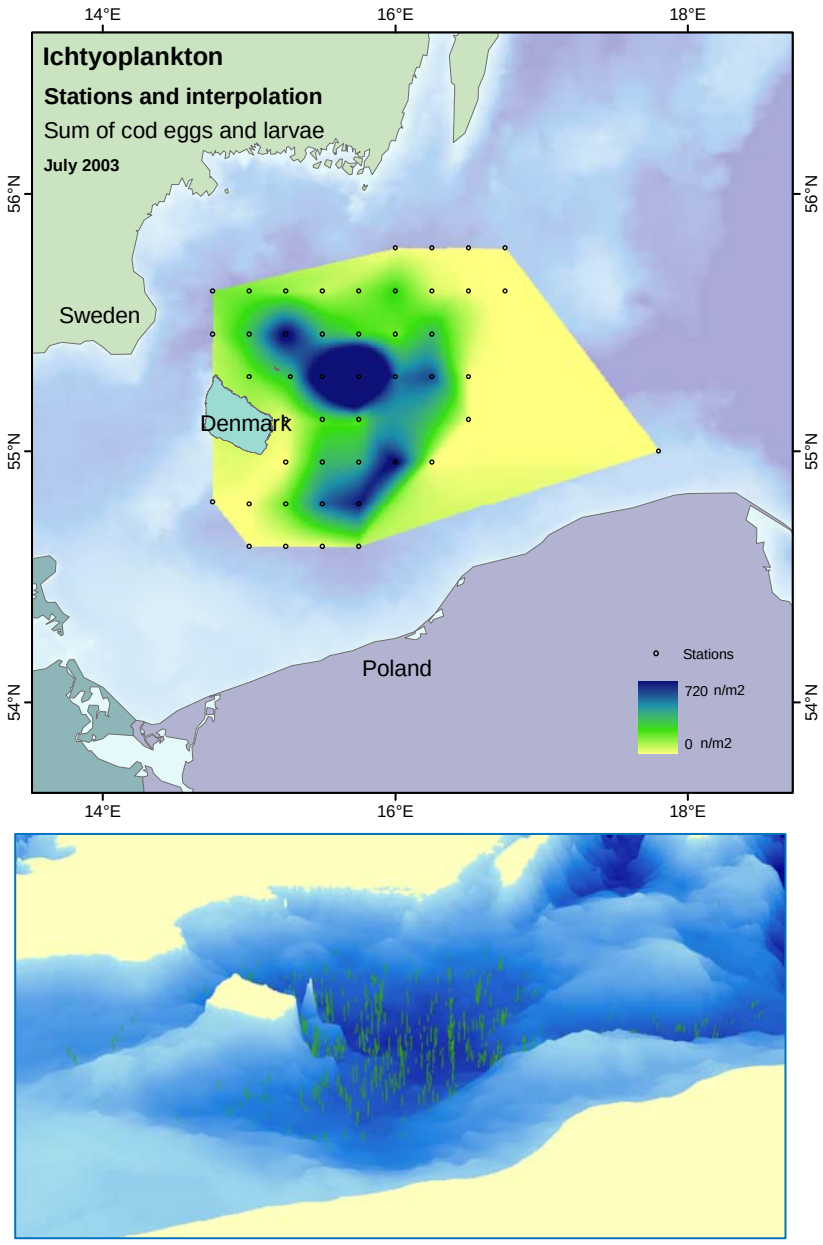

Figure 3.3: Distribution of cod eggs and larvae (top) and 3-D representation of reproductive volume for cod (bottom) in the Bornholm Basin, Baltic Sea (from the presentation "BALANCE – 3D habitat mapping" by Kerstin Geitner and Stefan Neuenfeldt at the BALANCE conference, Copenhagen, October 2007).

In order to achieve successful fertilisation and development of eggs, the Baltic cod is dependent on sufficient oxygen and salinity levels, and to a lesser degree temperature, in the water column at specific times of the year, i.e. salinity > 11 psu, oxygen > 2 ml/l and temperature > 2° C. The water volume that fulfils these threshold values is termed the *reproductive volume*. A 2D-visualisation was developed to indicate the distribution of the reproductive volume based on hydrographic data measured through CTD (conductivity, temperature and depth) profiles, supplemented by oxygen measurements, between 1994 and 2005. These maps indicate that the majority of the Baltic Sea provides little or no favourable spawning habitat for cod. In contrast, successful cod spawning is possible in the Bornholm Basin, underlining the current importance of this area as the only large, active spawning ground for Baltic cod.

3D-mapping of cod spawning habitat

3D-mapping was undertaken to describe the dynamics of the reproductive volume of the Baltic cod. Maps were developed to indicate the variability in a given year and between years of modelled favourable environmental conditions for two different life stages of cod (eggs: 1994-2005 and adults: 2003-2005). Three-dimensional pelagic habitat maps for the two specific life stages were modelled applying known thresholds in temperature, salinity and oxygen using 3D-hydrographic model outputs, as well as to *in situ* measurements of CTD data, for given time steps.

The 3D-maps show that the reproductive volume varies from year to year according to changing environmental conditions. Successful spawning habitat size depends largely on varying levels of inflow of saline, oxygen-rich water from the North Sea into the Baltic Sea during spring, mostly as a result of westerly or south-westerly winds during winter.

Application in area-based management of Baltic cod

Results provide evidence of a strong habitat association, i.e. that bathymetric and hydrographic factors significantly influence the spatial distribution of different life stages of Baltic cod during the spawning season. As a result, the reproductive volume in the Bornholm Basin is considered to be a pelagic essential fish habitat. This information can be used to design fisheries closures that reflect the dynamic nature of the habitat that is the object of protection. Forecasts of saline water inflow and other hydrographic observations could thus potentially be used to determine temporal and spatial locations for fisheries closures.

In discussion, WGMHM welcomed the contribution on pelagic habitat modelling, considering this important both in its own right and for assessing benthic-pelagic relationships. Such work was also important in linking fish populations to benthic habitats for protection of the stocks.

3.1.2 The OSPAR habitat mapping programme

David Connor (UK) outlined the OSPAR programme and its progress to date. The OSPAR Commission adopted an initial list of threatened and/or declining species and habitats in 2003, extending the list in 2004, and with further additions expected in June 2008. With the two new habitats (*Cymodocea* meadows, coral gardens) which are expected to be added by the Commission in June 2008, there will be a total of sixteen habitats on the *Initial OSPAR List*:

- Littoral chalk communities
- Intertidal *Mytilus edulis* beds on mixed and sandy sediments

- Intertidal mudflats
- *Zostera* beds
- *Cymodocea* meadows
- *Sabellaria spinulosa* reefs
- *Modiolus modiolus* horse mussel beds
- *Ostrea edulis* beds
- Maerl beds
- Seapens and burrowing megafauna communities
- Deep-sea sponge aggregations
- Coral gardens
- *Lophelia pertusa* reefs
- Carbonate mounds
- Oceanic ridges with hydrothermal vents/fields
- Seamounts

As part of a wider programme to develop measures for the protection and conservation of the species and habitats on this list, OSPAR's Biodiversity Committee (BDC) agreed in 2003 on a programme to collate data on the distribution of these habitats. Each Contracting Party compiles data for its own marine waters and submits these to the programme coordinator (the UK's Joint Nature Conservation Committee) for collation into composite maps on the distribution of each habitat across the whole OSPAR area. In addition, data for Seamounts and *Lophelia pertusa* reefs has been sought from other sources to aid, in particular, their mapping in Areas Beyond National Jurisdiction. To date, about 20,000 habitat records have been collated (Figure 3.4); the data are made available on the OSPAR mapping website[7] which was last refreshed in February 2008.

[7] OSPAR mapping site web address: www.searchNBN.net/hosted/ospar/ospar.html) or www.ospar.org/eng/html/welcome.html and follow links 'Protection and conservation of Marine Biodiversity and Ecosystems' then 'Mapping of habitats on the Initial OSPAR List'.

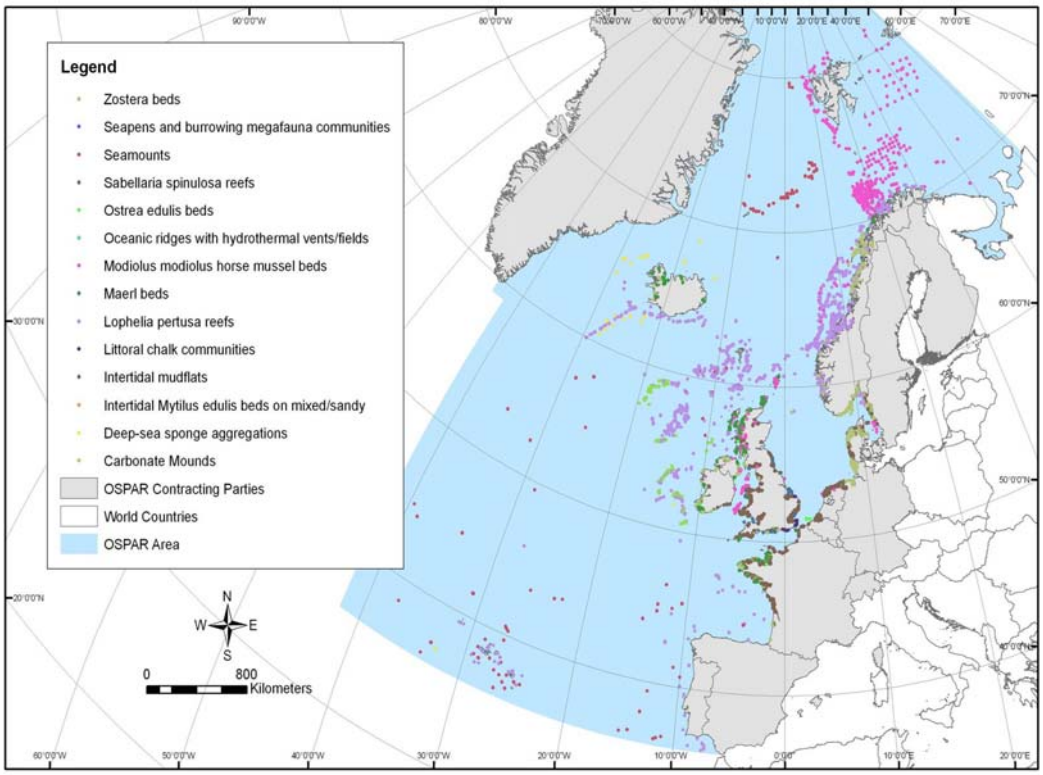

Figure 3.4: Distribution of habitats on the Initial OSPAR List at October 2007 (OSPAR MASH paper 07/5/1-E).

The OSPAR habitat mapping data are relevant to the following OSPAR work areas:

- Species and Habitats on the Initial OSPAR List – the mapping data provide essential information about the known distribution (and extent) of the habitats, which will be of use in relation to the assessment of threats (from human activities) and in the development of appropriate management measures.
- OSPAR Marine Protected Areas – OSPAR is working towards an ecologically coherent network of well-managed sites by 2010. It is expected that sites will need to be identified for habitats on the OSPAR List.
- Ecological Quality Objectives (EcoQOs) – an EcoQO for threatened and declining species and habitats is under consideration. This is likely to need specific EcoQOs for particular species and habitats. The habitat maps will inform the feasibility of establishing suitable EcoQOs.
- Assessments of human activities – consideration could be given in future assessments (by the Environmental Impacts of Human Activities Working Group) as to whether particular human activities are having an impact on any of the OSPAR habitats, and whether there is a particularly strong relationship between the habitat and a specific activity.
- Joint Assessment and Monitoring Programme (JAMP) – As part of the JAMP process, OSPAR requires an assessment of the status of the OSPAR habitats in 2009, including a collation of information on the distribution, extent and condition of each habitat. The habitat mapping data provide a clear contribution to the first two of these attributes (distribution, extent).

- Quality Status Report (QSR) – The 2010 QSR will include an assessment of the habitats on the OSPAR List (based on the JAMP assessments).

In 2007, the Data Exchange Format (DEF) for submitting habitat data was modified, adding the option to submit GIS polygon data, which is now the preferred format. In addition to the NBN website, the data for Belgium, France, Ireland, the Netherlands and the UK are also now available via MESH (www.searchMESH.net/webGIS).

3.1.3 CHARM

Jacques Populus (France) provided an update on the Interreg IIIa CHARM project (Channel integrated Approach for marine Resource Management), which now has proposals for a third phase (CHARM III).

One of the key deliverables of CHARM I was an atlas of the status of living marine resources and their habitats in the eastern English Channel. This atlas can be used to elaborate guidelines for their conservation in the face of climate change and anthropogenic disturbances. CHARM II is extending this initial effort and uses a process-oriented approach to further explain phase one's results and develop predictive tools for assessing management options. For instance, both habitat models and fisheries statistics on commercial fish stocks will serve as forcing variables and inputs to an integrative spatially-explicit modelling approach of the marine ecosystem of the area. Two types of models are foreseen for the Eastern English Channel: (i) a model of the ecosystem functioning using mass-balance food web models (Ecopath with Ecosim) will be built to evaluate management scenarios and (ii) a conservation plan using the MARXAN spatial planning software should enable identification of important sites for conserving biodiversity. The project's outputs will be available to the public through an interactive Web atlas.

3.1.4 HERMES

David Connor (UK) had been informed by Phil Weaver (National Oceanographic Centre, UK) of habitat mapping activities within the FP6-funded HERMES project (Hot Spot Ecosystem Research on Margins of European Seas). To date the project had undertaken swath mapping over a small number of mud volcanoes in the Gulf of Cadiz, parts of the Setubal and Nazare Canyons off Lisbon, parts of the Porcupine area including part of the Whittard Canyon and small areas off mid-to-northern Norway. A summary of the project is given in Annex 4, whilst Figure 3.5 shows the main areas of study.

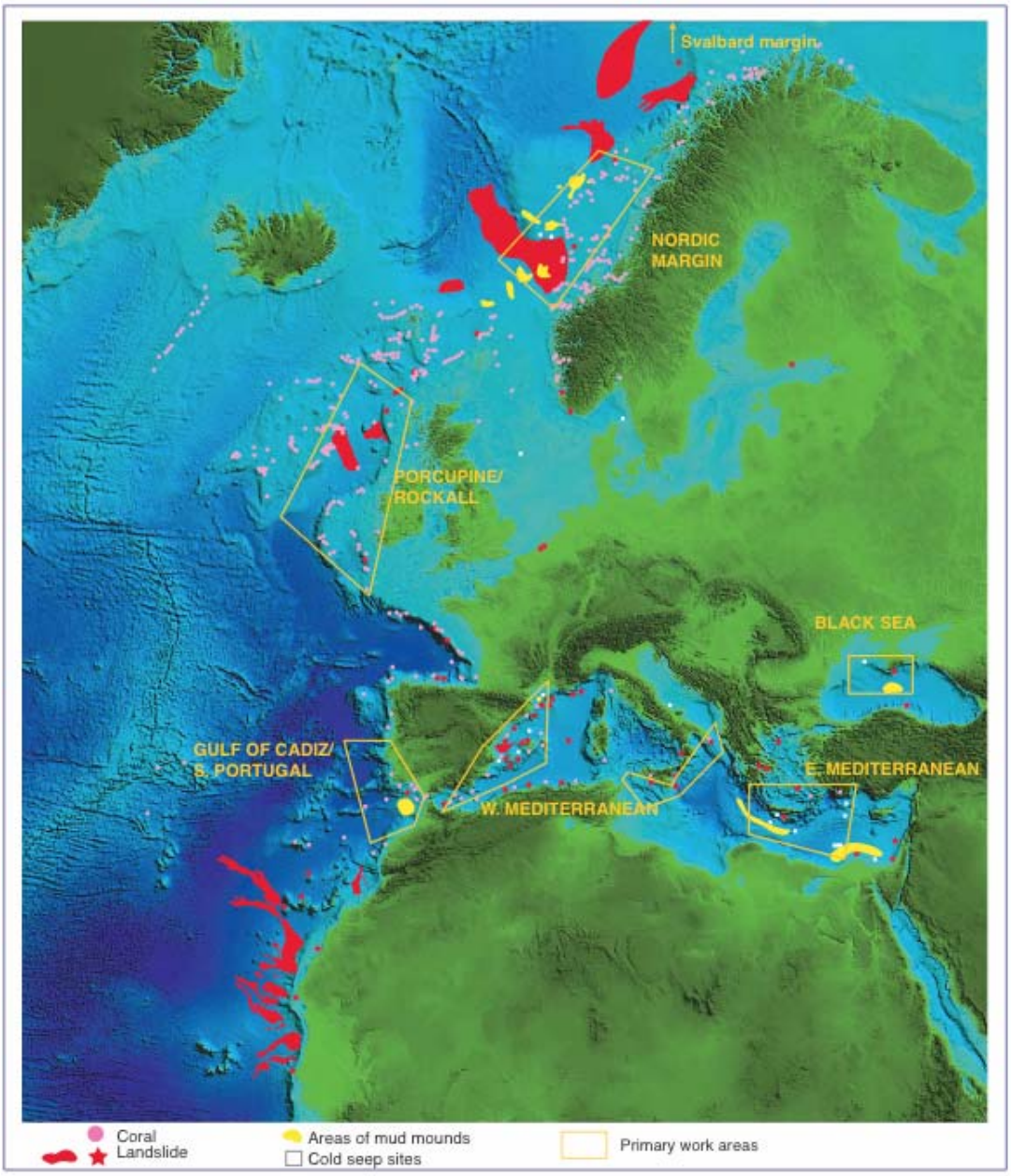

Figure 3.5: Locations of study areas and features in the HERMES project.

3.1.5 PLANOR

Kerstin Geitner (Denmark) outlined plans for a proposed PLANOR project (Integrated Management and Planning in the North Sea Region), which is expected to be submitted in September 2008 for co-financing through the INTERREG IVb North Sea Region Programme. If successful, the project would run from 2009 to 2012, with a budget of approximately €8 m and be led by the National Environmental Research Institute at the University of Aarhus, Denmark.

The goal of PLANOR is to work towards integrated marine management and planning in the North Sea region, involving the participation of all North Sea countries. As a foundation for developing management plans, the following main tasks connected with habitat mapping are envisaged:

- Sediment and bathymetry maps
- Hydrographical ensemble modelling at North Sea level
- Deterministic ecological ensemble modelling
- Species distribution maps
- Connectivity between essential habitats
- Benthic marine landscape maps
- Couple pelagic marine landscape maps with habitats and species distribution
- Development and application of confidence assessment tool
- Verification of landscape types
- Sensitivity assessment of disturbance of habitats
- Scenarios of long term environmental changes

3.1.6 Developments at the European Union

David Connor (UK) provided a brief overview of recent European policy developments which may influence the future use and direction of marine habitat mapping.

The European Commission has two new policy developments, the Marine Strategy Framework Directive (MSFD)[8], due to be officially adopted in May 2008, and the Maritime Blue Paper[9], published in October 2007. The MSFD will require periodic assessment of the state of European seas including the provision of information and maps on marine habitats. The mapping requirement is specifically directed towards those habitats which require protection (e.g. Annex I types of the Habitats Directive, OSPAR habitats) and for particular areas (e.g. subject to intense pressure, protected areas). However consideration should be given to the provision of more general maps for each Member State as these would contribute greatly to other requirements of the Directive. In addition to the habitat maps, Annex III of the Directive also requires information on the physical characteristics of the marine environment, such as seabed sediments and topography, salinity, temperature, and water movements. It is useful to note that these parameters are the same as those typically used in habitat modelling, thus offering potential to use such data to fulfil the habitat mapping requirements of the Directive.

The Maritime Blue Book represents a second phase in the development of an EU Maritime Strategy. It includes proposals for an Atlas of the Oceans and is expected to be followed up in 2008 with specific work to further develop seabed habitat maps across Europe. Linked to this is a workshop in July 2008 at the European Environment Agency which will examine the need for coastal atlases, in collaboration with the International Coastal Atlases Network (ICAN).

3.1.7 EUNIS habitat classification

David Connor (UK) reported on developments in the EEA's EUNIS scheme. The European Environment Agency (EEA) is responsible for developing the pan-European EUNIS habitat classification (http://eunis.eea.eu.int/habitats.jsp). During 2007 there has been further development of the marine section of the classification,

[8] http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2007-0595+0+DOC+XML+V0//EN&language=EN

[9] http://ec.europa.eu/maritimeaffairs/subpage_en.html

particularly for the Baltic and Black Seas. In the Baltic, a workshop in March 2008, hosted by the Swedish Environmental Protection Agency in Stockholm, developed initial proposals for restructuring the current EUNIS classification to better accommodate the main physical drivers for the region (salinity, substratum, depth, exposure), and examined the outputs of analyses of benthic data from Sweden, Finland, Lithuania, Latvia and Estonia. These proposals will be further developed during 2008 in order to finalise a set of habitat types within a suitable classification framework for the Baltic region. For the Black Sea, about 100 new habitats were added to the EUNIS scheme, and have been incorporated into the 200711 version of the classification.

In discussion it was noted that there was often confusion over the different schemes used for habitat mapping, both for scientists and policy-makers/managers. It was clarified that the Habitats Directive Annex I types and the OSPAR habitats were not classification schemes per se, but policy instruments that often formed the focus of habitat mapping programmes. The types in these lists could be matched to classes in EUNIS.

The BALANCE and MESH projects had developed 'marine landscape' maps. The similarities and differences to habitat classifications (such as EUNIS) were briefly discussed. It was noted that the UK marine landscape system (UKSeaMap) was to be merged with the higher level units in the EUNIS model from MESH in order to reduce confusion in the broad-scale modelled outputs for UK waters.

The use of EUNIS seemed to be growing, but there remained difficulties in applying the classification for three main reasons:

- Local variations in habitats were not always easily interpreted into EUNIS types
- Parts of the ICES area were poorly covered by the EUNIS scheme (arctic waters, southern Europe, deep sea)
- The higher level arrangement of EUNIS types did not always lend itself to practical mapping (e.g. surveyors can't assess wave exposure categories in the field).

Whilst EUNIS offered a reasonably comprehensive pan-European scheme, it was recognised that much further work was needed to improve its practical application. It was stressed that all mapping studies should firstly interpret the data into locally valid habitat types and only secondarily translate these into EUNIS types (and Annex I types if needed). This approach would ensure the best interpretation of the data in a local context are achieved and highlight where EUNIS could be improved. It would therefore be helpful to produce both a local map and a EUNIS map for each study.

As a pan-European classification scheme, it was considered important that the physically-defined habitat types in the upper part of the classification (levels 2-4) have widespread application across Europe (and potentially other parts of the world). Such types needed to have clear biological relevance, so that habitat models can be applied to predict the broad-scale distribution of marine habitats (in recognition that detailed habitat mapping was expensive and it would take many years to achieve full coverage for most countries). There was a need for further research into the relationship between the main physical/hydrographic factors (e.g. salinity, exposure, and substratum) and their effect on the biology, so that more precise categories for each parameter can be applied in habitat modelling. For instance, determining suitable categories in wave exposure and tidal currents which linked well to changes in community types was needed.

Below the physically-defined habitat classes in EUNIS, the focus should be on defining functionally- or structurally-relevant community types, rather than types defined too specifically by their species composition. Such gross features of community composition (e.g. forest, meadows, crusts) could be applied widely, were more readily identifiable with less demanding survey techniques (e.g. video) and potentially reflected similarities in habitat characteristics across different biogeographic regimes.

WGMHM recommended that further work was needed to harmonise habitat classification schemes across the ICES area, to facilitate to aggregation of data and maps across countries. In the short term, the focus should be on harmonisation to higher (physical) habitat classes and landscape features, whilst a longer-term goal would be greater harmony at the community level. It was recognised that the latter required greater understanding of the dynamics of communities in time and space to enable a robust classification to be developed.

3.2 International access to metadata and habitat maps

Review the range of metadata and data portals available for marine habitat mapping, and assess how these systems could be integrated or enhanced to provide more coherent international access to mapping metadata and international maps (**ToR b**).

3.2.1 Introduction

This item was addressed by a sub-group comprising Ulf Bergström, Dietmar Bürk, Margaret Dolan, Martin Isæus, Kerstin Geitner, Fergal McGrath, Mike Robertson, Mara Schmiing and Wouter Willems.

A number of data and metadata portals pertinent to marine habitat mapping are currently available. WGMHM considered there was benefit in examining these to assess the scope for making marine habitat mapping data and metadata more accessible at an international level, and to learn from how they operate and function.

A broad assessment of a selection of data and metadata portals was undertaken, indicating that they vary in quality, levels of usability and accessibility. Comments were made on various aspects of their composition and on their relative utility, based on the following headings:

- Metadata availability
- Dataset availability
- Geographical coverage
- Usability
- Confidence
- Limitations

3.2.2 Web portals reviewed

3.2.2.1 NOAA

The NOAA portal (www.csc.noaa.gov/benthic/data/dataportal.htm) is a centralised signpost page hosted by the Coastal Services Centre of the National Oceans and Atmospheric Administration in the USA, providing links to other sources of national (US), regional, and state-specific coastal benthic data. The marine geoscience data management system provides access to data portals as well as to various tools and applications. Metadata and datasets can be accessed. The databases are constantly being populated.

- Provides metadata and database access.
- Access to national projects.
- Access to raw and modelled data.

3.2.2.2 HERMES

This portal (http://gis-web.iu-bremen.de/gis-arcims.htm) is a GIS web server hosted at the Jacobs University, Bremen, Germany. It provides several geoscientific marine projects (including HERMES) with interactive maps based on ArcIMS technology from ESRI. These map services are designed to allow authorised users access to spatial and temporal data, and to create customised maps and map layouts as required. The databases are constantly being populated.

- Provides metadata and database access.
- Access to a selection of international projects.

3.2.2.3 MESH

The MESH website (www.searchMESH.net/webGIS) is designed to give access to an open source GIS mapping product covering north-west Europe. The interactive mapping application holds both habitat maps and modelled habitat maps for north-west Europe, as well as physical data layers, biological samples and seabed acoustic and photographic images. The site also incorporates project outputs from the MESH programme, including Recommended Operating Guidelines for habitat mapping, practical guides, tool kits, data templates and technical reports. Usable tools include the MESH confidence assessment tool and a survey planning scoping tool.

- Provides metadata and database access.
- Dedicated access to a focused discipline (habitat mapping) international project.

3.2.2.4 INFOMAR

INFOMAR is the successor national programme to the Irish National Seabed Survey. The programme has developed a new geodatabase to provide access to all INFOMAR survey coverage via ArcGIS (www.maps.marine.ie/infomar/default.aspx).

- Provides metadata and database access.
- Dedicated access to a national seabed mapping project and ancillary projects

3.2.2.5 GSI

Ireland's INFOMAR survey coverage is now freely available to the general public via a web-based data delivery service (https://jetstream.gsi.ie/iwdds/index.html). A wide variety of products can be easily downloaded based on a spatial search. These include 3D-data visualisations and fly-through videos of seabed terrain (enabled using IVS Fledermaus software). A suite of backscatter, bathymetry and shaded-relief charts are available as PDF images or plotted hard copy charts.

- Provides metadata and database access.
- Dedicated access to a national seabed mapping project.
- Access to raw and modelled data.

3.2.2.6 Marine Institute (Marine Data Online)

Marine Data Online is a metadata service that provides access to metadata on data and project archives of the Marine Institute and other marine research organisations in Ireland (www.marinedataonline.ie). It acts as the centralized contact for researchers and scientists interested in searching for datasets may be available in their specified geographic and thematic area of interest.

- Provides metadata access.
- Access to national projects.

3.2.2.7 BALANCE

BALANCE is a key programme in development of Baltic Sea spatial planning. The project data are accessed through a site hosted by the Geological Survey of Sweden (SGU) (www.sgu.se/sgu/en/fou/samarbete/balance_e.html). All the information which SGU collects through its mapping, survey and other work is documented in digital databases. Metadata and some reports are available but datasets need to be accessed via internal contact.

- Provides metadata access.
- Dedicated access to an international project.

3.2.2.8 VLIZ

The Flanders Marine Institute (VLIZ) is the coordination and information platform for marine scientific research in Flanders, Belgium. VLIZ is a focal point for marine and coastal-related research and serves as an international contact point. VLIZ signs cooperation agreements with Flemish research groups and administrations and integrates its activities in national and international networks via its portal (www.vliz.be).

- Provides metadata and database access.
- Access to national and international projects

3.2.2.9 MAREANO

MAREANO is a national programme financed by the Norwegian government to map the seabed in Norwegian waters. Their website (www.mareano.no) delivers a full suite of end-mapped products including biological, backscatter, geological and sediment maps as well as scaled low-resolution/high-resolution overview maps.

- Provides metadata and database access.
- Dedicated access to a national seabed mapping project.

3.2.3 Challenges

A list of challenges confronting data/metadata delivery through web portals were identified and discussed.

Content:

- Data is not harmonised
- Metadata is not standardised
- Variability in prescribed delivery formats
- Differing classifications
- Differing terminologies (e.g. habitat titles)

- Differing interpretation techniques
- Differing modelling techniques
- Data quality is variable where acquired on different platforms / at different times / by different agencies

Structure:

- Lack of data visibility/availability due to national inter-agency competition
- Technological evolutions can mean that the web portal can be outdated quickly
- Funding caps. Inheritance issues once funding stream has ceased

Usability:

- Websites are sometimes unintuitive to use

3.2.4 Recommendations

Content:

- Ensure data standardisation on a project and inter-project level
- Metadata standardisation
- Generic prescribed formats. Delivery of data should be in common, accessible formats
- Classification standardisation (at certain levels). For example a broad international classification with localized sub-classifications
- Terminology standardisation (e.g. consensus on habitat titles)

Structure:

- Development of centrally-located national repositories, in which all data must be lodged.
- Development of a centralised signpost website leading to greater dataset visibility at national and international levels.
- Standardised database and portal structures.

Usability:

- Intuitive user interfaces, i.e. via a map. Spatial selection facility (map area selection/co-ordinates input). Temporal selection facility (date/time range). Data type selection facility.
- Incorporation of a data-users tracking facility to enable assessment of end-user characteristics (to better target products)
- Make data freely available

WGMHM considered the quality and content of portals was very varied, and some had usability issues. Data availability is a concern, and it is hoped that the INSPIRE Directive will result in more data visibility at a national level, in turn leading to greater visibility at an international level. The result of INSPIRE implementation should include, but not be limited to, publication of metadata and data release. However it is recognised that this visibility can only be delivered if mechanisms are in place to highlight it.

WGMHM therefore **recommends** the establishment of centralised metadata signpost portals at national level, which could then be linked / assimilated into a European-

level portal for marine habitat mapping data. The end result would be a multi-national habitat mapping-related metadata signpost portal.

Of the web portals viewed it was noted that the VLIZ web application, whilst not comprehensive, appears to come closest to fulfilling the requirements for metadata signposting at a national level. For visualisation of mapped data, the MAREANO portal provided a very user-friendly interface.

For international web portals, it was noted that ICAN (International Coastal Atlas Network) is developing an interoperability prototype to make coastal atlases semantically interoperable (marine metadata interoperability), and that there were a number of institutions (e.g. ICES, EEA, JRC) providing European-level data portals, each focusing on differing types of marine data. At present, none of these offered a focus on marine habitat maps. The MESH application has such a focus, but is currently limited in geographical scope to north-west Europe (see Section 4.14 regarding recommended expansion for MESH).

4 National programmes (National Status Reports)

Present and review national habitat mapping activity during the preceding year, providing National Status Report updates according to the standard reporting format, an overview map, and focusing on particular issues of relevance to the rest of the meeting (**ToR c**).

WGMHM discussed the National Status Reports based on presentations from national representatives in the Working Group. Annex 5 provides a compilation of the National Status Reports submitted to the meeting, according to a modified format developed for WGMHM 2007. Additionally more detailed information is available in further annexes as detailed below.

4.1 Belgium

Wouter Willems (Ghent University) provided an overview of mapping studies at the University, further details of which are given in Annex 6.

At the Renard Centre for Marine Geology, different (geo)statistical methodologies are being developed to increase objectivity for datasets of the Belgian part of the North Sea (BPNS), a shallow sandy shelf environment with a sandbank-swale topography (contact: els.verfaillie@ugent.be).

To define the extent of the bioherms of *Owenia fusiformis*, a tube-building worm, very high-resolution multibeam images were obtained with an EM1002 multibeam echosounder. The aggregations occur in between the subtidal sand dunes and occupy large areas. They have a characteristic patchy pattern. The patches have an average height between 17-40 cm. Van Veen grab samples were taken to ground-truth the images and to define the density of *O. fusiformis*. Densities up to 6000 individuals/m² were found.

In the Marine Biology section of the University, a series of studies are underway (contact: wouter.willems@ugent.be):

- A review paper on marine habitat suitability modelling is being finalised. Such an up to date review does not exist and will guide users and project managers in the planning of marine habitat suitability modelling to generate species distribution models.

- Methodological research is dealing with the optimization of the use of Artificial Neural Networks in habitat suitability modelling.
- A model quality index is being developed to select the best combination of model complexity and input variables. This index incorporates model predictive performance, model generality, model robustness and model complexity.
- A paper to guide users in all the steps required for habitat suitability modelling (e.g. data requirements, variable selection, model validation) is to be developed.

Alain Norro (MUMM) described work by the Royal Belgian Institute of Natural Sciences and the Fund for Sand Extraction. Offshore subtidal gravel fields of the southern bight of the North Sea form a fragmented and heterogeneous benthic habitat. In the surroundings of the Westhinder bank, it was to date poorly studied, although a species-rich "boulder field" sheltering wild flat oyster beds was documented in the literature of the late 19th century. In order to investigate the long-term changes that have occurred on this habitat, a combination of seafloor classification based on multibeam echosounder, scuba-operated underwater video recording and epibenthic sampling was carried out at stations investigated in 1905 by G. Gilson (baseline data). The combination of acoustic seabed images and supervised classification maps with detailed terrain models allowed the delimitation of the gravel fields. Acoustically, it is characterized by high backscatter values, a clear distinct classification and a typical "hillocky" morphology. Scuba-operated video tracks revealed the strong heterogeneity of the marine landscape of this area. The seafloor consists of irregular cobbles and boulders partly covered with a rippled sand layer of varying thickness. Epibenthic samples revealed a degradation of its associated biodiversity since the early 20th century. Acoustic data and benthic samples point at the existence of a serious pressure by bottom trawls so far undocumented, and suggest the existence of refuge areas between large sand waves. This multidisciplinary study thus provides important background information for future management and monitoring of human activities in this ecologically sensitive area.

4.2 Canada

Brian Todd (Geological Survey of Canada) submitted a National Status Report (included in Annex 5), but was unable to attend the meeting due to travel problems.

4.3 Denmark

Kerstin Geitner DTU Aqua (DIFRES) presented part of the contribution from DTU Aqua describing the BALANCE project, while Martin Isæus (Aquabiota) presented more information on BALANCE and thereby described further mapping and modelling efforts undertaken by other Danish institutes. These presentations were not exhaustive and did not necessarily describe all the mapping effort and projects that have taken place in 2007.

4.4 Finland

Much of the Finnish marine mapping activities are performed within the master project named VELMU, which is a national marine biodiversity inventory programme. The aim is to collect information that can be used for marine spatial planning, in particular marine conservation, but also for obtaining new information on the biogeographical distribution of marine macroscopic species. VELMU began in 2004 with a three-year long pilot phase. Its intensive phase will last up until 2014, although the

inventory work is expected to continue for approximately three decades. Underwater video techniques and SCUBA diving are the main methods applied in VELMU.

4.5 France

Jacques Populus (Ifremer) reported not only on achievements over 2007 but also on the current situation in terms of mapping coverage for bathymetry, seabed type and habitats (Figure 4.1).

4.5.1 Bathymetry

A major step forward was made in late 2007 with the release by the French Hydrographic Office (SHOM) of their entire digital bathymetry database. This allowed Ifremer to generate a 100 m resolution Digital Terrain Model (DTM) of the whole coast of France, using geostatistical methods. Two products were produced: one limited to the data set outline and another one with extrapolation providing a fully continuous DTM. These DTM can be freely used within the public sector to generate products in various fields.

This endeavour filled a significant gap in coastal zone bathymetry. The shelf area (Channel, Biscay, and southern Irish Sea) is covered by a 500 m resolution DTM whose second version was produced in 2007. For inshore and tidal zones, a major project named Litto3D is being taken forward by SHOM and IGN to map elevation from 10 m on land to 6 miles offshore at metric X, Y and decimetric Z accuracy. Given the cost of such a project, no completion deadlines are given but Normandy will be the first candidate in 2008.

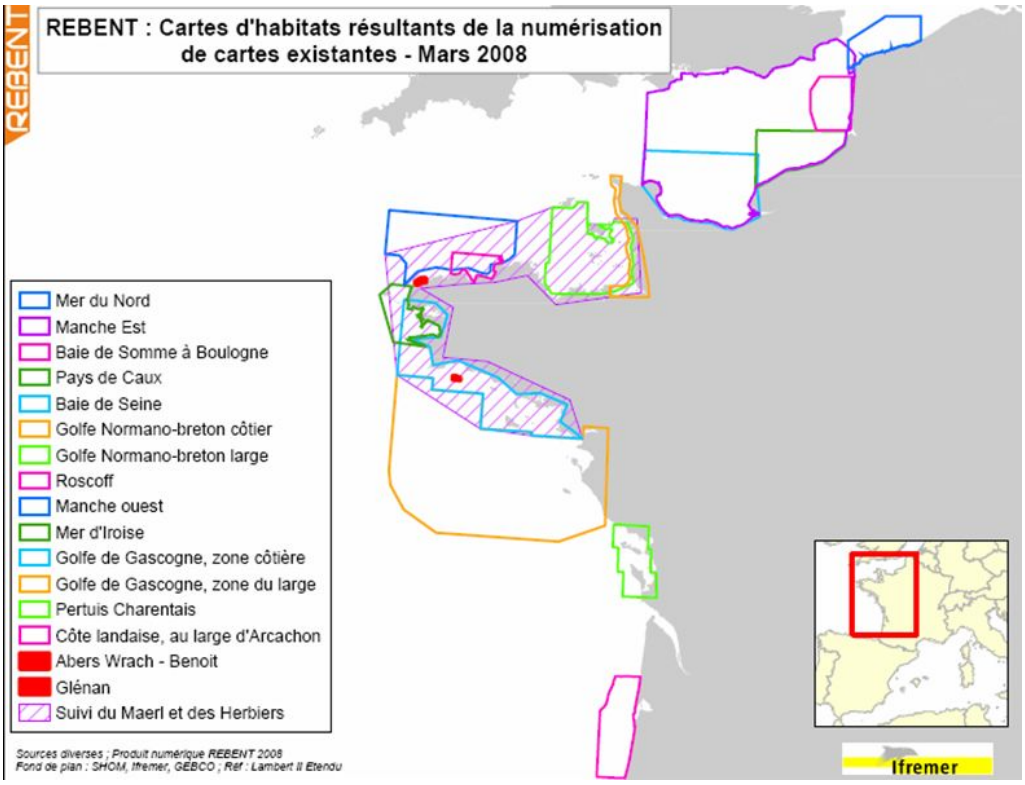

Figure 4.1: Summary of habitat mapping coverage in France (Rebent programme).

4.5.2 Seabed sediments

The so called "G series" from SHOM has progressed in 2007 (2 maps). These follow the usual 1:50,000 nautical chart series outlines. They now cover almost two thirds of the western coasts of France. Along with the recent Ifremer achievements (in the frame of the Rebent habitat network and other initiatives by the department of geology), about 80% or more of the coastal zone is now covered. Full coverage is expected by 2011.

4.5.3 Habitat maps

Three types of habitat maps are discussed here: historic, current and modelled.

Historic maps

The background task of collating historic maps has continued at Ifremer. Major maps have been transferred to JNCC for incorporation within the MESH webGIS, while others (usually more local) are still being digitised, quality checked, translated to the EUNIS classification and their metadata captured. There is now an almost complete coverage of French coasts with medium scale (roughly from 1:100,000 to 1:300,000) maps, either in their authors' original classification but also in EUNIS for a number of them. Only five new maps were incorporated in 2007, as this task is very time-consuming and requires ongoing staff resources.

Recent maps

Recent maps are being made in the frame of the Rebent habitat network. In 2007 three new maps were published on the Rebent interactive mapping site for the regions of Baie de Concarneau, Baie de Vilaine and Traict du Croisic. These were produced directly into the EUNIS classification, with a proposal for new habitat types where appropriate.

Marine landscape modelling

A French marine landscape map was produced in 2007 according to the methodology proposed by UKSeaMap (Connor *et al*. 2006[10]), as part of the MESH project. Its resolution varies from 1 km on the shelf through to 200 m in the coastal zone, which was permitted by the high resolution depth DTM. However there remains a strong potential to improve all other variables, which will be implemented shortly. Note this map only covers the area from the Belgian border to the central Atlantic coast. Southern Biscay will also be dealt with soon.

Kelp forest modelling

A bottom-up model was implemented between 2006 and 2007 across Brittany by establishing modelling rules derived from field samples on kelp forests. The model was then propagated using exhaustive data sets on the coast of Brittany. A map of kelp occurrence (meadows in the deeper water and forests in the shallower water) was produced and validated with a separate data set. This model was not applied in depths less than 10 m where virtually no data were available.

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[10] Connor, D.W., Gilliland, P.M., Golding, N, Robinson, P., Todd, D., & Verling, E. 2006. *UKSeaMap: the mapping of seabed and water column features of UK seas.* Joint Nature Conservation Committee, Peterborough.

4.6 Germany

Dietmar Bürk (GKSS, Institute for Coastal Research) presented a first draft of a marine landscape map of the German EEZ on behalf of Dieter Boedeker (BfN[11]) who could not attend the meeting.

Activities, related to seafloor and habitat mapping, are underway at different institutions at federal and provincial level. The Institute for Coastal Research at the GKSS (a member of the Helmholtz Gemeinschaft) has a number of poles and buoys installed to continuously record oceanographic parameters, e.g. around the island of Sylt, the "Jade-Busen", and along the Baltic coast (www.coastlab.org). The parameters include temperature, salinity, turbidity, wave height, current, wind and various others depending on the type of installation. Several surveys for 2008 are planned to investigate sediment dynamics and transport processes, tidal currents, and the bathymetry of the tidal inlets. Bathymetry is surveyed with a Simrad EM 3002 multibeam system onboard RV Ludwig Prandtl. The backscatter data will be used to implement algorithms for seafloor characterization (sediment type / habitat type) in the targeted areas. In collaboration with the BSH[12] in Hamburg (Manfred Zeiler), multibeam data from earlier cruises in the BSH are assessed for their potential for use in seafloor sediment characterization.

4.7 Ireland

Fergal McGrath (Marine Institute) presented an overview of the work currently being undertaken in Ireland (see Table 4.1 for summary).

Table 4.1: Summary table of mapping surveys undertaken in Ireland during 2007

CE07_INFOMAR	16th April – 03rd June	Acoustic, Lidar, In-situ
CE07_MESH	04th – 18th June	Acoustic, In-situ, Video Image
CV07_Nephrops_01	June / July	Acoustic, In-situ, Video Image
CV07_Nephrops_02	22nd – 30th June	Acoustic, In-situ, Video Image
CV07_INFOMAR_01	03rd Jul – 15th Aug	Acoustic, Lidar, In-situ
CV07_Ocean Energy	July	Acoustic, In-situ
CV07_SmartBay	July-August	Acoustic, In-situ, Video Image
CV07_INFOMAR_02	07th Sept – 16th Oct	Acoustic, Lidar, In-situ
CV07_JIBS	01st– 30th November	Acoustic, In-situ

[11] German Federal Agency for Nature Conservation (Bundesamt für Naturschutz)

[12] German Federal Hydrographic Service (Bundesamt für Seeschiffahrt und Hydrographie)

4.7.1 INFOMAR

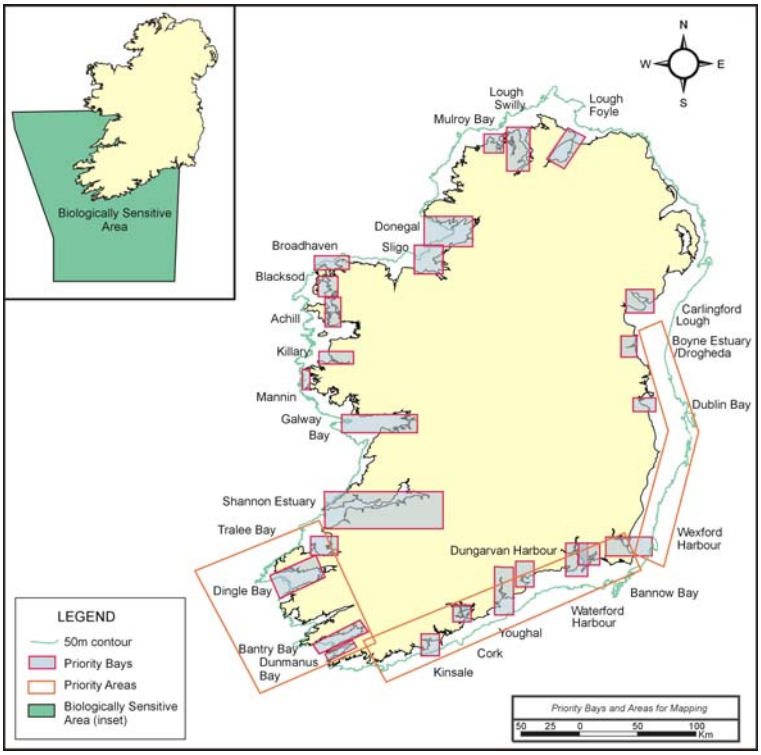

Figure 4.2: INFOMAR Priority Bays and Priority Areas

In 1999 the Irish Government allocated €32M to fund the Irish National Seabed Survey (INSS) project, which was designed to map Ireland's offshore area. The Geological Survey of Ireland (GSI), in partnership with the Marine Institute of Ireland (MI), managed the project mapping over 520,000 Km² of the Irish Extended EEZ prior to completion of the project in 2006. In mid 2005 a proposal was submitted to government for a successor programme, which was accepted in April 2006 with the launch of INFOMAR (Integrated Mapping for the Sustainable Development of Ireland's Marine Resource), with an allocated budget of €4m per annum between 2006-2008 (www.marine.ie; www.gsiseabed.ie). INFOMAR is currently a 20-year programme, which aims to carry out integrated mapping over the entire shelf and coastal waters of Ireland. Through extensive stakeholder consultation 26 Priority Bays and 3 Priority Areas have been identified for mapping during the first phase of the project (Figure 4.2).

Four priority bays and two priority areas were partially surveyed during 2007. In total 4,700 Km² of seabed area was surveyed and more than 100 samples acquired (Figure 4.3).

In 2007 the R.V. Celtic Explorer surveyed off south-west Ireland in the Biologically Sensitive Area (Priority Area for the INFOMAR programme), working northward from adjoining 2006 survey coverage. Operations extend from the INSS data acquired to the west, inshore to the 50 m contour around the Dingle Peninsula. Data acquisition included multibeam, geophysical data, and ground-truthing grab samples. The commissioning of a new Vibrocorer took place in April as part of INFOMAR work programme in Galway Bay with the acquisition of 6 m cores in selected sites throughout the bay.

In July the R.V. Celtic Voyager carried out a multibeam, seismic and sidescan sonar survey of a Marine Derived Authogenic Carbonate site in the Kish Bank for the Petroleum Affairs Division of the Geological Survey of Ireland, and the National Parks and Wildlife Service. An extensive hydrographic survey of Galway Bay took place between July and August on the R.V. Celtic Voyager as part of the INFOMAR project. This was to augment the 2006 LIDAR coverage. Contractors undertook a hydrographic and geophysical survey of the inner part of Galway Bay during October, to allow seamless merging of previously acquired R.V. Celtic Voyager and 2006 LIDAR coverage. Bantry Bay and Dunmanus Bay were surveyed by the R.V. Celtic Voyager during August as part of INFOMAR. A coastal area offshore Waterford and Wexford, and the outer approaches to Waterford Harbour, were surveyed during September and October on the R.V. Celtic Voyager. Preliminary results of seabed classification of this LIDAR data through GSI, Quester Tangent and LADS cooperation look promising, and will be subject to further development following final LADS data processing, and groundtruthing.

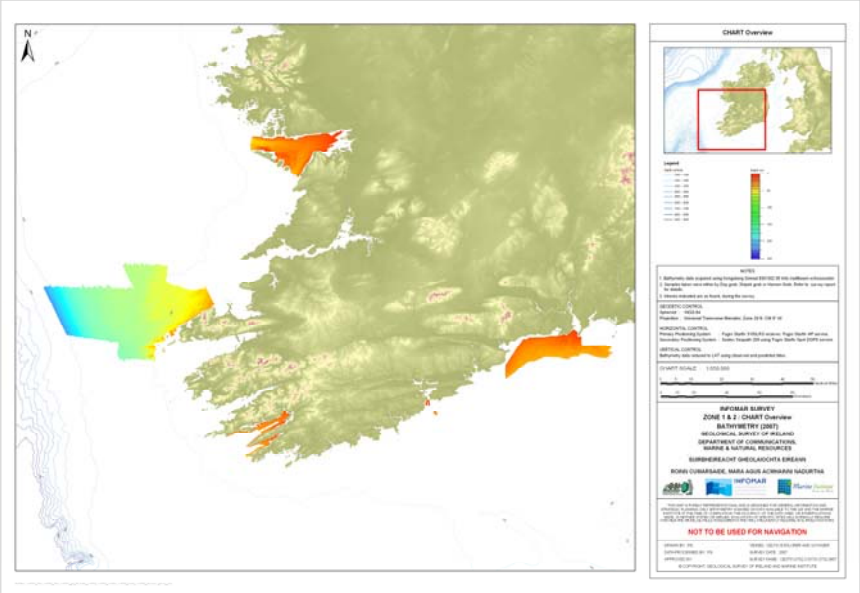

Figure 4.3: Coverage achieved during 2007 (MBES bathymetry)

4.7.2 MESH

The Marine Institute is a partner in the MESH programme which commenced in May 2004 (www.searchmesh.net). The Marine Institute entered into a strategic partnership with the Agri-Food and Biosciences Institute and the British Geological Survey in order to develop and test habitat mapping protocols. In June 2007 the Marine Institute, BGS and JNCC conducted the Submarine Canyon Survey on the south-west Approaches, approximately 320 km south-west of Land's End, across the British and Irish median line (Figure 4.5). The survey involved multibeam mapping of the variable morphology of the area, and underwater video investigation of the biological communities within the canyon system for the assessment of potential Special Areas of Conservation (SAC) under the EC Habitats Directive.

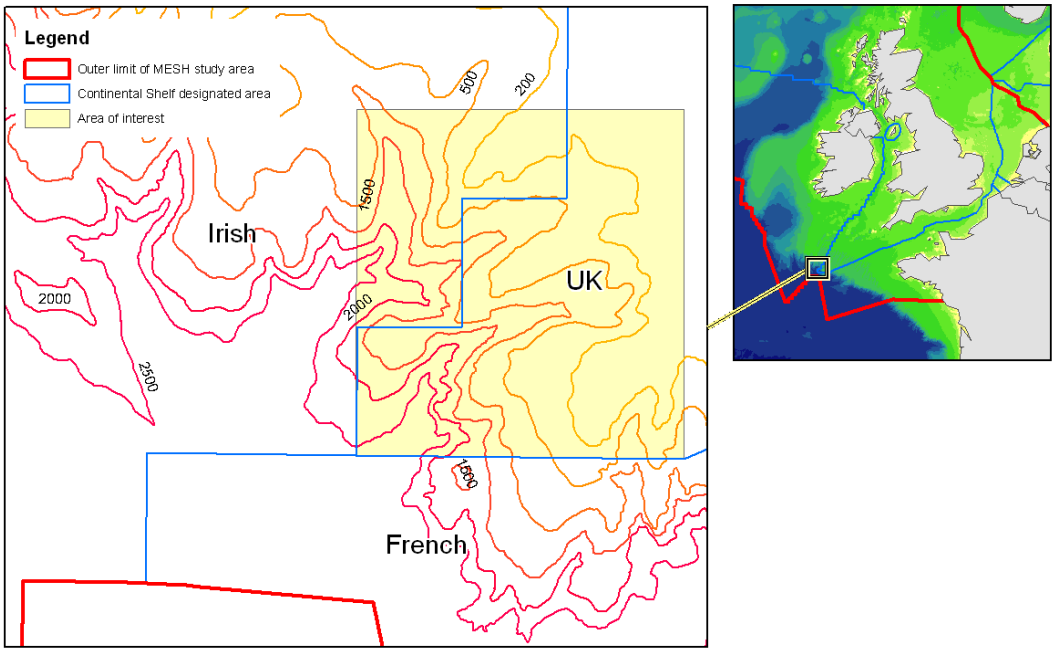

Figure 4.5: Location map of the MESH sites surveyed on the R.V. Celtic Voyager

4.7.3 *Nephrops*

An acoustic survey of the Aran Island *Nephrops* Ground took place in July 2007 with the objective of extending the knowledge of the seabed type within the area, and attempting to delimit the extent of the area. Since 2002 the Marine Institute have carried out Underwater TV surveys on the 'Aran Grounds'. The surveys are multidisciplinary in nature where as previous surveys have focused on *Nephrops* abundance and distribution mainly. The specific objectives are listed below:

- To complete the UWTV stations on a randomised fixed survey grid with 2.25 nm spacing for the Aran (~70 stations), Slyne (5 stations) and Galway Bay (4 stations) Nephrops grounds.
- To obtain estimates of distribution and abundance of Nephrops prawns on the Aran and Slyne grounds using underwater television. These will be compared with previous year's to help determine the current status of these stocks.
- To make use of the UWTV survey to estimate the densities of other shellfish and benthic species and to record evidence of trawl activity.
- To collect MBES and other acoustic data to enable the mapping and seabed habitat classification.
- To collect sediment samples to ground-truth the multibeam data.
- To complete a CTD section from 9°30W to 11°00W at 6 km intervals on the 53°00N.

Since 2003 the Marine Institute have undertaken UWTV surveys of the Irish Sea *Nephrops* grounds in co-operation with AFBI. The results of the 2003 to 2007 surveys

were used to describe the abundance, distribution and estimate the biomass of *Nephrops* in the western Irish Sea.

4.7.4 JIBS

The Joint Irish Bathymetric Survey Project (JIBS) commenced in April 2007 and will be completed by June 2008 (www.marine.ie/home/services/surveys/seabed/JIBS.htm).

This project is lead by the UK's Maritime and Coastguard Agency (MCA) with the Marine Institute of Ireland as project partner. Funding is through the European INTERREG IIIA programme and is co-ordinated by Northern Ireland's Department of the Environment (Environment and Heritage Service). The area initially proposed is the 3 nm coastal strip from Malin Head to Rathlin Island. The survey is being conducted to International Hydrographic Office "Order 1" standard. The R.V. Celtic Voyager spent a month surveying an area between Inishowen Head and Glengad Head in November 2007. Previously unknown areas of sand waves were discovered (Figure 4.4).

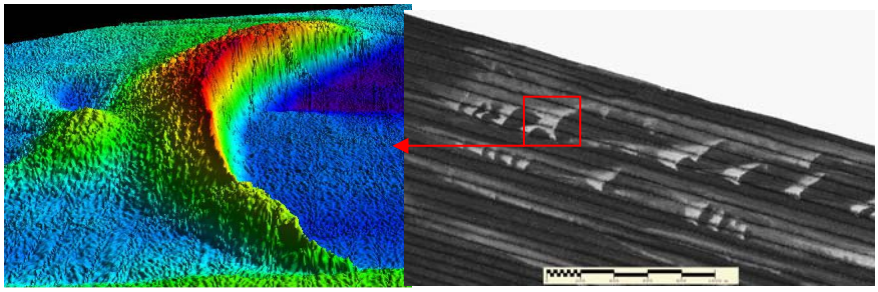

Figure 4.4: Sand waves from JIBS area surveyed by the R.V. Celtic Voyager

The JIBS project will provide a framework for north/south cooperation, via the steering group and stakeholders meetings.

4.7.5 SMARTBAY

A cable route survey in Galway Bay for the Smart Bay underwater observatory project was undertaken in tandem with the INFOMAR survey. A wireless network is to be set up in Galway Bay comprising three buoys measuring water quality and oceanographic parameters. It is hoped that this will be in place by December 2008. Phase 2 will involve the setting up of a test and demonstration facility for sensor testing. It is hoped that this will be in place by mid-to-late 2009. Phase 3 will see a functioning cabled observatory by 2010.

4.7.6 OCEAN ENERGY

Over €26 million in targeted funding will go to the ocean energy sector in Ireland over the next three years. An Ocean Energy Development Unit has been established part of Sustainable Energy Ireland (SEI). Operating with the support and assistance of the Marine Institute, this unit will oversee the implementation of the initiative. In 2008, the initiative will include establishment of a National Ocean Energy facility in University College Cork. The facility will have an advanced wave basin for the development and testing of early ocean energy devices. The first stage will include the development of a grid-

connected wave energy test site near Belmullet, Co. Mayo. A multibeam survey of a prospective wave-buoy ocean energy site off Eagle Island, Co. Mayo was undertaken during July 2007 by INFOMAR onboard the R.V. Celtic Voyager.

4.7.7 Others

Intertidal zone / shallow water surveys for habitat mapping have been carried out at several SACs by the National Parks and Wildlife Service and its contractors. Several commercial surveys have also been carried out around the country.

4.8 Norway

The delegates for Institute of Marine Research (IMR), Jennifer Dannheim (IMR) and Margaret Dolan (Geological survey of Norway), presented an overview of the work that has been undertaken under the MAREANO seabed mapping programme in the southern Barents Sea. This is the largest mapping project currently underway in Norway.

MAREANO (Marine area database for Norwegian coast and sea areas) is a multi-disciplinary mapping programme, focusing on offshore areas in the southern Barents Sea in a first phase (-2010). It is a collaborative venture between three main partners: the Institute for Marine Research (IMR), Geological Survey of Norway (NGU) and the Norwegian Hydrographic Service, coordinated by IMR. MAREANO was initiated to address the lack of knowledge about the seabed, natural resources and pollutants which is required for informed, sustainable management.

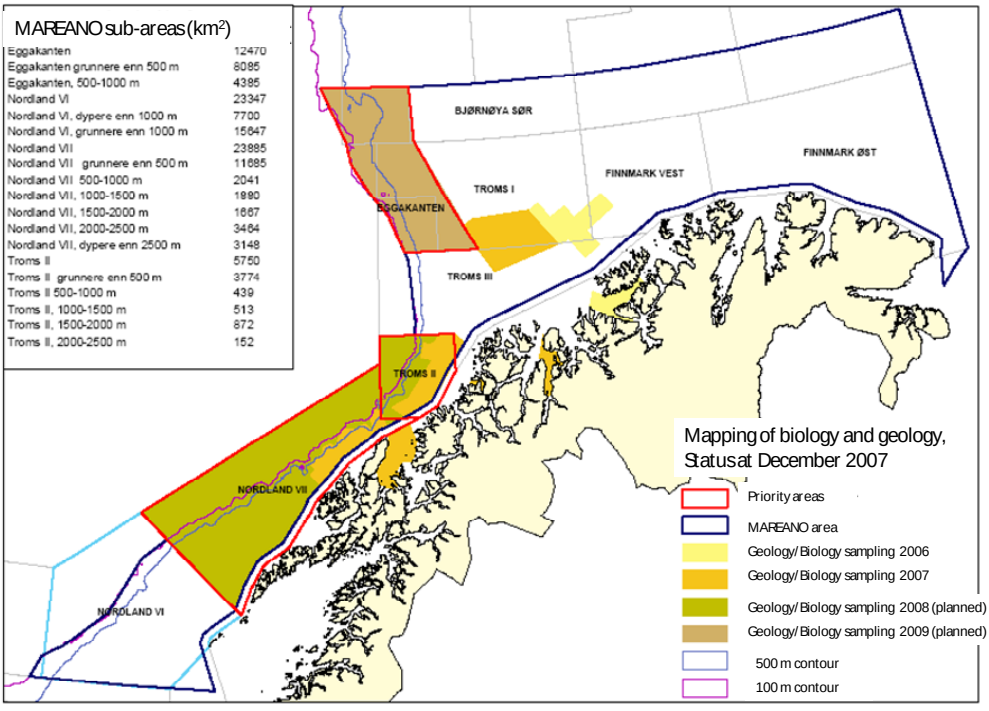

Figure 4.6: Overview progress in the MAREANO mapping seabed mapping programme to end 2007.

The project is financed through an inter-ministerial financial collaboration between the Ministry of the Environment, Fisheries and Coastal Affairs and Trade and Industry, with a budget of around €31 m. The first phase of the MAREANO mapping began in 2005 and will run until 2010.The mapping programme includes acquisition of

multibeam bathymetry and backscatter data together with a comprehensive, integrated biological and geological sampling programme. Equipment used includes underwater video (CAMPOD), box corer, grab, epibenthic-sled and beam trawl. Multicore samples are also taken for assessments of organic and inorganic contaminants in the sediment, and some shallow seismic data are also acquired. Mapping outputs from the project include bathymetric data, geological maps (morphology, hard and soft seabed, sediment grain-size distribution, sedimentary environment (erosion and deposition areas), and genesis), biological maps (including biodiversity and faunal distribution, i.e. species abundance and biomass), benthic habitat maps, and environmental geochemistry maps (contaminants). All results from MAREANO are integrated in the web portal, www.mareano.no. Other relevant datasets are also made available via this web portal by the project partners.

The MAREANO (phase 1) area covers 142,000 km2, and mapping has been prioritised in key areas (Eggakanten, Troms II and Nordland VII) within the MAREANO area, including areas of interest for commercial exploitation. Biological and geological sampling during the 2006-2007 period was conducted on Tromsøflaket and also in Troms II and Nordland VII where existing multibeam data were made available to the project. Multibeam data acquisition continued in Nordland VII during 2007 out to the 1000 m depth contour. During 2007 a decision was taken by government to extend the MAREANO area beyond the 1000 m contour in Nordland VII and Troms II. The maximum depth in these sectors is 2700 m. Multibeam mapping is underway and it is planned to sample this area during research cruises in 2008.

IMR and NGU cooperate to perform the habitat mapping following biological analysis of the video and sample data at IMR. Tromsøflaket is currently being used as a case-study area to develop suitable habitat mapping methods and products from MAREANO. Multivariate statistical methods are being used to relate bottom environment (including multi-scale physical descriptors of the seabed derived from multibeam data) and fauna distribution in order to find objective criteria for definition of habitats and biotopes. For future MAREANO cruises an important task will be to ground truth predicted occurrences of bottom fauna/biotopes based on observed relationships and to test the reliability of these predictions in the wider MAREANO area.

There is also a number of other seabed mapping projects in Norway, mostly in the coastal zone. IMR, NGU and NIVA (Norwegian Institute for Water Research) are currently involved in several applied mapping projects. These include the national programme on mapping and monitoring of biological diversity and marine nature types, under which occurrences of priority nature types (ice marginal deposits, carbonate sand, kelp forests, seagrass meadows, etc.) are predicted and validated. Further details of various projects are listed in the summary table in Annex 5.

4.9 Portugal

Fernando Tempera (Department of Oceanography and Fisheries, University of the Azores) described projects and tasks related to habitat mapping taking place in Portugal during 2007.

At a national level, the EMEPC task force continues to work on the claim for the extension of the country's continental platform under UNCLOS. An ongoing marine surveying programme using the resources of the Portuguese Navy's Hydrographic Institute (IH-PT) and partnerships with civil institutes has been producing geophysical, geological and biological datasets for extensive deep-sea areas within and outside the current Portuguese EEZ. RV D. Carlos I and RV Gago Coutinho are fully allo-

cated to the task. The INFORMAR portal, which is designed to process scientific data requests, was recently launched. A 6000 m-rated ROV was acquired by this task force, and will be involved in ground-truthing and seafloor exploration.

Two Portuguese partners (IH-PT and University of Aveiro) continue their participation in the FP6 project HERMES (see Section 3.1.5), studying canyons off Portugal.

Project ACOSHELF has also started. This work will study the Portuguese and the south-west Spanish shelf ecosystems using acoustic techniques, validated by grab samples for the study of superficial sediments and benthic macrofauna. Bottom habitats will be related to water column acoustics and fish density from pelagic surveys.

Research conducted under Project RENSUB, to develop ecological importance indices based on marine assemblages from data collected along the southern Portuguese coast, was also highlighted.

A catalogue of seamounts was completed for the Azores at the University of the Azores and published in MEPS (Morato *et al*, 2008[13]). Also in the Azores region, Project BANCOMAC (Interreg IIIb) continued the effort to collate coral and sponge bycatch records from commercial and scientific fishing activities which will be used to (i) identify the locations of deep-sea coral reefs and sponge aggregations on seamounts, (ii) preserve reference specimens and (iii) develop taxonomic expertise. Results of the joint cruise of the University of the Azores with Greenpeace were presented, which showed remarkable gorgonian, hydrarian and sponge communities to be present on Azores seamounts and island flanks.

A project conducting microhabitat mapping at the Lucky Strike hydrothermal vent site (D. Cuvelier at DOP/UAz) was referred to and a poster presented.

A project producing algal distribution maps of sublittoral rocky habitats in Faial Island and neighbouring channel was described. It is based on environmental variables such as depth, slope, swell exposure, current exposure, SST and chlorophyll-a (F. Tempera at DOP/UAz).

The FP6 project EXOCET/D conducted its final trials in the Azores, including mapping hydrothermal vent habitats using new acoustic instruments and imagery.

Results of the project MARMAC II (Interreg IIIb) were presented on the movements and habitat preference of a selection of fish, seabird and cetacean species.

The development of autonomous platforms to be used in mapping scenarios continued through projects MAYA and GREX.

Various posters were presented that provided more detailed information on the results of these projects.

4.10 Spain

Ibon Galparsoro (AZTI) supplied the following report on marine habitat mapping in the Basque country (Bay of Biscay).

[13] Morato, T., M. Machete, A. Kitchingman, F. Tempera, S. Lai, G. Menezes, R.S. Santos & T.J. Pitcher (2008). Abundance and distribution of seamounts in the Azores. *Marine Ecology Progress Series*, 357: 17-21. doi:10.3354/meps07268.

4.10.1 Introduction

The Basque Biodiversity Directorate agreed to establish a permanent observatory of the Natura 2000 network in the Basque Country in 2003 (Figure 4.7) to guarantee fulfilment of their objectives and of its formulation. A lack of cartographic information of the Basque continental shelf and the identification and characterisation of the most significant marine habitats within the Basque Country was thereupon made evident.

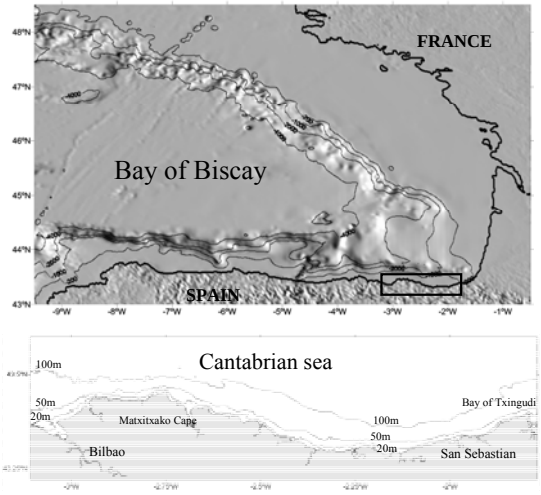

Figure 4.7: Upper: study area within the Bay of Biscay. Lower: part of the Basque continental shelf.

For the Basque continental shelf and coastal zone, a 3-year project started in 2005. The aims were to generate seafloor cartography and seabed characterisation, to define and mark out marine habitats, and to identify the main species of flora and fauna associated to each habitat type. In order to reach these goals, specific objectives were defined: (i) to obtain high resolution bathymetric data of the inner continental shelf; (ii) to characterise different seabed types with relation to geological and geomorphological features and sediment composition; (iii) to gain knowledge of the habitat distribution pattern with relation to environmental factors; (iv) to produce habitat maps of the intertidal and subtidal zones; (v) to classify habitats using the EUNIS classification of the European Environment Agency; and (vi) to identify and locate habitats of European Community interest.

4.10.2 Methods

Bathymetric and seafloor backscatter information was acquired using high-resolution multibeam SeaBat 7125 and SeaBat 8125 systems; both have very similar characteristics and most of the work was undertaken with the latest SeaBat 7125 model. It operates at 400 kHz frequency and produces 256 beams, at 128º angle swath and up to 50 swaths per second. Bathymetric data was acquired and processed using the PDS2000 software. Tidal correction was applied using the nearest gauge and, on this basis, a 1 m-resolution seafloor Digital Terrain Model (DTM) was produced. Finally, the DTM was exported into an ESRI grid format. The DTM was then integrated into an ArcGIS environment.

Spatial algorithms were applied to extract relevant topographical parameters: slope, orientation, shaded relief, and the topographical position index. Orientation or aspect of the DTM was calculated, to determine seafloor exposure to wave fetch. The shaded relief was calculated employing Lambert´s cosine law with different altitude and azimuth values of light source in order to highlight geomorphologic features that

could assist the interpretation of seabed classes. The Topographic Position Index (TPI) was used as a measure of relative elevation; it provides an indication of whether any particular pixel forms part of a positive (e.g., crest) or negative (e.g., trough) feature of the surrounding terrain.

The distribution of wave energy along the continental shelf was calculated using hydrodynamic numerical modelling. Wave analysis was undertaken assuming deep water conditions (off the continental shelf). The most representative cases were simulated and waves were propagated up to the coast. Results were processed, subsequently to obtain the average wave flux per meter of width of the front along the coast. Thereafter, the average flux of wave energy within the first meter over the seafloor was calculated to obtain the wave influence on the seafloor. The grid of energy distribution was integrated into ArcGIS 8.1, at 400 m resolution.

High-resolution orthophotographs were used to identify and classify the supralittoral, intertidal and first 5-10 m of the subtidal habitats. Habitat classifications were made using 0.25 m resolution airborne photographs taken in 2002, 2004 and 2006 by the Environment and Territory Management Department of the Basque Government.

Terrestrial DTM of 1 m resolution of the Diputación Foral of Gipuzkoa (2005) was extracted from airborne LIDAR data. Terrestrial DTM and seafloor DTM were integrated into the GIS as ancillary data for intertidal and marsh habitat mapping.

Biological data was gathered from other studies done in the same study area. Information concerning species presence, species richness and biomass was used for alter analysis.

4.10.3 Results

399 km^2 of sublittoral area has been already mapped with multibeam sonar. This area corresponds to all the inner continental shelf of the Basque continental shelf between 5 and 50 m depth. At present survey will continue in order to reach 100 m depth.

Eleven habitat types have been identified (including natural and artificial ones) and linked to EUNIS, reaching up to level three and four of the classification. Three of the identified habitats are considered to be of Community interest: 1110 sandbanks which are slightly covered by sea water all the time, 1160 large shallow inlets and bays and 1170 reefs.

In coastal zone, habitat maps have been derived from orthophotography from years 2002 and 2004, covering ca 78 km^2. Fifteen coastal habitats were identified; four of them are of Community interest:

- Estuaries (in this case, the habitat includes several classes);
- *Spartina* swards;
- *Salicornia* and other annuals, colonising mud and sand (in this case, these two latter habitats are joined with *Phragmites* saltmarsh);
- Fixed grey dunes, which is, moreover, labelled as a priority habitat.

One hundred and twenty-two polygons have been validated (i.e. 8%) to evaluate the reliability of the habitat map. The user's and producer's accuracies were higher than 75% for all of the classes, and the mean values were 98.3% and 97.4%, respectively.

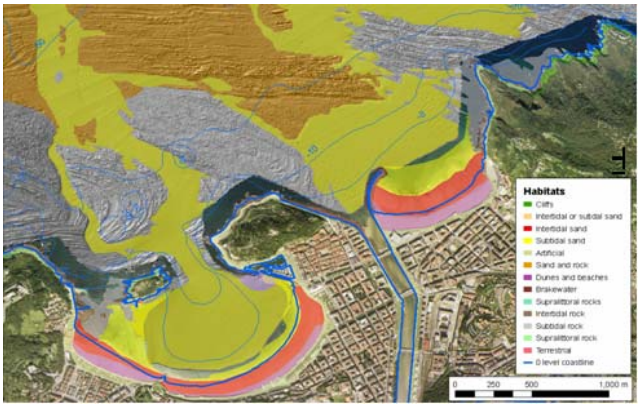

Figure 4.8: Map of the marine and intertidal habitats of La Concha beach (San Sebastián). Orthophotography corresponds to non-classified and terrestrial zones. Bathymetric levels (in m) and the coastline are shown using blue lines.

On the other hand, habitat changes were analysed using 2002 and 2004 orthophotography series. The main changes which occurred along the coast during this period were 32.3 ha of artificial land gained from tidal waters, an increase of 18.9 ha in unvegetated sand; and an increase of 9.9 ha in saltmarshes. Conversely, there was a loss of 24.8 ha of intertidal sediments and 31.6 ha of tidal waters.

At present, the 2006 orthophotography series is being processed in order to analyse any other habitat change or displacement.

LIDAR topographic information has been used to extract the "0" level coastline, and LIDAR height and intensity together with multi-spectral imagery has been used for coastal and estuarine automatic habitat classification. A new paper has been recently published with these results (Chust *el al*. 2008[14]).

In the near future, BathyLIDAR survey is due to be used in Gipuzkoa territory. The main aim of this work is to link multibeam sublittoral digital elevation model and terrestrial LIDAR digital terrain model. This information will be a valuable source of information to get a continuous coverage marine and coastal habitat map.

4.11 Sweden

Within the Interreg IIIB project BALANCE (2005-2007), Sweden has been involved in both the landscape mapping at a Baltic Sea scale as well as habitat modelling in Skagerrak and in the northern Baltic Proper. In the BALANCE landscape mapping, Baltic-wide maps of salinity, photic depth, and surface sediments were combined to produce the marine landscape map. In addition to these maps, layers of bed shear stress, slope, temperature, ice cover etc were also collated for the whole Baltic Sea region. In the landscape mapping, data from the national marine geological survey programme of the Swedish Geological Survey on sediment composition was used. The national geological survey programme works towards making high-resolution maps of the sediment composition within the whole Swedish EEZ, by using single beam echosounder, side-scan sonar, sub-bottom profiling, seismic reflection, cores, grabs, video and photography.

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[14] Chust, G., I. Galparsoro, A. Borja, J. Franco, and A. Uriarte. Coastal and estuarine habitat mapping, using LIDAR height and intensity and multi-spectral imagery. Estuar. Coast. Shelf Sci. (2008), doi:10.1016/j.ecss.2008.02.003

Bathymetric mapping is being performed by the Swedish Maritime Administration. Besides the mapping work using modern techniques they also run a project where 80-150 year-old bathymetric maps are digitised. These old measurements have a high spatial resolution (20-50 m), and are thus still the best data available for many areas. The maps also include data on surface sediments, which are useful for habitat mapping purposes. The applicability of these bathymetric and surface sediment maps will be tested in habitat modelling projects.

A national survey of Swedish offshore banks, involving mapping of geological, hydrological and biological features was conducted in 2003-2005. These data are now being used in several habitat modelling initiatives involving benthos and fish led by the Swedish Environmental Protection Agency and by the Swedish Board of Fisheries. In 2008 a second step of the national survey of Swedish offshore banks is initiated, and will continue until 2009. The survey will involve sampling of geology, zoo- and phytobenthos, birds and fish. Habitat modelling will be conducted for the most important habitats and species.

Modelling of Natura 2000 Annex I marine habitats has been performed for the whole coast of Sweden. The analysis is based on morphometric GIS modelling, aiming to define borders of specific Annex I habitat in coastal areas. These maps will be used for designation of new sites or to adjusting boarders of existing Natura sites.

Sweden has a strong profile in habitat modelling. Many projects developing methods for modelling of habitats for vegetation, zoobenthos and fish are running. The Swedish Board of Fisheries has, as part of the BALANCE project, modelled recruitment habitats for a number of important coastal fish species in a 30,000 km^2 archipelago region between Sweden and Finland. These high-resolution maps have been used for evaluating the connectivity and coherence of the Natura 2000 network in the region.

Several other fish habitat modelling projects are also running, identifying essential habitats for among others juvenile flatfish and cod as well as a number of crustaceans. Habitat modelling of vegetation and zoobenthos has, besides for the offshore banks, been performed for several coastal areas. The maps will primarily serve to identify areas that are sensitive to habitat disturbance, and will be used in marine spatial planning. There is a strong emphasis on methodological development in the habitat modelling projects.

Work has also been initiated to adapt the EUNIS habitat classification system to the Baltic Sea environment. Issues that are being considered are how to include effects of salinity, as this is one of the major factor governing the distribution of species in the Baltic Sea area, as well as how to take into account the variable surface sediments that are found in areas with moraine deposits where wave exposure is an important factor structuring the benthic community.

Sweden has vast coastal areas of very shallow water (<5-10 m), which are difficult to map using conventional ship-based methods. To investigate how remote-sensing methods may be employed in this work, several pilot studies using satellite imagery and LIDAR for mapping of coastal habitat features are being conducted. The satellite-imagery studies utilise SPOT5 and QuickBird images for identification of water depth, vegetation and turbidity. The LIDAR studies use primarily HawkEye II for mapping of water depth, vegetation and habitat complexity. Both the satellite imagery and LIDAR studies show promising results.

The Swedish government has pointed out the importance of mapping and describing the marine environment along the Swedish coast. An initiative has been taken that

will lead to detailed mapping of four pilot areas, and coarser descriptions of habitat building species distributions along the coast. In the pilot areas map layers of bathymetry, sediments, benthic species and fish will be produced. Also cultural layers describing ship-wreck locations will be produced. All layers may be used for management, but will also be provided to the public at a website.

4.12 UK

Matt Service (AFBI) presented work on Project 0431 *The Sensitivity of Benthic Habitats in NW Irish Sea and Malin Shelf*. This project includes the AFBI contribution to the MESH project. During 2007-08 survey work largely concentrated on multibeam activity in the North Channel between Ireland and Scotland. Two study areas are being investigated in detail in collaboration with the University of Ulster; Pisces Reef complex, an area of rocky outcrops in the Northern Irish Sea mud patch, and Beaufort Dyke, a deep glacial trench in the North Channel. Examples were given in the integration of fisheries data (*Nephrops* burrow counts) with mapping projects and the use of mapping data in dredge spoil management and aggregate extraction.

David Connor (JNCC) provided maps (Figures 4.9 and 4.10) of JNCC's offshore survey programme which aims to identify potential sites (SACs) for Habitats Directive Annex I habitats.

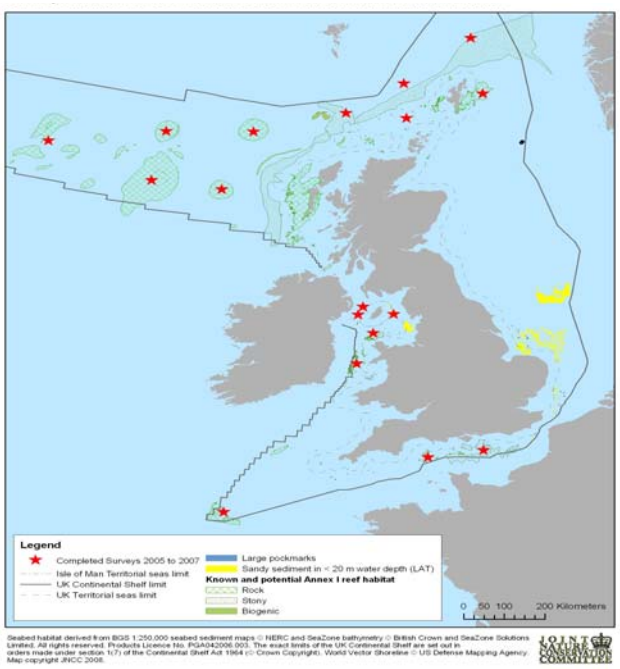

Figure 4.9: Study areas for Annex I habitat survey in UK offshore waters: 2005-07 (stars) (source: JNCC).

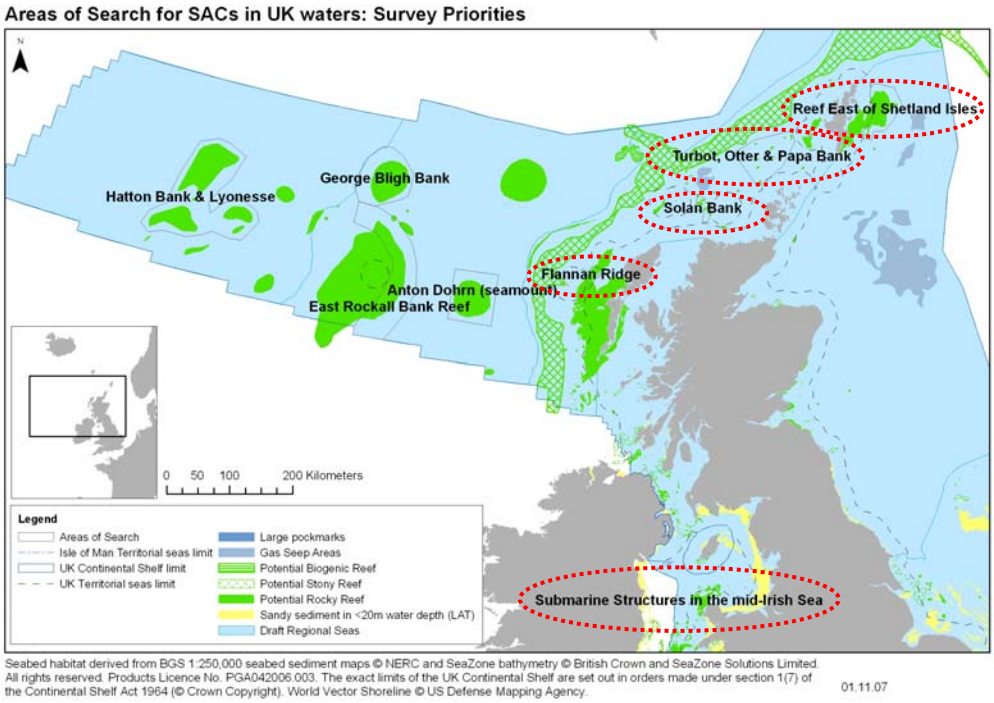

Figure 4.10: Study areas for Annex I habitat survey in UK offshore waters: planned 2008-09 (ringed) (source: JNCC).

4.13 USA

Tom Noji (NOAA) submitted a report prepared by Stephen Brown, James Thomas and Vincent Guida on mapping programmes in the National Oceanic and Atmospheric Administration. Sara Ellis submitted a report on the Gulf of Maine Mapping Initiative (GOMMI). These reports are given at Annex 7.

4.14 Improving access to National Status Reports

WGMHM has been compiling National Status Reports (NSR) each year in a tabulated format and including these as part of its annual report to ICES. This reporting format is considered to have two limitations, namely the information remains hidden within the WG report rather than being widely available (e.g. via a web portal) and secondly, the reports do not build, year on year, into a compiled catalogue of mapping studies.

The NSR format, in spite of recent standardisation improvements (a modified format with provision of digital GIS shapefiles to show the location of each study), falls short of showing the current situation of habitat mapping across the ICES geographic area. Such status reports are important to support claims for funding at national level or to establish statistics for e.g. the European Marine Strategy.

There appears to be no other group or website concerned with displaying the status of marine mapping programmes across the ICES area. This role could be further developed by WGMHM. It was noted that ICES appear to have limited capacity at present to handle web-based GIS data.

The MESH webGIS (www.searchMESH.net/webGIS) offers a possible candidate repository for the WGMHM metadata and GIS study area shapefiles, as it is already designed to handle such data. It would require additional work at the host institute (JNCC) to accommodate the much larger geographical concerned, and developments to allow sorting by study types (e.g. habitat map, bathymetry, video) and computing

of statistics on them (coverage by study types within each national territory). There should be two items in the status report; firstly the current situation and secondly the progress made over the last year as an illustration of how active each country is.

It was noted that the NSR should convey the right messages to decision makers, by not presenting an over optimistic view of the extent of high quality habitat mapping coverage.

In collating metadata on mapping studies, WGMHM considered it should focus on habitat (both pelagic and benthic) and substrate maps (the latter being very closely related to habitats), as other metadata catalogues focus on other types of marine data; there was no desire to duplicate such effort.

On the basis of the above considerations, WGMHM recommended that:

- JNCC (UK) should be approached to consider if they would host the NSR metadata and study area shapefiles for WGMHM on the MESH webGIS, which would require an expanded geographical scope and harmonisation of metadata DEFs (Data Exchange Formats). The affiliation to ICES work could be demonstrated by including the ICES logo on the MESH site.
- WGMHM members compile and update their metadata records from previously submitted NSR reports, into an agreed DEF, together with a supporting GIS study area polygons, in time for the 2009 meeting.
- Consideration should be given to the longer term need for a European portal for marine mapping data, in the context of EU developments on marine data infrastructures, such as WISE-marine proposals.

5 Mapping strategies and survey techniques

Review and assess recent advances with marine mapping techniques for habitat mapping (for example, developments in multibeam backscatter analysis, and in LIDAR) (**ToR d**).

5.1 Multibeam calibration with video

Alain Norro (Belgium) presented a paper entitled "Multibeam retrodiffused signal calibration using video images and *in situ* measurement of sand thickness on the hinderbank zone of the Belgian continental plate". The importance of targeted ground truthing for each acoustic class was stressed. Examples were given of how varying levels of sand thickness on hard substrate can skew the interpretations of the acoustic data. An example was given of how a habitat, apparently represented by one acoustic class, varied biologically due to a section of seabed being "protected" from trawling due to the presence of a large sand bank. The area not subjected to trawling contained a much higher coverage of exposed boulders and epifauna.

5.2 Bathymetric LIDAR

Jacques Populus (France) gave a detailed presentation on the principles behind the operation of bathymetric LIDAR along with some of the basic limitations of the system.

In practise LIDAR can measure depth to -+1 m, although manufacturers may claim higher levels of resolution. Data quality can be affected by water surface characteristics, principally water column turbidity. Water column penetration is normally limited to 3 times secchi depth. This will be an important limitation in certain inshore

environments and the importance of timing surveys to match the best conditions was stressed. Depth measurements may become compromised by the presence of erect vegetation, such as kelp forests or sea grasses, which provide false bottom signatures. Some general guidelines for surveys were proposed, such as avoiding certain lighting conditions and working at low tide during neap tides to maximise depth range and minimise tidal stirring of sediments. It was suggested that flying at night time may be best; however, it was acknowledged that civil aviation regulations might prohibit this.

The output from a number of studies was presented where topographic LIDAR, bathymetric LIDAR and multibeam bathymetry were combined. A bias between the multibeam system and the hydrographic LIDAR of a mean difference of 0.6 m was detected. LIDAR was able to confirm the presence of a uniform coverage of sea grass although kelp returned a more complex signal. Rocky substrata were delineated from soft sediment habitats using the GIS tools to measure slope and aspect of the bathymetry. Although to date LIDAR was mainly being used for depth measurement there is development work underway to provide a back scatter analysis procedure. Problems exist in calibrating the response of the system to particular physical units.

5.3 Video analysis

No formal presentations were made on this topic but papers were submitted by Sergej Olenin[15] (Coastal Research and Planning Institute, Klaipeda, Lithuania) and Paulo Fonseca[16] (IPIMAR, Lisbon, Portugal). The former used video editing software to capture frames from video transects with analysis done on a "quadrat" system. The Portuguese system uses automatic image analysis to count *Nephrops* burrows in real time during surveys. This technique has been demonstrated for potential use in *Nephrops* stock assessment studies.

A video presentation on the Norwegian Mareano Project led to useful discussion on approaches to video analysis. The relative merits of species counts over time versus distance were discussed, recognising that although recording by time may be logistically easier, results should preferably be presented as counts per unit area.

5.4 Habitat modelling techniques

This section is based on discussions in a sub-group comprising, Ulf Bergström, Jennifer Dannheim, Margaret Dolan, Kerstin Geitner, Martin Isæus, Alain Norro, Mara Schmiing, Fernando Tempera and Wouter Willems.

5.4.1 Going from biological point data to full coverage maps

Maps based on direct field sampling typically have high biological accuracy but provide data sets with only partial coverage, usually in the form of point data. Direct mapping with total coverage is economically unfeasible at larger scales in the marine environment, except for remote sensing of some biological features in shallow waters, because an extensive amount of data collection and analysis is required. Full coverage maps are preferable for efficient use in marine spatial planning. To go from biological point or transect data to full coverage maps, different interpolation and

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[15] Bučas, M., Daunys, D., & Olenin, S. 2007. Overgrowth patterns of the red algae *Furcellaria imbricalis* at an exposed Baltic Sea coast: the results of a remote underwater video data analysis. Estuarine Coast & Shelf Science,**75** (2007): 306-316.

[16] Correia, P.L., Lau, P.Y., Fonseca, P. & Campos, A. 2007. Underwater video analysis for Norwegian lobster stock quantification using multiple visual attention features. EUSIPCO, 1764-1768.

modelling approaches can be used to predict the distribution of species and habitats beyond that of the observed data. Three basic approaches for increasing the spatial coverage are: 1) spatial interpolation, 2) criteria analysis and, 3) statistical modelling. According to Bergström *et al*. (2007), the three approaches can be described as follows:

5.4.2 Spatial interpolation

The term interpolation refers here to spatial predictions that are based only on information available in the response variable itself at its spatial positions. Thus, predictions are made in geographic space, rather than considering properties of the ambient environment. Spatial interpolation techniques are based on the assumption that adjacent sites are spatially auto-correlated, which means that a variable at one site is more likely to have the value of an adjacent site than that of a more distant site.

Methods for interpolation are based on mathematical functions that may be defined as either exact or approximate. Exact methods preserve the values of the input data, while approximate methods produce smoother surfaces.

For biological data, approximate methods are often more appropriate, because they may account for local uncertainties in the input data. Common approximate methods for interpolating point data are inverse distance weighted averages, trend surface analyses and kriging, all of which are usually implemented in common GIS software.

Interpolation may be useful for producing layers of environmental data, such as estimating the probable depth or salinity in unsampled areas. For biological data, interpolation may be used for generalising the distribution of species at large, regional scales. At small scales, interpolation may be motivated when the environment is non-patchy with respect to the habitat demands of the species.

5.4.3 Criteria analysis

In criteria analysis, spatial predictions of the occurrence of a response variable are made in relation to a set of categorical (nominal or ordinal) layers of environmental variables. The environmental layers are arranged on top of each other, and combined to one layer where all possible combinations of the input layers are represented. The occurrence of the response variable within each combination is then defined from its observed frequency in field samples from corresponding environmental settings. For example, combinations of bottom substrate and wave exposure that correspond to certain abundances of a particular species may be identified.

The environmental layers should have full coverage and data for the response variable should be collected so that the relevant environmental gradients are covered. Although the procedure is basically non-statistical, the relevance of the output increases if the layers and categories applied are properly statistically defined and known to be relevant for the distribution of the response variable.

Criteria analyses are easy to apply and to communicate. Robust results can potentially be achieved, but the accuracy of the prediction may be low unless a high number of classes are defined within each layer. Thus, the procedure may require large amounts of data processing, especially when predicting the distribution of individual species and when a large part of the environmental data is originally in continuous data format.

5.4.4 Statistical modelling

The statistical modelling approach is referred to by a number of different terms, such as habitat modelling, habitat suitability modelling, spatial predictive modelling and species distribution modelling. Statistical modelling is technically more demanding than interpolation methods and criteria analysis, but may provide a way of utilising more (or all) of the information available on the relationship between predictor and response variables. The output is numerical, for example the abundance of a species, or the probability of finding a certain species or life-stage at a site may be estimated.

Predictions are based on a mathematical function describing the relationship between the response variable and relevant environmental variables. This function is then used to estimate the value of the same response variable at other sites based on existing information in environmental layers. The response variable should be represented by point data, and the environmental predictor variables must have full coverage over the area to be predicted. The environmental predictor variables should preferably be causally related to response variable and cover a gradient from the minimum to maximum for the response variable along each of the predictor variable gradients.

Table 5.1: Analytical approaches applied for producing full coverage biological maps.

Method	Coverage	Environmental data required	Data format
Direct mapping	Same as input data	No	All
Interpolation	Higher than input data	No (optional)	Continuous, Ordinal
Criteria analysis	Higher than input data	Yes	Ordinal, Nominal
Statistical modelling	Higher than input data	Yes	All

5.4.5 A general scheme for the modelling procedure

There are many different techniques for performing statistical habitat modelling, but the general scheme for performing the modelling applies to all these statistical methods. Here we outline these general steps, and point out a few important points to consider in each phase. The steps are: 1) Definition of model purpose, 2) Data collection, 3) Data exploration, 4) Model construction, 5) Model validation, and 6) Application.

1) Definition of model purpose

A clear definition of the purpose of the model should be formulated to focus modelling efforts correctly. The original purpose of the model should preferentially always accompany the map prediction to avoid misuses.

2) Data collection

Gathering a representative sample of both your response and predictor variables is crucial for successful modelling. The sampling scheme should cover the whole gradients of all important predictor variables, to ensure that the models constructed actually capture the important relationships between the species and its environment. In the modelling, the goal is to use causal predictors. In many cases though, it is necessary to use proxy variables, which only are only indirectly relevant. The use of proxy

variables may still produce powerful models, but the mechanistic understanding of the processes suffers.

3) Data exploration

Select the datasets that are suitable for the modelling you are aiming at. Many predictor variables are available at too coarse spatial scales to be useful for species distribution modelling. One problem of the predictor variables may be that the quality of input layers is often not known.

4) Model construction

Many kinds of statistical methods can be used for describing species-environment relationships. The major methods are outlines below, under "Statistical modelling methods". There are some inherent assumptions in the modelling, such as:

- species occupy its realised niche (today most fishes are found in areas that are most difficult to fish, not in the most suitable habitats)
- proxies are often used instead of the actual variables governing the distribution of the species
- no barriers limiting dispersal within the extent of the sampled area

Issues related to model construction are for example that the resolution of the predictor variables is often coarser than would be desirable from an ecological point of view, how to choose predictor variables to be used in the model, and the risk of over fitting the model.

5) Model validation

Model validation is a crucial step in the modelling procedure. Your predictor variables are often erroneous, and we seldom know the magnitude of these errors. Model validation can be done either internally or externally, where cross-validation serves as an intermediate. Ideally model validation should be done on separate, independent dataset. In practice, you often do not have enough data to afford omitting parts of it.

In the model validation it is desirable with visualisation of the model response to the different predictor variables. Some methods, such as regression base methods allow for variance partitioning. This visualisation gives you a good understanding of how the species responds to the different variables, which may be useful for example in the planning of future sampling programmes.

6) Application

Once the statistical model is in place and there are full coverage maps of the predictor variables available, spatial predictions of habitat distribution can be made. Potential applications of these modelled habitat maps are found both in marine spatial management and in basic science:

- identification of sensitive areas
- delineation of MPA borders
- analysis of ecological coherence of MPA networks
- assessment of the effects of environmental changes. Scenario production
- exploration of ecological relationships: for example studies of competition and niche separation, assessment of habitat-productivity relationships

5.4.6 Statistical modelling methods

There are many different techniques for mathematically describing the relationship between the distribution of a species and its environment. The following overview of methods is found in Bergström *et al*. 2007: The simplest way of describing the relationship between predictors and the response variable is multiple linear regression, while generalized linear models (GLM) and generalized additive models (GAM) are more technically complex, these being more flexible and better suited for describing non-linear relationships (Guisan and Zimmerman, 2000; Guisan *et al*., 2002; Lehmann *et al*. 2002; Garza-Pérez *et al*., 2004; Francis *et al*., 2005). GAM has the advantage of high flexibility, as the response curves are not predefined but may be explored and fitted to observed response distribution along environmental gradients. This makes GAM potentially better suited for modelling the spatial distribution of species with asymmetrical or polynomial distributions, which are often observed in real data (Lehmann *et al*., 2002). GRASP (Generalized Regression Analysis and Spatial Prediction) is a statistical software for spatial prediction based on regression analyses (GAM) that is implemented as an interface and a collection of functions in the statistical software S-plus and R. It also has the advantage of being compatible with the GIS software ArcView 3.x.

In some cases other methods may be preferred. For example classification and regression trees (CART) are more suitable for modelling interactions, although it does not allow observation of response shapes and is restricted to assuming Gaussian distributions (Lehmann *et al*., 2002). Another flexible modelling tool is artificial neural networks (ANN), which has the advantage of providing a way of modelling assemblages of species, as several response variables can be modelled simultaneously (Brosse *et al*., 1999; Lek and Guégan, 1999; Joy and Death, 2004). In datasets with many zero values in the response variable multivariate analytical models such as Canonical correspondence analyses (CCA), may be more appropriate than models of individual species (Austin 2002). As an alternative, the included data sets can be cut down to only represent the realized distribution of the response variable (Lehmann *et al*. 2002), or a "presence only" approach can be applied, using only the sites where the species is present (Zaniewski *et al*. 2002).

5.4.7 Current challenges in habitat modelling

Marine habitat modelling is a field in an intense expansion phase. The knowledge base is still not very wide, and many central questions of a technical nature are to be solved. Some of the most pressing challenges are issues related to:

- Spatial scaling: different variables are important when the resolution and extent is changed. General patterns of the characteristic scales of different governing variables should be explored.
- Inclusion of biological interactions in the models.
- Ontogenetic shifts in habitat preference, density-dependent habitat preference, disturbed distribution of fishes due to fishing.
- Validation techniques: cross-validation and external validation.
- Methods for modelling of species assemblages and communities.
- Modelling of patchy distributions, mobile organisms, schooling species.
- Auto-correlated data.
- Techniques for handling of outliers.
- Dynamic spatial modelling.

- Access to high-resolution data as predictor variables: discrepancy between resolution of data gathered in physical surveys and resolution needed for relevant biological modelling.

It is hoped that some of these issues can be discussed at future WGMHM meetings. To speed up progress in this field, collaboration between the few research groups active in marine habitat modelling should be intensified.

5.4.8 Network for marine habitat modelling

Currently there are no internet-based discussion groups for marine habitat modelling. Martin Isaeus (Sweden) has offered to start an informal discussion forum at the AquaBiota Water Research home page, including profiles of people involved in habitat modelling. The coming forum will be advertised at the 2008 GeoHab meeting, and posted at other related internet-based discussion fora.

5.4.9 References

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5.5 Modelling wave exposure for habitat mapping

Exposure to wave action provides a critical influence on coastal habitats, having a significant influence on rocky habitat types and strongly influencing the nature of sediment types and hence soft-bottom communities. The value of having biologically-

relevant wave exposure models to feed into habitat modelling was recognised by WGMHM. Martin Isæus (Sweden) presented an overview of different wave exposure models and showed how these had now been developed for large parts of Norway and the Baltic Sea. The models were fetch (wind) or oceanography (wave)-based applications. Each needed validation against species and habitats to develop biologically-valid exposure classes. Whilst the fetch-based models were well developed and validated for intertidal rocky habitats, further work was needed for the wave-based models for application in the subtidal zone.

6 Protocols and standards for habitat mapping

6.1 Guidelines for habitat mapping

Review and critique guidelines for habitat mapping, including the MESH Guide to Habitat Mapping and those developed under other relevant initiatives. Identify critical gaps in the guidance available (**ToR f**)

WGMHM noted that the MESH Guide to Marine Habitat Mapping had recently been made available on-line (www.searchMESH.net/mapping-guide) and that a summary publication of it had just been released. The Guide was also now available in French. Due to the very extensive nature of the Guide, it was not possible for the WG to undertake a thorough review; however the Guide was considered to provide a valuable tool for technical and non-technical readers with an interest in marine habitat mapping. The WG had reviewed a set of draft Recommended Operating Guidelines at its 2007 meeting and consequently focused on critical gaps in these. The following ROGs would be worth producing:

- Sub-bottom profiling (boomer, pinger, sparker)
- *In-situ* survey (intertidal, diver)
- Coring (other than box coring)
- Grabs

6.2 Accuracy and confidence in habitat maps

Further develop approaches for the assessment of accuracy and confidence in habitat maps, through the assessment of selected habitat maps and their associated reports/metadata, considering both the final maps and the survey design. (**ToR g**).

This ToR was addressed in a sub-group consisting of Ulf Bergström, Margaret Dolan, Kerstin Geitner, Martin Isæus, Jacques Populus and Wouter Willems.

6.2.1 Why assess accuracy and confidence?

As maps are being used more and more as the basis for marine management, some measure of confidence is necessary. Nowadays, confidence is seldom reported in published maps, and rarely included in software. Uncertainty assessment should be part of the mapping procedure and accompany the maps in the form of metadata. Users should be informed about the limits when the information on the map is applicable. Ideally the confidence assessment should be assessed for the initial map with its full content using the method designed by e.g. the MESH project[17]. What could be

[17] MESH Project. 2008. *MESH guide to habitat mapping*. Joint Nature Conservation Committee, Peterborough, UK.

done is to publish one or two successive generalized versions of the map, with a view to serving the needs of different users (e.g. decision makers). Confidence would then be re-assessed for these versions. As such each user group can use maps with a specific information level: detailed data for scientists and simple, easily interpretable maps for decision makers.

6.2.2 Some definitions

Error: implies knowledge about differences between observations and the map.

If error was exactly known, we could compensate for it. Some of the most common errors encountered in habitat mapping and modelling are listed below:

- Classification (e.g. pixel in wrong EUNIS class)
- Generalisation (classes too broad, much variation within class)
- Measurement (error on depth measurement, usually random error)
- Positional accuracy
- Interpolation (local residuals)
- Data age
- Systematic error (e.g. nautical charts always to deep)

Uncertainty: lack of such knowledge of the error

Confidence can be considered as the opposite of uncertainty. The confidence of a map is relative to its 1) purpose (MESH, 2008), 2) scale and 3) information content.

MESH (2008) defines confidence as an assessment of the reliability of a map against its purpose. It is subjective and may involve a judgment of the relative importance of many contributing factors, such as information content, how near the map is to reality, how relevant to the purpose and so on. When zooming in on a map beyond the scale of the original data, the confidence can drop significantly as the details observed may be just noise in the data. The information content is often inversely related to model confidence. Comparing bottom type maps based on the same sample points, the map with less categories will have a higher confidence as prior probability of attributing a pixel to the right category just by chance, is higher.

Accuracy is defined by MESH (2008) as the result of a validation: predictive power of a map to represent the world as measured against reality.

Validation is the comparison of a map or model against the truth, represented by some data collected for the purpose of validation. The map should be validated at the same scale as it is shown.

Error propagation: keeping track of the error in original data through the whole process. Identify the contribution of each input variable to the total error/uncertainty (see below).

6.2.3 Error propagation

A whole science has been developed in the field of GIS on the error propagation when geographic operations are performed on input variables (Heuvelinck, 1998[18]).

[18] Heuvelink G. 1998. *Error propagation in environmental modelling with GIS*. Taylor and Francis, London.

Mostly these approaches start from the assumption that the error on the input variables is known and spatially invariant.

Simple example:

If error is known per variable, the mathematical rules of error propagation can be used (formula 1).

$x \pm error\_x + y \pm error\_y = c \pm error\_c$ (1)

Model development

In model development of species/community distributions we use two kinds of data: environmental data and species/community observations (formula 2). Both carry their own error.

model(Var.1 ±error_1 env. Var.2±error_2)= Pred ⇔ obs ±error_ (2)

So the estimates of the model parameter can be influenced. The error on the environmental data will mostly be a random measurement error, which is thus not expected to introduce a bias. Species/community observations tend to be biased towards absences. In a suitable habitat the species is often not observed, which can introduce a bias. This could lead to a prediction of a lower amount of suitable habitat.

Remarks

- Positional accuracy responds differently to other errors, as it will not add up, but can give mismatch based in wrong positioning.
- The error on derived products such as slope, aspect calculated from a Digital Elevation Model decreases as spatial autocorrelation of the original data increases.
- Some of the newer multibeam software (Caris, Fledermaus, Qinsy) can calculate error propagation, based on the error on the sound velocity, ship positioning, gyro system and multibeam. This calculated error is however seldom reported to end users.

6.2.4 Methods to estimate and visualize error/ confidence

In any map, it is always good advice to plot the original data points, so the end-user can visually assess the distribution and density of the original data. However, local data density is relative to the local variability of the seabed; in highly variable areas you need higher data point coverage to have a similar accuracy then in a more uniform area. Below, some methods are provided that could estimate and visualize the error per mapping methodology.

Map derived from GIS operation (e.g. Marine Landscape map)

The confidence in this type of map could be visualized by showing the map production step in a flowchart, so users can get insight in the step that might generate errors. Error propagation as mentioned above can be applied if the error per input layer is known.

Map grid (e.g. annual chlorophyll from satellite data)

If a grid is produced by aggregating measurements per pixel, the number of data points per grid pixel and their standard deviation gives some insight into the (local) confidence per pixel.

Interpolated map (e.g. DEM)

The local error after geostatistical interpolation can be visualized by showing a (separate) map with the spatial residuals. This is relevant for averaging spatial interpolation methods.

Model (e.g. habitat suitability model)

Model validation can be regarded as a special case of confidence assessment. In the field of modelling, users expect that a model is an approximation of reality and some uncertainty will always remain. Validation of the end product, should overrule all discussion of accuracy in underlining layers.

Several techniques are developed to quantitatively estimate the global model error. This is ideally done by comparing the model predictions against observations in a different region then where the model training data were collected (external validation, see ToR d discussion on Habitat Modelling). If such a data set is not available, the original training data can be split into a training and test set to iteratively estimate the models predictive performance (cross-validation). The result of the validation is a global predictive performance of the model and a local residual per predicted sample, for which an observation is available. Because of spatial autocorrelations in the data set, samples to train and validate the model will be more similar then external samples. Using the same data set will thus overestimate the model performance and thus confidence. Some publications provide confidence intervals on habitat suitability (Burgman *et al.*, 2001[19]) which can be plotted on maps.

6.2.5 The MESH confidence assessment tool

A critical assessment of the MESH Confidence Assessment Tool (MESH, 2008) was undertaken. This is a specific tool which provides an overall assessment of a habitat map, based on the quality of its input remote-sensing and ground-truthing data and on the quality of the data interpretation to derive the final map. It was developed to enable an assessment of large numbers of maps collated from a wide range of sources (and hence qualities). The assessments for remote-sensing, ground-truthing and map interpretation are summarised as three scores and from this an overall confidence estimate is derived. The confidence ratings (in one of five classes) are presented on the MESH webGIS as a compiled confidence data layer (i.e. for all the maps assessed), each supported by the detailed assessment. WGMHM considered the tool to be very useful as it forces the mapper to think critically about the base data and final map.

Some remarks that could lead to improvement in the MESH tool:

- Only benthic habitat mapping is currently included; it would be useful to introduce an assessment of confidence for pelagic species maps and pelagic habitats maps (e.g. distribution of fish or marine mammals).
- It's suitability for use on maps derived only from biological sampling was queried. Does it assume that biological samples are always collected based on the physical maps? Biological samples are quite often not collected for the purpose of habitat mapping, but compiled opportunistically.
- In one single map, several mapping techniques could be used, especially in the coastal environment (e.g. LIDAR, diver survey, multibeam). Each sub-

[19] Burgman, M., Breininger, D., Duncan, B., & Ferson, S. 2001. Setting reliability bounds on habitat suitability indices. *Ecological Applications*. **11**:70-78.

area of the map could be assigned its own confidence score, depending on the suite of techniques used, which would convey a more reliable confidence across the map to the user.

- One of the main assumptions of the tool is that it deals only with metadata elements. This is a practical solution, but will give not as accurate a measure of confidence as a true validation using a validation data set.
- Biological ground-truthing technique. The methodology is relevant to the sediment type: for a sandy environment a grab sample can reveal more information than an ROV or diver. The division between soft and hard substrata is not always clear. One definition of hard substrata could be that the rock is immobile.
- The assumed role of biological ground-truthing data could be clearer. Biological data appear to be used for creating the habitat maps by assigning pixels to a habitat class, but are later then used to ground truth this habitat classification? Or alternatively did the developers of the tool assumed that biological data are collected after and based on the remote-sensing data? But often biological data for ground-truthing are compiled more opportunistically, using data not collected for the purpose of habitat mapping or modelling.
- In the ground-truthing, if one habitat class is not sampled, the whole map is deemed poor, rather then asking if the ground-truthing samples are well distributed between the habitat classes.
- Regarding data age (vintage), the question is raised if the age of the data is a good proxy for confidence. An alternative question could be "Is the age consistent for all data?" or more detail could be asked about the techniques used.
- The division between remote sensing/ground truthing and map interpretation seem to be artificial.
- There is no possibility to state that modelled data were used. Modelled data carry their own error, which is often quantified by means of model validation. One option would be to replace "remote-sensing" with "model" and "ground-truthing" with "validation data set".
- Subjectivity in the drawing of the polygons by the interpreter is not captured in the tool. Delineation errors (exact position of the border between polygons) are not covered in the confidence assessment tool.
- Something that seems to be missing in the MESH tool is the following item: "Are metadata properly filled in?"

6.3 Discovery and survey/method metadata standards

Review progress in the development of 'discovery' and 'survey/method' metadata standards for marine habitat mapping, illustrated with worked examples (e.g. from MESH) and assess whether these are suitable for wider application. (**ToR h**).

The WG examined the metadata standards developed by the MESH project, which included both habitat map metadata and survey metadata. The latter were created along with the Recommended Operating Guidelines (ROGs) to encourage best practise in running surveys.

6.3.1 Metadata for surveys and mapping techniques

The MESH project had developed a generalised scheme for organising information during mapping surveys applicable to any mapping endeavour. It includes levels for programme, survey, area and site through to sample and replicate levels. For each of these levels, a metadata sheet is provided (www.searchmesh.net/Default.aspx?page=1746). The whole metadata system has been developed into a standalone Access database, which can capture all metadata requirements for a survey and encompass each of the many mapping techniques currently in use, offering scrolling menus to ease their capture.

WGMHM considered the metadata system offered a comprehensive approach to capturing metadata across a series of techniques, enabling a logical and integrated set of metadata to be captured for each survey. The system also allowed the required metadata to be collated for each dataset arising from a survey, thus facilitating its archiving or transfer to third parties for onward use.

WGMHM **recommended** that the survey metadata system be tested by members during the forthcoming year. The Access database would be made available to members for them to populate and assess during the surveying season. Feedback should be given on:

- the relevance/completeness of the metadata fields (along with correctness of menus), and
- on the general ergonomy of the database. As the database in its current form is a stand-alone system, it does not have the advantage of linkages to position fixing equipment on survey vessels which could significantly improve the efficiency of data entry.

Feedback on its use should be collated and presented to WGMHM 2009.

It was noted that the Marine Institute had already developed a live connection between the survey meta-database and the multilog system on board its ships.

6.3.2 Metadata for habitat maps

A sub-group explored the metadata catalogue on the MESH webGIS application to assess its usefulness in portraying essential information about the habitat maps. The following general comments were made:

Some vagaries were identified, e.g. the metadata records for an original habitat map, a translated habitat map and a study area outline show differing information. It would be preferable to have consistency in the information displayed.

The metadata format lacked a field to capture a confidence or accuracy assessment for the map; it was noted that ISO 19115 offers a section to report on map quality. As the MESH webGIS offers a confidence assessment for its maps, it would be useful to link this to the metadata record by adding an extra field (to view a given map's confidence score, the user has to query another mapping layer). If more detailed assessment techniques are developed in the future, these should also be reflected in the metadata record.

When querying a habitat polygon on the MESH webGIS, it would be helpful to be able to directly link to the metadata for the whole study and from here directly to the map's confidence assessment.

The metadata record should allow the possibility to trace back to all data sources that contributed to making a given map. In other words, a link is necessary between the

map metadata and the component survey metadata. The survey metadata, as explained above, relate to any level of a mapping programme and links could be created to any level relevant to the map in scope. This would allow links to be created to various data blocks recorded during several surveys, if this happened to be the case, as shown in the example below, where a given site was covered by three different surveys X, Y and Z:

- SSS data set A from survey X
- MBES data set B from survey Y
- Biological samples set C from survey Z

This would easily be achievable, provided another field was created in the map metadata sheet to contain all the links to the relevant survey metadata sheets.

7 Uses of habitat mapping in a management context

7.1 Habitat mapping in ecosystem-based management

Review a draft document which addresses the application of and needs for habitat maps in an ecosystem-based management context. (**ToR i**).

Chris Coggan (USA) and Brian Todd (Canada) had prepared an outline paper which was intended to be presented at the 2008 ICES Annual Science Conference. As they were unable to attend the WGMHM meeting, they sought input on three topics to contribute to development of the paper. The WG addressed the three questions asked by the authors regarding their manuscript on "The role of marine habitat mapping in ecosystem based management (EBM)".

Question 1 – Are there any examples from the WG of EBM tied to marine habitat mapping that we could use in the manuscript as a box text?

There are a number of examples of work being done towards EBM, where habitat maps are used in marine management, for example the work on offshore banks from Sweden, and the Norwegian part of the Barents Sea.

In Sweden there are a few examples where habitat modelling has been used for management purposes. The Large off-shore bank survey in 2003-2006 provided the basis for classifying the banks according to the EUNIS system as well as according to Natura 2000 habitats. Data from the surveys were also used for modelling species distributions on the banks, which was used for comparing them and describing their conservation values.

Another example is the Svenska Högarna Nature Reserve. Svenska Högarna is a group of islands and skerries in the outer Stockholm Archipelago. An extended diving survey was used as input for modelling of species and habitat distributions. The resulting maps were used in the process of making an MPA of the surrounding marine areas.

There are also some Norwegian examples where habitat modelling is used as a method for providing basic layers for marine spatial planning. Kelp forests and seagrass meadows were predicted in two coastal areas in cooperation with county administrations.

Question 2 – Is it fair to say (as stated by Ruckelshaus *et al*. 2008) that there are very few real examples of EBM?

True examples where EBM has been fully implemented over larger regions are hard to find. However, at small spatial scales there are several examples of EBM, for example the management of the blue mussel fishery in Limfjorden, Denmark. Also the CHARM (Channel Habitat Atlas for Marine Resource Management) project provides a good example of how habitat maps are produced for management purposes in the English Channel.

Question 3 – In your work involving MHM, what has been cited as the direct goal?

In general, habitat mapping for spatial planning purposes has gained more attention in the last few years. For example, the Common Fisheries Policy is now recognising habitat protection as an integral part of fishery management. The National Status Reports for each country include a column on purpose and can be readily examined to see the range of reasons why mapping studies are being undertaken.

Regarding the goals of specific projects:

BALANCE: maps and methods for mapping have specifically been produced for spatial planning purposes.

Swedish offshore bank survey: mapping and habitat modelling have specifically been performed to identify areas sensitive to wind-farm establishment and for identifying areas that need protection.

7.2 Habitat mapping and ICES science and advisory needs

Assess the role of the Working Group and its relationship to the needs of ICES science and advisory programmes (**ToR j**).

In response to a request in February 2008 to all Expert Group Chairs for input to the draft ICES Science Plan (2009-2014), the WG reviewed the draft plan in the light of its expertise in marine habitat mapping and provided a number of constructive comments on how the plan could be enhanced to better reflect the importance of seabed habitats in ecosystem management and research.

On the basis of these comments, the WGMHM Chair offered to provide a response to ICES on the draft plan.

The WG made the following general comments:

- The apparent shift in emphasis from fisheries management issues to wider ecosystem management issues was welcomed.
- However, there was concern that the effects of fisheries on seabed habitats were not sufficiently highlighted in the programme. It was not a priority topic, but the WG considered it to be the single most damaging influence on seabed habitats.
- Greater emphasis should be placed on deep sea habitats, as these remained very poorly understood.

8 Recommendations and Actions

8.1 Location for future meetings

Offers had been received from Kerstin Geitner (DTU Aqua) to host the meeting in Copenhagen, Denmark.

Following the agreement at WGMHM 2007, the following arrangements for meeting locations (subject to the hosts still being able in subsequent years) are recommended:

2009: Copenhagen, Denmark (Technical University of Denmark)

2010: St Andrews, Canada (Department of Fisheries and Oceans)

2011: Klaipeda, Lithuania (Klaipeda University)

8.2 Terms of Reference for 2009 meeting

A draft set of Terms of Reference for next year's meeting were developed and are given in Annex 8, whilst Recommendations and Actions from the meeting are given in Annex 9.

8.3 Recommendation for a new Working Group Chair

David Connor had chaired the group for six years and was therefore standing down, according to normal ICES guidelines. Matt Service, on behalf of the WGMHM, offered a vote of thanks for the leadership and guidance which David had shown over the past six years.

Following consideration of proposals, WGMHM gave their full support that Jacques Populus (Ifremer, France) should be recommended to be appointed as Chair for the WG for the next three-year period.

9 Adoption of the Report

The draft report and list of annexes was discussed by the Working Group before the close of the meeting. It was circulated to the participants for comment before finalising.

10 Close of Meeting

The Chair, David Connor, thanked Fernando Tempera, the Department of Oceanography and Fisheries, the IMAR Centre at the University of the Azores, Centro do Mar and project MARMAC II (Interreg IIIb/FEDER) for providing funding, excellent facilities and hospitality for the Working Group meeting. In addition he thanked the Rapporteurs and delegates for their considerable contributions which had made for a productive, interesting and enjoyable meeting.

Annex 1: List of participants

NAME	ADDRESS	COUNTRY	EMAIL
Ulf Bergström	Swedish Board of Fisheries, Institute of Coastal Research, Box 109, SE-740 71 Øregrund	Sweden	ulf.bergstrom@fiskeriverket.se
Dietmar Bürk	Institute for Coastal Research, GKSS Forschungszentrum, Max-Planck-Str. 1, 21502 Geesthacht	Germany	Dietmar.Buerk@gkss.de
Ana Colaço	University of the Azores, IMAR Centre, Department of Oceanography and Fisheries, Cais de Santa Cruz, PT-9901-862 Horta (Azores)	Portugal	acolaco@uac.pt
David Connor Chair	Joint Nature Conservation Committee, Monkstone House, City Road, Peterborough PE1 1JY	United Kingdom	david.connor@jncc.gov.uk
Jennifer Dannheim	Institute for Marine Research, PO Box 1870 Nordnes, N-5817 Bergen	Norway	jennifer.dannheim@imr.no
Margaret Dolan	Geological Survey of Norway, Leiv Eirikssons ve39, 7491 Trondheim	Norway	margaret.dolan@ngu.no
Kerstin Geitner	DTU Aqua, Department of Information Technology and Techniques, Charlottenlund Slot, DK-2920 Charlottenlund	Denmark	kjg@aqua.dtu.dk
Jorge Gonçalves	University of the Algarve, Coastal Fisheries Research Group, Campus de Gambelas, 8005-135 Faro	Portugal	jgoncal@ualg.pt
Martin Isaeus	AquaBiota Water Research, Svante Arrhenius väg 21A, SE-104 05 Stockholm	Sweden	martin.isaeus@aquabiota.se
Cecilia Lindblad	Swedish Environmental Protection Agency, Vallhallarägen 184, 10691 Stockholm	Sweden	cecilia.lindblad@naturvardsverket.se
Fergal McGrath	Marine Institute, Rinville, Oranmore, Galway	Ireland	Fergal.McGrath@marine.ie
Alain Norro	Management Unit of the North Sea Mathematical Models (MUMM), Belgian Royal Institute of Natural Sciences, Gulledelle 100, B-1200 Brussels	Belgium	A.norro@mumm.ac.be
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Ana Maria Rodrigues	University of Aveiro, CESAM (Centro de Estudos do Ambiente e Mar), Departamento de Biologia, Campus Universitário do Santiago, 3810-193 Aveiro	Portugal	anarod@ua.pt
Mara Schmiing	University of the Azores, Department of Oceanography and Fisheries, Cais de Santa Cruz, PT-9901-862 Horta (Azores)	Portugal	mschmiing@uac.pt
Matthew Service	Agri-Food and Biosciences Institute, Agriculture and Environmental Science Division, Newforge Lane, Belfast BT9 5PX	United Kingdom	matt.service@afbini.gov.uk
Fernando Tempera HOST	University of the Azores, Department of Oceanography and Fisheries, Cais de Santa Cruz, PT-9901-862 Horta (Azores)	Portugal	tempera@uac.pt
Wouter Willems	University of Gent, Marine Biology Section, Krijgslaan 281/S8, B-9000 Gent	Belgium	wouter.willems@UGent.be

Annex 2: WGMHM 2008 Terms of Reference

2007/2/MHC08 The Working Group on Marine Habitat Mapping [WGMHM] (Chair: D. Connor, UK) will meet in Horta, the Azores, Portugal, from 31 March–4 April 2008 to:

a) review progress in international mapping programmes (including MESH, EEA, OSPAR, BALANCE, HERMES, CHARM).

b) review the range of metadata and data portals available for marine habitat mapping, and assess how these systems could be integrated or enhanced to provide more coherent international access to mapping metadata and international maps.

c) present and review national habitat mapping activity during the preceding year, providing National Status Report updates according to the standard reporting format, an overview map, and focusing on particular issues of relevance to the rest of the meeting.

d) (presentations strictly limited to a 10 minute overview per country; posters are encouraged for supplementary information; national status reports to be circulated prior to the meeting; outline map of study areas in shape-file GIS format)

e) review and assess recent advances with marine mapping techniques for habitat mapping (for example, developments in multibeam backscatter analysis, and in LIDAR).

f) review and critique guidelines for habitat mapping, including the MESH Guide to Habitat Mapping and those developed under other relevant initiatives. Identify critical gaps in the guidance available.

g) further develop approaches for the assessment of accuracy and confidence in habitat maps, through the assessment of selected habitat maps and their associated reports/metadata, considering both the final maps and the survey design.

h) review progress in the development of 'discovery' and 'survey/method' metadata standards for marine habitat mapping, illustrated with worked examples (e.g. from MESH) and assess whether these are suitable for wider application.

i) review a draft document which addresses the application of and needs for habitat maps in an ecosystem-based management context.

j) assess the role of the Working Group and its relationship to the needs of ICES science and advisory programmes.

WGMHM will report by 25 April 2008 for the attention of the Marine Habitat and the Fisheries Technology Committees, as well as ACOM.

Supporting Information

PRIORITY	This Group coordinates the review of habitat classification and mapping activities in the ICES area and promotes standardization of approaches and techniques to the extent possible.
SCIENTIFIC JUSTIFICATION	Action Plan nos.: 1.4.1, 1.4.2, 1.4, 1.4.3. The WG provides an important forum to present and discuss the progress of multinational programmes, in particular, within the Interreg MESH project for North West Europe, the OSPAR-wide programme, the BALANCE project for the Baltic Sea and the HERMES FP6 project. The strategies, standards and issues addressed by each programme need to be assessed to facilitate sharing of best practice, sharing of difficulties and to work towards integration of resultant maps if feasible. The compilation of National Status Reports is required to keep abreast of current activities and bring attention to new initiatives, developing techniques and data availability. In recent years there have been considerable advances in the use of remote acoustic techniques for marine exploration. Many of these new technologies provide excellent tools, which can be easily adapted to marine habitat mapping. The WGMHM provides an excellent forum in which new techniques can be shared and the relative merits discussed, transferring technology and experience. Review of standards for habitat mapping is of key importance to promoting best practice in mapping studies and in the interoperability of the data. The MESH project will have made significant progress on this topic in its publication of a Guide in 2007 and WGMHM should provide peer review of the work on the basis of its wider expertise, to assess whether any critical gaps exist in the available guidance. Assessment and presentation of issues about accuracy and confidence is marine habitat mapping, to better inform end users of potential limitations in the maps, is at an early stage in development. This is a significant new area in which WGMHM members can contribute to developing new approaches. Sound data management is important in the archiving and distribution of data sets and in interpreting the data to make maps and assess their confidence. There is a need to assess whether available standards are suitable for wider adoption (within ICES). The relevance of habitat mapping to other aspects of ecosystem structure and function needs to be examined, to reveal strengths and potential weaknesses and to highlight the relevance of habitat mapping to other sectors of research and environmental management, e.g. fisheries management. The importance of marine habitat mapping in ICES is growing and it is timely to assess whether the WG can improve its work in

	relation to the science and advisory needs of ICES (linked to proposals for restructuring ICES Science and Advisory Structures).
RESOURCE REQUIREMENTS	–
PARTICIPANTS	Representatives from Member Countries with experience in habitat mapping and classification. Participation of the Baltic countries and from USA and Canada is particularly sought. The participation of members of BEWG, WGEXT, WGECO, WGDEC, WGFAST would be helpful in developing appropriate linkages to other areas of ICES work.
SECRETARIAT FACILITIES	–
FINANCIAL:	–
LINKAGE TO ADVISORY COMMITTEE	ACOM
LINKAGES TO OTHER COMMITTEES OR GROUPS	BEWG and SGNSBP, WGEXT, WGECO, WGDEC, WGFAST and SGASC, SGEH (Baltic Committee)
LINKAGES TO OTHER ORGANIZATIONS	OSPAR, HELCOM, EEA

Annex 3: Agenda for the WGMHM 2008 meeting

ICES Working Group on Marine Habitat Mapping

Horta, Azores, Portugal, 1-4 April 2007

Agenda

1 April 10h00 OPENING OF THE MEETING

Adoption of the Agenda

- **Terms of Reference**
- **Appointment of Rapporteurs**

International programmes

ToR a: review progress in international mapping programmes (including MESH, EEA, OSPAR, BALANCE, HERMES, CHARM).

- **Overview of the north-west Europe MESH project and its main achievements (David Connor, UK)**
- **Progress with the Baltic Sea BALANCE project**
- **BALANCE marine landscape maps for the Baltic Sea (Martin Isaeus, Sweden)**
- **3D Pelagic marine habitat maps in the Bornholm Basin, Baltic Sea (Kerstin Geitner, Denmark)**
- **Progress in mapping habitats on the OSPAR List (David Connor, UK)**
- **See OSPAR paper MASH 07/5/1 – please visit www.searchNBN.net/hosted/ospar/ospar.html and consider whether there are further data that could be added.**
- **Briefing on HERMES & CHARM projects (if available), PLANOR (Kerstin Geitner, Denmark)**
- **Briefing on EU and EEA mapping and habitat classification perspectives (Marine Strategy Framework Directive, Maritime Blue Book, Atlas of the Seas, EUNIS developments (David Connor, UK)**

pm (sub-group)

ToR b: review the range of metadata and data portals available for marine habitat mapping, and assess how these systems could be integrated or enhanced to provide more coherent international access to mapping metadata and international maps.

To include:

- **BALANCE www.sgu.se/sgu/portal)**
- **MESH www.searchMESH.net/webGIS**
- **NOAA www.csc.noaa.gov/benthic/data/dataportal.htm**
- **INFOMAR www.maps.marine.ie/infomar/default.aspx**
- **HERMES http://gis-web.iu-bremen.de/gis-arcims.htm**
- **Others (WG to identify)**

pm (sub-group)

- **WG to consider whether the National Status Reports metadata submissions and GIS polygon study areas should be presented via a suitable web portal, and prepare metadata in a suitable format (NB – this year's submissions should be in the new standardised metadata spreadsheet).**

2 April 09h00

National programmes (National Status Reports)

ToR c: present and review national habitat mapping activity during the preceding year, providing National Status Report updates according to the standard reporting format, an overview map, and focusing on particular issues of relevance to the rest of the meeting.
(presentations strictly limited to a 10 minute overview per country; posters are encouraged for supplementary information; national status reports to be circulated prior to the meeting; outline map of study areas in shape-file GIS format)

- **Canada (Brian Todd, Bedford Institute)**
- **France (Jacques Populus, Ifremer)**
- **Germany (Dietmar Bürk, GKSS)**
- **Ireland (Fergal McGrath, Marine Institute)**
- **Portugal (Fernando Tempera, University of the Azores)**
- **Sweden (Ulf Bergström, Swedish Board of Fisheries)**
- **Finland (VELMU) (Martin Isaeus, Aquabiota, Sweden)**
- **Norway (MAREANO mapping programme) (Margaret Dolan, Geological Survey of Norway & Jennifer Dannheim, Institute for Marine Research)**
- **UK (Joint Irish Bathymetric Survey (JIBS) and Beaufort Dyke) (Matt Service, AFBI)**
- **Other contributions**
- **USA (GOMMI) (Sarah Ellis, GOMMI, submitted report)**
- **Spain (Ibon Galparsaro, submitted report)**
- **Belgium (Wouter Willems, University of Gent; Alain Norro, MUMM)**

Protocols and standards for habitat mapping

pm (sub-group)

ToR f: review and critique guidelines for habitat mapping, including the MESH Guide to Habitat Mapping and those developed under other relevant initiatives. Identify critical gaps in the guidance available.

- **WG to review on-line MESH Guide (www.searchMESH.net/mapping-guide) and other available guidelines to identify critical gaps and further work needed**

pm (sub-group)

ToR h: review progress in the development of 'discovery' and 'survey/method' metadata standards for marine habitat mapping, illustrated with worked examples (e.g. from MESH) and assess whether these are suitable for wider application.

- **The MESH survey metadata standards are now available (see www.searchmesh.net/Default.aspx?page=1681). WG to review these and others.**

ToR d: review and assess recent advances with marine mapping techniques for habitat mapping (for example, developments in multibeam backscatter analysis, and in LIDAR).

- **Multibeam retrodiffused signal calibration using video images and in situ measurement of sand thickness on the hinderbank zone of the Belgian continental plate (Alain Norro, Belgium)**

3 April 09h00	Mapping strategies and survey techniques
	ToR g: further develop approaches for the assessment of accuracy and confidence in habitat maps, through the assessment of selected habitat maps and their associated reports/metadata, considering both the final maps and the survey design.
	• **Confidence and sources of error in spatial models (Wouter Willems, Belgium)**
	• **Review testing of confidence assessment methodologies (e.g. by GOMMI, if available)**
cont.	**ToR d: review and assess recent advances with marine mapping techniques for habitat mapping (for example, developments in multibeam backscatter analysis, and in LIDAR).**
	• **LIDAR review (Jacques Populus, France)**
	• **Video methods (papers from Paulo Fonseca, Victor Henriques and Aida Campos, Portugal and Sergei Olenin, Lithuania)**
	Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions) and its relevance in understanding ecosystems
	ToR i: review a draft document which addresses the application of and needs for habitat maps in an ecosystem-based management context.
	• **Based on update from Chris Coggan (USA)/Brian Todd (Canada)**
	ToR j: assess the role of the Working Group and its relationship to the needs of ICES science and advisory programmes.
pm	• **Complete any sub-group work (ToRs b, f, h) and report back**
4 April 09h00	Recommendations and Actions, including proposals for new Chair
	Adoption of the Report
13h00	Close of Meeting

Annex 4: Summary of the HERMES project

The HERMES project (Hotspot Ecosystem Research on the Margins of European Seas), is an EU Integrated Project that began on April 1st 2005 and will run for 4 years. 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. The primary ecosystems under investigation include 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. Other environments being studied include open slopes, where landslides and deep-ocean circulation affect ecosystem development. 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, are being assessed using sediment archives. The HERMES project is making estimates of the flow rates of methane from the geosphere and calculating how much is utilised by benthic communities, leaving the residual contribution to enter the water column and possibly reach the atmosphere as a greenhouse gas. The HERMES project is developing the first pan-European margin Geographic Information System to provide a framework for integrating science, environmental modelling and socio-economic indicators in ecosystem management. The results will underpin the development of a European Ocean and Seas Integrated Governance Policy enabling risk assessment, management, conservation and rehabilitation options for margin ecosystems.

The figure (Figure 3.5 in main section of report) shows the bathymetry of the European margin and the distribution of canyons. Overlain on this map are the known occurrences of cold-water corals, cold seeps and mud volcanoes. The irregular red areas show the locations of major landslides. The study sites, outlined by yellow boxes, were selected on the basis of this map and other available information. The Nordic margin represents a cold-water end member with environmentally stressed ecosystems in a hydrocarbon province. The Porcupine/Rockall margin is rich in giant carbonate mounds with luxuriant coral reefs and canyon systems. The Portuguese margin has large canyon systems; the Moroccan margin of the Gulf of Cadiz has specialist seabed communities on mud volcanoes. The Western Mediterranean, bounded by the sills of Gibraltar and the Sicily Channel, has large contrasts between the strongly Atlantic-influenced southern area and the areas to the north where influence from European rivers is highly significant and has changed dramatically in just a few decades. The Eastern Mediterranean study area has areas of cold-seeps on the Mediterranean ridge together with unique but poorly understood ecosystems driven by events such as intermittent deep-water formation. The Black Sea is a unique environment where we can study newly discovered microbial ecosystems thriving in permanent anoxia and their interaction with hydrocarbons.

The scientific approach in each area has been to:

Understand better the natural drivers that control ocean margin ecosystems

- Produce comprehensive maps of each area, collecting new geophysical, chemical and biological data where necessary using swath bathymetry, sidescan sonar, seabed profilers and towed cameras
- Investigate the geological drivers of the ecosystems (fluid flow, gas hydrates, sediment transport and seabed composition) through geophysical surveys and geological sampling of hydrates and seabed monitoring of fluid escape
- Measure near-bed current flow, fluxes of particles to and from the seabed using sediment traps, transmissometers, etc, on moorings and bottom landers
- Analyse the in situ chemistry of the sites to determine composition and fluxes of key components, such as carbon, nitrogen, sulphur species and oxygen

Understand better the biodiversity and ecosystem function of hotspot ecosystems

- Assess and visualise the abundance and distributions of seabed megafauna with still and video cameras
- Sample the seabed with a variety of devices to identify megafauna, macrofauna, meiofauna, microfauna, and bacteria
- Perform identification and taxonomic studies including genetic analysis of species

Forecast changes in biodiversity and ecosystem functioning linked to global change

- Hind-cast ecosystem development through studies of the sedimentary sequences over at least a complete glacial/interglacial cycle
- Model the modern ecosystems and identify the key drivers
- Develop regional scale coupled or pseudo-coupled hydrographic-biogeochemical models using GIS linking to coupled climate models, e.g. CHIME (The Coupled Hadley-Isopycnic Model Experiment) and global change models e.g. OCCAM global change model and CLIVAR (Climate Variability and Prediction Programme).
- Forecast ecosystem response to global change through model simulations using boundary conditions identified in 10 and the selection of appropriate drivers.

Develop concepts and strategies for sustainable use of marine resources

- Characterise the different types of anthropogenic activity and their impacts
- Perform a socio-economic valuation of the provided goods and services
- Assess the current legislative framework
- Integrate all data and set it in terms of recommendations for a sustainable resource management

With 50 scientific partners (including 9 SMEs), a total budget in the order of €50M and an EU contribution of €15.5M the project is one of the largest marine science projects in Europe.

HERMES is co-ordinated by Prof. P. Weaver at the Southampton Oceanography Centre. EC funding is provided from the FP6 Global Change and Ecosystems programme (EC contract GOCE-CT-2005-511234-1). For more information on the HERMES project, please visit the website at http://www.eu-hermes.net.

Annex 5: National Status Reports – summary table

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Canada										
Benthic habitat mapping of the Gulf of Maine	01/04/2003	31/03/2010	Geological Survey of Canada	Canada, Gulf of Maine		30-300m	Governments (federal, provincial and state), NGOs, fishing industry, hydrocarbon industry, cable and pipeline industries	Banks range from 30 to 100 m, troughs and basins reach 300 m; regional multibeam sonar surveys are followed by groundtruth surveys to obtain both regional samples and samples of particular interest	Todd, B.J. and Shaw, J. 2006. Sun-illuminated seafloor topography, Browns Bank, Scotian Shelf, offshore Nova Scotia; Geological Survey of Canada, Map 2086A, scale 1:100 000. Todd, B.J., Shaw, J. and Courtney, R.C., 2006. Backscatter strength and sun-illuminated seafloor topography, Browns Bank, Scotian Shelf, offshore Nova Scotia; Geological Survey of Canada, Map 2085A, scale 1:100 000. Todd, B.J., Fader, G.B.J. and Shaw, J., 2006. Surficial geology and sun-illuminated seafloor topography, Browns Bank, Scotian Shelf, offshore Nova Scotia; Geological Survey of Canada, Map 2093A, scale 1:100 000. Todd, B.J., Kostylev, V.E. and Shaw, J., 2006. Benthic habitat and sun-illuminated seafloor topography, Browns Bank, Scotian Shelf, offshore Nova Scotia; Geological Survey of Canada, Map 2092A, scale 1:100 000. Todd, B.J., 2007. Sun-illuminated seafloor topography, German Bank, Scotian Shelf, offshore Nova Scotia; Geological Survey of Canada, Map 2107A, scale 1:50 000. Todd, B.J., 2007. Backscatter strength and sun-illuminated seafloor topography, German Bank, Scotian Shelf, offshore Nova Scotia; Geological Survey of Canada, Map 2106A, scale 1:50 000. Todd, B.J., Valentine, P.C., Longva, O., and Shaw, J. 2007. Glacial landforms on German Bank, Scotian Shelf: evidence for Late Wisconsinan ice sheet dynamics. Boreas, 36(2): 148-169.	Dr. Brian J. Todd, Geological Survey of Canada (Atlantic)

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Queen Charlotte Basin ocean management: Benthic habitat mapping, sponge reefs, deep-sea coral reefs. Georgia Basin ocean management; Transboundary area USA/Canada - San Juan and Gulf Islands.	31/03/2006	01/04/2009	Geological Survey of Canada	Canada, Queen Charlotte Basin; Georgia Basin		150-800m	Department of Fisheries and Oceans, Oceans Sector, Natural Resources Canada, Moss Landing Marine Laboratories, Alaska Department of Fish and Game, various stakeholders.	150-800 m shelf and upper slope of British Columbia, inclulding the transboundary areas bordering Washington State and Alaska.	Barrie, J.V. and Conway, K.W. (2008) Surficial geology: the third dimension in habitat mapping. Marine Habitat Mapping for Alaska, Alaska Sea Grant, in press. Conway, K.W., Barrie, J.V. & Krautter, M. (2005): Geomorphology of unique reefs on the western Canadian shelf: sponge reefs mapped by multibeam bathymetry. - Geo-Marine Letters, 25/2; Berlin. Whitney, F., Conway, K.W., Thomson, R., Barrie, J.V., Krautter, M., & Mungov, G. (2005): Oceanographic Habitat of Sponge Reefs on the Western Canadian Continental Shelf. - Continental Shelf Research, 25: 211-226, 10 figs., 2 tab.; Amsterdam. Conway, K.W., Krautter, M., Barrie, J.V., Whitney, F., Thomson, R.E., Reiswig, H., Lehnert, H., Mungov, G. & Bertram, M. (2005): Sponge reefs in the Queen Charlotte Basin, Canada: controls on distribution, growth and development. In: Freiwald, A. & Roberts J.M. (eds): Cold-water Corals and Ecosystems, 601-617, 9 figs.; Springer (Berlin Heidelberg). Conway, K. W., Barrie, J. V., Hill, P. R., Austin, W. C., Picard, K. 2007. Mapping sensitive benthic habitats in the Strait of Georgia: deep-water sponge and coral reefs. Geological Survey of Canada, Current Research 2007-A2, 6p.	Mr. Kim Conway and Dr. J. Vaughn Barrie, Geological Survey of Canada (Pacific)

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
A practical morpho-dynamic framework for mapping seafloor environment for seabed management in the Canadian EEZ	01/04/2006	31/03/2010	Geological Survey of Canada	Canada, continental shelves of the Atlantic, Pacific and Arctic Oceans		0-1000m	Department of Fisheries and Oceans, Oceans Sector, Natural Resources Canada, various stakeholders.	In recent years some of the largest advances in science have taken place at the intersection between formerly separate disciplines. Habitat mapping - at the intersection between marine ecology, marine geology and physical oceanography - has come to prominence as a necessary tool for ocean management. Habitat mapping recognizes that the physical nature of the sea floor, i.e., surficial geology, is critical to understanding the distribution of marine biological resources that economically sustain coastal communities in Canada. In 2006 Natural Resources Canada commenced a 4-year project to address these questions, with an emphasis on	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals	Dr. Vladimir E. Kostylev and Dr. John Shaw, Geological Survey of Canada Atlantic)

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Benthic habitat mapping of the Bay of Fundy	01/04/2006	31/04/2010	Geological Survey of Canada	Canada, Bay of Fundy		0-215m	Governments (federal, provincial and state), NGOs, tidal power industry, fishing industry, hydrocarbon industry, cable and pipeline industries	Bay of Fundy is 290 km long with an entrance 100 km wide; water depths are up to 215 m; tidal rage increases up the bay from 6 m to 16 m; regional multibeam sonar surveys are followed by groundtruth surveys to obtain both regional samples and samples of particular interest	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals	Mr. Russell Parrott and Dr. Brian J. Todd, Geological Survey of Canada (Atlantic)
Benthic Habitat and Offshore hydrocarbon development in the Beaufort Sea.	02/04/2006	01/03/2012	Geological Survey of Canada	Canada, Beaufort Sea		0-200m	Governments (federal, provincial and state), NGOs, fishing industry, oil and gas industry, cable and pipeline industries	0-200 m, as ice conditions permit.	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals.	Dr. Vladimir E. Kostylev and Mr. Steve Blasco, Geological Survey of Canada (Atlantic)
Deepwater Fauna of the Continental Slopes and Canyons	05-Jul-07	27/07/2007	Fisheries and Oceans Canada, Memorial University of Newfoundland	Scotian Slope, Southwest Grand Banks		200-2500m	International Governance, Policy and Oceans Branches of Fisheries & Oceans, Canada; Scientific community		In preparation	Dr. Ellen Kenchington and Dr. Kent Gilkinson, Fisheries and Oceans Canada

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Coastal research by principal contacts and other collaborators (e.g. Geological Survey of Canada (Atlantic); Department of Biology and Ocean Mapping Group, University of New Brunswick; Acadia University)	Different timelines and reporting mechanisms. Work by Buzeta in support of graduate thesis (completion expected 2007)	2010	Fisheries and Oceans Canada	Canada, Lower Bay of Fundy; New Brunswick coastal areas		0-20m (diving); 0-50m (remote video)	Area management & planning (coastal Marine Protected Area (Musquash) multibeamed during designation process, and work is underway to define biological monitoring requirements to evaluate its effectiveness) Environmental quality assessment (monitoring) Nature conservation Navigation (including dredging) Research (development of coastal diving and remote video approaches to groundtruthing) Coastal development (Preliminary coastal habitat classification used in GIS-based decision support tool for coastal zone management, to be revised as new regional-scale seabed mapping	Diver-based quadrat and transect video are acquired in depths ranging from 0 to 20 m. Initial remote video system used low-light B/W cameras on transects ranging from 200 m to > 1km in extent in water depths to 40 m (path width 0.7 to 1.5 m, speed over bottom < 1kt). A new survey system incorporating a color pan and tilt camera will be operational in 2007 with enhanced survey capability to 60m depth)	Strong M.B., and Lawton, P. 2004. URCHIN – Manually-deployed geo-referenced video system for Underwater Reconnaissance and Coastal Habitat Inventory. Can. Tech. Rep. Fish. Aquat. Sci. 2553: iv + 28 p. Buzeta, M-I, R. Singh and S. Young-Lai. 2003. Identification of significant marine and coastal areas in the Bay of Fundy. Rep. Fish. Aquat. Sci. 2635. 177 p + 69 figs. Singh, R, and M-I Buzeta, Eds. 2005. Musquash Ecosystem Framework development; progress to date. Can. Manuscr. Rep. Fish. Aqua. Sci. 2727.	Dr. Peter Lawton and Ms. Maria Buzeta, Fisheries and Oceans Canada, Biological Station, Saint Andrews, NB

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Denmark										
BALANCE	2005	2007	DTU Aqua	Bornholm Bassin	Area 25, Eastern Baltic	0-100 m	EU	The hydrographical conditions suitable for egg and fish are used to make a delimination of the suitable areas at different times of the year, especially during the spawning period. The focus is on cod and sprat. The extension of the reproductive volume is analysed for the different species and life stages throughout the year.	BALANCE report: Mapping of pelagic habitats and applications for area-based fisheries management in the Baltic Sea	Kerstin Geitner DTU Aqua Department of IT-T Charlottenlund Castle DK-2920 Charlottenlund kjg@difres.dk
BALANCE	2005	2007	DTU Aqua	Kattegat	Area 3A, The Kattegat		EU	Biological and fysical parameters that charcterize areas suitable for juvenile flatfish are identified and a predictiv model is developed that can generate predictive maps of potential areas suitable for juveniles.	BALANCE final report	Claus R. Sparrevohn DTU Aqua Department of Marine Ecology and Aquaculture Kavalergården 6 DK-2920 Charlottenlund crs@difres.dk

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BALANCE	2005	2007	NERI & GEUS	Denmark, Kattegat		10–120m	EU	Methodology for detailed mapping of the seabed using the advanced acoustic techniques that can cover a large area of the seabed at relatively short time with high accuracy combined with divers ground truthing.	Mapping hard bottom and sandy habitats and modelling seaweed forest on hard stable substrate in Pilot area 1, Kattegat, Denmark.	Jørgen O. Leth GEUS Øster Voldgade 10, DK-1350 Copenhagen K, Denmark, jol@geus.dk Tel: +45 38142000 Fax: +45 38142050

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BALANCE	2005	2007	SNS & GEUS	Denmark, Kattegat		10-50m	EU	The applicability of the combined use of multibeam sonar and sidescan sonar systems has been tested as a tool for mapping of marine habitats. The project aimed at providing evidence on the intercalibration of newly acquired acoustic data with other geological and biological information acquired from a dive survey within the well-known Natura 2000 site.	Benthic Habitat mapping at Læsø Trindel - an integrated approach.	Jørgen O. Leth GEUS Øster Voldgade 10, DK-1350 Copenhagen K, Denmark, jol@geus.dk Tel: +45 38142000 Fax: +45 38142050
Oceanographic influence on herring recruitment	2005	2006	DTU Aqua	North Sea		10–150 m	Scientific community	Aanalysis of bottom and/or surface temperature, salinity and density	Journal article	Peter Munk DTU Aqua Department of Marine Ecology and Aquaculture Kavalergården 6 DK-2920 Charlottenlund pm@difres.dk

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Pacific Oyster mapping	2007	2007	DTU Aqua	Limfjord			National authorities in Denmark	Interviews with people with local knowledge, reporting through the Internet and ground truthing	Report	Helle Torp Christensen DTU Aqua Department of Marine Ecology and Aquaculture Kavalergården 6 DK-2920 Charlottenlund htc@difres.dk
Development of a marine assessment tool for Natura2000 areas	Oct. 2007	April 2008	NERI and DHI	Danish shallow inlets and bays habitats			Danish Forest and Nature Agency	Tools for assessment of conservation status of marine Natura2000 areas will be developed using area of eelgrass beds and the composition of benthic fauna as indicators.	Compilation of metadata on distribution of eelgrass and calculation of DKI bottom fauna indices for selected areas	Peter Henriksen NERI Dept. of Marine Ecology Frederiksborgvej 399 PO Box 358 DK-4000 Roskilde, Denmark Tel: +4546 3012 00 Fax: +4546 3012 12
AHA.DOT		2007	DTU Aqua	Sandeel fishing areas in the North Sea and Skagerrak			DK Gov't Dept's	Fishing grounds are mapped using fishermens navigation data and detailed information about the fishery		Henrik Jensen DTU Aqua Department of Marine Fisheries Charlottenlund Slot DK-2920 Charlottenlund hj@difres.dk

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Characterisation of the Baltic Sea Ecosystem: Dynamics and Functions of Coastal Types (CHARM).		2002-2004, date of reporting 2005		The Baltic Sea			Gov't Dept's in Denmark, Poland, Sweden, Finland, Latvia, Lithuania Estonia, Germany and Italy	Development of a typology for the Baltic ecoregion on the basis of hydrographic and biological variables. Evaluate and modify the typology with respect to the biological indicators of the Water Framework Directive.	Second annual report covering the preiod 1st. Dec. 2001to 30th Nov. 2003. Characterisation of the Baltic Sea Ecosystem (CHARM), In press.	Bo Riemann NERI Dept. of Marine Ecology Frederiksborgvej 399 PO Box 358 DK-4000 Roskilde, Denmark Tel: +4546 3012 00 Fax: +4546 3012 11
Geological mapping off the Danish west coast		1991-2001		Eastern North Sea, west coast of Jutland, Denmark		0-50 m	DK Gov't Dept's, Industry	Survey of the geological composition of the seafloor and sediment transport analysis along the coast of Jutland.	GEOLOGI - nyt fra GEUS nr. 3. Leth, J.O. 2003. Nordsøen efter istiden - udforskningen af Jyske Rev. GEOLOGI - nyt fra GEUS nr. 4 Larsen, B. 2003. Blåvands Huk - Horns Rev området - et nyt Skagen?	Jørgen O. Leth GEUS Øster Voldgade 10, DK-1350 Copenhagen K, Denmark, jol@geus.dk Tel: +45 38142000 Fax: +45 38142050
Mapping of marine Annex 1 habitats in Denmark (Natura 2000 code 1110, 1140 and 1170)		1980-2005, review produced in 2005		The Danish Territorial Waters		0-100m	DK Gov't Dept's, Industry	Mapping of marine Annex 1 habitats in Denmark (Natura 2000 code 1110, 1170 and 1180) using eksisting data on bathymetry, marine aggregates and seismic data.	Leth, J.O. 2005. Revurdering af marine kortlægningsdata som grundlag for udpegning af habitatområder offshore i Nordsøen. GEUS Rapport no. 2005/37	Jørgen O. Leth GEUS Øster Voldgade 10, DK-1350 Copenhagen K, Denmark, jol@geus.dk Tel: +45 38142000 Fax: +45 38142050

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Mapping of marine Annex 1 habitats in Denmark (Natura 2000 code 1110, 1140 and 1170)		1980-2000, review produced in 2000		The Danish Territorial Waters		0-100m	DK Gov't Dept's, Industry	Mapping of marine Annex 1 habitats in Denmark (Natura 2000 code 1110, 1140 and 1170) using eksisting data on bathymetry, marine aggregates and seismic data.	Jensen, J.B. 2000. Kortlægning af marine naturtyper i Danmark i forbindelse med EF-Habitatdirektivet.GEUS Rapport no. 2000/106	Jørn Bo Jensen GEUS Øster Voldgade 10 DK-1350 Copenhagen K Denmark, Tel: +45 38142000 Fax: +45 38142050
National monitoring of mussels		ongoing, annual status reports	DTU Aqua	Specific areas for mussels in Denmark (Wadden Sea, Limfjord, Little Belt)		0-15 m	DK Gov't Dept's	Annual surveys of mussel beds based on interpretation of aerial photography. Quality control based on field surveys.	DIFRES report, available on webpage. http:/www.difres.dk	Per Sand Kristensen DTU Aqua Department of Marine Fisheries Charlottenlund Slot DK-2920 Charlottenlund psk@difres.dk
NOVANA (national monitoring programme)		2004-2009 (continued from previous monitoring programmes since 1987). Reports produced every year.		Denmark (aquatic and terrestic environment)			National and regional authorities in Denmark	NOVANA integrates environmental monitoring of aquatic and terrestical ecosystems and ensures a coherent approach at a national level.	NOVANA. Programbeskrivelse del 1-3. Several technical guidelines and status reports (most in Danish). Published on \www.dmu.dk	Peter Henriksen NERI Dept. of Marine Ecology Frederiksborgvej 399 PO Box 358 DK-4000 Roskilde, Denmark Tel: +4546 3012 00 Fax: +4546 3012 11

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Satellite tracking of Harbour Porpoise (Phocoena phocoena) in Danish waters and surrounding seas.		1997-2002, date of reporting 2004		Inner Danish Water, western Baltic, North Sea (DK) and area around the Shetland Isle (UK)			DK Gov't Dept's	From 1997 to 2002 Harbour Porpoises were marked with satellite transmitters and a number of areas important for Harbour Porpoises were identified.	Teilmann, J., Dietz, R., Larsen, F., Desportes, G., Geertsen, B.M., Andersen, L.W., Aastrup, P., Hansen, J.R. & Buholzer, L. 2004: Satellitsporing af marsvin i danske og tilstødende farvande. Danmarks Miljøundersøgelser 86 s. NERI Technical Report no. 484	Jonas Teilmann NERI Frederiksborgvej 399 DK-4000 Roskilde Denmark Tel: +45 46301947 Fax: +45 4630 1114 E-mail: jte@dmu.dk
Seabed classification and habitat mapping of stone reefs in Denmark		2003		The Great Belt, Inner Danish Waters.		3-20m	DK Gov't Dept's	Seabed mapping and classification of sediment as well as biomass contents of stone reefs.	Poster: Alhamdani, Z. K., Lundsteen S., Jensen, J. B. Sea-bed classification and habitat mapping of stone reefs in Denmark. A multibeam and ground truthing pilot study. Available at azk@geus.dk	Zyad Alhamdani GEUS Øster Voldgade 10 DK-1350 Copenhagen K Denmark, Tel: +45 38142905 Fax: +45 38142050 E-mail: azk@geus.dk
France										
Cartes G project	1995	2012?	SHOM (French hydrographic office)	Eastern Channel Western Channel Bay of Biscay		<0m (intertidal) 0-20m 20-50m 50-100m (partly)	Nature conservation Research Aggregate industry Cables & piplines Coastal development Fisheries Renewable energy	summary	http://www.shom.fr/fr_page/fr_act_geo/siteg.htm	SHOM (Thierry Garlan)

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Rebent	2003	2010	IFREMER	Eastern Channel Western Channel Bay of Biscay		0-200m	Area management & planning (e.g. SEA) Nature conservation Research Aggregate industry Cables & piplines Coastal development Fisheries Oil & gas industry Renewable energy	Historic habitat maps are being digitised, geo-referenced, topologically checked and a) labelled according to author's classification, b) translated to Eunis	RST/IFREMER/DYNECO-AG/07-27/CC http://www.rebent.org/	IFREMER Chantal Croguennec chantal.croguennec@ifremer.fr
Rebent	2003	2010	IFREMER	Eastern Channel Western Channel Bay of Biscay		0-100m	Area management & planning (e.g. SEA) Nature conservation Research Aggregate industry Cables & piplines Coastal development Fisheries Oil & gas industry Renewable energy	Recent habitat maps, mostly generated in GIS form are being topologically checked and a) labelled according to author's classification, b) translated to Eunis	RST/IFREMER/DYNECO-AG/07-27/CC http://www.rebent.org/	IFREMER Claire Rollet claire.rollet@ifremer.fr

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Mesh (Specific habitat modelling) To be continued after Mesh	2005	2008	IFREMER	Brittany (Western Channel + North Biscay)		0-50m	Nature conservation Research Coastal development Fisheries	Prediction of specific habitats is a bottomp up approach whereby field data are used to establish probability laws of presence of given habitats as a function of some relevant environmental (physical) drivers. Based on the availability of these variables on larger extents at suitable resolutions, predictive maps can then be computed.	4.1 MESH PERIOD 8 Activity IFREMER_kelp_modelling_final .pdf	IFREMER Jacques Populus jpopulus@ifremer.fr
Depth DTM	2006	2007	IFREMER	Eastern Channel Western Channel Bay of Biscay		<0m (intertidal) 0-20m 20-50m 50-100m (partly)	Area management & planning (e.g. SEA) Nature conservation Research Aggregate industry Cables & piplines Fisheries Oil & gas industry	A depth DTM was computed at 500 m resolution from the inshore area to the high seas and made available to the research community. It used a compilation of source data from Ifremer, SHOM, UKHO and regional data	NA	IFREMER

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
MESH	2007	2008	IFREMER	Eastern Channel Western Channel Bay of Biscay		<0m (intertidal) 0-20m 20-50m 50-100m (partly)	Nature conservation Research Aggregate industry Cables & piplines Coastal development Fisheries Renewable energy	A depth DTM was computed at 100 m resolution from the inshore area to the high seas, using the best available sounding data sets. Ordinary kriging was the interpolation method used, with a neighbourhood of 500 metres.	GEOVARIANCES - MNT Façade Atlantique - Rapport final - P7198.doc	IFREMER (Jacques Populus)
Mesh (Marine landscape map) Nota: To be continued after Mesh	2007	2010	IFREMER	Eastern Channel Western Channel Bay of Biscay		0-200m	Area management & planning (e.g. SEA) Nature conservation Research Fisheries	The Marine landscape is a top down approach that provides a potential inference tool for habitat mapping First assessed as a tool for global planning, it is also deemed to be adaptable to more local needs. It still needs to be cross-checked with habitat classifications such as Eunis and Natura 2000.	4.2 MESH PERIOD 8 Activity IFREMER_marine_landscapes.pdf	IFREMER Jacques Populus jpopulus@ifremer.fr

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Ireland										
INFOMAR	16 April 2007	16 October 2007	Marine Institute and Geological Survey of Ireland	W & SW Irish Coastal Waters	ICES Area VIIb, VIIj2, VIIg, VIIa	15–200m	Coastal Zone Management, conservation, research, marine resources	National Mapping Programme 2006 - 2008. Hydrographic, Geophysical, Groundtruthing, Oceanographic data acquisition in support of the national mapping strategy, from 0 - 200m water depth. Target areas incorporate a prioritised selection of the 26 priority bays and 3 priority areas identified during INFOMAR stakeholder consultation process.	Survey reports, hydrographic and geophysical data , groundtruthing analysis reports, digital map products to be defined Q2 2008	Fergal McGrath - Marine Institute

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
JIBS	1 Nov 2007	30 Nov 2007	Marine Institute, MCA, DOE Environment and Heritage (NI)	N Irish Coastal Waters	ICES Area Via	10 –50m	UKHO Chart update, SOLAS, research, marine resources	The Joint Irish Bathymetric Survey Project (JIBS) is lead by the Maritime and Coastguard Agency (MCA) with the Marine Institute of Ireland as project partner. Funding is through the European INTERREG IIIA programme and co-ordinated by the DOE, Environment and Heritage Service of NI. The area initially proposed is the 3nm coastal strip from Malin Head to Rathlin Island. The survey is being conducted to International Hydrographic Office "Order 1" standard.	UKHO Survey reports, hydrographic and geophysical data , Interpreted backscatter, Secchi measuremnts, Tidal stream data	Fergal McGrath - Marine Institute

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
MESH South-west Approaches Canyons Survey (MESH Cruise 01-07-01)	4 June 2007	18 June 2007	Marine Instiute, British Geological Survey, University of Plymouth and Joint Nature Conservation Committee	Atlantic South West Approaches	ICES Area XIIc	200–1000 m	Habitat mapping Conservation assessment Research	This report contains the results of a survey of the canyons in the South West Approaches area conducted during June 2007. The survey provided valuable geomorphological and biological data in an area with previously poor data and thus further enhanced our understanding of marine habitats found in waters offshore Ireland and the UK. During this survey, high quality multibeam bathymetry, backscatter data were successfully acquired over the study area in a bathymetric range 200–1000m. Habitat data recorded in video and photographic stills data, including Annex 1 reef were collected. These data have enabled the habitats to be mapped and this work will allow for an assessment of the interpretation of Annex1 reef according to the EU Habitats Directive.	MESH Southwest Approaches Canyons Survey (MESH Cruise 01-07-01) Final Report Weblink:http://www.searchmesh.net/PDF/SWCanyons_FinalReport_v1.4_final.pdf	Janine Guinan - Marine Institute Heather Stewart - British Geological Survey Neil Golding - Joint Nature Conservation Committee Jamie Davies- University of Plymouth

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Annual Irish Sea Nephrops UWTV	2003 August	2008 August	Marine Institute-Ireland and AFBI-Northern Ireland	western Irish Sea (Functional Unit 15)	ICES Area VIIa	15-150m	Fisheries	Since 2003 the Marine Institute have carried UWTV surveys of the Irish Sea Nephrops grounds in co-operation with Agri-Food and Biosciences Institute, Northern Ireland (AFBI). The results of the 2003 to 2007 surveys were used to describe the abundance, distribution and estimate the biomass of Nephrops in the Western Irish Sea. The 2008 survey will have similar objectives listed below. Specific Objectives: 1. Technology and protocol transfer between Marine Institute (Ireland) and Agri-Food and Biosciences Institute, Northern Ireland (AFBI). 2. To develop a fishery independent survey to produce a relative index for the Nephrops stock. 3. To develop a fishery independent survey to a biomass estimate for the Nephrops stock. 4. To map the Irish Sea Nephrops grounds. 5. To gather data on the abundance, distribution and patchiness of Nephrops burrows in the Irish Sea. 6. To collect secondary data on the seabed in the Irish Sea using benthic grabs and multibeam. 7. To satisfy the requirements of the Irish National programme under the 'Data collection ..regulation' EC Regulation 1543/2000.		Dr. Colm Lordan Team Leader Fisheries Science Services The Marine Institute Rinville Oranmore Co. Galway Ireland

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Annual Aran Grounds Nephrops UWTV	2002 June	2008 June	Marine Institute-Ireland	Aran Grounds (Functional Unit 17)	ICES Area VIIb	30-120m	Fisheries	since 2002 the Marine Institute have carried out UWTV surveys on the 'Aran grounds'. The surveys are multi disciplinary in nature where as previous surveys have focused on Nephrops abun-dance and distribution mainly. The specific objectives are listed below: 1. To complete the UWTV stations on a randomised fixed survey grid with 2.25Nmil spacing for the Aran (~70 stations), Slyne (5 stations) and Galway Bay (4 stations) Nephrops grounds. 2. To obtain estimates of distribution and abundance of prawns on the Aran and Slyne grounds using underwater television. These will be compared with pre-vious year's to help determine the current status of these stocks. 3. To make use of the UWTV survey to estimate the densities of other shellfish and benthic organisms and to record evidence of trawl activity. 4. To collect multi-beam and other acoustic data to enable the mapping and sea-bed habitat classification. 5. To collect sediment samples to ground truth the multibeam data. 6. To complete a CTD section from 9o30W to 11o00W at 6km intervals on the 53o00N.		Dr. Colm Lordan Team Leader Fisheries Science Services The Marine Institute Rinville Oranmore Co. Galway Ireland

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Annual Celtic Grounds Nephrops UWTV	2006 July	2008 July	Marine Institute-Ireland	Celtic Sea (Functional Unit 20-22)	ICES Areas VIIg, VIIa	70–130m	Fisheries	In 2006 the Marine Institute Ireland conducted the first UWTV survey of the Celtic Sea Nephrops grounds. This survey will be used to describe the abundance, distribution and estimate the biomass of Nephrops in the Celtic Sea. The survey has the following objectives as listed below. Specific Objectives: 1. To develop Technology and protocols. 2. To develop a fishery independent survey to produce a relative index for the Nephrops stock. 3. To develop a fishery independent survey to a biomass estimate for the Nephrops stock. 4. To map the Celtic Sea Nephrops grounds. 5. To gather data on the abundance, distribution and patchiness of Nephrops burrows in the Celtic Sea. 6. To collect secondary data on the seabed in the Celtic Sea using benthic grabs and multibeam. 7. To satisfy the requirements of the Irish National programme under the 'Data collection regulation' EC Regulation 1543/2000.		Dr. Colm Lordan Team Leader Fisheries Science Services The Marine Institute Rinville Oranmore Co. Galway Ireland

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
HabMap	01/07/2004	01/11/2007	TCD, UCC, MI, CCW, NMW, CU	Irish Sea	ICES Areas VIIg, VIIa	0-100m	Area management & planning (e.g. SEA) Research	Marine habitat mapping is necessary to comply with European legislation (92/43/EEC, 9/409/EEC and 2001/60/EEC), with international obligations to organi-zations such as ICES and with agreements such as the OSPAR Convention. Clearly defined habitats are needed before conser-vation and manage-ment practices can be implemented. The HABMAP project has used sediment particle size, organic matter, organic carbon and nitrogen along with benthic macrofaunal species and abundance to define habitats in the southern Irish Sea. The sea floor of the southern Irish Sea is predominantly sandy gravel, grading down through sand to mud in the deeper parts of the Celtic Sea and similarly in the shal-lower northern basin beyond Anglesey. The physical gradient in particle size is correla-ted with organic con-tent and also with bio-logical communities. Nevertheless, there are marked discre-pancies between boundaries defined by the Folk sediment charac-terization trigon, by the chemical characteristics of the sediments and by biol ogical communities.	Robinson, K et al. (2007) Habmap: Habitat mapping for conservation and management of the southern Irish sea. CCR Report 810, Bangor, Wales. www.habmap.org Summary abstract (continued) The validity of using continuous physical and chemical sediment characteristics to more accurately predict categorical biological assemblages was tested with use of stepwise backward elimination Binary Logistic Regression (BLR).	Karen Robinson k.robinson@ccw.gov.uk

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Norway										
MAREANO	2005	2010	Institute of Marine Research (IMR), Geological Survey of Norway (NGU), Norwegian Hydrographic Service	southern Barents Sea	IIa2	ca. 50 -3000 m	Baseline mapping for ecosystem management, nature conservation, environmental monitoring.	MAREANO is a national programme financed by the Norwegian government to map the seabed in Norwegian waters. The mapping, which started in 2005, includes bathymetry, geology, biology and contaminants. By 2010 a 142,000 km2 large area of the Barents Sea will be fully mapped to contribute to a revision of the National Management Plan of the Barents Sea adopted in 2006. The programme is a collaboration between the Institute of Marine Research, the Geological Survey of Norway and the Norwegian Hydrographic Service.	www.mareano.no	Lene Buhl-Mortensen, Institute for Marine Research, Bergen. lenebu@imr.no

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Softmod	2005	2008	Norwegian Institute for Water Research (NIVA)	Skagerrak		various	Modelling substrate	Modelling the effect of geophysical factor on the distribution of sediment	Reports, research articles.	Trine Bekkby, Norwegian Insitute for Water Research (NIVA). trine.bekkby@niva.no.
Kelp Predict	2007	2010	Norwegian Institute for Water Research (NIVA)	Møre	Iva, IIa2	various	Finding the effect of exposure on species diversity	A research project finding the effect of wave and current exposure on biodiversity in the kelp forest for use in modelling.	Reports, research articles.	Trine Bekkby, Norwegian Insitute for Water Research (NIVA). trine.bekkby@niva.no.
National programme on mapping and monitoring of biological diversity and marine nature types	2003 (phase 1), 2007 (phase 2)	2006 (phase 1), 2010 (phase 2)	Norwegian Institute for Water Research (NIVA), Geological Survey of Norway (NGU), Institute for Marine Research (IMR)	Aust-Agder, Hordaland, Nordland, Finnmark (phase 1). Skagerrak / Sørlandskysten, Trøndelag og Troms (phase 2)	IIa2	various	Mapping and monitoring of biological diversity and marine nature types in the coastal zone for management and conservation.	The Norwegian national programme on mapping and monitoring of biological diversity and marine nature types aims to map 50% of coastal area by 2010. Phase 1 began with method development, project organisation and data gathering. Mapping will continue in phase 2.	Datasets available at the web. http://www.dirnat.no/content.asp?thisId=500014853	Eli Rinde, Norwegian Insitute for Water Research (NIVA). eli.rinde@niva.no. Terje Thorsnes, Geological Survey of Norway (NGU). terje.thorsnes@ngu.no. Torjan Bordin, Institute for Marine Research (IMR), torjan.bodvin@imr.no

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Astafjord			Geological Survey of Norway (NGU)	Troms county	IIa2	shallow, coastal	Seabed mapping for local authorities, management & conservation	Mapping of seabed sediments and nature types in close cooperation with local and national partners.	Reports, research articles.	Terje Thorsnes, Geological Survey of Norway (NGU). terje.thorsnes@ngu.no
MarModell			Norwegian Institute for Water Research (NIVA), Geological Survey of Norway (NGU)	Møre	Iva, IIa2	various	Mapping and modelling of seabed habitats. Main focus: kelp forest and eelgrass meadows, liking geotopes and biotopes	The MarModell project examines mapping and theoretical aspects of habitat modelling e.g. effects of scale, linking geophysical factors with distribution of species and habitats	Reports, research articles.	Trine Bekkby, Norwegian Insitute for Water Research (NIVA). trine.bekkby@niva.no.
Oslofjord			Geological Survey of Norway (NGU)	Oslo		shallow, coastal	Mapping and monitoring dumped, polluted sediments	NGU has mapped bathymetry, seabed sediments and contaminants, and is now focussing on the sediment dynamics and methodological challenges related to monitoring of dumped, polluted sediments.		Terje Thorsnes, Geological Survey of Norway (NGU)

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Portugal										
Study of the structure, distribution and dynamics of Codium elisabethae populations (Faial, Açores) through the use of cartographical techniques of marine habitats aided by underwater robotics	2002	2007	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Faial Island, Azores)	X	5-30m	scientists and conservation managers	Study of the structure, distribution and dynamics of Codium elisabethae assemblages (shallow sublittoral to 30m deep)	posters, abstracts, thesis	d.sirjacobs@ulg.ac.be
Classification and Mapping of Benthic Sublittoral Biotopes in Faial Island and Neighbouring Channel	2003	2008	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Azores)	X	5-200m	scientists, coastal zone managers	Mapping and classification of sublittoral biotopes in Faial island and neighbouring Channel to Pico Island (0-60m)	report, probably papers	tempera@notes.horta.uac.pt
Mapping of island slopes and shelves in Azores Central Group	2003	2008	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Azores)	X	50-1300m	scientists and public safety	Analysis of slope geomorphology and identification of potential hazardous areas (50 to 1300m)	reports, papers	tempera@notes.horta.uac.pt

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
BANCOMAC	2004	Mar-07	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Azores)	X	0-1500m	scientists and fisheries managers	Database of Marine Organisms of Macaronesia. Main aim: to build up an inventory of historical and present georreferenced occurences of deep-sea corals and sponges; build up and maintenance of a reference collection of specimens by-caught by demersal fishermen and scientific cruises; supply material for genetic and taxonomic analyses; build taxonomic expertise	database, reference collection	filipe@notes.horta.uac.pt
Cory's shearwater foraging habits and habitats	2004	2008	Dept. of Oceanography & Fisheries - Univ. of the Azores	Azores archipelago and North Atlantic	X, XII	Epipelagic	scientists, marine environment managers	Study of the foraging range of Calonectris diomedea borealis (Cory's shearwater) during the breeding season	thesis, papers	mcarvalho@notes.horta.uac.pt

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
IBAS marinhas	2004	2008	SPEA	Portuguese EEZ	IXa, IXb, Xa1,Xa2	Epipelagic	scientists, marine environment managers	Application of the Birds Directive in the marine environment through an inventory of the marine areas most important to seabirds (IBAs) in Annex I which occur in Portugal. The final aim is to use the list of identified IBAs to designate SPAs in coastal and marine areas.	http://programamarinho.spea.pt	ivan.ramirez@spea.pt and http://programamarinho.spea.pt/

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
RENSUB	2004	2009	CCMAR - Univ. Algarve	southern Portuguese coast	IXa	0-30m	scientists, coastal zone managers	The entire portuguese coast, as far as 30 meters deep, is classified as National Underwater Ecological Reserve. However, its characterization is only beginning. The biological characterization is being made at a 1:50000 scale and includes density maps and calculation of several biodiversity, vulnerability and ecological sensibility indexes. The sampling procedure includes underwater visual census for ichthyofauna and macrofauna on rocky bottoms; quadrats for algae; beam trawl and video transects for sandy bottoms. All the information is being integrated in Geographic Information Systems for a complete analyses of all the different maps.	reports, papers	Jorge Gonçalves jgoncal@ualg.pt http://www.ualg.pt/fcma/cfrg/

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
TELEMETRIA	2004	2008	CCMAR - Univ. Algarve	southern Portuguese coast (Ria Formosa)	IXa	0–20m	Scientists, coastal zone managers	Sea bream spatio-temporal dynamics and habitat use in the Ria Formosa lagoon. The main objective of this project is to study habitat use within the Ria Formosa lagoon. We will be using tagging studies (telemetry and external T-tags) to obtain information on sea bream movements within the lagoon. We will be able to answer questions such as: how important are the sea grass beds for sea breams? do sea breams use the small creeks and the areas that are flooded at high tide? are there daily migratory patterns?	reports, papers	Karim Erzini kerzini@ualg.pt http://www.ualg.pt/fcma/cfrg/

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
DEEPCO	2005	2009	Portuguese Hydrographic Institute	western Portuguese margin	IXa	100-3000m	Scientists	Deep sedimentary conduits of the west-Iberian margin. Bathymetry, geophysics and sedimentology of Portuguese canyons	reports, papers	aurora.bizarro@hidrografico.pt
GOLFINICHO	2005	2007	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Azores)	X	Epipelagic	Scientists, marine environment managers	Ecological niche partitioning between two species of dolphins around the Azores and Madeira. Main aim: to investigate spatial and trophic niche partitioning between two dolphin species, the common dolphin (Delphinus delphis) and the Atlantic spotted dolphin (Stenella frontalis), around the Azores and Madeira.	reports, papers	squerouil@notes.horta.uac.pt

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
HERMES	2005	2009	Dept of Biology, University of Aveiro and Portuguese Hydrographic Institute	Nazaré and Lisbon-Setúbal canyons (off Portuguese mainland coast)	IXa	200–4000m	Scientists, conservation managers?	Description of benthic assemblages in canyons off mainland Portugal; characterization of physical, geological and chemical processes	reports and possible papers	http://www.eu-hermes.net/
LIMITS	2005	2008	CIIMAR - Univ. of Oporto	mainland Portugal	IXa	<0m; 0–50m	Scientists, coastal zone managers	Population dynamics, geographical distribution and genetic diversity of macroalgal species at their southern distributional limits - The overall objective of this project is to determine the vulnerability and conservation value of some brown algae and the communities they dominate at their distribution limit.	reports, papers	http://www.ciimar.up.pt/biodiversidade/index_biocost.htm

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
PORTCOAST	2005	2007	Instituto de Oceanografia, Faculdade de Ciências da Universidade de Lisboa	Portugal	IXa, X		Scientists, coastal zone managers	Aims: a) to characterize the Portuguese coastal climate variability during the XXth Century with special emphasis on the physical effects on the ocean environment that are most relevant for the climate change vulnerability of biological communities. These include changes in sea-surface temperature, wind stress, upwelling, wave climate, storminess, salinity, stratification, and circulation patterns. b) study the vulnerability of selected coastal biological communities to climate change effects. Particular attention will be given to sea-surface temperature, wind stress, upwelling, and column stratification. The sensitivity of	reports, papers	http://www.io.fc.ul.pt/zoologia/projectos/portcoast/index.htm

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Task Group for the Extension of the Continental Shelf	2005	2009	Ministry of National Defence	Portuguese EEZ and Continental Shelf area to be potentially claimed	IXa, IXb, X	50–2000; >2000m	Scientists and ocean resources managers	Study of geomorphology and geological nature of deep sea structures	Reports, maps and publications	mapabreu@emepc.gov.pt
LIFE SOS Freira do Bugio	2006	2010	SPEA & PNM	southern Portuguese Coast	IXa	Epipelagic	Policy makers, scientists	Application of the Birds Directive in Madeira with special emphasis in the at-sea distribution of Pterodroma feae in the Madeira EEZ	http://programamarinho.spea.pt/	ivan.ramirez@spea.pt and http://programamarinho.spea.pt/
MAERLPICON	2006	2009	CCMAR - Univ. of the Algarve	Atlantic coasts of the Iberian Peninsula	IXa	0–20m	Scientists, coastal zone managers	Conservation status of maërl beds in the Atlantic coast of the Iberian Peninsula. Main aim: to describe the long-term changes in the benthic marine flora of the continental coast of Portugal by comparing the actual situation with the only available description of the Portuguese marine flora, which was done in the 1960´s by Ardré (1970, 1971).	Reports, papers	http://www.ualg.pt/ccmar/maree/index.php

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
PADEL/Graciosa	2006	2007	Dept. of Biology - Univ. of the Azores	Portugal (Graciosa Island, Azores)	X	<0m (intertidal); 0–30m	scientists, coastal zone managers	Natural Heritage and Sustainable Development in the Azorean Coastal Zone: Graciosa island as a case study	reports, papers?	aneto@notes.uac.pt
MARMAC II - Knowledge, promotion and enrichment for the sustainable use of the Marine Protected Areas of Macaronesia – Phase II	2007	2008	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Azores)	X	0–150m	scientists, conservation and fisheries managers	Analysis of movements and habitat selection for a selection of coastal fish species with the aim of testing the theorectical benefits of marine protected areas with field experiments (0-100m)	reports, thesis, papers	afonso@notes.horta.uac.pt
MARE-Tecnologias da Pesca	2001	2007	INRB/L-IPIMAR	Mainland Portuguese slope	IXa	600–1500	Scientists and Fisheries managers	cartography of seabed morphology oriented to deep-water fishing and assesment	Reports, Papers	victorh@ipimar.pt
ACOSHELF	2007	2010	CESAM/UA	Portugal: north and south coast. Spain: Bay of Cadiz and Mar Menor.	IXa	5–200m	Scientists/fisheries	Identification, mapping and characterisation of soft bottom biotopes, over the portuguese coast. Mapping of underwater vegetation (Spain).	Scientific papers, reports	Ana Rodrigues (anarod@ua.pt)

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
BIOMARES	2007	2010	INRB/L-IPIMAR	Arrábida Marine Park (Sesimbra, Portugal)	IXa	5–100	Area management and Nature conservation	Seabed physical and biological characterization. The project proposes an active management strategy for Habitat 1170- Reefs and the restoration of Habitat 1110 – Sand banks, permanently covered with sea water. The project goals are to restore the lost seagrass meadow at Portinho da Arrábida and invert the current tendency for overexploitation and damage to these two rich habitats, which has lead to the almost complete destruction of seagrass meadows and their associated biological diversity, in what was the last truly marine example of this habitat on Atlantic Iberian coastlines.	Reports, papers	victorh@ipimar.pt

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
IMAGING - Automated counting for Norway lobster population estimation	Autumn 2006	ongoing	Instituto Nacional de Recursos Biológicos/Laboratório de Investigação das Pescas e do Mar (INRB/L-IPIMAR) Instituto Superior/Instituto de Telecomunicações, Técnico/(IST/IT)	Portuguese continental coast (Norway lobster fishing ground)	IXa	300–700m (preliminary work at about 500m depth)	scientists, fisheries managers	Development of a method to automate the detection and counting of Morway lobster, Nephrops norvegicus, and their burrows in underwater imagery collected over deepwater crustacean fishing grounds.	Conference presentations; paper; software development	INRB/l_IPIMAR Paulo Fonseca (pfonseca@ipimar.pt) IST/IT Paulo Lobato Correia (plc@lx.it.pt)
Satellite Imagery (ocean colour and temperature)		ongoing	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Azores)	X	Epipelagic	scientists	Epipelagic environment	Reports, papers, maps	http://oceano.horta.uac.pt/detra/
Seamounts (Azores)		2007	Dept. of Oceanography & Fisheries - Univ. of the Azores	Portugal (Azores)	X	0–5000m	scientists, conservation and fisheries managers	Seamount inventory within the Azores EEZ sub-area (max ca. 5000m deep)	Papers, map, thesis; http://www.horta.uac.pt/ppl/tmorato/publ.html	telmo@notes.horta.uac.pt
Telemetry of loggerhead turtles in the North Atlantic		ongoing	Dept. of Oceanography & Fisheries - Univ. of the Azores	North Atlantic	X	Epipelagic	scientists and conservation managers	Epipelagic environment	Reports, probably papers	msantos@notes.horta.uac.pt
Sweden										
Baltic Algae Watch System	1997	ongoing	Swedish Meteorological and Hydrological Institute	Baltic Sea, incl. Kattegatt			Environmental monitoring	Satellite imagery for monitoring of algal blooms in the Baltic Sea	Daily reports on algal blooms	Martin Hansson, Swedish Meteorological and Hydrological Institute

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Benthic habitat mapping in Swedish parts of Skagerrak	1999	2002	Swedish Board of Fisheries, County administration of Västra Götaland, Tjärnö marine biological laboratory	Northern parts of Swedish territorial waters in Skagerrak		0–300	Nature conservation, fisheries management, research. National and regional environmental managers	Bathymetric and biological surveys in Skagerrak, for nature conservation and fisheries management purposes	Bathymetric and biological maps, reports	Mattias Sköld, Swedish Board of Fisheries
Identification of Areas of special importance for the Swedish commercial fishery	1999	2003	Swedish Board of Fisheries	Swedish EEZ		0–400	Area management and planning, fisheries. National and regional planning agencies	Mapping of fishing areas for commercially important species, using fishermens logbook data	Thörnqvist 2006. Områden av riksintresse för yrkesfisket. Finfo 2006:1. ISSN 1404-8590 (at www.fiskeriverket.se)	Ulf Bergström, Swedish Board of Fisheries
Benthic habitat mapping and modelling in Gullmarsfjorden, Skagerrak	2003	2004	Swedish Board of Fisheries, County administration of Västra Götaland	Gullmarsfjorden, a fjord in Skagerrak		0–120	Nature conservation, fisheries management, research. National and regional environmental managers	Bathymetric and biological surveys in Skagerrak, for research, nature conservation and fisheries management purposes	Bathymetric and biological maps, reports	Mattias Sköld, Swedish Board of Fisheries
Benthic habitat mapping in Bratten, Skagerrak	2003	2004	Swedish Board of Fisheries, County administration of Västra Götaland, Tjärnö marine biological laboratory	Bratten, an offshore area in Skagerrak		130–440	Nature conservation, fisheries management, research. National and regional environmental managers	Bathymetric and biological surveys in Skagerrak, for research, nature conservation and fisheries management purposes	Bathymetric and biological maps, report at http://www.forumskagerrak.com/download/744/x/WP6%20pop%20web.pdf	Mattias Sköld, Swedish Board of Fisheries

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Morphometric identification of potential Natura 2000 areas	2003	2003	Swedish Environmental Protection Agency, Metria	Swedish EEZ		0–30	Identification of certain Annex 1 habitats by morphometric analyses	Morphometric modelling of the distribution on a national scale of six Annex I habitats of the Habitat Directive: 1130 estuaries, 1150 Lagoons, 1160 Large shallow inlets and bays, 1650 Narrow bays in the Baltic, 1620 Skerries and small islands in the Baltic.	www.naturvardsverket.se	Cecilia Lindblad, Naturvårdsverket
National survey of Swedish offshore banks	2003	2005	Swedish Environmental Protection Agency	Swedish waters in Skagerrak, Kattegatt, the Baltic Proper and the Gulf of Bothnia		0–20m	Area management, nature conservation. National and regional environmental managers, wind farming industry	Mapping of geological, hydrographic, and biological characteristics of Swedish offshore grounds, for spatial planning purposes (especially the large scale establishment of offshore windfarms)	Inventering av marina naturtyper på utsjöbankar. Naturvårdsverkets rapport 5567. ISBN 91-620-5576-3 (at www.naturvardsverket.se)	Swedish Environmental Protection Agency

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Fish recruitment habitat modelling (part of the BALANCE EU Interreg IIIB project)	2005	2007	Swedish Board of Fisheries	Northern Baltic Sea: Stockholm-Uppland archipelagos i Sweden, Åland archipelago and Archipelago Sea in Finland		0–6m	Research, area management, nature conservation. National and regional fisheries and environmental managers	Mapping of recruitment habitats of coastal fishes in the Baltic Sea. Field data on fish occurrence is coupled with environmental characteristics predictions are made using statistical GIS modelling.	www.balance-eu.org	Ulf Bergström, Swedish Board of Fisheries
Habitat modelling projects	2005	ongoing	Aquabiota	Several smaller coastal areas in Swedish territorial waters		0–50	Area management, nature conservation. National and regional environmental managers	Modelling of vegetation and benthos using field survey data		Martin Isaeus, Aquabiota
Inventories and mapping of deep benthic habitats	2005	ongoing	Swedish Environmental Protection Agency	Kosterhavet		10–150m	Mapping of planned marine national park	Extensive inventory and mapping of biological values using several sampling methods and detailed bathymetry.		Anita Tullrot, Per Nilsson and Mats Lindegarth, Göteborg University
National biological survey of marine Natura 2000 areas	2005	2007	Swedish Environmental Protection Agency, regional environmental authorities	Designated Natura 2000 habitats in Swedish territorial waters		0–30	Area management, nature conservation. National and regional environmental managers	Mapping of biota of designated marine Annex 1 habitats in Sweden	www.naturvardsverket.se	Swedish Environmental Protection Agency

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Fish habitat modelling (part of the Swedish Energy Agency project VINDVAL)	2006	2008	Swedish Board of Fisheries, Aquabiota	Fladen and Lilla Middelgrund in Kattegatt		0–20	Research, area management, nature conservation. National and regional fisheries and environmental managers, windpower industry	Mapping of essential fish habitats at offshore grounds in Kattegatt. Field data on fish occurrence is coupled with environmental characteristics predictions are made using statistical GIS modelling.	www.naturvardsverket.se/Vindval	Ulf Bergström, Swedish Board of Fisheries
Swedish Natura 2000 habitat modelling	2006	2007	Metria	Swedish EEZ		0–30	Area management, nature conservation. National and regional environmental managers	Physiographic modelling of Annex 1 habitats using data on bathymetry, geology, wave exposure etc	www.balance-eu.org	Sandra Wennberg, Metria
LIDAR survey of planned marine nature reserve	2007	2008	County Administrative Board of Östergötland	A small coastal area in Östergötland archipelago		0–15 m	Area management, nature conservation. National and regional environmental managers	LIDAR survey for management and habitat modellling purpose	Depth data in point and rasterdataset, habitat mapping in progress	Erik Årnfelt County administrative board of Östergötland
Local surveys and modelling of EUNIS habitats in coastal areas.	2007	2007	County Administrative Board of Västra Götaland	Vinga and Marstrand		0–35m	Mapping of planned nature reserve and general planning	Mapping of EUNIS-habitats based on newly collected data and data from the Swedish SAKU dataset.	Reports to the county administration	Mats Lindegarth and Anita Tullrot, Göteborg University

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Multi-Sensor Approach for Mapping of Aquatic Biotopes	2007	2008	Swedish Defence Research Agency	A small coastal area in Östergötland archipelago		0–15 m	Research for environmental quality assessment	Combined approach including panchromatic and multi-spectral high-resolution satellite imagery, LIDAR and measurements of water optical parameters	Habitat classification in progress	Michael Tulldahl, Swedish Defence Research Agency
National survey of Swedish offshore banks	2008	2009	Swedish Environmental Protection Agency	Swedish waters in Skagerrak, Kattegatt, the Baltic Proper and the Gulf of Bothnia		0–20m	Area management, nature conservation. National and regional environmental managers, wind farming industry	Mapping of geological, hydrographic, and biological characteristics of Swedish offshore grounds, for spatial planning purposes (especially the large scale establishment of offshore windfarms)		Swedish Environmental Protection Agency

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
Geological mapping of the Swedish Territorial Waters and EEZ		Ongoing	Geological Survey of Sweden	Swedish Territorial waters and EEZ		0-400 m	Various stakeholders (e.g. national and regional authorities)	A systematically survey of the geological composition of the seafloor within the Swedish marine territory and Exclusive Economic Zone (EEZ). Depth range, from the coast to the deepest basins (0-400 m). Fieldwork during 2007 was mainly conducted on the northern Swedish west coast around the Koster archipelago on detailed scales (1:100 000). Data-sets compiled and delivered during 2007 are the Swedish Baltic east-coast in scale 1:500 000 and Hanöbukten in scale 1:100 000.	Digital maps and reports published by the Geological Survey of Sweden (at www.sgu.se)	Geological Survey of Sweden, Dr. Johan Nyberg
National Swedish marine biological monitoring programme		Ongoing	Swedish Environmental Protection Agency, regional environmental authorities	Swedish territorial waters		0-400	Environmental quality assessment. National and regional authorities	Environmental monitoring programme of plankton, vegetation, benthos, fish		Swedish Environmental Protection Agency

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
United Kingdom										
The sensitivity of benthic habitats in NW Irish Sea and Malin shelf	01/06/2004	01/06/2009	AFBI	Irish Sea	VIIa	20-300m	Fisheries	Recent developments have highlighted the increasing need to develop an ecosystem approach to fisheries management. The potential for conflict between the fishing industry and conservation bodies was underlined by recent interest in Strangford Lough. The Habitats Directive has been extended to the 200nm Limit and the WFD affects coastal waters. Therefore, in order to manage future developments it is necessary to conduct a "stocktake" of Habitats liable to be impacted by the N Ireland fishing industry and determine their sensitivity to disturbance		Dr M Service, AFBI

Programme or project title	Date - start	Date - end	Organisation(s) undertaking survey	Geographical coverage (country, region)*	ICES rectangle	Depth range surveyed	Purpose of study/targeted end-users	Summary abstract for study	Outputs	Contact name & Organisation
MESH SW Approaches canyons survey	04/06/2007	18/06/2007	JNCC; Marine Institute; BGS	Celtic Sea	26E0; 25E0	500-1000m	Research	The MESH SW Approaches canyons survey was a collaborative survey involving the Joint Nature Conservation Committee, the Marine Institute, the British Geological Survey and the University of Plymouth. Defra Natural Environment Group Science Division (CRO 361) made a significant contribution to this work. The work contributed to the MESH project (www.searchmesh.net) that received European Regional Development Funding through the INTERREG IIIb Community Initiative (www.nweurope.org). The aims of the survey were to acquire high resolution multibeam, sub-bottom profiler and seabed imagery data in the SW Approaches area, located approximately 320km southwest of Land's End. The cruise not only mapped the variable morphology of the area, but also investigated the biological communities within the canyon system for the assessment of potential Special Areas of Conservation (SAC) under the EC Habitats and Birds Directive (Annex I) (Johnston et al. 2002). The cruise also tested the application of the survey standards and protocols developed under the MESH project. The cruise was the first thorough test for the recently completed MESH Guidance Framework, providing a 'proof of concept' from planning to completion.	DAVIES, J., GUINAN, J., HOWELL, K., STEWART, H. and VERLING, E. (editor). 2008. MESH South West Approaches Canyons Survey (MESH Cruise 01-07-01) Final Report. MESH Partnership, 2008. http://www.searchmesh.net/Default.aspx?page=1935	Neil Golding, JNCC

Annex 6: National Status Report - Belgium

Renard Cente for Marine Geology, Ghent University

Classifying ecologically-relevant marine landscapes, a statistical approach Verfaillie, E., Degraer, S., Schelfaut, K., Willems, W. & Van Lancker, V. (submitted to Continental Shelf Research)

An objective methodology for marine landscape mapping is now being proposed where abiotic variables are subjected to a statistical approach, using principal components analysis (PCA) and a cluster analysis. The optimal number of clusters is being defined using the Calinski-Harabasz criterion. The final model results classified the BPNS into 8 marine landscapes that represent well the natural variability of the seafloor. The internal cluster consistency was validated with a split-run procedure, with more than 99% correspondence between the validation and the original dataset. Cross tabulation was used to validate the ecological relevance of the clusters. The clusters and samples of macrobenthic communities give a Cramer's V index of 0.578, indicating a strong relationship between both variables. The proposed methodology, as exemplified for the BPNS, can easily be applied to other areas and provides a strong basis for environmental protection and management of the marine environment.

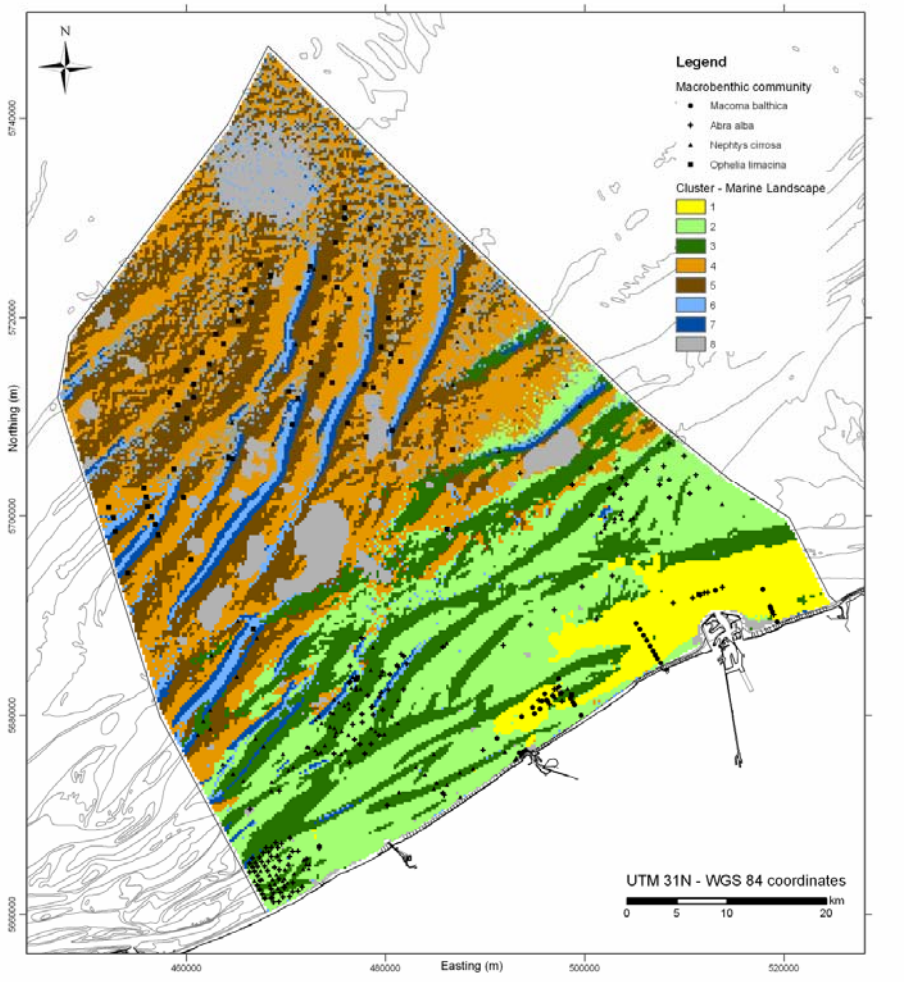

Figure A6.1: Belgian marine landscapes.

Cluster	Characteristics
1	Shallow, high silt-clay percentage, high current velocity, high bottom shear stress, turbid, high Chl a concentration
2	Shallow NW orientated flats and depressions, fine sand, slightly turbid, high Chl a concentration
3	Shallow SE orientated sandbanks, fine to medium sand, slightly turbid, high Chl a concentration
4	Deep NW orientated flats and depressions, medium sand
5	Deep SE orientated flats and depressions, medium sand
6	Crests of sandbanks, medium sand
7	Slopes of sandbanks, medium sand
8	High percentage of gravel – shell fragments

Geostatistical modelling of sedimentological parameters using multi-scale terrain variables: application along the Belgian Part of the North Sea Verfaillie, E., Du Four, I., Van Meirvenne, M. & Van Lancker, V. (submitted to International Journal of Geographical Information Science)

The sediment nature and processes are the key to the understanding of the marine ecosystem, and can explain particularly the presence of soft-substrata habitats. For predictions of the occurrence of species and habitats, detailed sedimentological information is often crucial. This paper presents a methodology to create high quality sedimentological data grids of grain-size fractions and the percentage of silt-clay. Based on a multibeam bathymetry terrain model, multiple sources of secondary information (multi-scale terrain variables) were derived. Through the use of the geostatistical technique, Kriging with an external drift (KED), this secondary information was used to assist in the interpolation of the sedimentological data. For comparison purposes, the more commonly used Ordinary Kriging technique, was also applied. Validation indices indicated that KED gave better results for all of the maps.

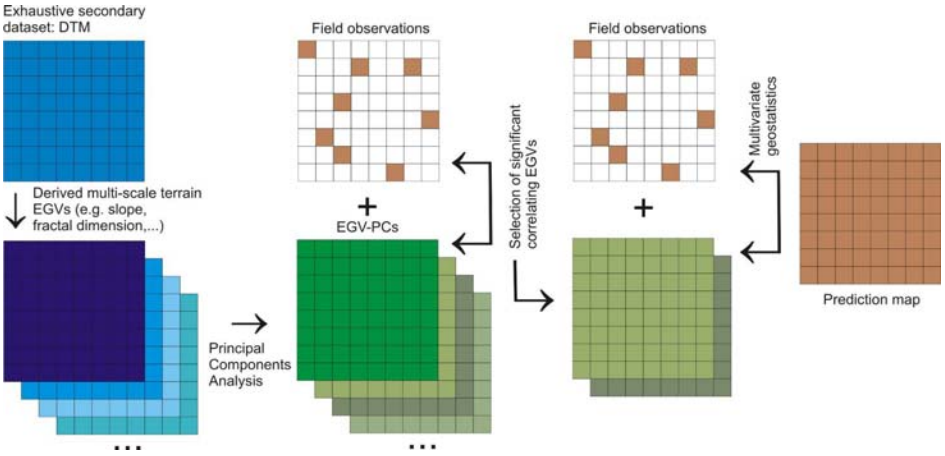

Figure A6.2:

The relevance of ecogeographical variables for marine habitat suitability modelling of *Owenia fusiformis*. Verfaillie, E., Degraer, S., Du Four, I., Rabaut, M., Willems, W. & Van Lancker, V. (submitted to Estuarine, Coastal and Shelf Science)

This paper presents how different combinations of abiotic or ecogeographical variables (EGVs) influenced habitat suitability models of the macrobenthic species *Owenia fusiformis*. This tube building polychaete is living in a well defined habitat and is strongly linked to the sediment and topography of the seabed. Therefore, subsets of sedimentary, (multi-scale) topography and other EGVs (e.g. hydrodynamics) were used to predict the distribution of the species. Until now, only sedimentological and bathymetrical EGVs were considered for this species. The habitat suitability models were based on ecological niche factor analysis (ENFA). The exercise was executed on two study areas: (1) the BPNS and (2) a small area in the BPNS, where *O. fusiformis* is known to occur abundantly. Cross-validation for both study areas showed that topographical EGVs were crucial for a good habitat suitability model. For both study areas, the combination with sedimentological and other EGVs improved the model.

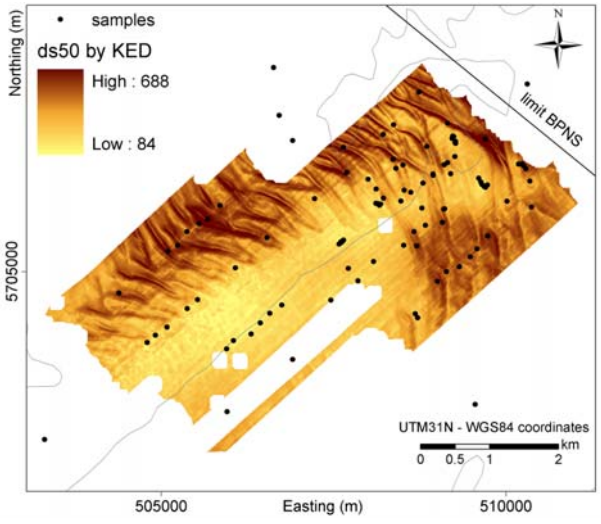

Figure A6.3: Predicted habitat suitability for the Belgian part of the North Sea for the polychaete *Owenia fusiformis*.

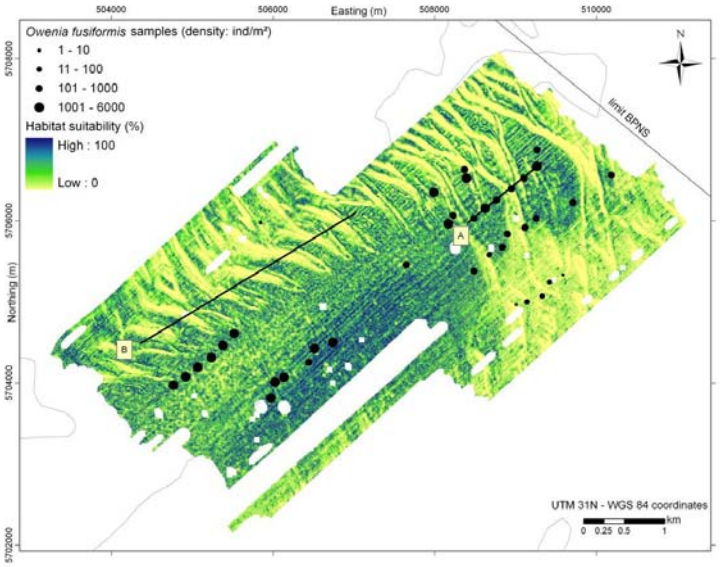

Figure A6.4: Predicted habitat suitability for each sub-area for the polycheate *Owenia fusiformis*.

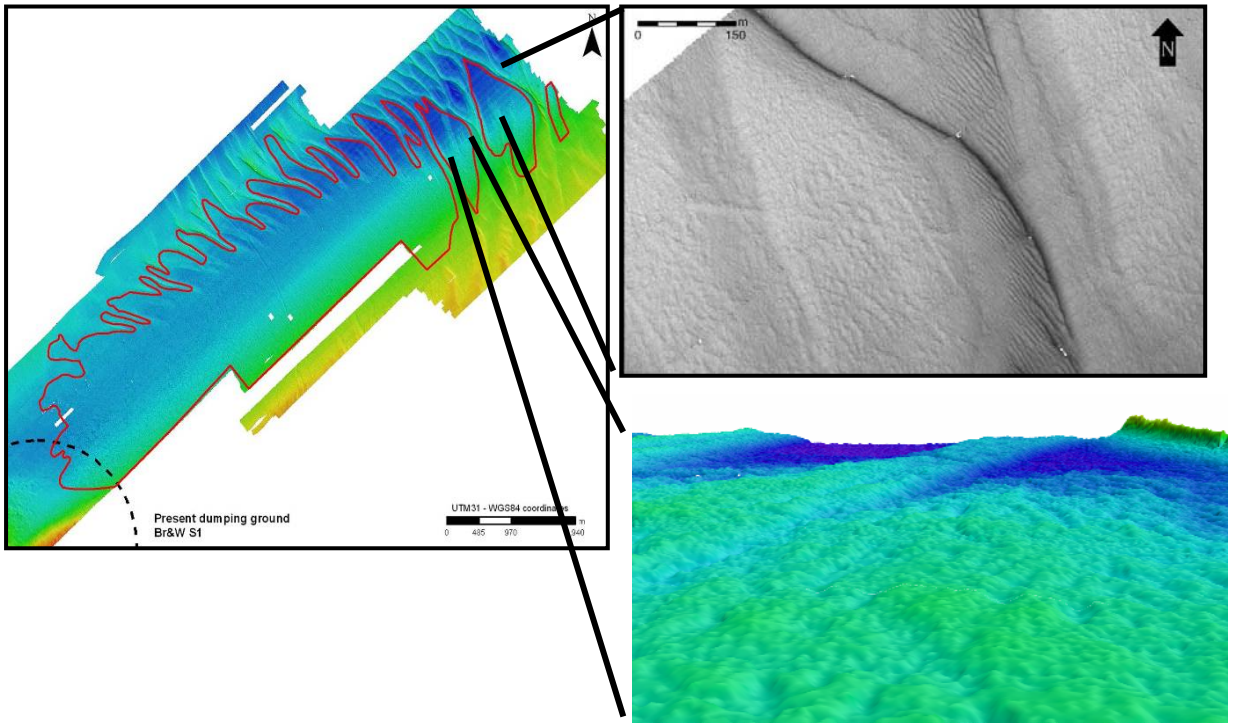

Figure A6.5: Multibeam mapping of the tube-building polychaete Owenia fusiformis on the Belgian Part of the North Sea.

Royal Belgian Institute of Natural Sciences and Fund for Sand Extraction

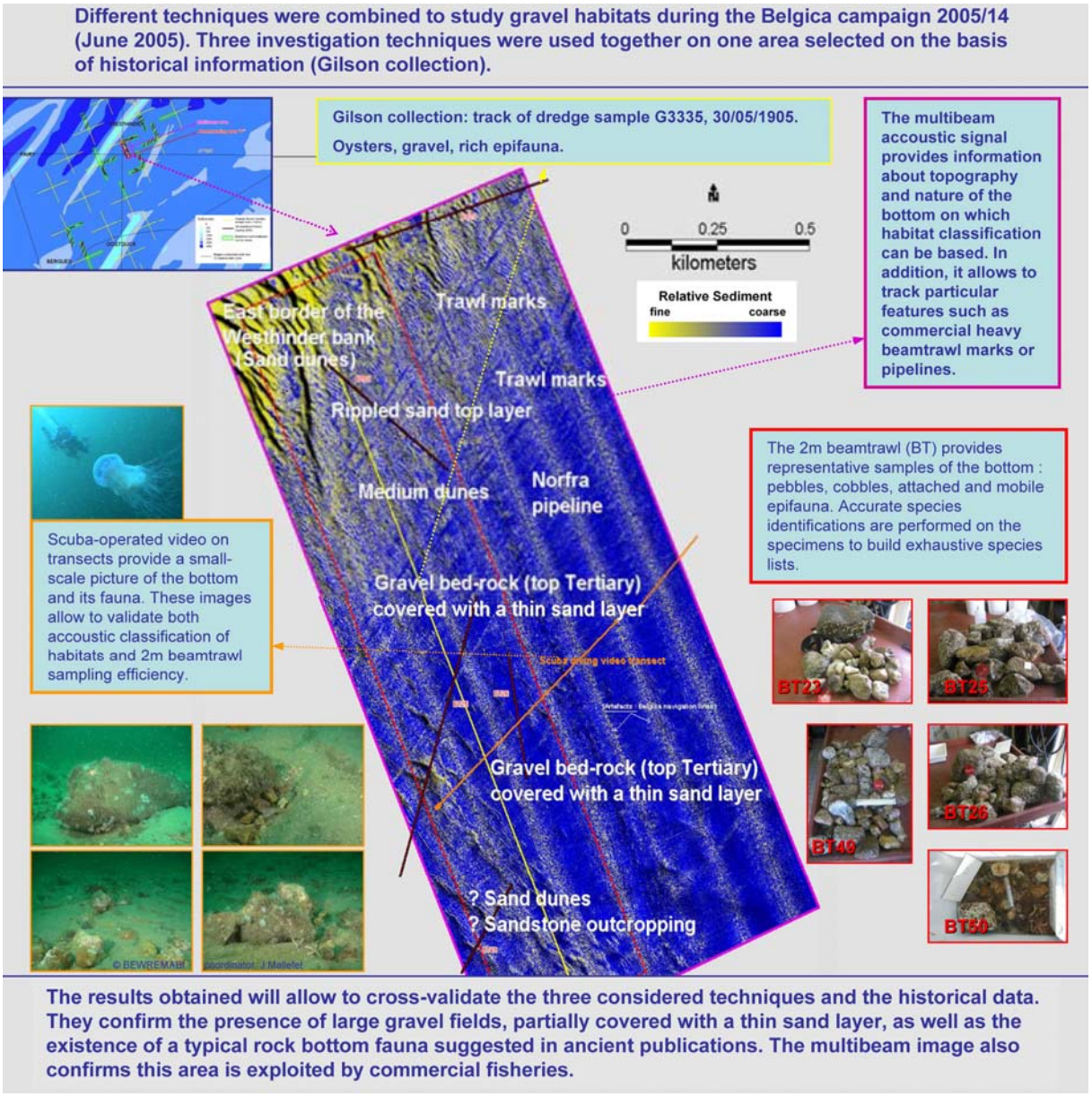

Figure A6.6: Poster of studies

Annex 7: National Status Report – USA

Report from NOAA

The following report was received from Stephen K. Brown (NOAA, Office of Science and Technology, Silver Spring, MD, USA), James Thomas (NOAA, Office of Habitat Conservation, Silver Spring, MD, USA), Vincent Guida and Thomas Noji (NOAA, National Marine Fisheries Service, Sandy Hook, NJ, USA).

The information provided here is a summary of some of the current and planned seabed mapping activities conducted by the National Oceanic and Atmospheric Administration. The information is not intended to be exhaustive but rather illustrative.

Mapping objectives

In the U.S. there is a large set of needs or drivers for broad-scale habitat mapping. Some of these include:

- Delineation of Essential Fish Habitat
- Elucidation of Habitat-Species Linkages
- Documenting and Understanding the Effects of Fishing on the Sea Floor
- Improve Stock Assessments
- Extrapolations to Regions Over Which Fisheries Managed
- Recover Protected Species
- Nautical Charting
- Monitoring Invasive Species
- Characterizing Marine Sanctuaries
- Charting Coral - Shallow
- Charting Coral - Deep
- Removing and Reducing Marine Debris
- Marine Protected Areas
- Restoration Monitoring (oysters & coral)
- Develop and Test New Technology

Data standards

IHO and FGDC metadata standards are generally applied. However, the standards applied vary according to the mapping objectives.

Data archiving

Data are archived in several repositories. These include databases at regional science centers, at national data repositories including NGDC, other federal agencies such as the U.S. Geological Survey, and in databases administered by regional data partnerships.

Methods

A wide array of mapping methods is utilized. These include:

- Multibeam Bathymetry

- IHO Standards
- Multibeam Backscatter
- Side Scan
- Single Beam
- Classification Scheme - Greene et al. 1999
- Classification Scheme - QTC
- Laser Line Scan
- Sub-bottom Profile
- Ground Truth - Video
- Ground Truth - Still Images
- Towed Drift Camera
- Ground Truth - Submersible (manned, ROV, UAV)
- Ground Truth - Diver
- Ground Truth - Trawl
- Ground Truth - Long-line
- Ground Truth - Grab Sampler
- Free Fall Cone Penetrometer
- Corer
- Lithology from USCGS Archived Lead-line Data
- Satellite Imagery - IKONOS
- LIDAR (0 to 30 meters+).

Issues and concerns

There is a suite of needs associated with seabed mapping. These include a need for increased training in data collection and data processing, more and better survey equipment, consensus on collection standards, comparability of habitat classification systems, ensuring access and exchange of archived data, development of rigorous and efficient ground-truthing methodologies, additional staffing capacity and improved coordination of seabed mapping activities.

Example of activities in the north-east region of the USA

The North-east region is roughly defined as the coastal and marine waters in the north-eastern USA from the northern-most tip of Maine to Cape Hatteras, North Carolina.

Ongoing and FY08 seabed mapping and characterization

- Georges Bank
- Hudson Canyon
- Coastal
- Broad-scale, theoretical
- The Kostylev Approach - Habitat Modelling of Habitat Disturbance and Growth Potential to Produce Cost-Effective Broad-Scale Habitat Maps

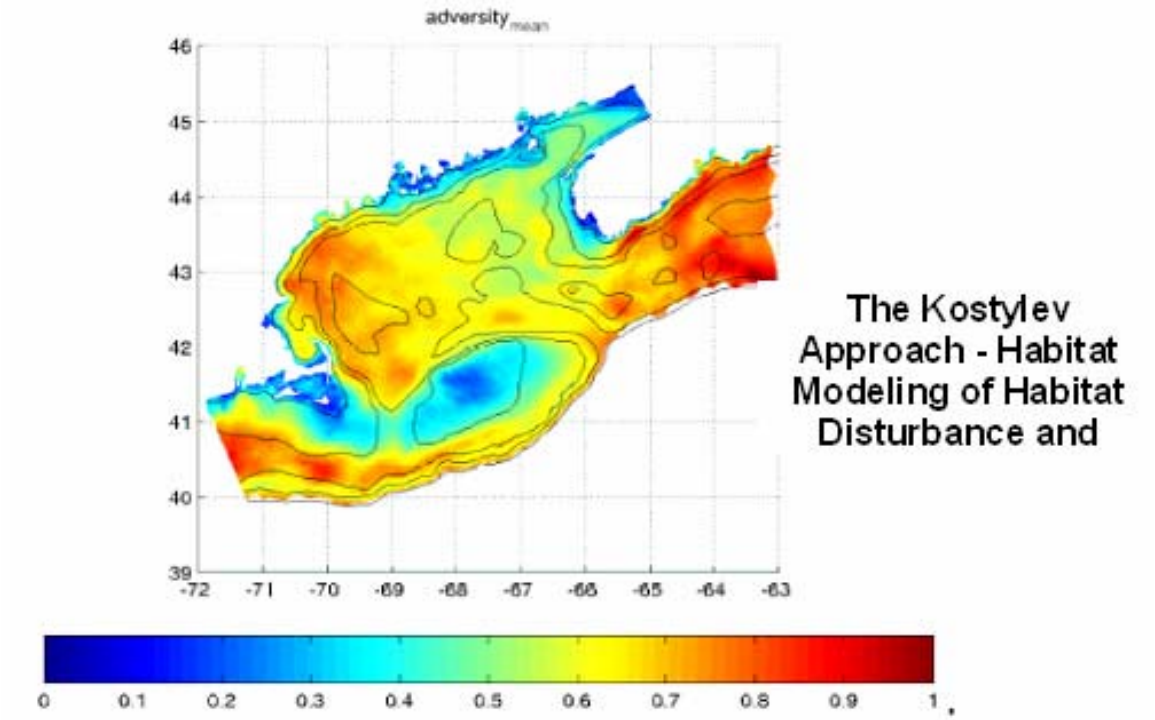

Figure A7.1: The Kostylev Approach to habitat modelling

Areas already mapped and characterized

- Several "small" areas on the shelf and in bays / estuaries have been mapped using primarily pelagic and benthic sampling supplemented in some cases with side-scan sonar.
- Parts of Georges Bank have been mapped (chiefly by Canada) using multi-beam sonar and ground-truth benthic sampling as well as hydrographic sampling. Extensive trawl and visual ground truth and hydrographic data exist for the U.S. side, but only limited acoustic mapping.
- Portions of the Gulf of Maine, particularly inshore off Massachusetts, Stellwagen Bank and some of the other banks in the western Gulf have been mapped with multibeam sonar by a variety of agencies, in a number of cases with the encouragement of the Gulf of Maine Mapping Initiative (GOMMI). Biological sampling and visual ground truth data are available for these.
- Large parts of the Hudson Canyon have been mapped using at varying resolutions using side-scan, single beam, and hull- and AUV-mounted multibeam sonars. Some trawl, benthic, pelagic, and hydrographic sampling and visual ground truth data are also available.

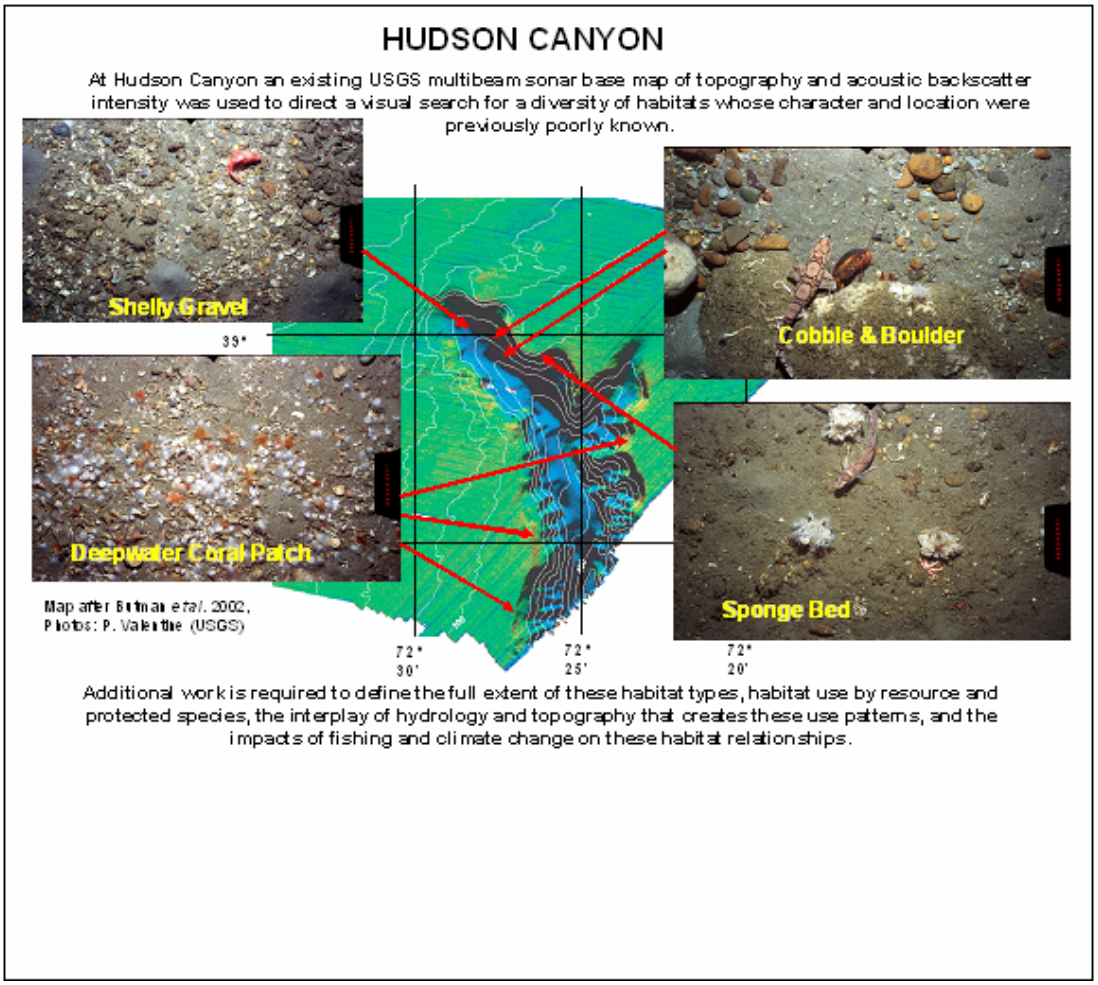

Figure A7.2: Mapping of the Hudson Canyon

Standards

NEFSC participated in an IOCM workshop to develop uniform mapping standards for use by NOAA offices. The resulting document was in reviewed by participating NOAA offices early in FY08. Standards for acoustic methods mapping methods are based on International Hydrographic Office (IHO). Their employment should facilitate greater cooperation/collaboration between NOAA offices in performing mapping tasks and in merging adjacent map data sets so as to avoid the need for redundant or overlapping coverage. These standards cannot be met by the NEFSC's Kongsberg ME 70 as presently configured aboard F/V HENRY B. BIGELOW.

Priority areas requiring mapping within next two years

Georges Bank - Rationale: Georges Bank is the richest fishing area in the NE and some of its most productive habitats are under combined threat from fishing gear effects and the invasive tunicate Didemnum sp. Detailed topographic and sediment maps are urgently needed to guide investigations to identify critical habitats and to track the progress of the tunicate across areas too large and complex for visual or grab sampling surveys.

Outer Shelf around Hudson Canyon - Rationale: The major area of tilefish stocks and important habitat for monkfish, silver hake, longfin squid, scup, and butterfish have not been mapped. Accidental discovery of hitherto unsuspected relict ice age features like boulder fields (drop stones) and iceberg gouges that appear to be aggregation habitats for fishes suggest that these expansive shelf areas may offer more diverse habitat support for resource species than previously realized. As on Georges Bank, heavy bottom trawling bears the potential threat of habitat damage.

Inner Shelf off Maryland coast - Rationale: Exploration is underway for the development of wind power installations off the Maryland ocean shoreline. The area is

known to contain a number of reefs, both natural and artificial, that are important habitats for black sea bass and tautog, and which harbor dense stands of soft coral. There is no habitat base map that relates these features to each other or surrounding habitats from which to judge broad-scale impacts or plan monitoring programs. The most recent bathymetric data at NGDC for this area dates from the 1930's.

Long-term mapping, characterization and product needs

- High resolution biological / geological habitat maps with GIS layers of sector activities (current and planned) are needed as tools for SPATIAL PLANNING. Issues of particular concern, which could benefit significantly include:
  - Essential Fish Habitat
  - Energy development, e.g. wind turbines, tide turbines
  - Energy delivery, e.g. LNGs, pipelines
  - Aquaculture both coastal and offshore
  - Transportation
  - Homeland Security
- Continued development of a network of regional users to optimize use Initiative (GOMMI)of mapping assets (vessels, equipment, personnel)
  - Build upon regional efforts already in place by the Gulf of Maine Mapping
- Continued development of online Habitat Decision-Making Tools (e.g. EcoGIS)
- Develop capabilities to visualize changing characterization of habitats in response to natural and anthropogenic stressors like climate change
- Build upon theoretical habitat mapping activities based on the Kostylev Approach.
- Development of "best cost-effective methodologies" to combine sampling technologies for broad-, medium and fine-scale sampling to produce habitat maps.

Collaborations

- Existing intra-agency collaborations
  - Discussions with Office of Habitat Conservation, particularly with Jim Thomas
  - Research collaborations planned with Chesapeake Bay Office, particularly with Steve Giordano
  - UNH CCOM has been supportive of our mapping efforts for several years and will participate on upcoming FY08 summer habitat happing cruises.
  - NOS collaboration for mapping of potential overlap of shipping lanes & right whale habitat in Cape Cod Bay
- Existing inter-agency collaborations
  - Mapping of shelf habitats has been an ongoing partnership with USGS, particularly with Page Valentine and other staff at the USGS Woods Hole office

- Other
  - Academic partnerships have been especially fruitful with staff from University of Rhode Island, Rutgers University and University of Maryland Eastern Shore.
  - The NJ Marine Science Consortium (composed of NJ colleges and universities) has partnered with us on habitat suitability and characterization projects.
  - Participation in Gulf of Maine Council on the Marine Environment's "Gulf of Maine Mapping Initiative" (GOMMI) to promote mapping
  - MIT Sea Grant partnership for Georges Bank mapping.

Report from the Gulf of Maine Mapping Initiative

Submitted by Linda Mercer (ME Department of Marine Resources), Megan Tyrrell (Northeast Fisheries Science Center) and Sara Ellis (GOMMI Coordinator)

Background

In December 2005, GOMMI contracted a part-time Coordinator to support the Steering Committee. Over the following two years, the Coordinator's main projects were:

- facilitating a Two-Year Planning Workshop;
- fundraising for, and coordinating, a pilot benthic habitat mapping project on Cashes Ledge;
- writing and distributing an electronic newsletter to the regional seafloor mapping community (~500 recipients);
- developing a web tool showing existing mapping efforts in the US and Canada (with support from MA CZM's GIS specialist and the Council's Web Producer);
- broadening support for GOMMI (Steering Committee now includes all 3 New England states, US and Canadaian federal agencies, and academia)
- exploring a partnership with UNH's Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC);
- increasing public outreach and education via presentations and the web site;
- writing grants (six grant proposals submitted: $370k requested; $37k awarded to GOMMI-related projects);
- developing a legislative outreach strategy (with guidance from the Council's Policy & Development Coordinator)

In December 2007, the Coordinator announced her resignation from GOMMI (effective April 2008). The Steering Committee met by conference call in January and agreed to hire a new part-time Coordinator. The new a 6-month contract would start in April 2008, using the balance of funds already awarded to GOMMI (~$24,000). The position announcement was posted on the Council's website, and elsewhere, in February.

The Coordinator, Committee Chair, and Working Group Contract Manager are in the process of developing a Davis Conservation Foundation proposal for an April submittal to continue GOMMI's work plan.

Possible activities and next steps

The new Coordinator will help implement Phase IV of GOMMI's Strategic Plan through the following tasks:

- Strengthen ties with other entities involved with seafloor mapping in the Gulf of Maine and beyond (e.g. CCOM/JHC, NOAA's Integrated Ocean and Coastal Mapping Program, NOAA's Office of Coast Survey, GOM Census of Marine Life, GOM Ocean Data Partnership, etc.).
- Create an informational brochure with updates on the status of GOM seafloor mapping and explaining GOMMI's role in coordinating several recent projects.
- Maintain a database of relevant mapping activities in the Gulf of Maine, including goals, description, and points of contact. Facilitate data and information sharing between GOMMI and others involved in seafloor map production as well as map users.
- Work with GOMMI's Steering Committee and other Council contractors to describe the program and its objectives to interested parties.
- Publish GOMMI's newsletter and represent GOMMI at regional meetings.
- Coordinate periodic GOMMI conference calls and track progress on action items.
- Explore a cost-sharing strategy for project coordination by seeking financial support through federal grants, private foundations, and state and federal agency contributions.

Annex 8: Draft Terms of Reference for WGMHM 2009

The Working Group on Marine Habitat Mapping [WGMHM] (Chair: J. Populus, France) will meet in Copenhagen, Denmark from 21 to 24 April 2009.

International programmes

a) Review progress in international mapping programmes (including OSPAR & HELCOM Conventions, EC & EEA initiatives, HERMES, CHARM, PLANOR, JIBS)

National programmes (National Status Reports)

b) Present and review national habitat mapping activity during the preceding year, providing National Status Report updates according to the standard reporting format, an overview map, and focusing on particular issues of relevance to the rest of the meeting.

(presentations strictly limited to a 10 minute overview per country; posters are encouraged for supplementary information; NSR entries in standard spreadsheet format and outline map of study areas in shape-file GIS format to be submitted before meeting)

Mapping strategies and survey techniques

c) Review and assess recent advances in marine habitat modelling techniques.

d) Review ground-truth sampling strategies and validation for remote-sensed data and modelling predictions in the production of habitat maps. Develop recommendations for operational guidelines.

Protocols and standards for habitat mapping

e) Review methodology for the assessment of accuracy and confidence in habitat maps, through the assessment of selected habitat maps and their associated reports/metadata, considering both the final maps and the survey design. Develop guidelines for standard presentation of results to the end user.

f) Review the testing of the MESH survey metadata standards (and use of the associated Access database application) and make recommendations for improvements if required. Explore the traceability of survey data in metadata for habitat maps.

Uses of habitat mapping for management

g) Review the range and style of habitat maps, including issues of map scale and thematic content, in relation to broad types of applications (e.g. spatial planning, protected area design, local development). Recommend standard approaches with regard to the main areas of habitat map application.

WGMHM will report by 25 May 2009 for the attention of the Marine Habitat and the Fisheries Technology Committees, as well as ACE.

Supporting Information

PRIORITY	This Group coordinates the review of habitat classification and mapping activities in the ICES area and promotes standardization of approaches and techniques to the extent possible.
SCIENTIFIC JUSTIFICATION	Action Plan nos.: 1.4.1, 1.4.2, 1.4, 1.4.3. The WG provides an important forum to present and discuss the progress of multinational programmes, in particular, within the Regional Conventions (OSPAR and HELCOM), the EU and its funding instruments (Interreg and FP7 programmes) and the EEA. The strategies, standards and issues addressed by each programme need to be assessed to facilitate sharing of best practice, sharing of difficulties and to work towards integration of resultant maps if feasible. The compilation of National Status Reports is required to keep abreast of current activities and bring attention to new initiatives, developing techniques and data availability. Marine habitat modelling is a growing area of research, with multiple approaches and techniques. WGMHM should share and develop best practice in this field. In recent years there have been considerable advances in the use of remote acoustic techniques for marine mapping. There is a need to examine how well these techniques are validated through ground-truth sampling and to provide suitable guidance. Similarly, maps developed through modelling need validation and associated guidance on this is necessary. Assessment and presentation of issues about accuracy and confidence is marine habitat mapping, to better inform end users of potential limitations in the maps, is at an early stage in development. This is a significant new area in which WGMHM members can contribute to developing new approaches. Sound data management is important in the archiving and distribution of data sets and in interpreting the data to make maps and assess their confidence. WGMHM members have agreed to test a standard developed by MESH and to report back. Habitat maps can be presented in a variety of ways and levels of detail, depending on their purpose. Examination of presentation techniques linked to end-user requirements could help improve the outputs.
RESOURCE REQUIREMENTS	
PARTICIPANTS	Representatives from Member Countries with experience in habitat mapping and classification. Participation of the Baltic countries and from USA and Canada is particularly sought. The participation of members of BEWG, WGEXT, WGECO, WGDEC, WGFAST would be helpful in developing appropriate linkages to other ar-

	eas of ICES work.
SECRETARIAT FACILITIES	
FINANCIAL:	
LINKAGE TO ADVISORY COMMITTEE	ACE
LINKAGES TO OTHER COMMITTEES OR GROUPS	BEWG and SGNSBP, WGEXT, WGECO, WGDEC, WGFAST and SGASC, SGEH (Baltic Committee)
LINKAGES TO OTHER ORGANIZATIONS	OSPAR, HELCOM, EEA

Annex 9: Recommendations and actions

RECOMMENDATION OR ACTION	ACTION
1. Review maps available for the OSPAR habitat mapping programme (www.searchnbn.net/hosted/ospar/ospar.html), and advise of data gaps, supplying additional data where possible, to JNCC.	All WGMHM members by 31 July 2008
2. International classification schemes - WGMHM recognises the benefits of consistent interpretation of mapping data so that data from different areas and sources can be readily compared and aggregated. To this end there is a need to harmonise classification systems and to work towards fully operational international habitat classification schemes. Additionally WGMHM recognises that individual schemes do not always meet the needs of all end users and that there is merit in having several schemes or being able to arrange particular schemes in different ways to suit different end needs. WGMHM recommends directing further effort towards establishing suitable international classification schemes, based on approaches available in North America (Green et al., 1999, Valentine et al., 2005) and Europe (EUNIS 2007; BALANCE Al Hamdani & Reker 2007 and UKSeaMap Connor et al. 2006). Furthermore, national, regional and local mapping programmes should be encouraged to use and test the available classification schemes to help ensure they are 'fit for purpose'.	European Environment Agency, ICES and other relevant international authorities
3. Metadata on mapping programmes: In recognition of the growing volume of information (metadata) being produced from mapping programmes, WGMHM recommend that marine habitat mapping data be clearly signposted in national metadata portals and that these be brought together via a single international web-portal with webGIS facilities to display the distribution and coverage of marine habitat mapping studies across the ICES area.	National and EU marine data management authorities
4. MESH webGIS and metadata portal: in recognition that MESH at present offers the most suitable international web portal for ICES National Status Report metadata, the MESH host institute (JNCC) should be approached regarding the feasibility of expanding the MESH facility to accommodate date from WGMHM.	David Connor by 31 May 2008
5. WGMHM National Status Report metadata and GIS shapefiles of study areas: Members to compile and update all records for each country from the national reports submitted since 2000 (standard DEF to be agreed).	WGMHM members for each country before WGMHM 2009
6. Evaluate MESH survey metadata standard (and associated Access database) during forthcoming surveys.	WGMHM members by WGMHM 2009
7. Review procedures for updating habitat maps and report to WGMHM	Jacques Populus by WGMHM 2009
8. Develop aspects of habitat modelling and confidence assessment in support of 2009 ToRs	WGMHM members by 31 January 2009