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

4–7 April, 2006

Galway, Ireland

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Executive summary

The Working Group on Marine Habitat Mapping (WGMHM) convened in Ireland from 4–7 April 2005 and was hosted by Fiona Fitzpatrick from the Marine Institute. The meeting was chaired by David Connor (UK) and was attended by 23 delegates from 11 countries.

International programmes

Progress in the following international mapping and classification programmes was reviewed:

- The OSPAR priority habitat mapping programme, led by JNCC (UK), in which OSPAR Contracting Parties have submitted data on the distribution of 14 threatened habitats which are presented in a web-based mapping application. Whilst substantial progress has been made, WGMHM recognised some significant gaps in the data coverage.
- The Interreg-funded MESH programme (www.searchMESH.net), which has now released a web-GIS application of habitat maps and an associated metadata catalogue the north-west Europe area, and is developing broadscale habitat distribution models, together with guidance on protocols and standards for habitat mapping. WGMHM considered that the framework developed by MESH needed to be continued beyond the project end data (April 2007), both to add further data within the MESH area and to expand the mapping to other parts of Europe.
- The Interreg-funded BALANCE project, led by DFNA (Denmark), which is developing a broadscale map of marine landscapes for the Baltic Sea and finer scale habitat maps in four pilot areas.
- The Arctic Coastal Biodiversity Assessment project, under the IASC, which includes a significant coastal classification and mapping element for the circum-Arctic region.
- Development of the EEA's EUNIS habitat classification. Improvement of the EUNIS marine section for the north-east Atlantic and Baltic is underway, via practical mapping programmes (such as MESH and BALANCE) and a standard proforma for proposing modifications to the classification. WGMHM recommended that the classification continue to be orientated to defining real habitat types and not be unduly directed by particular types of survey techniques.

Developments in **habitat maps for the North Sea** considered EUNIS, MarGIS, UKSeaMap and MESH project outputs, some still in draft form. WGMHM recommended that these be reviewed to assess the merits of the different methodologies adopted, before recommending how further mapping of the North Sea might best be achieved.

National programmes

WGMHM discussed the National Status Reports for Canada, USA, Portugal, Spain, Ireland, UK, Germany, Norway, Sweden, Denmark, Poland, Russia and Finland, and agreed ways to improve this aspect at future meetings.

Mapping strategies and survey techniques

A generic set of data types required for use in modelling the potential distribution of marine habitats types was agreed, and sources for such data sets identified.

Protocols and standards for habitat mapping

WGMHM agreed the following definition of the term 'habitat' for use in a mapping context: *A particular environment which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular but dynamic spatial and temporal scales in a recognizable geographic area*.

WGMHM reviewed progress on guidelines for habitat mapping and metadata standards for mapping studies, developed under the MESH project, and agreed to provide periodic input over the coming year as this valuable work progressed.

Guidance on the calibration standards for multibeam acoustic survey was drafted and finalised.

Terms of Reference

The following terms of reference were substantially completed: a, b, d, e, f, h, i, j, k; some are to be taken forward as ongoing work.

ToR c) (REGNS data request) could not be achieved as the relevant data were not available to WGMHM. However requests to release suitable mapping data have been made.

ToR g) (SGASC report) was not undertaken as the relevant report is not yet available.

ToRs l) and m) could not be effectively addressed within the time available, due to their large scope. In recognition of the importance and scale of these issues, and to further improve the productivity of the WG, WGMHM identified three key topics which would be further developed intersessionally, form the focus of working during future meetings and lead to peer review publications, as described in Section 7.

1 Opening of the meeting

The Working Group on Marine Habitat Mapping (WGMHM) convened in Galway, Ireland from 4–7 April 2006. Dr Fiona Fitzpatrick opened the meeting on behalf of the Marine Institute.

The meeting was chaired by David Connor (UK) and hosted by Fiona Fitzpatrick, with the financial support of the Marine Institute. It was attended by 23 delegates from Canada, Denmark, Finland, Germany, Ireland, Norway, Poland, Portugal, Spain, Sweden and the UK, and Russia by correspondence (Annex 1). Each participant provided a brief introduction about themselves. Apologies were received from the following WG members: Becky Allee (USA), Ulf Bergström (Sweden), Roger Coggan (UK), Ingeberg de Boois (the Netherlands), Dick de Jong (the Netherlands), Brigitte Guillaumont (France), Peter Lawton (Canada), Pål Mortensen (Norway), Ricardo Santos (Portugal), Doris Schiedek (Germany) and Els Verfaillie (Belgium).

1.1 Appointment of Rapporteurs

The task of preparing the report of the meeting was shared amongst delegates as follows: Neil Golding (item 3.1), Brian Todd and David Limpenny (items 3.2 and 3.3), Matt Service (item 4), Mike Robertson (item 5), Chris Cogan (items 6.1 and 7), Fiona Fitzpatrick (items 6.2 to 6.4), and with additional contributions from individuals who made presentations.

1.2 Terms of Reference

The Terms of Reference for the meeting were noted and are given in Annex 2. The Agenda and this report were specifically structured to address each item on the ToR.

2 Adoption of the agenda

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

3 International programmes

3.1 Progress of international mapping programmes

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

3.1.1 The OSPAR priority habitat mapping programme

David Connor (UK) outlined the OSPAR programme and its progress to date. In 2003/2004 the OSPAR Commission adopted the following list of 14 habitat types, which were considered to be in need of protection:

- Littoral chalk communities;
- Intertidal *Mytilus edulis* beds on mixed and sandy sediments;
- Intertidal mudflats;
- *Sabellaria spinulosa* reefs;
- *Modiolus modiolus* horse mussel beds;
- *Zostera* beds;
- *Ostrea edulis* beds;

- Maerl beds;
- Seapens and burrowing megafauna communities;
- *Lophelia pertusa* reefs;
- Carbonate mounds;
- Deep-sea sponge aggregations;
- Seamounts;
- Oceanic ridges with hydrothermal vents/fields.

The UK Joint Nature Conservation Committee has led a programme to map the distribution of these habitats across the OSPAR area (north-east Atlantic). The OSPAR Biodiversity Committee (BDC) agreed a timetable for this work and habitat definitions in 2004, and subsequently each OSPAR Contracting Party has been submitting data to the JNCC. The data have been collated into a GIS and summary distribution maps prepared, as well as developing a web-GIS mapping facility. Only simple dot distribution maps are being produced at the moment, but some polygon boundary data have been submitted and may be made available in the future. In 2005, OSPAR approved the data to be disseminated via the web and the initial phase of the programme was completed with presentation of maps to the 2006 meeting of the Biodiversity Committee. In recognition of the many outstanding gaps in data coverage as well as new data becoming available, an annual update mechanism has been established.

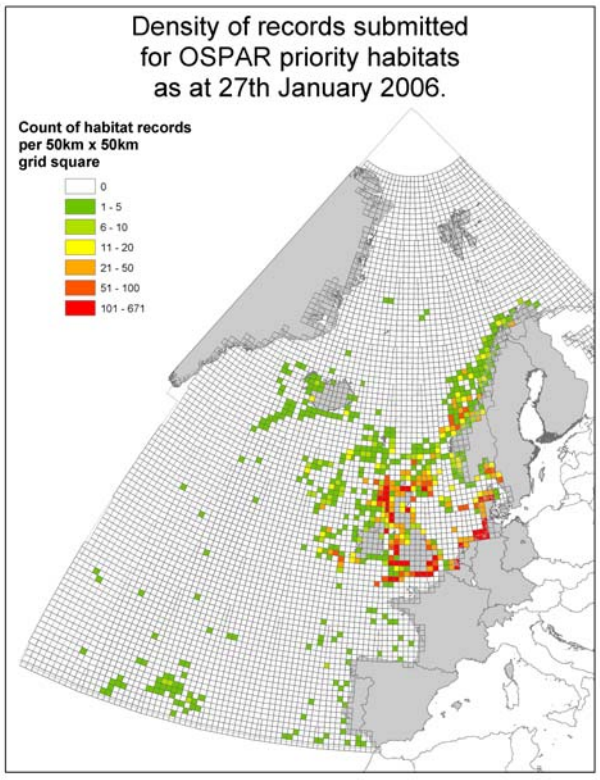

Figure 3.1.1: Map showing the composite distribution and density of all records available for the 14 habitats on the OSPAR Initial List, summarized by 50km by 50km grid squares (as at January 2006).

Working Group members were invited to review the maps on the NBN Gateway: (www.searchnbn.net/hosted/ospar/ospar.html) and advise of any gaps in data that could be filled, for example data on *Ostrea edulis* beds in Denmark.

3.1.2 The Interreg MESH programme for north-west Europe

Neil Golding (UK) described progress with MESH (Mapping European Seabed Habitats), an Interreg IIIB-funded project, which commenced in May 2004 and will come to an end in April 2007. There are five main project actions:

- Develop a first set of unified habitat maps for north-west Europe (Ireland, UK, Netherlands, Belgium and northern France)
- Develop standards and protocols for habitat mapping
- Test standards and protocols through new survey
- Predictive mapping and modelling
- Stakeholder engagement, case studies on the use of habitat maps and communications

All aspects of the project can be found on the project website (www.searchMESH.net). The presentation focused on three particular aspects:

1) An on-line metadata catalogue of mapping studies for north-west Europe

The MESH online metadata catalogue lists habitat mapping studies undertaken in north-west Europe. The MESH metadata standard is ISO19115 compliant, and has a set of core and additional data fields. A set of standard terms are provided on the MESH website along with a template for data entry. The website has 'simple' and 'advanced' search options.

2) Creating a harmonised habitat map for north-west Europe

A key aim of MESH is to produce harmonised habitat maps for north-west Europe. The maps will be classified according to three schemes: EUNIS, OSPAR priority habitats and EC Habitats Directive Annex I types. Before any maps can be produced, a data collation exercise needed to be undertaken. The majority of maps collated were classified according to local classification schemes, so a major task within the project has been the 'translation' of these maps to EUNIS, OSPAR and Annex I types. The flow diagram in Figure 3.1.2.1 shows the general data flow mechanism adopted.

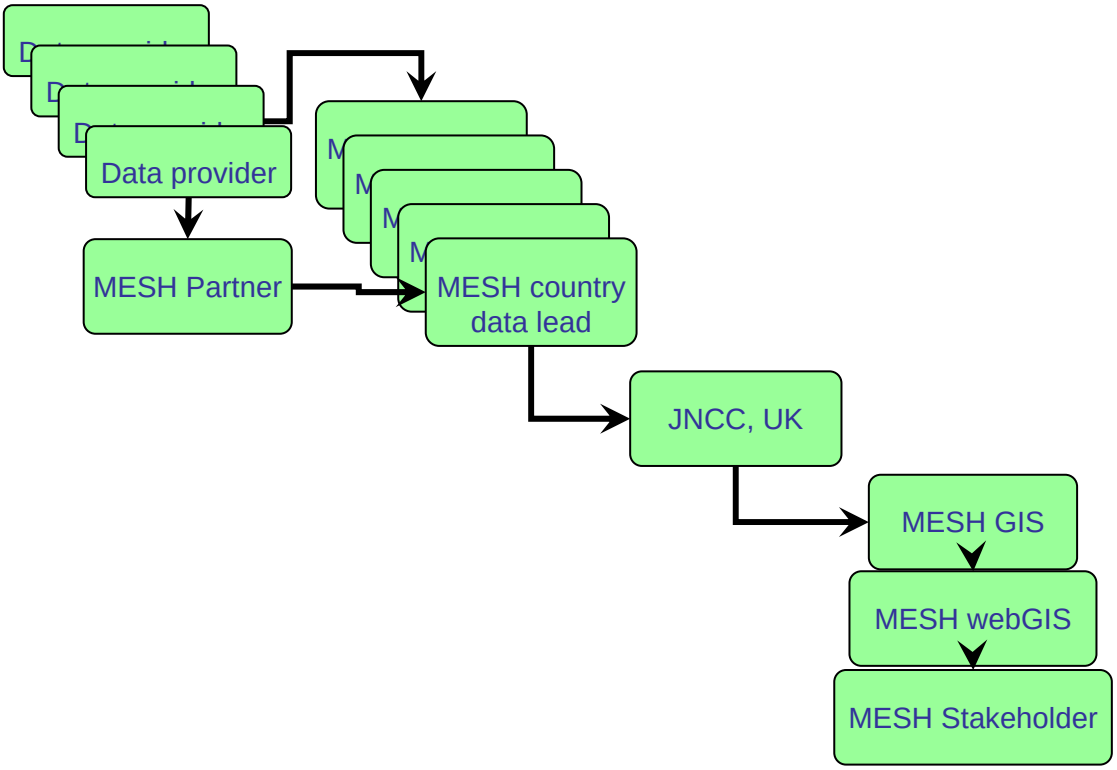

Figure 3.1.2.1: Data flow mechanism used in MESH to develop harmonised habitat maps for north-west Europe.

An important part of data transfer process between MESH partners has been the development of a suite of MESH Data Exchange Formats (DEFs). DEFs have been defined for the following data types and are available on the MESH website (www.searchMESH.net):

- Coastline and geographical regions;
- Study area (boundary polygons);
- Physical (e.g. bathymetry);
- Original habitat classification ;
- Translated habitat classification (e.g. EUNIS, OSPAR, Annex I) ;
- Sample (biological).

3) Creating a 'modelled' broad-scale EUNIS map for the MESH project area.

Predictive EUNIS level 3 habitat maps are being produced using the following datasets:

- Seabed sediments;
- Bathymetry;
- Energy index;
- Wave-base;
- Light attenuation.

Datasets were summarised to a vector grid with a resolution of 1 nautical mile on the continental shelf (0 to 200 m depth) whilst a coarser resolution will be applied beyond the shelf. Draft maps have been produced but which now require validation using biological sample data. This work may be extended by focusing on certain areas in more detail, perhaps at a finer resolution grid (approx 200 m). The overall process adopted can be seen in Figure 3.1.2.2.

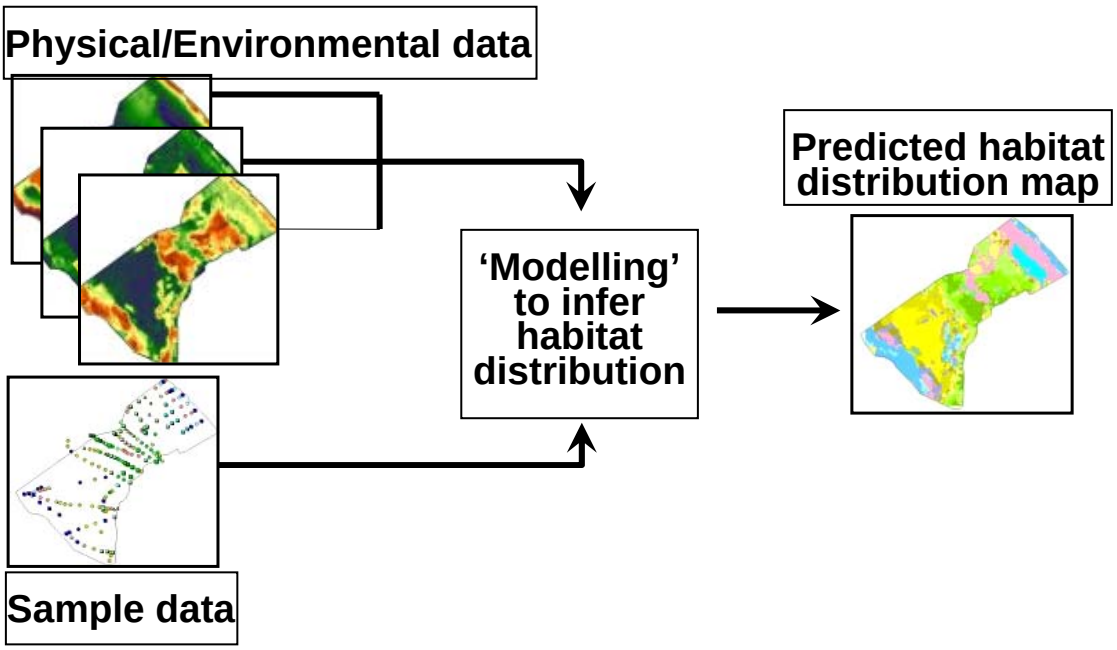

Figure 3.1.2.2: Overall structure of broad-scale EUNIS modelling within MESH.

In discussion, it was noted that the considerable developmental work achieved by MESH needs to be continued beyond the end of the project in 2007 and that this was being addressed through the formulation of a follow-on strategy. The development of broad-scale maps was welcomed, but it was unfortunate that the Interreg IIIb funding area for this project only covered part of the North Sea (south and west); WGMHM felt that funding should be sought to extend the project area. MESH should also seek working links with the HERMES EU6FP Project (Hot Spot Ecosystem Research on Margins of European Seas). The use of modelling to develop broadscale maps should recognise the quality of the underlying input data and reflect this in an assessment of confidence in the resultant map (this is being addressed by the project). In recognition of the high costs of collecting full coverage acoustic data for mapping, the need to develop modelled maps is increasingly being adopted by a number of countries. Such strategies are important in achieving mapping coverage of immediate use for environmental management. The long term goal should be to map all areas with best available quality surveying techniques. The broadscale maps, whilst having limitations in terms of their level of detail and accuracy, nevertheless are considered useful in providing a broad contextual perspective for interpretation of localised, more detailed data.

3.1.3 The Interreg BALANCE programme for the Baltic Sea

Martin Isaeus (Sweden) and Kerstin Geitner (Denmark) provided an update on the BALANCE project.

BALANCE aims to provide the Baltic Sea Region with spatial planning tools based on mapping marine landscapes and habitats, combining this with information on key stakeholder interest. These tools will assist managers in planning and implementing effective solutions for sustainable use and protection of the marine resources. BALANCE will include establishment of a database, which will hold details of marine data repositories. Additionally, the intention is to produce marine landscape maps for the entire Baltic Sea and habitat maps in selected areas to underpin the development of the Baltic approach to marine spatial planning, which will include a "blue corridors" concept and an evaluation of the appropriateness of the Baltic network of marine protected areas.

The Lead Partner is the Danish Forest and Nature Agency and there are 26 institutions from nine countries around the Baltic Sea, including Norway, involved in the project. Activities will be undertaken in the Baltic Sea, Kattegat and Skagerrak. The project is co-financed by the EU INTERREG IIIB fund for the Baltic Sea Region and has a total budget of €4.7 million. More information is available at www.balance-eu.org, http://maps.sgu.se/Portal or BALANCE@SNS.DK. Lead contact: Johnny Reker, Forest and Nature Agency, Copenhagen. Further details about the project are provided in Annex 4.

3.1.4 IASC working group for Arctic Coastal Biodiversity Assessment (ACBIO)

Christopher Cogan (Germany) outlined the current state of work with ACBio. Looking north there is increasing international focus on Arctic coastal habitats, biodiversity and ecosystems.

The Arctic Coastal Biodiversity (ACBio) is a research project of the International Arctic Science Committee (IASC). The presentation covered the background and status of ACBio, and described the importance of evolving conservation targets which function at different spatial scales. Trade-offs between precision and relevance in biodiversity indicators were discussed, in the context of policy and social pressures, to more effectively address issues such as ecosystem health and sustainability. Whilst it was relatively straightforward to collect data at the species level, there is an increasing demand for information at the ecosystem level (see Figure 3.1.4.1). How these more theoretical issues relate to marine habitat mapping was also discussed.

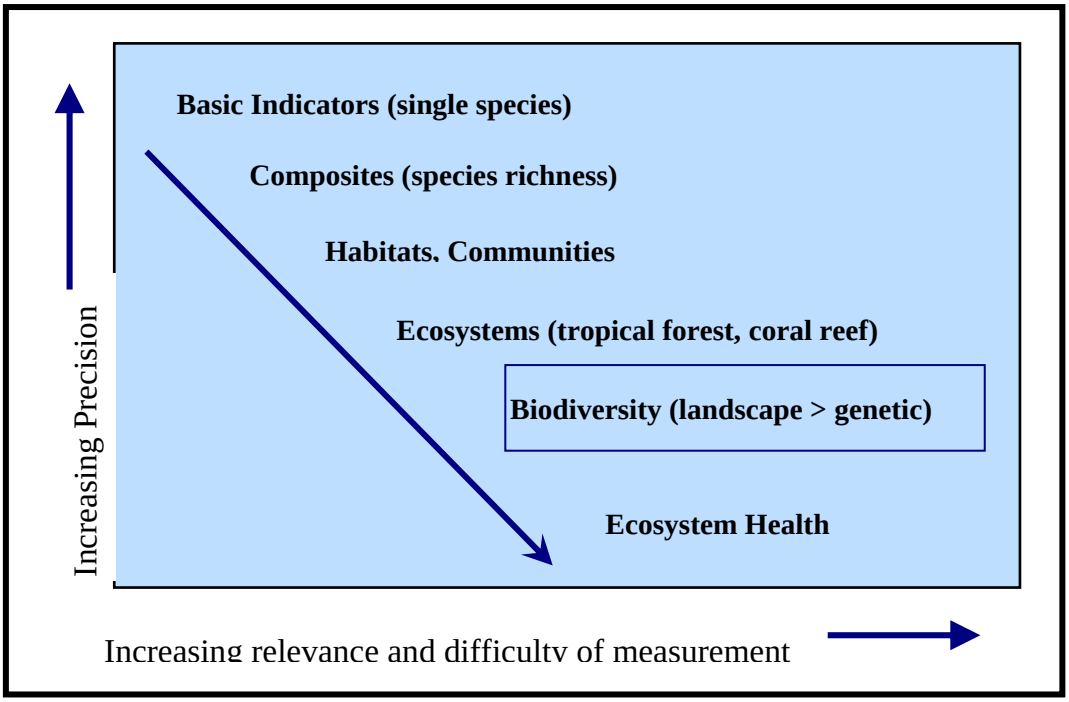

Figure 3.1.4.1: Thematic scales and conservation targets: biodiversity in context with tradeoffs, prerequisites and trends.

The presentation concluded with an outlook on connections between marine habitat mapping and current activities in Arctic research, such as the second International Conference on Arctic Research Planning (ICARP II) and the International Polar Year (IPY).

Following the presentation, WGMHM discussed the anticipated problems associated with a reduced number of taxonomists being trained up through academia. As detailed species data becomes harder to come by following this trend, this will impact the flow of information needed to gain insight into habitat and ecosystem biodiversity and ultimately ecosystem

health. In working towards answering questions about ecosystem health, the WG highlighted the importance of providing information at the habitat and marine landscape scale, as a means to bridge the gap between the traditional species-level data and the ecosystem scale.

3.1.5 Update on development of the EEA's EUNIS habitat classification

David Connor (UK) presented information on recent developments with EUNIS. The EUNIS habitat classification (http://eunis.eea.eu.int/habitats.jsp) was developed for the European Environment Agency by the European Topic Centre on Biological Diversity (ETC/BD). It is designed as a Pan-European classification and covers terrestrial, freshwater and marine habitats. It aims to be comprehensive and consistent, and to cover all habitat types. It is set in a hierarchy (broad through to fine scale), and is capable of being used for habitat mapping.

The ETC/BD has a four-year programme (2005–2008) to develop aspects of the classification. There is a strong focus on marine, and there are aims to improve the classification in all areas including the Black Sea. The JNCC is 'leading' development of the classification for the Atlantic and Baltic Seas. In this process, MESH and BALANCE projects will be important test beds for revising the classification.

Recent developments have included the preparation of a MESH Technical Paper on the application of EUNIS in marine habitat mapping, recognising that there is a clear need for additional EUNIS habitat classes. To this end, a proforma has been developed to allow new EUNIS habitat classes to be proposed. The paper and proforma are available at (www.jncc.gov.uk/page-3365). A workshop was held at the Swedish Environment Protection Agency in February 2006 to progress the Baltic Sea classification. A meeting was also held at Ifremer, France at which the issue of how best to relate remote-sensed data to EUNIS was discussed; it was proposed to use 'mapping units' to link remotely-sensed data to the EUNIS classification and this will be further considered to develop a more practical way of using EUNIS in habitat mapping.

Discussion focussed on the feasibility of integrating 'habitat classes' derived from a variety of different techniques (e.g. satellite imagery, sidescan, video, grabs). It was recognised that each technique offers a different view of the marine environment and that their integration into a single (hierarchical) classification would prove a challenge. WGMHM considered it preferable to define a classification which reflected real differences in habitat type and not to focus overly on one that depended on particular surveying techniques; in this sense the classification was required as a tool to understand and manage the marine environment and should not be technique-dependent.

The ability of EUNIS to deal with dynamic change in habitats was raised. It was noted that this was in part dealt with by the hierarchy: broader types (e.g. level 4) being more long-term features within which the more dynamically changing level 5 and 6 types occur. There was a need to define the degree of dynamism that might be expected of each habitat type, but recognition that this needed much further work.

3.2 Habitat maps of the North Sea

Assess and review existing habitat maps for the North Sea and make recommendations on how these maps may be further developed (ToR b)

This item was addressed by a sub-group comprising Brian Todd, Dave Limpenny, Neil Golding, Kerstin Geitner, Kjell Magnus Norderhaug and Mike Robertson, following several initial presentations and discussion.

3.2.1 The EEA's EUNIS marine habitat map of the North Sea

Kjell Magnus Norderhaug (Norway) presented work undertaken by NIVA on behalf of the European Environment Agency (Annex 5).

A principal aim of the EEA is to identify habitat distributions at a European level, thus permitting national authorities to place and assess their habitats in a European context. The project has collected and collated freely available relevant data and constructed a marine habitat map at EUNIS level 3 for the North Sea in a GIS environment. This was done as a test case and to identify data gaps. In 2003 an overview of existing data relevant to EUNIS mapping was collated, identifying in particular bathymetry, substrate and exposure. Data were derived by questionnaire to stakeholders and searches of EIONET and other potential sources. The test map was produced in 2004. There were several challenges to the project: the input data are at different scales; few data from shallow water areas were identified; high resolution bathymetry is not readily available due to national security issues and data are presented in different formats. Problems were also encountered with variations in data density and consequently mismatches between terrestrial and marine boundaries resulted. If a continuation of the project were to be funded, further development of the map should focus on issues of scale. For example, broad areas of the central North Sea are essentially homogenous in character and therefore lower resolution information is sufficient to map habitats in this region. On the other hand, in near-shore areas, where habitats change over short horizontal distances, high resolution spatial information is necessary.

3.2.2 The MarGIS habitat map for the German North Sea

The German MarGIS project (described in 2005 WGMHM Annex 8) used statistical techniques on available abiotic data to characterise and identify distinct seafloor habitats in the German EEZ. Benthic community data were combined with the geostatistically-treated abiotic data to delineate a series of benthic habitat types.

3.2.3 UKSeaMap: the mapping of seabed marine landscapes and water column features for UK seas

Neil Golding (UK) presented the current state of progress with UKSeaMap, a project which had developed broadscale maps, of both the seabed and water column for all UK waters, through an integrated analysis of geological and hydrographic datasets in a GIS environment. This first attempt to produce such broadscale ecological maps for UK waters is intended to support national and regional-level marine spatial planning and to promote an ecosystem-based approach to environmental management. The project started in November 2004, and is due to be completed in summer 2006. The methodology, first trialled in the Irish Sea Pilot, was further refined to improve upon both the datasets used and the data analysis techniques. The following datasets were used for mapping seabed types:

- Bathymetry and slope (topography);
- Seabed sediments;
- Light attenuation (photic depth);
- Maximum near-bed tide stress (tidal currents);
- Maximum wave-base depth;
- Bottom temperature.

Datasets used for water column features:

- Surface salinity;
- Surface to bed temperature difference;
- Probability of fronts.

All of the above datasets were summarised to a vector grid at two resolutions, to reflect differences in available data quality across UK seas. The continental shelf area (down to 200 m depth) was at a resolution of 0.02 decimal degrees grid, whereas beyond 200m depth, a grid 25 times larger was adopted. Figure 3.2.3.1 describes the overall methodology adopted.

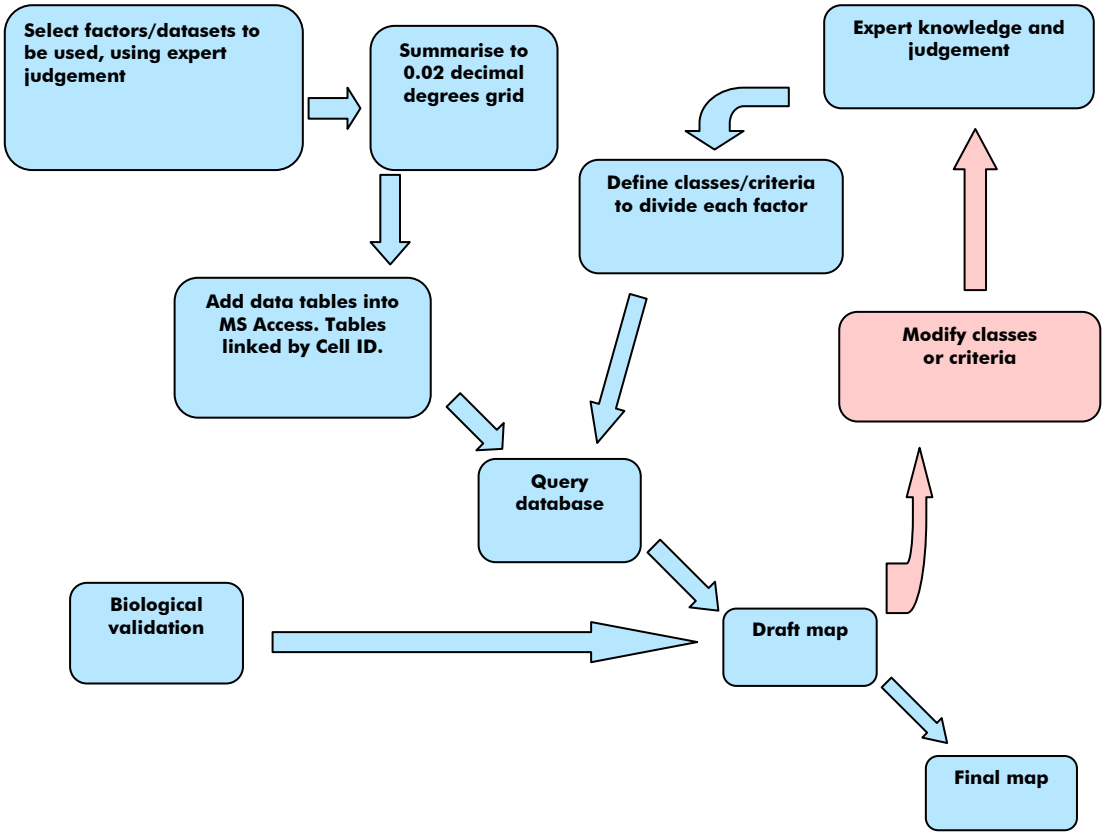

Figure 3.2.3.1: UKSeaMap methodology flow chart.

Five maps have been produced; one seabed and coastal marine features map and four seasonal water column feature maps. These maps are currently in a draft form, with the next steps being to release the maps for wider consultation and feedback and to validate the maps using biological data: benthic sample data for the seabed features and plankton distribution data for the water column features. The final maps, together with the underlying data layers used to develop them, will be made available in a web GIS application at the end of the project (www.jncc.gov.uk/page-2117).

3.2.4 MESH modelled maps for Dutch, Belgian, French and UK waters

A modelled habitat map to EUNIS level 3 of the southern and western parts of the North Sea is being developed by the MESH project (see Section 3.1.2). The derived polygons should be released by 2007, but some of the raw data may have restrictions on access.

3.2.5 Conclusions

In reviewing the current state of habitat maps for the North Sea, it is apparent that some significant progress has been made recently and that new maps (UKSeaMap, MESH) will become available shortly which will cover significant parts of the area. Given that each of the maps reviewed to date has been developed using different data sets and methodologies, WGMHM considers that there is considerable merit in reviewing the different approaches to compare and contrast them; to undertake such a review, the full methodological details of each

study would need to be made available to WGMHM over the coming year. The review would enable WGMHM to make a more informed recommendation on how further mapping in the North Sea should be undertaken.

Notwithstanding the various methodological options that are available to further this work, WGMHM clearly recognises the need to pursue further work which will lead to comprehensive and more detailed maps of the North Sea, particularly in view of the growing demand for such maps. It recognises also that this work is data dependent and takes considerable effort to complete; financial support and dedicated project time are therefore required to satisfactorily develop such maps. It will be important to pool the available data from the different projects and sources to ensure the best possible maps can be generated.

3.3 Response to REGNS request for benthic habitat data

Review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the 'overview' assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant (ToR c)

Clarification was sought from the REGNS Chair, Andrew Kenny, in March 2006 as to how WGMHM might best address this Terms of Reference. Rather than review REGNS work itself, he requested that WGMHM focus on the possibility of providing numerical data relating to habitat classes (i.e. % spatial extent of EUNIS level 3 classes) within ICES rectangles across the North Sea.

As described in section 3.2, predictive habitat maps of the North Sea (or part of it) exist from the following sources:

- EEA - EUNIS North Sea habitat map;
- MESH - EUNIS habitat map (western and southern North Sea);
- UKSeaMap - seabed marine landscape map (western North Sea).

The EEA map is complete but is the intellectual property of the EEA; it is therefore not possible for WGMHM to directly provide these data. The project manager at the EEA is Beate Werner (beate.werner@eea.eu.int) who will be contacted by David Connor to seek release of the data and report. If the data are available from the EEA, WGMHM will advise REGNS on a suitable way to extract the information.

The final maps from MESH and UKSeaMap are not currently available, as the projects are not yet complete. On completion of the projects the maps will become available (expected during 2006/7). David Connor will approach MESH partners and UKSeaMap funders on behalf of the REGNS request.

4 Mapping strategies and survey techniques

4.1 Generic set of habitat mapping datasets

Refine the table of generic habitat mapping datasets, developed by WGMHM 2005, particularly to develop a generic specification of the information needed to produce habitat maps (ToR e)

As there is growing interest in developing predictive habitat maps for areas where insufficient detailed survey data are available, WGMHM started to develop a generic list of necessary data types during its 2005 meeting. This table of data types was re-examined and refined to provide

an improved guide to which types of data are relevant to such modelling studies, including an indication of the units in which the data are required and the purpose of the data set. The group considered whether the list of mapping datasets could be arranged in priority order by specifying key datasets that were of most importance in developing habitat models. However, given that each study is likely to have different aims, scales and data available, it was felt inappropriate to be over prescriptive. In general however, seabed substratum and bathymetric data sets are considered critical to most studies modelling seabed features. The refined table is given in Annex 6.

4.2 Sources for habitat mapping datasets

Initiate the compilation of a list of metadata catalogues which provide data suitable to support habitat mapping studies (i.e. linked to the table of generic datasets) (ToR f)

The following section providing an overview and resource guide to metadata, metadata servers, and data servers was prepared by Chris Cogan.

Metadata:

Metadata or "data about data" describe the content, quality, condition, and other characteristics of data. The US National Biological Information Infrastructure (NBII) provides a good overview of metadata: www.nbii.gov/datainfo/metadata.

Metadata Standards:

Leading metadata standards include the US Federal Geographic Data Committee (FGDC) publication (FGDC-STD-001-1998), and the more recent International Organization for Standardization (ISO) Technical Committee (TC)211 Metadata Standard 19115. The FGDC standard is in the process of 'Harmonization' with the ISO standard. For more information see www.fgdc.gov/metadata/geospatial-metadata-standards.

For ISO Core Metadata, there are 22 basic elements, with seven (shown here in bold) considered mandatory:

Dataset title	Spatial representation type
Dataset reference date	Reference system
Dataset responsible party	Lineage statement
Geographic location	On-line resource
Dataset language	Metadata file identifier
Dataset character set	Metadata standard name
Dataset topic category	Metadata standard version
Spatial resolution	Metadata language
Abstract	Metadata character set
Distribution format	**Metadata point of contact**
Additional extent info (vert / temp)	**Metadata date stamp**

National Profiles build upon the ISO Core elements to create national standards.

Additional profiles add custom options for metadata elements where needed for specialized data types. Examples include the Biological Data Profile and the Metadata Profile for Shoreline Data. These profiles enable data documentation for items such as non-spatial

laboratory reports, bio-systematics, glacial time periods, tides, shoreline variability, etc. For more information see http://biology.usgs.gov/fgdc.bio/metaprof.html and www.csc.noaa.gov/metadata/sprofile.pdf.

In addition to custom profiles, a series of metadata extensions add new elements to the metadata standard. The Extension for Remote Sensing Metadata is one of the first to be endorsed. For more information see www.fgdc.gov/standards/projects/FGDC-standards-projects/csdgm_rs_ex/MetadataRemoteSensingExtens.pdf.

When documenting a data set, there are two general goals, which target different levels of completeness. Under the ISO guidelines, a brief description of a dataset is referred to as compliance level 1 metadata. Metadata at this level are intended to help a user locate the data of interest. Compliance level 2 implies a more complete level of documentation, and is intended to help the data user appropriately use the data once it has been obtained.

Metadata Authoring Tools:

One of the most common tools for metadata authoring is the ArcCatalog tools from ESRI. For Refer to the US National Biological Information Infrastructure (NBII) web page www.nbii.gov/datainfo/metadata/tools/index.html for a list of additional tools to write standardized metadata.

Metadata tools are also listed on the NASA Global Change Master Directory site at http://gcmd.gsfc.nasa.gov. Follow the links to Data Services > Metadata Handling.

A consortium in Spain has developed another shareware metadata editor called CatMDEdit. This runs on both Unix and Windows platforms. For more information see http://catmdedit.sourceforge.net/.

Metadata Servers:

Metadata servers generally do not serve data, instead they point the way to the actual data servers. Actual data servers do both, allowing the user to browse through metadata, and to download the specific data of interest. The problem is, there are thousands of data servers, and finding the appropriate ones is often the largest challenge. Below are some starting points for metadata servers:

A general list of metadata servers with hourly status updates is available from the US Federal Geographic Data Committee's "Clearinghouse Registry": http://registry.fgdc.gov. From the home page, click on the globe icon for "International Server Status".

One server from the above list is the NASA Global Change Master Directory for earth science and global change data. See in particular the many categories under "Oceans": http://gcmd.gsfc.nasa.gov/.

Web search engines like Google (www.google.com) are also often effective in locating a data server!

Data Distribution:

As described above, there are thousands of data servers in operation, and a metadata server will typically be the best way to locate them and evaluate the appropriateness of the data. For marine habitat mapping, below are some examples of useful data servers:

International Council of Scientific Unions (ICSU) – World Data Center System (WDC).

WDC (www.ngdc.noaa.gov/wdc/wdcmain.html) targets solar, geophysical, and environmental data.

One of the data servers that is part of the WDC system is WDC-MARE, specializing in marine environmental data: www.wdc-mare.org.

The UK Natural Environment Research Council (NERC) also has a directory of data centres appropriate for marine habitat mapping: www.nerc.ac.uk/data/directory.shtml.

There are many additional sources of data relevant to marine habitat mapping, including the following examples used by the WGMHM:

DATA TYPE	SOURCES
Coastlines	Coastline Extractor: www.ngdc.noaa.gov/mgg/shorelines/shorelines.html
EEZ boundaries	www.vliz.be/vmdcdata/marbound
Satellite imagery	US: NASA: www.OceanColor.gsfc.nasa.gov
Wind, wave	Archive data to 2003: www.Windguru.com
Oceanographic data (e.g. temperature, salinity)	ICES data centre: www.ices.dk/datacentre/data_intro.asp
Tides	http://easytide.ukho.gov.uk/EasyTide/EasyTide/index.aspx
Bathymetry	Etopo2 (2 minute resolution): www.ngdc.noaa.gov/mgg/fliers/01mgg04.html Gebco (1 minute resolution): www.ngdc.noaa.gov/mgg/gebco/grid/1mingrid.html
Seabed sediments	EUSeaSed: www.eu-seased.net/frameset_flash.asp?v0=1
Biology – fish	ICES Data Centre: www.ices.dk/datacentre/data_intro.asp Fishbase: www.fishbase.org/search.php?lang=English
Biology – benthos	ICES Data Centre: www.ices.dk/datacentre/data_intro.asp OBIS: www.iobis.org/#ctr_y=0&ctr_x=-170&ctr_zoom=15&
Habitat maps	MESH North-West Europe: www.searchMESH.net
EC spatial data	INSPIRE: www.ec-gis.org/inspire/home.html

4.3 Report of the SGASC relating to acoustic seabed classification

Review the report of the SGASC relating to acoustic seabed classification (ToR g)

WGMHM were advised that the report of SGASC on acoustic seabed classification was not yet available.

5 National programmes (National Status Reports)

Present National Status Report updates according to the standard reporting format by evaluating national habitat mapping activity during the preceding year (ToR d).

WGMHM discussed the National Status Reports based on presentations from national representatives in the Working Group. Annex 7 provides a compilation of the National Status Reports submitted to the meeting, according to the standard format agreed at WGMHM 2002. Additionally more detailed information is available in further annexes as detailed below.

5.1 Canada

Brian Todd (Geological Survey of Canada, Natural Resources Canada) described how habitat mapping is being undertaken in Canada's three oceans: the Pacific, the Arctic and the Atlantic.

Within the GSC, the national Geoscience for Oceans Management programme (http://gom.nrcan.gc.ca) completed Phase 1 (2003–2006) and entered Phase 2 (2006–2009) in April 2006. Approval to initiate GOM Phase 2 was received after a positive international review of the mapping products delivered in Phase 1. Projects within the GOM programme are tasked with habitat mapping in specific geographical regions to address ocean management

priorities. Selection of areas to be mapped is based on the requirements of stakeholders including governments (federal, provincial and territorial), industry and other stakeholders.

Phase 1 mapping is complete, or close to completion, in the Georgia Basin and Queen Charlotte Basin (Pacific Ocean), the Mackenzie Delta in the Beaufort Sea (Arctic Ocean), and on the Scotian Shelf and Gulf of Maine (Atlantic Ocean). New Phase 2 projects include the North-west Passage through the Canadian Arctic Islands, Placentia Bay in Newfoundland, the St. Lawrence River estuary, and the Bay of Fundy. Maps at scales of 1:50,000 and 1:250,000 will be produced. A map series is nominally composed of four sheets: topography, backscatter strength, surficial geology and, where sufficient groundtruth data allow, benthic habitat.

The Department of Fisheries and Oceans Canada (DFO) is completing a project on Essential Fish Habitat mapping on the Scotian Shelf, with multibeam bathymetric mapping and analysis contributed by the GSC. DFO is also involved with academia, the US Gulf of Maine Census of Marine Life Program and the GSC in the multi-year Discovery Corridor project (http://marinebiodiversity.ca/en/corridor.html). The Discovery Corridor extends from the Fundy Isles Region of the lower Bay of Fundy across the northern Gulf of Maine, and has been situated with two objectives in mind: 1) maximize known information and 2) to traverse a variety of habitats. The area encompasses coastal areas, offshore banks, submarine canyons, and seamounts. In conceptual terms the corridor extends from the land-sea margin to abyssal plain depths of 6000 m. An expedition with the ROPOS submersible (http://www.ropos.com/) is scheduled for June 2006.

5.2 USA

Becky Allee, who was not able to attend the meeting, submitted a paper on the projects overseen by the NOAA in the US. The document presented reflects only the work which NOAA is leading, and should not be considered an exhaustive list of all US marine mapping efforts.

Further details on the following projects are provided in Annex 8:

- Exploration and characterization of near-shore habitats (from 5-1,000 meters) within waters in the U.S. Virgin Islands and Puerto Rico;
- Benthic habitat mapping of Florida coral reef ecosystems (2004);
- Benthic habitat mapping of Palau and development of mapping plan for the Freely Associated States (2005);
- Design and implementation of EcoGIS to support fisheries science and management: A cooperative investigation between NCCOS and NMFS (2004);
- Development of mapping plan for the Freely Associated States (2004);
- Pacific benthic habitat mapping in Hawaii (2004);
- Seagrass mapping in Core and Bogue Sounds in North Carolina (2005);
- Habitat classification standards;
- Chesapeake Bay National Estuarine Research Reserve benthic characterization;
- Apalachicola Bay Oyster, sediment, and bathymetric mapping;
- South Carolina Oyster mapping;
- Texas Coastal Bend benthic mapping project;
- Mapping technology workshop;
- Gulf of Maine mapping initiative;
- GIS and ocean mapping workshop.

5.3 Portugal

Fernando Tempera (University of the Azores) described projects and tasks related to habitat mapping which have taking place in Portugal during 2005.

At a national level, a task force working in the scope of the Portuguese Ministry of National Defence has been in charge of preparing a 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, e.g. Department of Oceanography and Fisheries, University of the Azores (DOP-UAz), has been producing geophysical, geological and biological datasets for extensive deep-sea areas within and outside the current Portuguese EEZ. The RV *D. Carlos I* is fully allocated to this task. Later in 2006, the RV *Gago Coutinho* (currently undergoing conversion to hydro-oceanographic ship) will join this effort.

Two Portuguese partners (IH-PT and University of Aveiro) are incorporated in the FP6 project HERMES (Hotspot Ecosystems on the Margins of European Seas), a large multidisciplinary European project. Study areas include canyons off Portugal, where research concentrates on characterizing physical, geological and chemical processes and relating biological distributions with environmental factors.

An inventory of records of OSPAR priority habitats was undertaken in the Azores EEZ-sub-area and immediate surroundings. Project BANCOMAC (Interreg IIIb) contributed with historical and recent records of the cold-water coral *Lophelia pertusa* and continues to (i) follow the coral and sponge by-catch from commercial and scientific fisheries activities to identify locations of deep-sea coral reefs and sponge aggregations, (ii) preserve reference specimens and (iii) provide expert taxonomic identifications.

Three ongoing projects (one at DOP-UAz and two at DB-UAz) will deliver rocky biotope descriptions, classifications and distributions for littoral and/or sublittoral areas around four Azorean islands. GIS maps of environmental variables (bathymetry, slope and bottom types based on multibeam and swath surveys; and synoptic surface temperature and productivity based on satellite imagery analysis) used in the study focused around Faial island and neighbouring shelf to Pico (F. Tempera at DOP/UAz) were presented. This study has also been developing an exposure index for oceanic coastlines based on swell statistics and modelling local currents. It will eventually develop statistical models predicting biological occurrences/abundances (based on SCUBA, ROV and drop-down camera observations) as a function of the environmental variables.

Mapping work of soft bottom habitats in Portugal has concentrated on the production of surficial sediments charts (IH-PT) and completing surveys and reports on underwater sand beds for management of extraction activities in two Azorean Islands (DOP-UAz/IGM/University of St. Andrews).

DOP/UAz participates in the FP6 project EXOCET-D under which instruments and methodologies are being developed, tested and implemented aimed at exploring, describing, quantifying and monitoring biodiversity in the deep-sea. EXOCET/D final trials in the Azores include the mapping of species patches in hydrothermal vent fields using new acoustic instruments and imagery.

References were also made to work on:

- movements, habitat preference and occurrence of a selection of fish (FCT project MAREFISH at DOP-UAz), cetaceans (FCT project CETAMARH at DOP-UAz) and turtle species;
- development of autonomous platforms that can be of used for mapping purposes continues through the AdI project MAYA and a new project GREX.

See Annex 9 for further information.

5.4 Spain

Ibon Galpasoro (AZTI Foundation) provided a report for Spain. However, this presentation does not represent an exhaustive list of all Spanish marine habitat mapping efforts. There are additional mapping projects involving other agencies and private entities apart from those described below.

ESPACE, A systematic study of the Spanish Continental Shelf.

All the Spanish continental shelf is being mapped and characterised using funding from the Spanish Ministry of Agriculture and Fishing Affairs. The project started in 1994 and is foreseen to finish in 2014. The study area encompasses all the national continental shelf lying between 10 m and 170 m depth where multibeam and high resolution seismic techniques are being used. Further to these activities, grab samples are being collected and underwater video tracks are being recorded in order to classify different seafloor types and habitats. At the same time, a marine GIS is being developed by the Spanish Oceanographic Institute (IEO) in which all available data are being integrated in order to create a multidisciplinary database for use in marine environmental management. ESPACE's latest products consist of 166 charts divided into three thematic series:

- Series A: Bathymetry and Seafloor Characterisation;
- Series B: Environmental Management; and
- Series C: Digital Terrain Models and Geomorphology.

Seafloor cartography and marine habitat delimitation of the Basque continental shelf.

This project is being lead by AZTI-Tecnalia Foundation with the Basque Government providing funding. The project started in 2005 and is foreseen to last until 2007. During this time period the Basque continental shelf, including the intertidal zone, will be studied down to 100 m depth. The principal aims of the project are to produce a high resolution bathymetry and digital terrain model of the study area, a seabed classification and characterisation and to provide an analysis of the environmental abiotic factors determining species and habitat distribution. Habitat maps using the EUNIS habitat classification will also be generated along with different types of thematic maps and charts.

Different sampling methods are being used to fulfil these objectives, including multibeam acoustic surveying, grab sampling and the collection of underwater videos for subtidal waters. High resolution orthophotographs (0.25 m pixel size) are also being used to map the intertidal zone where multibeam survey work cannot be carried out. Orthophotography is going to be a tool for studying habitat distribution shifts and anthropogenic impact in the coastal zone. Further to these techniques, LIDAR altimetry and reflectivity (1 m cell size) are also being used to study the intertidal area.

5.5 Ireland

Fiona Fitzpatrick (Marine Institute) presented the national status report for Ireland.

In 2005, there were six major mapping projects undertaken within Ireland.

1) Irish National Seabed Survey (INSS) project which undertook mapping, over an area of 10 248 km^2, of baseline hydrographic and geophysical data acquisition with limited sampling.

2) Irish Sea Marine Aggregates Initiative (IMAGIN), which aims to facilitate the evolution of a strategic framework for development and exploitation of marine aggregate resources from the Irish Sea. Surveys employed multibeam and side-

scan sonar with seismic profiles. A total of 200 grabs and 36 vibro cores were acquired.

3) HABMAP project, which brings together existing information on seabed habitats for the southern Irish Sea. Relationships between physical data (e.g. sediment type, tidal currents) and biological data will be examined to develop a model to predict biological community type based on physical parameters. Survey work concentrated in four areas within the Irish Sea, the North Arklow Bank, St-Georges Channel, and two areas on the outer limits of Cardigan Bay and Caernarfon Bay.

4) Two areas were mapped within Irish waters for the Mapping European Seabed Habitats (MESH) project: the Hempton's Turbot Bank and Greencastle Codling Grounds. The principal objective of the survey was to provide or improve the geological and ecological knowledge of these sites using different techniques, like multibeam swath bathymetry (MBES), single beam echo sounder (SBES), pinger sub-bottom profiler, side scan sonar (SSS) systems, EchoPlus acoustic ground discrimination system (AGDS), video camera and sea-floor substratum samples.

5) The Marine Institute of Ireland carried out integrated survey over a know herring spawning area, using multibeam echo sounder, single beam echo sounder combined with an EchoPlus ADGS system and pinger sub-bottom profiling. Video traverses were then carried out over areas identified by backscatter analysis. Grab and dredge samples were taken. Vertical plankton samples and CTD profiles were also obtained during the surveys.

6) ROV Investigations of cold-water coral habitats in the Porcupine/Rockall areas off the west coast of Ireland using an ROV-mountable RESON 8125 multi-beam and onboard high performance position and motion reference system.

Summaries of these mapping activities are given in Annex 10.

5.6 United Kingdom

Matt Service (AFBI, formerly part of DARD) provided information on mapping activities currently being carried out in Northern Ireland to investigate the sensitivity of benthic habitats in the North West Irish Sea and on the Malin Shelf. The main aims of this research are:

- To complete synoptic maps of key areas in the north-west Irish Sea, North Channel and Malin Shelf.
- To indicate sensitivity to fishing and aquaculture.
- To map gravel extraction sites and other areas for offshore developments, such as windfarms.
- To identify gaps in current knowledge (unsurveyed areas), rank in order of relevance and to begin targeted surveying, using acoustic technology.
- To develop a video database of Northern Ireland benthic habitats and to review techniques for quantifying video data.
- To develop sensitivity indices and predictive models for benthic habitats.

Further to the activities listed above, AFBI are actively involved in the ongoing MESH project, as follows:

- Ground-truthing (video and grabs), single-beam AGDS and some sidescan sonar for a range of the North Western Shelf Consortium sites; metadata are in the MESH web GIS.
- Hosting a data-holding GIS for North Western Shelf Consortium sites.
- Ongoing research on consortium sites (EUNIS habitat map production, testing of standards and protocols, modelling work).
- Additional surveys were completed on the Irish Sea/Isle of Man sandbanks (sidescan sonar, AGDS, video), reefs in the Irish Sea mud patch (sidescan sonar,

AGDS, video), and on the East Antrim maerl beds (MBES, Lidar). These data are to be used in predictive habitat modelling.

- To the west of the Hebrides, a subtidal habitat mapping project was completed, a report produced and a GIS created. Associated data were submitted to JNCC and Scottish Natural Heritage in January 2006.

David Limpenny (CEFAS) presented an overview of acoustic mapping activity undertaken by CEFAS. Currently there are projects investigating aspects of gravel extraction and the mapping of *Sabellaria spinulosa* and cobbly reefs. Further details are available at Annex 11.

David Connor (JNCC) advised that a comprehensive set of mapping studies for the UK (and other MESH partner countries) was available on the MESH web site (www.searchMESH.net). In addition he indicated that a outline proposal was being prepared to undertake a national seabed survey for the UK, aimed at providing comprehensive acoustic and remote sensed data, together with ground-truthing, for all UK waters; it was a multi-disciplinary proposal, involving hydrographic, geological, environmental and heritage organisations and was expected to be submitted to the UK Government in Spring 2006.

5.7 Germany

Dieter Boedeker (Federal Agency for Nature Conservation) gave a short presentation on marine habitat mapping activities with special focus on the German EEZ of the North Sea and Baltic Sea. Maps and GIS layers of the sediment distribution for the entire German marine area are available at a scale of approx. 1:375 000 and a 100 m grid for the bathymetry (locally depth data have been generated by a GIS model). Further, the Habitats Directive Annex I habitat types *sandbanks* and *reefs* have been identified and mapped using up to date geoscientific and biological methods, including SCUBA diving. Also the most important habitats for harbour porpoises and sea birds are available as GIS layers. Additional data, images, maps, reports and important links are available from www.habitatmarenatura2000.de and in von Nordheim *et al.* (2006)[1].

5.8 Norway

John Alvsvåg (Institute of Marine Research) provided the Norwegian report.

MAREANO

MAREANO is an integrated mapping programme for the Norwegian seas and costal areas, which has recently received funding approval. The programme is a co-operation between NGU (Geological Survey of Norway), IMR (Institute of Marine Research) and SKSK (Norwegian Survey of Norway). IMR is the coordinator of the programme. The objectives for the programme are to survey and perform basic studies of the seabed's physical, biological and chemical environment and to systematise the information in a marine area database. The main products of the programme are detailed topographical maps of the sea bottom and detailed information about bottom categories, habitat categories and geological resources. The MAREANO programme is planned to run until 2010, and a total area of 142 000 km^2 will be mapped with multibeam echosounder. Biological samples will be collected by a combination of towed video camera system, dredges and grab/corer samples.

Good management of our coastal and marine regions requires us to garner knowledge via surveys and research and make it available to decision-makers and users in the public sector,

1 Henning von Nordheim, Dieter Boedeker, Jochen C. Krause (eds) (2006). Progress in marine conservation in Europe. NATURA 2000 sites in German offshore waters. 281pp (in press)

fisheries, aquaculture, the offshore industry, etc. MAREANO will produce new biotope maps that will describe species diversity and biomass on the basis of a network of sampling stations. Certain types of seabed are of great importance as spawning and nursery grounds for fish and other forms of marine life, and are an important element in surveys of benthic communities and marine biotopes. Seabed conditions are also important in mapping and performing risk evaluations of sediment contaminants. Environmental monitoring of the Barents Sea is an important aspect of national management of national marine areas and the MAREANO programme is important in identify areas which will be optimal locations for monitoring sediment-bound pollution in the future.

HERMES

IMR is a partner in the FP6 HERMES project, and completed one survey in 2005. The main objective of the cruise was to map and inspect *Lophelia* reefs located off northern Norway. Five areas were selected for this purpose. The Træna Deep study area was selected for more specialized studies of the physical environment, coral reef morphology and the biodiversity associated with *Lophelia pertusa*.

The 2004 Tsunami

In 2005 Institute of Marine Research joined an international team of marine scientists to document damages on coral reefs in Indonesia after the 2004 tsunami. Three large reef areas were mapped with multibeam acoustics and fisheries acoustics.

5.9 Sweden

Martin Isaeus (NIVA) presented the report for Sweden.

A national project SAKU has modelled 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*. For modelling coastal areas at this scale only map layers covering the whole coast can be used, which is a limitation. However, the resulting map layers are useful for describing in which areas different habitat types occur. The method is objective and is not affected on by different interpretations in different counties. Contact: Cecilia.lindblad@naturvardsverket.se.

The off-shore bank survey is a project headed by the Swedish EPA that has been running from 2003-2006. The aim of the project is to collect data from 20 off-shore banks along the whole Swedish coast for management of the banks that has potential value for wind-power industry, fishery, but also contain high nature values. Marine geomorphology, bathymetry, oceanography, and biology (diving, UW-video, ROV, grab) were investigated during the surveys. From these data GIS maps on EUNIS (level 3) and Natura 2000 habitats, observations of red-listed species, and species lists have been prepared and will be distributed to authorities at county level. Modelling of species distributions has just started and will continue during 2006/07. The maps will also contribute to the BALANCE project. During the surveys bubble reefs, a habitat previously unknown in Sweden, were observed at two banks. Additionally several species not known before in Sweden were found, and several species that are no longer common in Swedish coastal waters were found in high numbers at the banks. Contacts: kjell.grip@naturvardsverket.se, cecilia.lindblad@naturvardsverket.se, martin.isaeus@niva.no.

The Forum Skagerrak II project is modelling the *Lophelia* reefs in the coastal waters by the Norwegian/Swedish boarder. The project, that just started, will collect biological data using ROV, and bathymetry and back-scatter from a multi-beam survey. Contacts: per.nilsson@tmbl.gu.se, tomas.lundalv@tmbl.gu.se.

A wave exposure model has been developed which has been used for production of exposure grids of 25 m resolution covering the entire coasts of Finland, Sweden and Norway. The exposure values are divided into eight classes according to the descriptions of the EUNIS system. However, the descriptions are quite coarse and the classes will be revised to be sure they are as biologically relevant as possible. Contact: martin.isaeus@niva.no.

5.10 Denmark

Kerstin Geitner (DIFRES) outlined a variety of mapping projects that are being carried out at the Danish Institute for Fisheries Research (Annex 12).

A GIS is used in the TEMAS project, which aims to give a description of the fisheries in the North Sea, the Baltic and the Skagerrak / Kattegat area. This is accomplished by visualizing the fishing effort in relation to survey data from the area or in relation to the fisheries Catch per Unit Effort or Value per Unit Effort.

GIS maps are also used in the pilot project Laesoe National Park to illustrate where and at what time of the year the data used to describe the marine life were collected.

The mapping of the North Sea sandeel fishing grounds project aims to monitor the Danish sandeel fishery in the North Sea. The mapping of the fishing grounds is hoped to improve the knowledge about the spatial distribution of sandeel and sandeel fisheries. The Danish fishermen have collected the GPS locations of fishing grounds for at least 20 years. Further, information about individual trawl hauls has been collected by Danish Fishermen since 1999. This information together with VMS data for a selection of the Danish industrial fleet for the years 1999 to 2004 is now available for the sandeel work at DIFRES, and is considered to provide a good representation of sandeel distribution.

Inspired by the mapping of sandeel fisheries in the North Sea, data for locating fishing grounds in the Kattegat have been processed in a GIS. GPS locations have been collected by Danish fishermen since 1995 and represent hundreds of individual trawl hauls for various fish species.

Herring larvae data are sampled on a yearly basis by ICES member countries in the North Sea. DIFRES holds the database for the larval stages. Analyses has been carried out in order to detect if there is a connection between the number of larvae, environmental conditions one year and the number of one-year old herring the next year.

Galathea3 is a successor to the marine expeditions Galathea1 and Galathea2 which went around the world in the 1840s and 1950s respectively. Galathea3 will commence on the 11 August 2006. Amongst other things, DIFRES will be responsible for a website showing a range of background data, such as the planned route, satellite pictures and nearly real-time data for various hydrographic information to follow the route around the world, as well as project-specific data made available by the various research teams. Users will be able to interact with the data via a standard web browser.

Further to the research described above, a project mapping the distributions of Danish exploited shellfish stocks was described by Per Sand Kristensen (Danish Institute for Marine Fisheries Research). The paper is presented in Annex 13. The work includes mapping of mussel *Mytilus edulis* beds, seagrass *Zostera marina* beds, oyster *Ostrea edulis* beds, cockle *Cerastoderma edulis* beds and shrimp *Crangon crangon* populations. This presentation was welcomed by the WGMHM, as it provided a shell-fishery focused perspective on habitat mapping.

Denmark led the Interreg BALANCE project, which is described elsewhere in this report (Section 3.1, Annex 4).

5.11 Poland

See National Status Reports Spreadsheet submitted by Eugene Andrulewicz.

The is no nation-wide marine habitat mapping programme in Poland; however several institutions originate and collect useful and relevant data for coastal and open sea marine habitat mapping. The Maritime Institute in Gdansk does mapping for various coastal and open sea technical installations. The National Geological Institute-Marine Branch in Gdansk undertakes mapping of sediment types and sediment contamination. The Institute of Oceanology, Polish Academy of Sciences in Sopot undertakes projects on vascular vegetation mapping.

In 2006, the Institute of Oceanology, Polish Academy of Sciences in Sopot completed a project on the application of hydro-acoustical techniques for mapping of underwater meadows in Puck Bay/Gulf of Gdansk (2001–2003). Down-looking echosounder and side-scan sonar were used for this. Ground-truthing consisted of biological sampling and video recording by divers. Maps of the spatial distribution of underwater meadows and the height of underwater vascular plants were produced. A similar project was completed in the Hornsund Fjord, Svalbard Archipelago, North Atlantic (2005–2006). The same techniques were used as in Puck Lagoon. Maps of spatial distribution of marine habitats and maps of the height of underwater plants were prepared. Results from both projects were presented in various conferences and are published in Proceedings of the 8th European Conference on Underwater Acoustics.

5.12 Russia

Vadim Paka (Shirshov Institute for Oceanology, Russian Academy of Sciences), who was unable to attend the meeting, provided information about Russian mapping activities in the Baltic Sea. This was presented by Eugene Andrulewicz.

These activities are placed in two different regions (and cities) of Russia: in Kaliningrad (south-eastern Baltic Sea, Gulf of Gdansk) and in St. Petersburg (eastern part of the Gulf of Finland). There were three projects run in Kaliningrad (Atlantic Branch of P.P. Shirshov's Institute) and two projects run in St. Petersburg (Zoological Institute, Russian Academy of Sciences):

<u>Shirshov Institute for Oceanology in Kaliningrad</u>

i) Project under “World Ocean” EMERCOM of Russia was run in the Baltic Proper, Gulf of Finland, Skagerrak and the White Sea (1997-2006). Measurements covered hydrographic description of Baltic Sea, Skagerrak and White Sea sub-basins, links with the Baltic inflow events, chemical pollutants, distribution of chemical weapons in dumpsites and locations of unexplored wrecks. Side-scan sonar, towed multiparameter probes, underwater video, bottom grab, bottom corer, rosette system, ADCP, moored current meters, microstructure profilers were used. There were prepared reports, charts and publications.

ii) Local project of regional fishery agency ZAPBALTRYBVOD named “Planktonic and benthic communities of coastal marine area of Kaliningrad region” was run between 2001 and 2003. The aim of this project was description of spatial distribution of bottom communities (0-100 m depth range). Techniques used were: grab samples, SCUBA diving, underwater photography and video. Datasets were published as customer reports, institute reports, charts and papers.

iii) Investigations in Russian coastal waters in the south-eastern Baltic Sea were carried out between August 2005 and December, 2006. They covered bathymetry, distribution of bottom sediments and mapping of underwater vegetation. Techniques used were: echosounder-sediment profiler, side-scan

sonar, underwater video, grab samples, ADCP, CTD and SCUBA diving. Results included physical habitat descriptions and distributions, video records, bathymetric data, granulometric data and SCUBA diving reports. Data were used for preparation of a PhD thesis, reports and papers.

Zoological Institute in St. Petersburg

i) Zoological Institute in St. Petersburg carried out a project in the eastern part of the Gulf of Finland on littoral ecology and invasive species (2003-2005). Echo-sounding and SCUBA diving were used for geo-botanical surveys, description of bottom, collection of biological samples, description of bottom communities, mapping of shoreline vegetation, distribution of habitats over depths, description of communities and dominant species at littoral and shallow water localities, development and establishment of monitoring of invasive species. Data were delivered to regional authorities and partners of Baltic Sea Regional Project (BSRP). Results are also published in peer review journals.

ii) Another project in the eastern part of the Gulf of Finland was related to characteristic of spatial distribution of hypoxic zones, revealing of impact of short-term hypoxia, intrusions of salt waters into the eastern Gulf of Finland and description of the state of soft-bottom habitats and macrozoobenthos. Box corer, van Veen grab and Petersen bottom samplers were used. Data on spatial and temporal variation of salinity, oxygen saturation in upper and bottom layers and on benthic communities were collected. Reports were prepared for regional authorities.

5.13 Finland

Anna Nöjd (Finnish Environment Institute) presented a description of a programme currently being conducted in Finland.

Finland began a national effort to map its marine habitats and biodiversity, The Finnish Marine Underwater Nature Inventory Programme (VELMU), in 2002. VELMU is a co-operation programme involving seven government Ministries. The practical work will be carried out by government institutions, universities and other parties. After a preparatory phase, pilot projects were set up in the Archipelago Sea starting in 2003-04. The pilot projects aimed to build a foundation for the inventory programme by evaluating and developing inventory methods, creating a data-sharing system and internet portal and building a co-operation network. The methods tested in the pilot projects included aerial photos, drop video, dive surveys and grab samples. The pilot projects also included mapping of geology by the Geological Survey and some hydrographical measurements, all concentrated in the same co-operation area. Field survey methods have been discussed at a workshop in Spring 2006, based on the experiences from the pilot projects and protocols for VELMU surveys will be prepared by the end of 2006. Work on a database and internet portal is ongoing.

The main aims of VELMU include:

- Inventory of marine habitats by 2014;
- Classification of habitats for Finnish waters;
- Maps of habitat distribution;
- Overview of the distributions of species;
- Database and internet portal for inventory data;
- Enhanced co-operation and networks;
- Public awareness and education;
- Important topics for further research.

The coast is divided into five zones: 1) Archipelago Sea, 2) The Quarck, 3) Gulf of Finland, 4) Bothnian Bay and 5) Bothnian Sea. Inventories in each area begin consecutively at yearly

intervals and are expected to take four to five years per area. During their first year each area receives the most input from the national level.

VELMU has been arranged into projects surrounding five thematic areas: 1) Data Management, 2) Education and Research, 3) Geological Field Surveys, 4) Biological Field Surveys and 5) Maps, Modelling and Remote Sensing. Currently work is done as a combination of budget-funded activities of government institutes and research and development-funded projects.

An important aim of VELMU is to produce maps of the distribution of marine species and habitats in Finnish waters at three resolutions. Both the scale and the thematic resolution of the maps will increase between levels. At the national level the aim is to have full cover of coarse species distributions and marine landscapes. The regional level maps will aim to have extensive cover of coarse level habitats. Maps at the local level will be more detailed but cover relatively small areas.

In discussion it was noted that the programme currently received funding of about €200,000 per annum and as such was unable to include acoustic seabed surveys. WGMHM recommended that work to classify the seabed habitats should focus on developing a classification based on the actual data and habitats present, rather than pigeon-hole the data into EUNIS classes. Consideration of incorporating such a Finnish habitat classification into EUNIS should be considered as a secondary step, as part of the wider development of a Baltic habitat classification.

A more detailed description of VELMU can be found in Annex 14.

6 Protocols and standards for habitat mapping

6.1 Definitions of the terms habitat and marine landscape/seascape

Finalise the definitions of the terms habitat and marine landscape/seascape for the purposes of marine habitat mapping (ToR h)

A number of definitions of the term 'habitat' are available in the literature, and are variously used in a marine habitat mapping context. These were examined at the 2005 WGMHM meeting (Annex 12) in order to develop a definition which adequately reflects the group's understanding and use of the term. Further examination of the draft text indicated that improved explanation of the relationship between abiotic and biotic elements in the definition was needed. In particular reference to the term *biotope* has been added to reflect both its use in scientific circles to encompass the combination of abiotic and biotic elements, and its effective synonymy with the more popular term *habitat* which also encompasses the biotic aspect, but should more strictly refer just to the abiotic aspect. Consideration of this topic was assisted by a paper, entitled 'Habitat maps, legends and seascapes', prepared for the meeting by Dick de Jong (RIKZ, Netherlands).

A revised definition of habitat is as follows:

Habitat: "A particular environment which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular but dynamic spatial and temporal scales in a recognizable geographic area."

Further explanation of the term, alternative definitions and a commentary on the associated terms *marine landscapes*/*seascapes* is provided at Annex 15.

6.2 Guidelines for habitat mapping

Review and critique guidelines for habitat mapping, including the review of protocols and standards for habitat mapping developed under relevant initiatives (e.g. MESH). In addition, identify other areas where the development of guidelines is required (ToR i)

A review of standards and protocols for habitat mapping techniques was published by the MESH project and is available at www.searchmesh.net/Default.aspx?page=1442. WGMHM members had provided comments on the review during 2005 and these had been incorporated into a revised set of reviews which would be released in spring 2006. The meeting participants were asked to comment on the content of the document, and in particular to identify any topics that they considered should be added. WGMHM considered the set of techniques described to be comprehensive, but suggested the following improvements:

- The section pertaining to grain-size analysis should (a) include a translation of the MESH-preferred Folk classification to other sediment classifications in use and (b) the grain-size analysis should make cross references to the EUNIS classification.
- A section should be added relating to navigation, position fixing and georeferencing; particularly with reference to sensor-carrying vehicles, such as deep-water ROVs. This could draw upon a guideline document on position fixing in the UK's Marine Monitoring Handbook (Davies *et al*. 2001)[2].
- The report should include a chapter on different types of surveys and survey strategies (this is currently under development).
- A section should be included, if possible, on oceanographic measurements and pelagic habitat mapping techniques.
- Clarification was needed on terminology (digital imagery/satellite photography; ROVs are transport vehicles rather than techniques per se).

Fiona Fitzpatrick (Ireland) provided an update on progress and outlined plans for further work by MESH (Action 2) in developing a dynamic framework document on mapping techniques and standards, including hyperlinks between various sections to more detailed information. WGMHM welcomed this initiative and looked forward to being able to review and contribute to it as it further developed during 2006.

Discussion focused on the issues of assessing and portraying confidence and accuracy in habitat maps, which WGMHM considered an important new area to be addressed. Means of assessing accuracy and confidence are being addressed by a MESH Working Group on Accuracy and Confidence, and include the following:

- an evaluation of data layers created by combining techniques;
- confidence evaluations for areas where species are missing;
- an evaluation of the confidence associated with boundaries, i.e. boundaries are generally artificial, unless clearly defined by observation techniques, but are becoming increasingly important for planning purposes. One method that should be evaluated is the development of buffers of confidence; and
- scale issues, which should be clearly defined with definitions included for spatial and temporal scale.

2 Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson, W., Turnbull, C., and Vincent, M. 2001. Marine Monitoring Handbook. Peterborough, Joint Nature Conservation Committee (UK Marine SACs Project).

It was acknowledged that confidence assessments needed to be derived in part from metadata for the maps and their underlying datasets; as such there should be a good link between the confidence assessment parameters and the information collected as metadata (see Section 6.4).

WGMHM was invited to actively contribute to this area of MESH development and agreed that a report from MESH to WGMHM 2007 would be very welcome.

6.3 Calibrating acoustic survey systems

Review standards for calibrating acoustic survey systems (ToR j)

A document entitled 'Field calibration procedures for multibeam sonar systems', prepared by Fiona Fitzpatrick and Fabio Sacchetti (Marine Institute, Ireland), was presented as the basis for addressing this Term of Reference. WGMHM considered the document provided an excellent account of calibration requirements for MBES, and made the following comments on how it could be improved:

- Further explain sound velocity profiling, with particular reference to equipment types and methods of deployment.
- Acoustic ground discrimination systems (AGDS), single beam echo sounding (SBES) and underwater television/video also needed to be included in the review.

A revised and completed document for MBES calibration is given at Annex 16.

6.4 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 (ToR k)

WGMHM 2005 examined initial ideas on the development of metadata standards for specific survey techniques used in habitat mapping studies. It considered that data arising from each technique should be accompanied by good quality metadata, so that those using the data knew of its provenance and quality. To date the absence of agreed standards for such metadata (at the survey technique level) meant that data were often poorly documented leading to subsequent limitations on its use. Since WGMHM 2005 the MESH project had undertaken further development of the task and made a draft metadata spreadsheet available to the WG for comment. Following consultation and finalisation of metadata fields, the MESH project plans to design an Access database to facilitate capture of metadata during new surveys. It is expected that such metadata should follow the associated data, from acquisition, through processing, to interpretation and ultimately to its archiving.

The discussion followed two parts:

Firstly, there was a need to review and include relevant metadata entries abstracted from existing metadata structures, including: UK National Marine Monitoring Programme database, ISO metadata fields, the ICES database, DIASIS standard codes, the ArcGIS marine data model, and HERMES.

Secondly, the following additional fields should be included:

(a) For biological samples, include reference literature used to identify the species and the completeness of the species data (e.g. is it a complete list or a superficial list; is there any absence data (species not found));

(b) include a form of confidence;

(c) list the responsible scientist/surveyor;

(d) include if there are photographs linked to the samples (e.g. in situ photographs on deck, photographs of sub-samples); and

(e) include a HELP key.

WGMHM were invited to provide comments on the draft metadata fields, as presented at Annex 17.

7 Uses of habitat mapping in a management context

Review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications. Develop a link between various scales and types of maps to relevant issues and end user needs (ToR l)

Explore the use of habitat maps in understanding and assessing ecosystem structure and function (ToR m)

This agenda item represents an important topic for marine habitat mapping. WGMHM discussed a range of approaches to address these broad issues, and developed a plan to focus in on a series of critical topics.

In keeping with the goals of ICES to move forward to more effectively address issues on ecosystem-based management – including ecosystem-based management for fisheries – the Working Group proposed a series of focal topics that can support advances in marine habitat mapping and simultaneously be developed as a series of journal publications. With this focused approach based on publications, it is considered that the Working Group can more effectively address the critical issues relevant to habitat mapping, reach out to a larger audience, and provide additional incentive for Working Group efforts throughout the year. Where possible, these focal topics will also be used to forge synergetic connections to other ICES Working Groups.

To accomplish this, WGMHM generated a list of suggested topics:

1) The role of marine habitat mapping in ecosystem-based management;
2) Accuracy assessment and validation for marine habitat maps;
3) Metadata standards for marine habitat maps;
4) Habitat classification in practice – technical advances in marine habitat mapping;
5) Habitat classification theory – new developments for marine habitat mapping;
6) Issues and advances with acoustic techniques for marine habitat mapping;
7) Who are the real users of marine habitat maps? The case for use-oriented marine habitat maps.

Three of these (topics 1, 2, and 6) were selected for initial priority, and are outlined below:

Focal Topic A) The role of marine habitat mapping in ecosystem-based management – targets the concept of marine habitat mapping in context with evolving technological capabilities, conservation targets, and policy priorities. Because each of these is supported by marine habitat mapping, the theory and methods of habitat mapping are also evolving. In particular, with this focal topic, there is a need to address issues of implicit and explicit linkages between classification, mapping and biodiversity with management goals. Policy objectives such as sustainability, ecosystem health, or the design of marine protected areas, are directly supported by marine habitat maps, yet the appropriate (or inappropriate) use of the maps is not always clearly identified.

Focal Topic B) Accuracy assessment and validation for marine habitat maps – is another focal topic for the working group. Previously, many types of maps were "understood" to have particular precision and accuracy standards, and the majority of map users understood the limitations of the map. Marine habitat maps are not so easily understood, representing features that are not typically viewed first-hand, often incorporating multiple sources of remote sensing data to produce the final maps. For producers of marine habitat maps, as well as users of the data, our focus on this subject includes topics of accuracy, completeness, error matrix calculation, and the effects on overall map accuracy by changes in spatial, thematic, and temporal grain. This topic also includes methods to work with map data which have uncertain accuracy and incomplete metadata.

Focal Topic C) Issues and advances with acoustic techniques for marine habitat mapping – Outline to be developed.

Provisional leaders for each topic were identified, recognising that wider consultation amongst WG members who were unable to attend the meeting could identify further interest in leading/participation. These topic leads would endeavour to make significant progress on the topics during the year, and gain additional input from a wider group during subsequent meetings. It was considered that a more effective use of Working Group time during meetings could be made by spending more of the meeting time working in such focussed sub-groups, developing these three topics. As a starting point, the three focus groups need to review relevant work of other ICES WGs to assess what is being done and how the WGMHM work can best link in with other ICES activities.

Thematic mapping examples for use with WGMHM focal topics

In conjunction with the WGMHM focal topics described above, a series of thematic mapping examples were discussed. As the focal topics are further developed, it is envisioned that map themes such as the high priority topics listed here can help to illustrate our reports:

- Geohazards;
- Oil and Gas;
- Aggregates;
- Ecosystem-based fisheries management;
- Conservation targets;
- Offshore wind farms;
- Cables;
- Pipelines;
- Munitions dumps, including chemical and radioactivity.

8 Recommendations and Actions

In addition to developing three focal topics and associated map themes as sub-group activities (see Section 7), there was discussion on other ways to enhance the working of WGMHM:

1. National Status reports

Recognising these were a valuable part of the meeting, the Working Group would like the National Status Reports to become more useful through highlighting specific issues of relevance to the agenda of the meeting, such as problems encountered or solutions and lessons learned. Members additionally would be asked to present material in poster format or distribute presentations/summaries ahead of the meeting, in order to free time for other areas of work. It would be helpful to provide a GIS file outlining the study areas within the country's EEZ, linked to each entry in the NSR spreadsheet. The Chair needs to remind

members of these requirements before the meeting and, if necessary reflect changes in the proforma NSR spreadsheet (e.g. costs, area covered).

2. Field trip

Inclusion of a field trip, as some other Working Groups had, should be considered, to allow time for members to build relationships, and discuss and exchange ideas on topics of mutual interest. Suggestions were to start the meetings at 08h00 and finish at 18h00 daily, and nest a field trip into the Wednesday afternoon or to have a field trip on the Saturday after the close of business.

A draft Terms of Reference for 2007 is given at Annex 18, whilst recommendations and actions arising from the meeting are given in Annex 19.

3. Location for 2007 meeting

Offers had been received from Kirsten Geitner (DIFRES) to host the meeting in Copenhagen, Denmark, from Peter Lawton (DFO) to host the meeting in St Andrews, Canada and from Thomas Noji (NOAA) to host the meeting in either Sandy Hook or Woods Hole, USA.

There was considerable support to hold the meeting again in North America to encourage greater participation from US and Canadian scientists and to help exchange ideas between Europe and America. After careful consideration, the Group recommended going to Woods Hole.

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 Fiona Fitzpatrick and the Marine Institute for providing excellent facilities and hospitality for the Working Group meeting. In addition he thanked the Rapporteurs and participants for their considerable contributions which had made for a productive, interesting and enjoyable meeting.

Annex 1: List of participants

NAME	ADDRESS	EMAIL
Alvsvåg, John	Institute of Marine Research PO Box 1870 Nordnes N-5817 Bergen Norway	john@imr.no
Andrulewicz, Eugeniusz	Sea Fisheries Institute in Gdynia Baltic Sea Regional Project; ICES/BSRP SGEH ul. Kollataja 1 PL-81-332 Gdynia Poland	eugene@mir.gdynia.pl
Boedeker, Dieter	Bundesamt für Naturschutz INA Insel Vilm 18581 Putbus/Rügen Germany	dieter.boedeker@bfn-vilm.de
Cogan, Chris	Alfred Wegener Institute for Polar and Marine Research Am Handelshafen 12 D-27570 Bremerhaven Germany	ccogan@awi-bremerhaven.de
Connor, David (Chair)	Joint Nature Conservation Committee Monkstone House, City Road Peterborough PE1 1JY United Kingdom	david.connor@jncc.gov.uk
Fitzpatrick, Fiona, (Host)	DCMNR Marine Institute Rinville, Oranmore Galway Ireland	fiona.fitzpatrick@marine.ie
Galparsoro, Ibon,	AZTI Foundation Herrera kaia, Portualdea z/g 20110 Pasaia (Gipuzkoa) Spain	igalparsoro@pas.azti.es
Geitner, Kerstin,	Danish Institute for Fishery Research Department of Information Technology and Techniques Charlottenlund Slot DK-2920 Charlottenlund Denmark	kjg@dfu.min.dk
Golding, Neil	Joint Nature Conservation Committee Monkstone House, City Road Peterborough PE1 1JY United Kingdom	neil.golding@jncc.gov.uk
Grehan, Anthony	National University of Ireland Earth and Ocean Science Department University Road Galway Ireland	Anthony.Grehan@nuigalway.ie
Isaeus, Martin	Norwegian Institute for Water Research Sweden	martin.isaeus@niva.no
Keskinen, Essi,	Metsähallitus Natural Heritage Services PO Box 81 FIN-90101 Oulu Finland	essi.keskinen@metsa.fi

NAME	ADDRESS	EMAIL
Kristensen, Per Sand	Danish Institute for Fishery Research Department of Sea Fisheries Charlottenlund Slot DK-2920 Charlottenlund Denmark	psk@dfu.min.dk
Limpenny, David	CEFAS Burham-on-Crouch Laboratory Remembrance Avenue, Burnham-on-Crouch Essex CM0 8HA United Kingdom	d.s.limpenny@cefas.co.uk
Neuvonen, Samuli	Finnish Environment Institute Research Programme for the Protection of the Baltic Sea P.O. Box 140 FIN-00251 Helsinki Finland	samuli.neuvenen@environment.fi
Nöjd, Anna	Finnish Environment Institute Research Programme for the Protection of the Baltic Sea P.O. Box 140 FIN-00251 Helsinki Finland	anna-leena.nojd@ymparisto.fi
Norderhaug, Kjell Magnus	Norwegian Institute for Water Research Brekkeveien 19, PO Box 173 Kjelsaas, N-0411 Oslo Norway	kjell.norderhaug@niva.no
Paka, Vadim (by correspondence)	Atlantic Branch of Shirshov's Institute of Oceanology Pr. Mira 1 236000 Kaliningrad Russia	paka@ioran.gazinter.net
Reijonen, Anu	Geological Survey of Finland P.O. Box 96 02151 Espoo Finland	anu.reijonen@gsf.fi
Robertson, Mike	Fisheries Research Services Marine Laboratory P.O. Box 101, Victoria Road Aberdeen AB11 9DB United Kingdom	m.r.robertson@marlab.ac.uk
Sacchetti, Fabio	DCMNR Marine Institute Rinville, Oranmore Galway Ireland	fabio.sacchetti@marine.ie
Service, Matthew	Agri-Food Biosciences Institute Agriculture and Environmental Science Division Newforge Lane Belfast BT9 5PX United Kingdom	matt.service@afbini.gov.uk
Tempera, Fernando	University of the Azores Department of Oceanography and Fisheries Cais de Santa Cruz PT-9901-862 Horta (Azores) Portugal	tempera@notes.horta.uac.pt

NAME	ADDRESS	EMAIL
Todd Brian	Geological Survey of Canada (Atlantic) Natural Resources Canada, Bedford Institute of Oceanography P.O. Box 1006 Dartmouth, NS B2Y 4A2 Canada	Brian.Todd@NRCan.gc.ca

Annex 2: WGMHM Terms of Reference 2006

2005/2/MHC05 The **Working Group on Marine Habitat Mapping** [WGMHM] (Chair: D. Connor, UK) will meet in Galway, Ireland, from 4–7 April 2006 to:

International programmes

a) review progress of international mapping programmes (including MESH, EEA, OSPAR, BALANCE).

b) assess and review existing habitat maps for the North Sea and make recommendations on how these maps may be further developed.

c) review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the 'overview' assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant.

National programmes (National Status Reports)

d) present National Status Report updates according to the standard reporting format by evaluating national habitat mapping activity during the preceding year. (presentations limited to 10 minutes per country).

Mapping strategies and survey techniques

e) refine the table of generic habitat mapping datasets, developed by WGMHM 2005, particularly to develop a generic specification of the information needed to produce habitat maps.

f) initiate the compilation of a list of metadata catalogues which provide data suitable to support habitat mapping studies (i.e. linked to the table of generic datasets).

g) review the report of the SGASC relating to acoustic seabed classification.

Protocols and standards for habitat mapping

h) finalise the definitions of the terms habitat and marine landscape/seascape for the purposes of marine habitat mapping.

i) review and critique guidelines for habitat mapping, including the review of protocols and standards for habitat mapping developed under relevant initiatives (e.g. MESH). In addition, identify other areas where the development of guidelines is required.

j) review standards for calibrating acoustic survey systems.

k) review progress in the development of 'discovery' and 'survey/method' metadata standards for marine habitat mapping, illustrated with worked examples.

Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions) and its relevance in understanding ecosystems

l) review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications. Develop a link between various scales and types of maps to relevant issues and end user needs.

m) explore the use of habitat maps in understanding and assessing ecosystem structure and function.

WGMHM will report by 31 April 2006 for the attention of the Marine Habitat and 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 AND RELATION TO ACTION PLAN	Action Plan nos.: 1.4.1, 1.4.2, 1.4, 1.4.3. a) The WG provides an important forum to present and discuss the progress of multinational programmes, in particular those of NIVA for the EEA, within the Interreg MESH project for North West Europe, the OSPAR-wide programme and the proposed BALANCE project for the Baltic Sea. 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. b) WGMHM has considered the production of habitat maps for the North Sea for several years, through the assessment of data requirements and consideration of various approaches to development of such broad-scale maps. Several mapping projects covering all or part of the North Sea (e.g. the EEA's EUNIS map, MarGIS and ongoing MESH work) will become available during 2005/6 and these should be assessed in the light of ongoing ICES needs for North Sea maps (e.g. by REGNS) and to consider whether WGMHM can provide data or expertise which will help further develop the maps. c) This is in response to a request from REGNS. d) 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. e) A generic table of data requirements developed in 2005 needs further refinement to provide a guide to the types of data and their format which are necessary to map or model the distribution of marine habitats. f) A compilation of sources of suitable data for marine habitat mapping is considered a helpful adjunct to the generic table developed above. g) The SGASC report is due for release in 2005 and its relevance to WGMHM work needs to be assessed. h) Draft definitions for the terms Habitat and Marine landscape, developed during WGMHM 2005, need to be finalised. i) Review of standards for habitat mapping is of key importance to promoting best practice in mapping studies and in the interoperability of the data. Expertise with WGMHM should contribute to such best practice approaches. The development of standards and protocols within the MESH project provides a significant source of information for discussion, further development and the identification of any gaps. j) As part of the development of standards, an assessment of the needs for calibrating acoustic survey systems is required, again to promote best practice in use of this equipment. k) Sound data management is important in the archiving and distribution of data sets. There is a need to build upon the 2005 WGMHM work to clarify the relationship between data types, including through illustrated examples and to learn from data management approaches adopted in other sectors. l) Habitat maps can have many different purposes, styles and scales, dependent on end user needs. There is a need to compile guidance on the types of maps which are best suited for particular end uses and scales. m) 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.
RESOURCE REQUIREMENTS	None.
PARTICIPANTS	Representatives from Member Countries with experience in habitat mapping and classification. Participation of the Baltic countries 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	None required.
FINANCIAL:	No financial implications.
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
SECRETARIAT COST SHARE	

Annex 3: Agenda for the meeting ICES Working Group on Marine Habitat Mapping Galway, Ireland 4-7 April 2006

Tuesday 4 April

1 Opening of meeting (1000)

1.1 Appointment of Rapporteurs

1.2 Terms of Reference

2 Adoption of Agenda

3 International programmes

3.1 review progress of international mapping programmes (including MESH, EEA, OSPAR, BALANCE (ToR a)

3.1.1 The OSPAR priority habitat mapping programme (David Connor, UK)

3.1.2 Progress with the Interreg MESH programme (Mapping European Seabed Habitats) for north-west Europe (Neil Golding, UK)

3.1.3Progress with the Interreg BALANCE programme for the Baltic Sea (Kerstin Geitner, Denmark; Martin Isaeus, Sweden)

3.1.4 IASC working group for Arctic Coastal Biodiversity Assessment (ACBIO) (Chris Coggan, Germany)

3.1.5 Update on development of the EEA's EUNIS habitat classification (David Connor, UK)

3.2 assess and review existing habitat maps for the North Sea and make recommendations on how these maps may be further developed (ToR b)

3.2.1 The EEA's EUNIS marine habitat map for the North Sea (paper & presentation from Kjell Magnus Norderhaug, NIVA, Norway)

3.2.2 The MarGIS habitat map for the German North Sea (2005 WGMHM Annex 8)

3.2.3 The UKSeaMap habitat map and associated maps from MESH (Neil Golding, UK)

3.2.4 North Sea sub-group to review and report (led by Brian Todd, Dave Limpenny)

3.3 review and report on the results of the North Sea ecosystem (overview) assessment undertaken by REGNS and prepare recommendations for further or modified analysis made where appropriate. The tables of gridded data used for the 'overview' assessment should be checked and where necessary new data (parameters) included and/or existing data (parameters) updated if relevant (ToR c)

3.3.1 North Sea sub-group to review and report, based on documentation from WGREGNS (via email from Andrew Kenny)

4 Mapping strategies and survey techniques

4.1 refine the table of generic habitat mapping datasets, developed by WGMHM 2005, particularly to develop a generic specification of the information needed to produce habitat maps (ToR e)

4.1.1 Based on updated version of 2005 WGMHM Annex 5

4.2 initiate the compilation of a list of metadata catalogues which provide data suitable to support habitat mapping studies (i.e. linked to the table of generic datasets) (ToR f)

4.2.1 ALL to identify suitable data sources (national, international)

4.3 review the report of the SGASC relating to acoustic seabed classification (ToR g)

Working Group Dinner (1930)

Wednesday 5 April

5 National programmes (National Status Reports)

5.1 present National Status Report updates according to the standard reporting format by evaluating national habitat mapping activity during the preceding year (ToR d).

(please limit presentations limited to 10 minutes)

5.1.1 Canada (Brian Todd)

5.1.2 USA (report to be submitted by Becky Allee)

5.1.3 Portugal – mainland and Azorean studies (Fernando Tempera)

5.1.4 Spain – mapping on the Basque continental shelf (Ibon Galpasoro)

5.1.5Ireland (Fiona Fitzpatrick)

5.1.6 UK

Ongoing and future mapping projects (Dave Limpenny)

Mapping studies in Northern Ireland, including a pilot project to merge LIDAR with multibeam off East Antrim (Matt Service)

5.1.7 Norway – the MAREANO programme (John Alvsvåg)

6 Protocols and standards for habitat mapping

6.1 finalise the definitions of the terms habitat and marine landscape/seascape for the purposes of marine habitat mapping (ToR h)

6.1.1 Based on 2005 WGMHM report (Annex 12)

6.2 review and critique guidelines for habitat mapping, including the review of protocols and standards for habitat mapping developed under relevant initiatives (e.g. MESH). In addition, identify other areas where the development of guidelines is required (ToR i)

6.2.1 The MESH review of mapping protocols and standards is available to down load (www.searchmesh.net/Default.aspx?page=1442). Note: the MESH review is currently being updated to incorporate comments received during 2005 and should be available in Spring 2006.

6.2.2 MESH Action 2 (development of protocols and standards) – update on progress and outline of plans (Fiona Fitzpatrick)

6.2.3 Other guidelines to be considered (**ALL** to assess and make available to the meeting, particularly where these add significantly to the MESH reviews or cover different techniques or topics)

6.3 review standards for calibrating acoustic survey systems (ToR j)

6.3.1 Based on draft report to be circulated

6.4 review progress in the development of 'discovery' and 'survey/method' metadata standards for marine habitat mapping, illustrated with worked examples (ToR k)

6.4.1 Based on spreadsheets to be circulated

3 Continued

Further work and report back from North Sea sub-group

Thursday 6 April

7 Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions) and its relevance in understanding ecosystems

7.1 review the application of and needs for habitat maps in a management context, including case studies to illustrate particular applications. Develop a link between various scales and types of maps to relevant issues and end user needs (ToR l)

7.2 explore the use of habitat maps in understanding and assessing ecosystem structure and function (ToR m)

5 National programmes (National Status Reports) - continued

- Germany - progress in mapping Annex I Habitats, Habitats Directive and results of a feasibility study for marine habitat mapping in German marine waters (Dieter Boedecker)
- Sweden (Martin Isaeus)
- Denmark

Mapping of the Danish exploited shellfish stocks (P.S. Kristensen, K. Geitner, P. Sandbeck and R. Borgstrøm)

DIFRES GIS mapping project (Kirsten Geitner)

- Poland (Eugene Andrulewicz)
- Russia – Baltic Sea waters (Eugene for Vadim Paka)
- Finland - national inventory programme (Anna Nöjd/ Samuli Neuvonen)
- Other countries

Time to complete any sub-group working and reporting

6 Any other business

Friday 7 April

7 Recommendations and Actions

8 Adoption of the Report

9 Close of Meeting (1300)

Annex 4: BALANCE project overview

Figure A4.1: An overview of the Baltic Sea Region (BSAR) and the four pilot study areas.

BALANCE aim to provide the Baltic Sea Region spatial planning tools based on mapping marine landscapes and habitats and combined this with information on key stakeholder interest. These tools will assist agencies and stakeholders in planning and implementing effective management solutions for sustainable use and protection of our valuable marine landscapes and unique natural heritage. Activities also include establishment of a database with an overview of marine data keepers, marine habitat mapping, development of the "blue corridors" concept, evaluation of the Baltic network of marine protected areas as well as the development of a Baltic approach to marine zone planning.

The Danish Forest and Nature Agency is the Lead Partner of the partnership, which include 26 institutions based in 9 different countries around the Baltic Sea including Norway. Activities occur in the Baltic Sea, Kattegat and Skagerrak. The project is co-financed by the EU BSR INTERREG IIIB fund and has a total budget of 4.7 Mio. Euro. More information is available on the www.balance-eu.org, http://maps.sgu.se/Portal or BALANCE@SNS.DK.

Biologist Johnny Reker, Forest and Nature Agency, phone

Project description

BALANCE aims to:

1) Develop a strong transnational marine spatial planning toolbox and an internationally agreed template for marine management plans based on all available information. It will be exemplified in one operational management plan for a transnational pilot area demonstrating the political, economical and environmental value of habitat maps. The toolbox and management plan will be based on access to knowledge, compilation of available marine data and stakeholder involvement during the project period.

2) Develop the "blue corridor" concept and promote the use of "blue corridors" between protected sites adding true spatial development dimensions to the implementation of EC Directives.

3) Assess whether the Baltic marine Natura 2000 network is an ecological coherent network adequate for marine nature conservation.

4) Develop a communication strategy with local stakeholders in government and private sectors to ensure the purpose and products are well understood and used after the end of the project.

5) Disseminate the outputs through a variety of media including an interactive web site to ensure a wide public awareness of the BALANCE results and the values in the Baltic Sea.

The spatial planning elements of the BALANCE toolbox are:

6) The identification of marine landscapes of the Baltic Sea presented in a collated and harmonised GIS map.

7) A holistic approach to marine habitat mapping combining data on benthic, pelagic and fish habitats collected in 4 transnational pilot areas.

8) The development of habitat models for areas with little biological information.

9) A metadatabase of BSR marine databases, so that ownership, techniques and data availability are widely known enabling stakeholders easy access in the future.

10) The development of internationally agreed protocols for habitat mapping based on the intercalibration of existing national protocols. This will ensure data emanating from future mapping initiatives is compatible.

3. Work packages

The following description of the work packages is based on an earlier version of the draft and is part of the concept development. It is included for your convenience as an explanation and background of the basic concepts of the project. No comments are needed at this stage for this section.

WP 1 Data Management:

- **Data collation.** Work package 1.1 involves the collation of data from various national and international partners and stakeholders in order to provide the other work packages with the necessary level of information to enable their satisfactory completion. The work package will involve different aspects of data compatibility and consistency between a wide range of governmental data managers in the BSR in order to ensure a solid foundation on which to base future spatial planning and management of the natural resources of the marine environment. The wide-ranging partnership will ensure that the information is used in the development and implementation of a unique marine spatial planning tool.
- **Meta database.** Work package 1.2 will develop a meta-database that contains an overview over available marine data and dataholders in the Baltic Sea Region. This is required for developing and maintaining a forceful spatial planning tool for the marine environment e.g. information ideally required for developing habitat maps. Information on the ownership of different databases as well as an overview on metadata (who, where, why, when, how (survey), how (mapping)) and data (biological, physical) available for the Baltic Sea region will be included. The meta-database will be continued after the end of the project period.
- **Establishing protocols and standards.** Work package 1.3 will compare co-ordinate and establish common standards monitoring guidelines for habitat classification, data collection, data processing, data integration and interpretation throughout the Baltic Sea Region. Guidelines for broad scale mapping techniques and ground truthing techniques as well as the intercalibration between them will be established. This will lead to more harmonised and internationally accepted standards and protocols and form the basis for future strategies and sustainable management of the marine environment.

- **Field tests and Pilot areas.** Work package 1.4 will test the results and recommendation obtained through work package 1-4.
  - A) It will test and improve the established standards and protocols from WP 1.3 through trans-national *in situ* co-operation in 4 pilot areas selected throughout the Baltic Sea Region. This is necessary in order to assess the robustness and applicability of the guidelines.
  - B) It will provide the highly detailed information necessary for the development and testing of the marine landscapes, habitat maps and predictive models developed under WP 2.1 –2.3
  - C) It will use the recommendations and experiences of the project to develop a comprehensive management plan for a selected trans-national pilot area. The management plan can be use as a guideline or standard for central governmental bodies in the future development of management plans in the BSR. This will ensure a standardised approach in the Baltic region.
  - D) It will produce an example on how to disseminate information and liase with stakeholders at a local through to international level in regard to a trans-national marine protected area. This will promote natural heritage for both regional development and as a tourist attraction and can be used to foster an increased public awareness of limited natural resources.

Four pilot areas were chosen to achieve these goals. These areas cover a variety of habitat types at different geographic locations in the Baltic Sea. The involvement of different partners in the surveys performed in the pilot areas will enhance *in situ* collaboration and exchange expertise and best practice between the environmental managers and scientists from the involved Baltic Sea countries. The 4 proposed pilot areas will be 1) Northern Kattegat 2) Arkona 3) Åbo - Åland - Stockholm 4) Gulf of Riga

WP 2 Marine landscapes and habitats:

- **Marine landscapes.** Work package 2.1 will use geophysical, hydrographic and biological data to identify and map major marine landscapes of the Baltic Sea. The marine landscape approach will include benthic and pelagic "landscapes", which can be used to identify habitat types in the absences of biological data. It will result in a list of internationally agreed landscapes with associated maps for the Baltic Sea and associated marine areas (eastern Skagerrak and Kattegat). It will be based upon the data collation obtained through work package 1. The landscape approach can be adopted as a key element for marine nature conservation in the Baltic Sea with associated marine areas and utilised in spatial planning and the management of the marine environment. The marine landscape's associated biological communities will be identified or predicted through work package 2.2 and 2.3.
- **Habitat maps.** Work package 2.2 will identify and describe the marine habitats present within the individual marine landscapes in greater detail through 4 pilot areas distributed evenly throughout the Baltic Sea as well as using the collated data. This will include benthic habitats based on macroalgae and infauna, essential fish habitats based on fish related data as well as pelagic habitats. Hereby the project will be able to present the first holistic approach to habitat mapping of the Baltic Sea in order to promote spatial planning and a wise management of the limited BSR natural resources.
- **Predictive habitat modelling.** Work package 2.3 will develop predictive habitat models for pelagic and benthic habitats to enable an initial assessment of marine areas with no or little information on the basis of remotely sensed information.

WP 3 Sustainable management of the marine environment in the Baltic Sea Region:

- **Ecological coherent NATURA 2000 network.** Work package 3.1 will use the developed landscape and habitat maps and underlying biological information to evaluate whether the marine sites designated within the Natura 2000 network in the Baltic Sea Region in reality is an ecologically coherent network or not. It will assess whether the representation of the main marine landscape and habitat types within the Natura 2000 network is capable of sustaining and maintaining the full range of biodiversity characteristic of Baltic Sea habitats and thus fulfilling the intention of the Habitats Directive. It will also identify and asses the need for "blue corridors" throughout the Baltic Sea Region through a set of recommendations in order to ensure the linkage within the NATURA 2000 network. Work package 3.1 will thus ensure that the NATURA 2000 network is an ecological coherent network and thereby provide an essential element in the framework for marine nature conservation in the BSR and spatial planning in general. The holistic approach to habitat mapping will also help to ensure a sustainable development of the marine environment for the future and contribute to the successful implementation of national and international legislation e.g. the Water Framework and Habitats Directives.
- **Management plans.** Work package 3.2 will provide a set of recommendations for the development of management plans which will target both specific national designated sites, trans-national marine protected areas as well as develop an integrated strategy for the management of the NATURA 2000 network throughout the Baltic Sea Region. The proposed concept will be tested through the development of a fully functional "test" management plan for the pilot areas. The data collated through WP 1 and the development of international agreed management plans will form a strong foundation for future spatial planning of the entire Baltic Sea Region. This will ensure an efficient use and wise management of our natural heritage, valuable landscapes and natural resources without endangering regional economies. Rather it will strengthen the use of valuable marine landscapes through e.g. sustainable fisheries and future recreational tourism.

WP 4 Dissemination:

- **Communication strategy**
- To keep an effective communication between the project partners and the relevant stakeholders from both the habitat mapping practitioner community and the end-user community (managers, planners, policy makers) a dissemination and communication strategy is developed. The strategy aims of propagating the project objectives amongst the governmental agencies as well as scientific and commercial partners to ensure the input of data and expertise are made available to the project to develop the protocols and standards.
- **Stakeholders**
- A key part is to develop a contact database accessible for all the stakeholders and the establishment of a network of mapping practitioners such as governmental research institutes, universities and the private sector. It is essential to build such a set of contacts to allow rapid and cost-effective communication with the relevant sectors at each stage of the project. Promotion of the project takes place via a final international project conference for all stakeholders, end-users, managers and policy makers with presentation and promotion of all achievements of the project.
- **Web-site**
- A web-site will be established in the early stage of the project to ensure access for the stakeholders as well as the public to progress reports and newsletters. From the web-site protocols and maps will be available for the policy makers and the spatial planners, management and policy makers.

- **School room**
- A specific link from the project home page will lead to “The School class”, which aims to communicate marine science, management and exploitation of the Baltic Sea into the classroom. From this web-site teachers and the pupils at primary and secondary levels will get access to the Baltic seabed i.e. scientific results written in a popular language (to chose amongst Baltic languages), exercises on marine processes (biological, geological, hydrographical) etc. It should be possible to measure waves, currents and study the pollutants from land to sea.
- It will be possible to download pictures, videos showing different types of habitats. Direct links to the cluster of stakeholders and end-user including the fishery. It should be possible to communicate and demonstrate seabed mapping in practise by involving school classes in the ongoing research (communicating with the researchers on sea, in the laboratories etc.

Annex 5: EUNIS North Sea EEA report

Note to inform ICES WGMHM about the project Holistic mapping of potential occurrence of EUNIS habitats in the North Sea

Based on the draft report from NIVA to the EEA December 2004

By Kjell Magnus Norderhaug and Frithjof Moy, NIVA

1. Background

The project Holistic mapping of potential occurrence of marine habitats was defined in the Technical Annex for 2003 by the European Topic Centre on Water (ETC/WTR) and was carried out by Norwegian Institute of Water Research (NIVA). The principal aim of EEA is to produce holistic European maps of marine habitats classified according to EUNIS (European Nature Information System) to obtain an overview of habitat distribution at a European level which will enable national nature conservation authorities to identify and assess their habitats in a European context. EUNIS has been developed and maintained for the EEA by the ETC on Nature Protection and Biodiversity (ETC/NPB).

NIVA was engaged by the EEA to investigate to what extent there were free-of-charge available data that could be used to produce benthic habitat maps. In 2003 a metadata table of available data was produced and in 2004 a map of EUNIS habitats in the North Sea was produced as a test case to see to what extent the data could be used for habitat mapping and to identify gaps.

EUNIS provides a “common language” that enables mapping of units at a regional level and provides a framework for aggregation, evaluation and monitoring of habitat units at different levels of complexity. EUNIS information is being used to support the NATURA2000 process, for EEA reporting and for international co-ordination, e.g. with the Bern Convention EMERALD Network and the others such as, the Helsinki, OSPAR and Barcelona conventions.

The first three levels of a hierarchical structure of EUNIS define a physical and chemical framework for the biology. The mapping of levels 1-3 with a GIS-tool makes it possible to produce maps of potential marine habitats. Such maps create an infrastructure for biological information, the estimation of possible biological content and deviation from expected biological content.

The classification level 1 of EUNIS separates coastal habitats (class B) from marine habitats (class A). The main factors at classification level 2 are depth, substrate stability and special features (Table A5.1). At level 3 the marine habitat classes are further differentiated according to wave exposure, currents, tidal currents, substratum, light depth, salinity, stratification and special features. An overview of the main factors for classification of benthic communities is shown in TableA5.2. At level 4 the habitats are classified according to *dominant species* not very different from BIOMAR of UK.

Free-of-charge and available chemical, physical, geological and biological data relevant for predicting EUNIS habitats have been collected and a habitat map at EUNIS level 3 of the North Sea was produced as a test case. Data sources were explored through internet search, questionnaires and interviews with identified data owners. The North Sea was chosen as the area for the test case because it had been expected to be an area with much available data.

Table A5.1: Marine habitat classification according to EUNIS level 2.

		HARD SUBSTRATA	UNSTABLE SUBSTRATA	SOFT SEDIMENTS
On shore	B: Coastal habitats	B3 Rock cliffs, ledges and shores, including the supralittoral	B2 Coastal shingle habitats	B1 Coastal dune and sand habitats
Tidal zone	A: Marine habitats	A1 Littoral rock and other hard substrata		A2 Littoral sediments
Sub-tidal zone		A3 Sublittoral rock and other hard substrata		A4 Sublittoral sediments
Abyssal				A5 Deep-sea bed
Water column			A7 Pelagic water column	
Special features		A6 Isolated 'oceanic' features: seamounts, ridges and the submerged flanks of oceanic islands	A8 Ice-associated marine habitats	

2. Generic habitat mapping

Our data mining showed that important data for EUNIS mapping are available, although to a limited extent because of the frequently associated high costs and, in many cases, data are not stored in databases which makes acquisition of data a time-consuming operation. In addition, many data gaps have been revealed. In particular data on shallow waters are limited, probably because larger research vessels do not go into shallow waters. Depth data with high resolution, and essential for EUNIS mapping, is generally unavailable because of national restrictions. Such shortcomings reduce the reliability of the produced map in some geographical areas. However, there were many contributors to the project and their names are listed in a reference list. The project also cooperated and exchanged data with ICES, which works on a similar activity.

The resulting EUNIS map of the North Sea is shown in Figure A5.1.

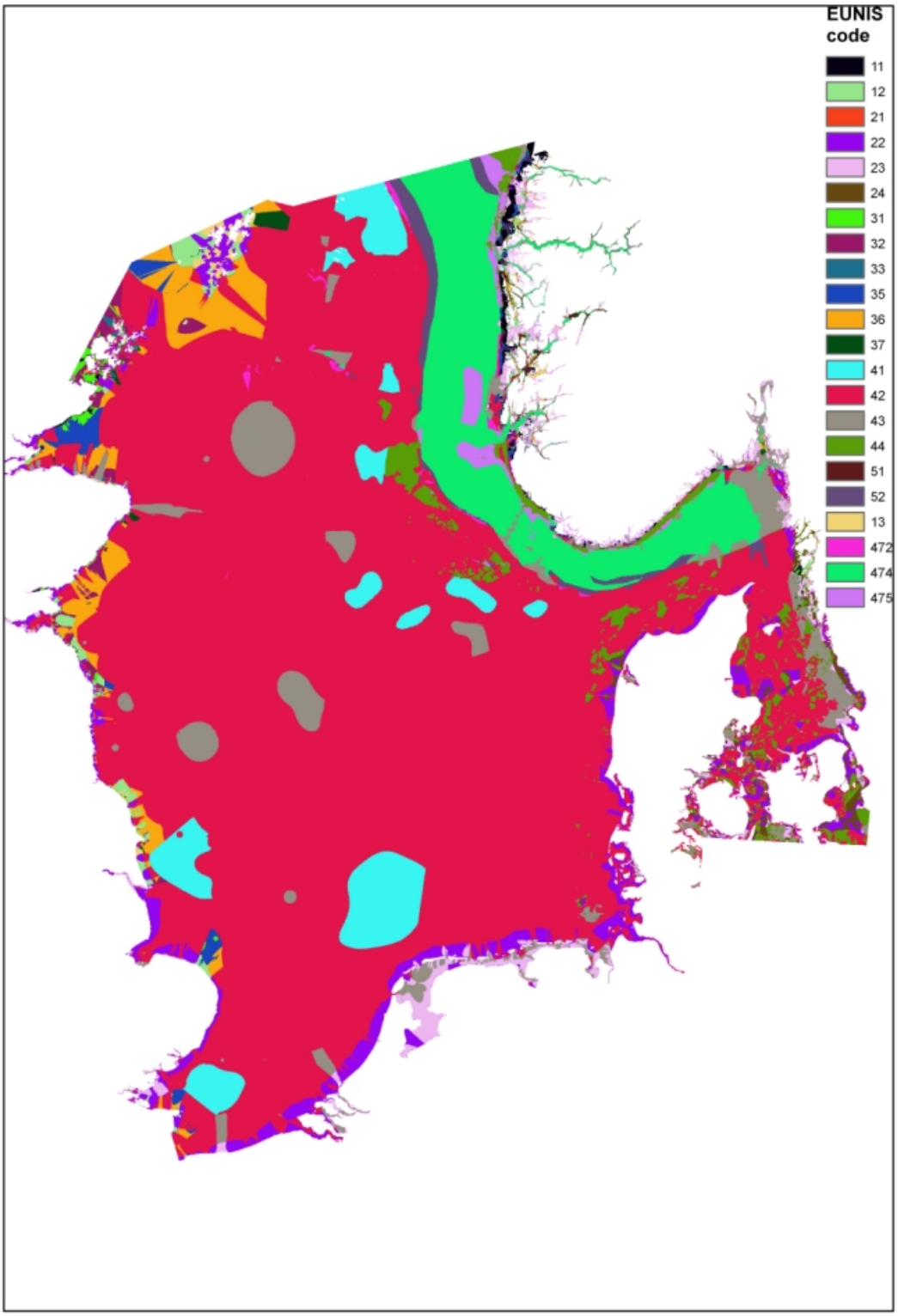

Figure A5.1: EUNIS habitats at level 3-4 in the North Sea. Numbers in the legend refer to EUNIS codes given in Table A5.2 (below).

Table A5.2: Marine benthic habitats classified according to EUNIS level 3-4.

SUBSTRATUM	ROCK (R)	ROCK (R)	ROCK (R)	SEDIMENT GRAVEL, COARSE SAND (GS)	SEDIMENT SAND, MUDDY SAND (MS)	SEDIMENT MUD (MU)	SEDIMENT MIXED SEDIMENT (MX)
Exposure \ Depth	Exposed (E)	Mod. exposed (M)	Sheltered (S)	(Exposed)	(Mod.exp.)	(Sheltered)	
Littoral zone (L)	A1.1 (ELR)	A1.2 (MLR)	A1.3 (SLR)	A2.1 (LGS)	A2.2 (LMS)	A2.3 (LMU)	A2.4 (LMX)
Infra-littoral (I)	A3.1 (EIR)	A3.2 (MIR)	A3.3 (SIR)	A4.1 (IGS)	A4.2 (IGS, IMS)	A2.3 (IMU)	A4.4 (IMX)
Circa-littoral (C)	A3.5 (ECR)	A3.6 (MCR)	A3.7 (SCR)	A4.1 (CGS)	A4.2 (CMS)	A4.3 (CMU)	A4.2 (CMS)
Deep sea	A3.8 A5.1	A3.9	A3.A	A4.71 A5.3	A4.72 A5.4	A4.74 A5.5	A4.75 A5.2

The project has produced amendments to reporting routines by member countries to the EEA, and data arrangements in the EEA databases. These amendments should facilitate more efficient production of EUNIS maps in the future.

3. Map resolution

As far as possible the target was to obtain a map resolution that conserved the data resolution in areas with high densities of data (i.e. the distance between data points) without overestimating this resolution in other areas with longer distance between data points. Typically, data points were dense in some areas and sparse in others (Figure A5.2). Areas with rapid changes were regarded as most critical when deciding which resolution should be used. For instance, when depth changes little offshore but varies widely in shallow areas, the resolution in shallow areas should be given the most attention when choosing the resolution, even though this results in overestimating the resolution in offshore areas. Two of the challenges lying ahead when mapping larger areas are: uneven data coverage and differences in marine habitat spatial variability from littoral to deep water.

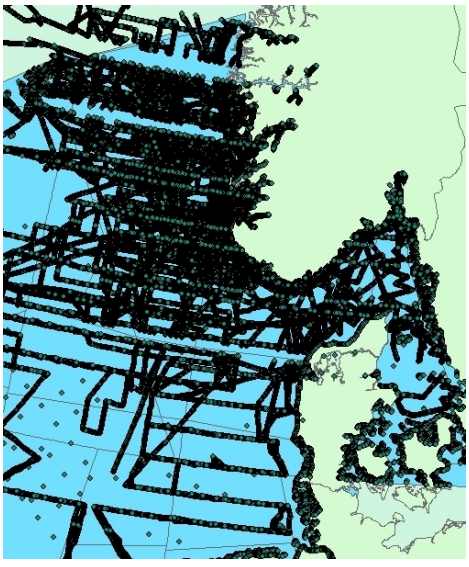

Figure A5.2.

To be able to combine the different rasters and produce a seamless map, a 500 m resolution was used in the whole area. This resolution conserves information in areas with the densest data without overestimating too much the resolution in the areas with low data point density, however it is overly coarse to properly reflect many EUNIS habitats, e.g. the littoral zone. Still, it is the lack of correct overlay between the terrestrial coastlines and marine seashore data that introduces an even larger error locally (Figure A5.3).

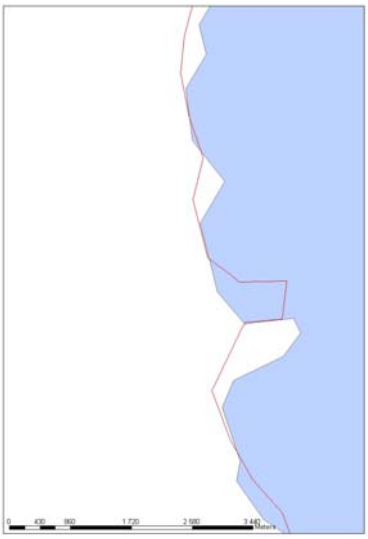

Figure A5.3.

4. Material and methods

The collected data sets were in a variety of formats and data types, e.g. text, numbers representing points, lines and polygons (see reference list). They expressed a variety of different output data classifications with different denominations. All data sets (points, lines, polygons, rasters or tables) were imported to ArcView 8.3 as and transformed into the same format to be compatible. Shape files were converted to rasters, and point files were used to interpolate to rasters. The rasters were combined to identify EUNIS habitats (Table A5.2). Since no value in the raster surface should exceed the highest or lowest values in the sample point sets, the Inverse Distance Weighted (IDW) method was used as an interpolation method.

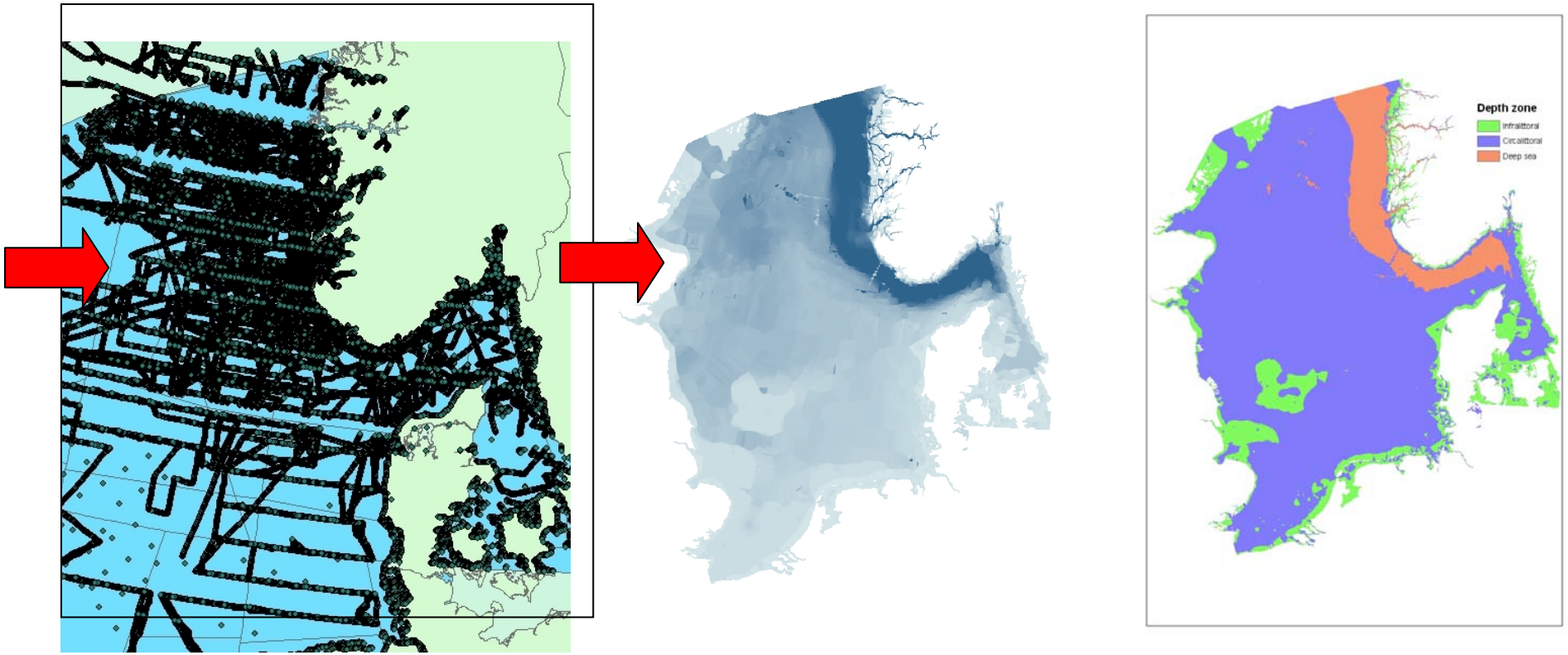

Figure A5.4: Rasters were produced by interpolation from point data, lines and polygons and reclassified to EUNIS relevant classes.

A number of benthic habitats could not be mapped from the available data:

A1.4, A2.5 habitats exposed to wind action

A1.5 Rock pools

A1.6, A3.4 Caves and overhangs

A2.6 Salt marshes and saline redbuds

A2.7 Littoral sediments dominated by aquatic angiosperms

A3.C, A4.8, A6.5 Vents and seeps

A4.5 Shallow sub littoral dominated by angiosperms

A4.6 Biogenic structures over sub littoral sediments

A5.7, A5.8 Canyons and Trenches

A5.9 Deep-sea reducing habitats

A5A Deep-sea bed influenced by hypoxic water

A6.1, A6.2, A6.3 Oceanic islands, Seamounts, Ridges

Depth data

Depth data was received from ICES. The coastline was assigned a depth value 0. Bartholomew Sea Depth data were converted to points (to fit ICES data) and used in near shore areas where there were few ICES point data. All depth data points were merged and interpolated to raster. Generally, depth data were classified according to the Water Framework Directive, i.e. shallow water down to 30 m, intermediate water 30-200, and deep water below 200 m. In addition, the following depth zones according to EUNIS were used:

Littoral zone

The littoral zone was identified from tide tables. In this case study the tidal zone was defined as a zero line (middle water level, low water or uncertain in some areas, where depth=0) minus predicted tide level because the detailed altitude data above water was not available.

Infralittoral zone

Benthic areas within 1% light depth zone were defined as the area where 1.9 x Secchi depth was deeper than the absolute depth which holds for coastal areas (from Sørensen et al. 1993). Secchi data was provided by ICES (Aarup et al.). For many stations Secchi measurements from different seasons were provided. As the light depth during the main growing period was expected to be most important factor for the vertical distribution of algae, the average Secchi depth during spring and summer from multi-annual period were used to the fullest extent of data availability.

Sublittoral

Below littoral zone to 200 m.

Circalittoral

Below a 1% light depth (below the infralittoral zone).

Deep sea

Deeper than 200 m

Too few data in shallow waters most likely resulted in the underestimation of depth in near shore areas. This error may result in the near shore habitats being projected too far from the coast. This is visible in Western coastal areas in Figure A51.

Exposure data

Wave exposure

Exposure is composed of several factors (e.g. waves, currents, etc.) affecting the energy flow and the organisms subjected to it. Along the UK coast, exposure is well defined, but the validity of data causes some concerns. In Norway and Sweden, exposure has been defined based on location, i.e. open coast, semi-exposed coast and sheltered coast. In Norway, the draft classification according to the WFD was used, while in Sweden the regions were defined according to the Swedish Meteorological and Hydrological Institute, SMHI. For the rest of the North Sea area, erosion data from the WFD Common Implementation Strategy Working Group 2 on Ecological Status (ECOSTAT CIS WG 2) was used as follows: firm substrate was defined as exposed, erosion coast defined as semi-exposed, and the areas with sediment deposits as sheltered coast.

Tidal currents

Tidal currents were interpolated from point data manually, digitalised from tidal system maps of surface currents, and web-forecasts. Currents exceeding 1.5 m/s were defined as areas with high tidal currents (according to WFD).

Substrate data

Several sources of different data were identified. Generally, there were two different types of data, i.e. data based on quantitative grain size, and data classified in different grain size classes or bottom types (mud, combination sediments, etc.). A typical sediment classification, derived from EUNIS web-site, is shown in table A5.2.

Table A5.3: Sediment grain size.

SEDIMENTS	SIZE (MM)
Gravel	4-16
Coarse sand	1-4
Sand	0.063-4
Medium sand	0.25-1
Fine sand	0.063-0.25
Mud	004-063
Silt	004 to .063

Near shore data were scarce in southern part of the North Sea which most likely resulted in the near shore habitats being extended too far from the coast on the map. The near shore data (with some gaps) was received from Norway, Denmark and the UK.

Coastline data, provided by the ECOSTAT CIS WG 2 was used to identify substrate in the littoral zone for all countries except Norway and Sweden. In case of Sweden, substrate information from satellite data was used. The Norwegian coast is generally homogenous and defined as rocky, except for the Jæren area which has been defined as sand. In addition, near shore point data from many areas were provided by Norges Geologiske Undersøkelser (NGU) which increased the accuracy of near shore Norwegian habitats. Point data from different sources were merged and interpolated to rasters, and polygon files were converted to rasters. The resulting sediment map is shown in Figure A5.5.

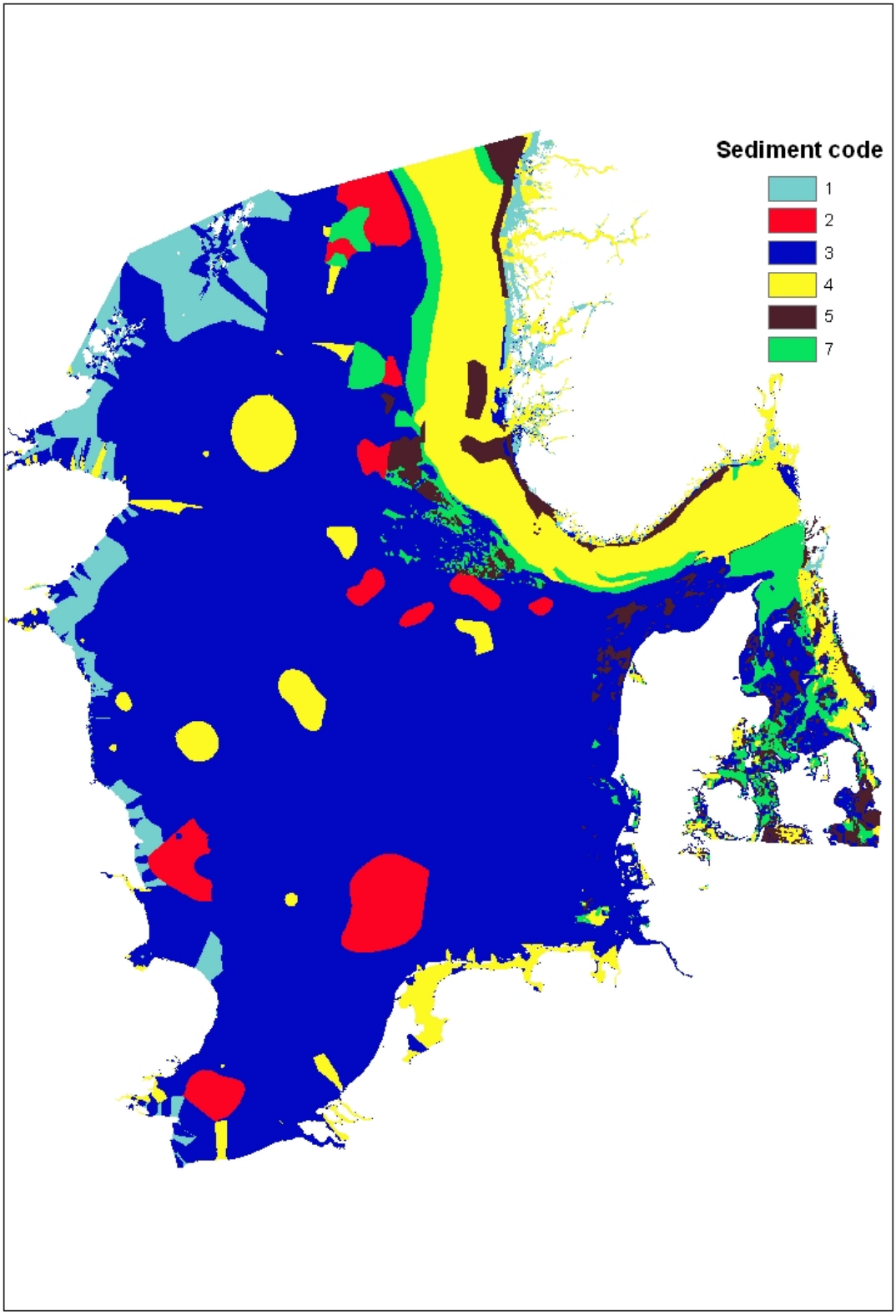

Figure A5.5: Sediments. 1: rock, 2: gravel and coarse sand, 3: sand, 4: mud, 5: combination sediments, 7: muddy sand.

5. Amendments to data compilation

It was concluded that there is a need for standardisation of reporting routines as well as data storing. Much work was needed to recalculate data sampled with different methods in order to make them comparable. Direct comparison is in some cases impossible, e.g. sediment grain size data is not directly comparable to bottom type classes. Few data were identified on EIONET and it was frequently necessary to search many sources to gather appropriate data. In some cases, there were different factors listed in the same data column that needed to be manually separated. Such tasks tend to be time-consuming, particularly when working with large datasets.

National restrictions due to security issues prevent access to high resolution depth data, an obstacle that may not be solved in the nearest future. Mapping could be performed by the respective countries because the end products are often more easily released than the raw input data. This would however create new challenge with producing seamless maps for larger areas.

Presently, there are many ongoing national projects which produce data useful for EUNIS mapping. In particular, the near shore high resolution depth and substrate data being produced in projects using acoustic methods will be of great value for mapping in the future. To produce reliable maps that include littoral zone habitats from interpolation, substrate and hight/contour lines above sea level in addition to high resolution depth data is needed.

It is of utmost importance that marine and terrestrial maps match along the interface of the two environments. It is presently a significant problem that coastlines and seashores do not overlay correctly.

Reference list (Contributing institutions, reports used and other data sources). Heading shows data type; a data type is given in parenthesis.

Depth data

Bartholomew Digital Data Harper Collins Publishers London, UK (polygons)

International Council for the Exploration of the Sea (ICES), (point data)

Institute for Marine Research (IMR), Norway (point data)

Joint Nature Conservation Committee UK (point data)

Norwegian VERITAS, DNV. (point data)

Secchi/visibility data

European Environment Information and Observation Network (EIONET) (point data)

International Council for the Exploration of the Sea (ICES) (point data)

Institute for Marine Research (IMR), Norway (point data)

Joint Nature Conservation Committee UK (point data)

Aarup, T (2002) Transparency of the North sea and the Baltic Sea, a secchi depth data mining study. Oceanologia 44:323-337 (point data)

Exposure/current data

Danmarks Meteorologiske Institut, www.dmi.dk Denmark (digitilized point data)

Management Unit of the North Sea Mathematical Models (MUMM) (digitalised point data)

Norwegian Institute for Water Research NIVA. (polygons)

Joint Nature Conservation Committee UK (point data)

Swedish Meteorological and Hydrological Institute, SMHI (digitalised polygons)

WG2a expert group on Coastal issues, COAST (point data)

Substrate/sediment data

Alfred Wegener-Institut, Bremerhaven, Germany (point data)

Biologische Anstalt Helgoland, Hamburg, Germany (point data)

Bondesforschung-Sanstalt for Fisherei, Hamburg, Germany (point data)

Callaway, R. - Alsvåg, J. - de Boois, I. - Cotter, J. - Ford, A. - Hinz, H. - Jennings, S. -

Kröncke, I. - Lancaster, J. - Piet, G. - Prince, P. - Ehrich, S 2002. Diversity and community structure of epibenthic invertebrates and fish in the North Sea.ICES J Mar Sci 59 (National Groundfish Survey) (point data)

Centre for Environment, Fisheries and Aquaculture Science, UK (point data)

Danish geotechnical institute (polygons)

Danish Hydraulic Institute (polygons)

Danish Institute for Fisheries Research (polygons)

Danish national forest and nature agency (polygons)

Danske Miljøundersøkelser, DMU Denmark (polygons)

Flanders Marine Institute, VLIZ. (point data)

Forschungsinstitut Senckenberg, Germany. (point data)

Geological survey of Denmark and Greenland (polygons)

Geological survey of Poland (point data)

Heriot-Watt University, Institute of Offshore engineering, Edinburgh, Scotland (point data)

Institut für Hydrobiologie, University of Hamburg, Germany (point data)

Institut für Meeresbiologie und Meeresgeologie 'Senkenberg', Wilhelmshaven, Germany (point data)

Institut für Meereskunde, Kiel, Germany (point data)

Institute of Baltic sea research in Warnemünde (point data)

Institute for Marine Research (IMR), Norway (point data)

Joint Nature Conservation Committee UK (point data)

Marine Laboratory, Aberdeen, Scotland (point data)

Netherlands Institute of Ecology, Centre for Estuarine and Coastal Ecology, Yerseke, The Netherlands (point data)

Netherlands Institute for Fisheries Research (RIVO) (point data)

Netherlands Institute for Sea Research, Texel, The Netherlands (point data)

Norges Geologiske Undersøkelser, NGU (point data near shore, polygons files offshore)

Norwegian VERITAS, DNV. (point data)

North Sea benthos survey (point data)

Philipsson P, Lindell, T. 2003. Nationell kartering från satellitbilder av strandtyper längst Svenska havskusten. Report for Naturvårdsverket. CIA, Center for Image Analyses Swedish University of Argiculture Science, Uppsala University, Sweden (line data)

Statens Kartverk, Norway www.statkart.no (point data, polygons)

Station Marine, Wimereux, France (point data)

Swedish geological survey (line data)

University of Oslo (point data)

University of Wales, Swansea, UK (point data)

WFD Common Implementation Strategy Working Group 2 on Ecological Status (ECOSTAT CIS WG 2)

Annex 6: Generic specification for predictive habitat mapping datasets

The ICES WGMHM identified the following types of datasets that can be used for compiling marine landscape and marine habitat maps. The particular data types used, how many are needed and the particular way they are applied needs to be determined, based on the geographical area to be mapped (type of environment), the availability and format of suitable data, and the scale and accuracy needed for the resultant maps.

Linkage

VARIABLE	UNIT	APPLICATION
Shoreline/coastline (HAT - Highest Astronomical Tide)	Meter	Defines the land/sea boundary Complexity of coast/aspect/ruggedness
Bathymetry(including topography)	Meter/gradient	Topography, 3D modelling, slope, ruggedness, bed-forms. Relation to biological zonation
Surficial substrata	Top 1 meter of sediment. Sediment structure (phi, mm) Lithology. Redox discontinuity (mv)	Identification of seabed sediments, potential habitats and range of biological communities. Contaminant sinks/anoxic zones
Maximum wave base	Meters below sea surface (mean value – at least over 1year, preferably over last 10 years)	To assess the degree of seabed disturbance which may affect biological communities
Wave exposure/fetch	Exposure coefficient/shear Orbital velocity (e.g. for relevant storm conditions); may be dependant of life span of the relevant organisms	Identification of potential habitats, range of organisms, seabed disturbance.
Temperature (surface, bottom, profile) Thermocline	ºC Annual average	Biogeographic zones Special communities Stratification
Salinity (surface, bottom, profile) Halocline	‰	Potential habitats, range of organisms
Current speed (residual/maximum near-bed stress)	U .cms^{-1} (see below)	Identification of potential habitats, sediment distribution
Stratification Mixing	Potential energy anomally Jm3 Spatial and temporal extent (see below)	Water column stability Retention of juvenile Development of anoxia
Tidal range/sea level changes	Cm/meter	Identification of potential habitats, zonation, exposure time
Transparency/light attenuation Turbidity	Secchi depth (m) FTU (turbidity)	Depth of photic zone Potential habitats (macroalgae/maerl, etc.)
Ice Cover, (seasonal surface cover not anchor ice)	Number of days with ice coverage and area covered. Thickness (m)	Range of sessile organisms Tendency for anoxia in shallow basins
.ph sediment/water column		Acidification
Dissolved gases Oxygen/methane	mg/l percent saturation	Anoxic area or time period of oxygen sag Special communities
Water quality nutrients	DIN/DIP/silicate uml^{-1}	Anthropogenic enrichment
Anthropogenic activities	Multiple	Habitat modifiers
Occurrence frequency/ intensity of algal blooms	Chlorophyll *a* Presence of toxic species	Eutrophication/may lead to anoxia/ toxic species may selectively impact species
Benthic species	Benthic community metrics(abundance/diversity, etc)	Range of organisms, benthic diversity. May form habitat (biogenic reefs or modify habitat). Not needed for prediction but for validation
Pelagic species	Pelagic community	Range of organisms pelagic diversity - for model validation

Glossary:

Stratification: Pingree and Griffiths (1978) (cf. Jenkinson, 1983) calculated a stratification parameter (S) as follows:

S = log10(d) /IUI3 where d is depth and IUI3 is the cube of current speed

Secchi depth: May be used to give an indication of the irradience, and by comparing this with the water depth, the potential for light to limit primary production may be evaluated. The compensation depth may be approximated from the depth of 1% of the surface radiation (Tett, 1990) which may be estimated as being three times the depth of the secchi disc visibility (Parsons *et al*., 1984).

Stratified: Water bodies that have a sharp vertical interface, above and below which is water of different physical and/or chemical properties.

Entrainment: The shearing effect at the halocline which precipitates the formation of internal waves between the two water masses, therefore creating turbulence. During this process salt water is transfused through the halocline into the lower salinity water.

Halocline: The sharp vertical gradient of salinity in stratified waters.

Anthropogenic: Derived from human activities.

Eutrophication: 'The enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorous, causing an accelerated growth of algae and higher plant life to produce an undesirable disturbance to the balance of species in the water and to the quality of the water concerned' (EEC, 1991a).

Shear stress: Frictional velocity U. Can be either tidally or wave induced, i.e. at the boundary layer 2 m above seabed or U200 >2 cms^{-1} can cause sand transport.

Annex 7: National Status Reports for 2006

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Canada									
Geological Survey of Canada (Pacific), Kim Conway, Vaughn Barrie	Queen Charlotte Basin, Canada	Queen Charlotte Basin ocean management: Benthic habitat mapping, sponge reefs, deep-sea coral reefs.	31 March 2006 to 1 April 2009	Multibeam, sidescan, ROV, sampling.	Provide assessment of potential coral reef distribution as determined from multibeam data sets as they are acquired. Refine models of controls on sponge reef development. Provide geoscience basis to groundfish and rockfish habitat related studies.	150–800 m shelf and upper slope of British Columbia.	Conway, K.W., Barrie, J.V., and 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., and Bertram, M. 2005. Sponge reefs in the Queen Charlotte Basin, Canada: controls on distribution, growth and development. Ed. by A. Freiwald and J.M. Roberts . *In* Cold-water Corals and Ecosystems, 601–617, 9 figs.; Springer (Berlin Heidelberg).	None applied yet	Department of Fisheries and Oceans, Oceans Sector, Natural Resources Canada, various stakeholders.

Organisation, name of contact person*	Geographical coverage (country, region)*	Project title	Date of work, expected year of reporting*	Techniques used (e.g. acoustics, ground-truthing)*	Datasets generated (e.g. bathymetry, physical habitat, biological, photographic)*	Brief description of work (including depth range)	Outputs: Reports, publications, maps, reference lists	Classification used; local (within project), national (state), EUNIS	Targeted end-users
Geological Survey of Canada (Atlantic), (Dr Brian J. Todd)	Canada, Gulf of Maine	Benthic habitat mapping of the Gulf of Maine	1 April 2003 to 31 March 2007	Multibeam sonar, seismic reflection profiling, sidescan sonar, sediment coring and grab sampling, video and still photography	ESRI ArcGIS coverage including bathymetry, backscatter, sediment grain size, videography and photography, surficial geology and benthic habitat maps	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	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals	Local classification scheme (I.e. northeastern US and eastern Canadian waters) has been developed by tailoring EUNIS and other schemes	Governments (federal, provincial and state), NGOs, fishing industry, hydrocarbon industry, cable and pipeline industries
Geological Survey of Canada (Atlantic), (Dr Brian J. Todd)	Canada, Bay of Fundy	Benthic habitat mapping of the Bay of Fundy	1 April 2006 to 31 March 2009	Multibeam sonar, seismic reflection profiling, sidescan sonar, sediment coring and grab sampling, video and still photography	ESRI ArcGIS coverage including bathymetry, backscatter, sediment grain size, videography and photography, surficial geology and benthic habitat maps	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	Local classification scheme (i.e. northeastern US and eastern Canadian waters) has been developed by tailoring EUNIS and other schemes	Governments (federal, provincial and state), NGOs, tidal power industry, fishing industry, hydrocarbon industry, cable and pipeline industries
Geological Survey of Canada (Dr. Vladimir E. Kostylev and Mr. Steve Blasco)	Canada, Beaufort Sea	Benthic Habitat and Offshore hydrocarbon development in the Beaufort Sea.	April 2002 to March 2007	Multibeam bathymetric surveys, sidescan surveys, photo and video sampling, box cores, grabs.	GIS maps of bathymetry, backscatter, grain size, iceberg scouring rates, benthic biomass and diversity.	0–200 m, as ice conditions permit.	Digital maps published by the Geological Survey of Canada, scientific publications in peer-reviewed journals.	Habitat template based on disturbance and scope for growth as developed and applied to Scotian shelf	Governments (federal, provincial and state), NGOs, fishing industry, oil and gas industry, cable and pipeline industries

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Fisheries and Oceans CanadaBedford Institute of Oceanography (Dr Donald Gordon)	Six 10 x 10 km boxes on the Scotian Shelf off eastern Canada (Emerald, Western and Sable Island Banks)	Spatial utilization of benthic habitat by demersal fish	2001–2005 Results will be released when available	Sidescan sonar, single beam seabed classification, DT Biosonics fish assessment, towed (Towcam) and tethered (Campod) video, still photography (both Towcam and Campod), grab sampling and experimental fishing with otter trawl.	Bathymetry, Physical habitat (i.e. sidescan, single beam acoustic metrics, video, photos and grabs) Benthic communities (i.e. video, photos and grabs) Fish communities (i.e. Biosonics, video, photos and trawl) Stomach contents of fish	Large team effort including scientists from DFO at both the Bedford Institute (BIO) and the Northwest Atlantic Fisheries Centre; also scientists from the Natural Resources Canada at BIO. Conducting surveys at the six 10 x 10 km study sites. Depth range 40–70 m. Sites selected after analysis of historical groundfish data (32 years). Three sites have the highest probability of encountering juvenile haddock (hot spots) while three sites have the lowest probability of encountering juvenile haddock (cold spots). Selected paired hot and cold spots on each of the three banks. Data are gathered on annual cruises run in September/October after juvenile haddock have settled to the bottom. Different data sets are being compared. Also attempts at data synthesis and extrapolation. Full field program completed in 2005, including high-resolution (0.1 m) multibeam coverage at three of six sites.	Multiple outputs are expected including maps, reports at scientific meetings, and publications. Gave some preliminary results at the 2004 GEOHAB meeting in Galway.	No decision yet. Most likely local but done with knowledge of other classification systems. Habitat is being assessed by different tools (i.e. acoustic, imagery, and sampling) and by different team members.	Scientific community, resource managers, offshore industry (e.g. oil and gas, fishing), NGOs, etc.

Organisation, name of contact person*	Geographical coverage (country, region)*	Project title	Date of work, expected year of reporting*	Techniques used (e.g. acoustics, ground-truthing)*	Datasets generated (e.g. bathymetry, physical habitat, biological, photographic)*	Brief description of work (including depth range)	Outputs: Reports, publications, maps, reference lists	Classification used; local (within project), national (state), EUNIS	Targeted end-users
Fisheries and Oceans Canada (Dr Peter Lawton and Maria Buzeta)	Lower Bay of Fundy, Canada; New Brunswick coastal areas	Several coastal research projects are underway involving the individuals mentioned, independently or jointly working with other collaborators (e.g. Geological Survey of Canada (Atlantic); Department of Biology and Ocean Mapping Group, University of New Brunswick; Acadia University)	Different project timelines and reporting mechanisms. Work by Maria Buzeta is in support of a graduate thesis from which publications are expected in 2006–2007	Both invesigators are using diver and remotely-operated video to document benthic community composition in relation to habitat complexity in coastal habitats (0 - 40 m). Buzeta's work has included synthesis of historical biodiversity studies in the lower Bay of Fundy in relation to environmental context. Much of Lawton's prior coastal habitat work has focussed on evaluation of habitat suitability for commerical invertebrates (e.g. lobster).	Principal contributions by the investigators noted is development of quantitative approaches to benthic diversity inventory in coastal habitats. Remote video system developed by Lawton and coworker Mike Strong has a comprehensive relational database architecture for storage of habitat class, and biota event records derived from video analysis. Maria Buzeta is conducting multivariate analysis of biological, structural and environmental factors to develop a framework for predicting species assemblages and species richness in coastal habitats.	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 > 1 km 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 is undergoing initial sea trials this spring.	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 Buzeta. M.I .2005. Musquash Ecosystem Framework development; progress to date. Can. Manuscr. Rep. Fish. Aqua. Sci.,2727.	A current project led by Lawton, investigating effects of ocean dredge spoil disposal on habitat suitability for lobsters, has applied the northeastern US and eastern Canadian waters habitat classification scheme developed by Valentine, Todd and Kostylev. Selection of this scheme was due to the incorporation of human usage and habitat disturbance classes in the schema.Coastal habitat framework developed by Maria Buzeta will be compared against other classification schemes.	Scientific community, government (federal and provincial) resource managers, NGOs, inshore industry (e.g. coastal development, fishing). Preliminary coastal habitat classification is being used in development of GIS-based decision support tools for coastal zone management, and will be revised as new regional-scale seabed mapping projects are completed. DFO's St. Andrews Biological Station is initiating work (with other federal and provincial partners) towards an Ecosystem Overview and Assessment Report for the Bay of Fundy/Gulf of Maine in support of Canada's Ocean Action Plan. A coastal pilot Marine Protected Area (Musquash) was multibeamed as part of the designation process, and work is underway to define biological monitoring requirements to evaluate its effectiveness.

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Department of Fisheries and Oceans (Drs Ellen Kenchington and Peter Lawton), Dalhousie University (Dr. Anna Metaxas), Memorial University of Newfoundland (Dr Paul Snelgrove)	Gulf of Maine Biodiversity Discovery Corridor in the northern Gulf of Maine (http://www.marinebiodiversity.ca)	Census of Biodiversity Resources in Canada's Discovery Corridor	Two week research cruise (July 2006) co-funded by the Dept of Fisheries and Oceans and Canada's Natural Science and Engineering Research Council will revisit sites initially sampled in 2005 as well as extend deepwater sampling within the corridor. Results will be released when available	Deepwater ROV (www.ropos.com) will be used to investigate hard and soft-bottom habitats to 2500m. A priority objective will be to investigate deepwater distribution of coral in the NE Channel/Georges Bank area from 500m - 2500m. Additional sampling tools include a multicorer for soft-sediments. Available seabed mapping coverage within the discovery corridor will be used to assist in site selection and analysis of benthic diversity	Benthic diversity from video and still imagery and in situ collection (e.g. suction sampling), correlated with habitat type/complexity measures derived from seabed acoustic coverage where available, or interpretation of imagery. Evaluation of coral communities inside and outside of coral conservation area, as well as in relation to bathymetry . Collection of voucher specimens for species previously recorded from 2005 survey, but not identified yet to species. Additional studies on coral and brittlestar community genetic diversity.	This is the second offshore cruise to be conducted in the Gulf of Maine Biodiversity Discovery Corridor, a large swath of ocean space extending from intertidal to abyssal plain depths across the northern Gulf of Maine. The biodiversity-related inventory and research to be conducted within the corridor will represent a component of Canada's contributions to the International Census of Marine Life.	Multiple outputs expected including graduate theses, reports at scientific meetings, and publications. A significant element of the corridor program is education and outreach, and thus results will be interpreted through various media. New taxonomic reports will become available online through regional (http://gmbis.marinebiodiversity.ca) and international (http://www.iobis.org) bioinformatics nodes.	Primary emphasis of the research is the documenting of benthic diversity including genetic components for some selected groups (corals, brittlestars). Habitat classification scheme to use for analysis of imagery is still under discussion.	Scientific community, resource managers, offshore industry (e.g. oil and gas, fishing), NGOs, etc. The specific focus in the current research on the deepwater coral communities in the NE Channel is expected to provide context for ongoing management of coral conservation areas.
Denmark									
Per Sand Kristensen DIFRES Department of Marine Fisheries psk@difres.dk	Specific areas for mussels in Denmark (Wadden Sea, Limfjord, Little Belt)	National monitoring of mussels	ongoing, annual status reports	Aerial photography, ground truthing	Distribution maps for different mussels	Depth range 0-15 meters. 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	None	DK Gov't Dept's

Organisation, name of contact person*	Geographical coverage (country, region)*	Project title	Date of work, expected year of reporting*	Techniques used (e.g. acoustics, ground-truthing)*	Datasets generated (e.g. bathymetry, physical habitat, biological, photographic)*	Brief description of work (including depth range)	Outputs: Reports, publications, maps, reference lists	Classification used; local (within project), national (state), EUNIS	Targeted end-users
Peter Munk DIFRESDepartment of Marine Ecology and AquacultureKavalergården 6DK-2920 Charlottenlund, DenmarkTel: +45 3396 3300Fax: +45 3396 3333 pm@difres.dk	North Sea	Oceanographic influence on herring recruitment	period 2005–2006, reported ultimo 2006	Databases of hydrography and herring larval distribution	Physical habitats compared to distributions	Depths from 10–150 m, analysis of bottom and/or surface temperature, salinity and density	Journal article	none	Scientific community
Henrik Jensen DIFRES Department of Marine Fisheries Charlottenlund Slot DK-2920 Charlottenlund, Denmark Tel: +45 3396 3300 Fax: +45 3396 3333 hj@difres.dk	Sandeel fishing areas in the North Sea and Skagerrak	AHA.DOT	2007	GPS data on fishing locations	GIS maps on fishing locations	Fishing grounds are mapped using fishermens navigation data and detailed information about the fishery		None	DK Gov't Dept's
Jørn Bo Jensen GEUS Øster Voldgade 10 DK-1350 Copenhagen K Denmark, Tel: +45 38142000 Fax: +45 38142050	The Danish Territorial Waters	Mapping of marine Annex 1 habitats in Denmark (Natura 2000 code 1110, 1140 and 1170)	1980-2000, review produced in 2000	Review based on existing datasets acoustics, ground truthing, models and literature	Digital maps of the distribution of marine Annex 1 habitats (1110, 1140 and 1170)	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	None	DK Gov't Dept's, Industry

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Jørgen O. Leth GEUS Øster Voldgade 10 DK-1350 Copenhagen K Denmark, Tel: +45 38142905 Fax: +45 38142050 E-mail:; jol@geus.dk	Eastern North Sea, west coast of Jutland, Denmark	Geological mapping off the Danish west coast	1991-2001	Acoustics (sidescan sonar, boomer, pinger, chirp sonar, watergun, sparker), ground truthing (sediment coring and grab sampling)	Bathymetry, sediment grain size, geology maps	Survey of the geological composition of the seafloor and sediment transport analysis along the coast of Jutland. Depth range 0-50 m	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?	None	DK Gov't Dept's, Industry
Zyad Alhamdani GEUS Øster Voldgade 10 DK-1350 Copenhagen K Denmark, Tel: +45 38142905 Fax: +45 38142050 E-mail: azk@geus.dk	The Great Belt, Inner Danish Waters.	Seabed classification and habitat mapping of stone reefs in Denmark	2003	Multibeam and ground truthing (grap sampling, under water video and still photography) and Quester Tangent software	Bathymetry, sediment grain size, geology maps	Seabed mapping and classification of sediment as well as biomass contents of stone reefs. Depth range 3-20m	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	None	DK Gov't Dept's
Jonas Teilmann NERI Frederiksborg vej 399 DK-4000 Roskilde Denmark Tel: +45 46301947 Fax: +45 4630 1114 E-mail: jte@dmu.dk	Inner Danish Water, western Baltic, North Sea (DK) and area around the Shetland Isle (UK)	Satellite tracking of Harbour Porpoise (Phocoena phocoena) in Danish waters and surrounding seas.	1997–2002, date of reporting 2004	Satellite tracking, biological sampling	Biological, homerange area maps	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	None	DK Gov't Dept's

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Bo Riemann NERI Dept. of Marine Ecology Frederiksborg vej 399 PO Box 358 DK-4000 Roskilde, Denmark Tel: +4546 3012 00 Fax: +4546 3012 11	The Baltic Sea	Characterisation of the Baltic Sea Ecosystem: Dynamics and Functions of Coastal Types (CHARM).	2002–2004, date of reporting 2005	Wide range of physical, hydrochemical and biological data generated from national monitoring programmes.	Predictive models of hydrochemical compounds with maps. Distribution maps for infauna and macrophytes and predictive models. Draft typology.	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 period 1 December 2001 to 30 November 2003. Characterisation of the Baltic Sea Ecosystem (CHARM), In press.	Local ?	Gov't Dept's in Denmark, Poland, Sweden, Finland, Latvia, Lithuania Estonia, Germany and Italy
Jesper Andersen NERI Dept. of Marine Ecology Frederiksborg vej 399 PO Box 358 DK-4000 Roskilde, Denmark Tel: +4546 3012 00 Fax: +4546 3012 11	Denmark (aquatic and terrestic environment)	NOVANA (national monitoring programme)	2004–2009 (continued from previous monitoring programmes since 1987). Reports produced every year.	Wide range methods to collect physical, hydrochemical and biological data.	Among the outputs is distribution maps for macrophytes and predictive models. Marine habitat mapping is not a priority	NOVANA integrates environmental monitoring of aquatic and terrestical ecosystems and ensures a coherent approach at a national level.	NOVANA 2003. Programbeskrivelse del 1-3. Several technical guidelines and status reports (most in Danish). Published on \www.dmu.dk	None	National and regional authorities in Denmark

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Kerstin Geitner DIFRESDepartment of IT-TCharlottenlund SlotDK-2920 Charlottenlund, DenmarkTel: +45 3396 3354Fax: +45 3396 3333 kjg@dfu.min.dk	Specific areas for mussels in Denmark (Wadden Sea, Limfjord, Little Belt)	National monitoring of mussels	ongoing, annual status reports	Aerial photography, ground truthing	Distribution maps for different mussels	Depth range 0–15 meters. 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	None	DK Gov't Dept's
Finland									
Alleco Ltd - Jouni Leinikki	Finland	Classification of Baltic marine biotopes - criteria, definitions and EUNIS compatibility	June 2003–April 2004	Literature, existing data	Bathymetry, physical habitat, biological habitat, biotope names	Clasification system, list of found biotopes, criteria for creating new biotopes and instructions for data collection are defined	Final report ready at the beginning of April, 2004	EUNIS, new local	Data collectors, scientists, planners, decision makers
Alleco Ltd - Jouni Leinikki	Finland	Testing marine habitat mapping methods	August2004-December 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0-–0 meters	Final Report	EUNIS, new local	Data collectors, scientists, planners, decision makers
Alleco Ltd - Jouni Leinikki	Latvia	Testing marine habitat mapping methods	June 2004-Dec 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0–20 meters	Final report	EUNIS, new local	Data collectors, scientists, planners, decision makers

Organisation, name of contact person*	Geographical coverage (country, region)*	Project title	Date of work, expected year of reporting*	Techniques used (e.g. acoustics, ground-truthing)*	Datasets generated (e.g. bathymetry, physical habitat, biological, photographic)*	Brief description of work (including depth range)	Outputs: Reports, publications, maps, reference lists	Classification used; local (within project), national (state), EUNIS	Targeted end-users
Alleco Ltd - Jouni Leinikki: CORPI, Sergej Olenin	Lithuania	Biodiversity study and mapping of marine habitats in the vicinity of the Būtingė Oil Terminal, Lithuanian coastal zone, Baltic Sea	June 2002-March 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0–30 meters	Final report	local	Data collectors, scientists, planners, decision makers
Alleco Ltd, Panu Oulasvirta	Finland	Mapping of Natura 2000 habitats in Vuosaari Natura 2000 area	July 2003-April 2004	Acoustic, cable video, divers, GIS	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0–15 meters	Final report	Natura 2000, (Data for EUNIS and local system is used in the classification project mentioned above)	Planners, decision makers
Alleco Ltd, Panu Oulasvirta	Finland	Mapping of underwater biotopes in Otsolahti, Espoo	08/02	Divers, aquascope	Physical and biological habitats, vegetaton to the species level	Mapping underwater vegetation and biotopes of a sheletred, shallow bay in Southern Finland; 0–7 meters	Final report	local	Planners, decision makers
Alleco Ltd	Finland, Estonia, Lithuania	Numerous underwater nature mapping projects	1991-2001	Divers, aquascope, acoustics, remote video, diver operated video, aerial photography	Bathymetry, physical habitat, biological habitat, biotope names	Mapping underwater habitats with a hierarchical approach from coarser to fine-scale methods; 0–25 meters	See http://www.alleco.fi/public.html	Local, HELCOM	Scientists, planners, decision makers
Alleo Ltd, Jouni Leinikki and Viktoras Didziulis	Lithuania, Finland	Developing Allmaps tool to assist underwater habitat mapping	June 2001–still continuing	Desktop work	Predictions of spatial features	Developing a predicting tool and testing it with ground truth data	www.alleco.fi/allmaps/	Any	Scientists, planners, decision makers

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Metsähallitus/ Natural Heritage Services, Jan Ekebom	Finland	MERLIN/SAVELIN - Marine inventories of the Archipelago Sea	February 2004– February 2007	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	Survey of the marine habitats and species (flora & sessile fauna). Depth range 0–30 m. Project is a part of the Natural Heritage Services MERLIN programme and the national VELMU programme	Habitat and speices database, research papers (ready by 2006), photographic database	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers
Metsähallitus/ Natural Heritage Services, Michael Haldin	Finland	MERLIN/MERVI - Marine inventories of the Quarc area	February 2005– February 2008	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	Survey of the marine habitats and species (flora & sessile fauna). Depth range 0-30m. Project is a part of the Natural Heritage Services MERLIN programme and the national VELMU programme	Habitat and speices database, research papers (ready by 2006), photographic database	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers
Åbo Akademi University, Christoffer Boström	Finland	"BIOGEO" Linking Marine Key Biotopes and Geological Features: A Pilot Survey of Macrophyte Communities on Sublittoral Moraines	February 2003 to February 2006	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	Mapping of macrophytes on moraine seafloors. This project is a part of the Finnish underwater nature inventory programme VELMU	research papers (ready by 2006), photographic database	Local	Natural Heritage Services (Manag.plans), Researchers
Finnish Environment Institute, Madeleine Nyman	Finland	Finnish underwater nature inventory programme VELMU	ongoing, annual status reports	Wide range of methods to collect physical, geological and biological data.	Marine habitat maps, distribution maps for macrophytes/sessile species	Coordination of the VELMU programme, data management, predictive models	Predictive models, database, general reports, maps	EUNIS?/HELCOM/Local	National and regional authorities in Finland, researchers, public and decision makers

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Geological Survey of Finland, Aarno Kotilainen	The Finnish Territorial Waters	Geological mapping of the Finnish Territorial Waters	ongoing, annual status reports	Echosounder, side-scan sonar, seismic reflection, multibeam echosounder, different sediment sampling techniques, video	Digital geological maps, bathymetry, sediment grain size	Survey of the geological composition of the seafloor. Depth range, from the coast to the deepest basins (0-400 m)	Digital maps published by the Geological Survey of Finland, scientific publications in peer-reviewed journals	none yet	Various stakeholders (e.g. national and regional authorities)
Alleco Ltd	Finland	Scientific diver training	Since 1996	Theoretical and practical training methods	Practical skills for planning and carrying out the fieldwork for underwater nature mapping	Training of biologists to work underwater, special emphasis on underwater biological mapping	About 90 professional scientific divers from eight countries		Scientists, students
Jan Ekebom	Finland	MERLIN/SAVELIN - Marine inventories of the Archipelago Sea	February 2004-February 2007	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	This project is a part of the Natural Heritage Services MERLIN project & Finnish National Marine Inventories (VELMU)	Final report ready in 2006	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers
Michael Haldin	Finland	MERLIN/MERVI - Marine inventories of the Quarc area	February 2005-February 2008	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	This project is a part of the Natural Heritage Services MERLIN project & Finnish National Marine Inventories (VELMU)	Final report ready in 2006	EUNIS?/HELCOM/Local	Natural Heritage Services (Manag.plans), Public, Decision makers, Researchers
Christoffer Boström	Finland	"BIOGEO" Linking Marine Key Biotopes and Geological Features: A Pilot Survey of Macrophyte Communities on Sublittoral Moraines	February 2003 to February 2006	Acoustic, Cable Video, Diving, GIS	Bathymetry, habitats & biotopes, UW.photography, species data & samples	This project is a part of the Finnish National Marine Inventories (VELMU)	Manuscripts (Research papers) ready by 2006, Final report ready in 2006	Local	Natural Heritage Services (Manag.plans), Researchers

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Germany									
Federal Agency for Nature Conservation (BfN), Dieter Boedeker, Isle of Vilm, D-18581 Putbus	EEZ of German North- and Baltic Seas (partly also Territorial Sea)	HABITAT MARE NATURA 2000	Started in 2002 ongoing	Grabs (sediments and biota), acoustic sediment mapping, video profiles, SCUBA diving, ship based and aerial bird and mammal investigations, stationary PODs to detect harbour porpise movements, satellite tracking of seals	Maps of sediment distribution, bathymetry and habitat maps on Natura 2000 habitats (OSPAR in prep.) as well as for birds and harbour porpoise in the German North- and Baltic Seas (Maps 1:375.000, depth 100m grid)	Commissioning projects to marine research institutions, collecting and assessing relevant data at BfN (GIS)	Scientific reports, publications, maps, reference lists and links www.habitatmarenatura2000.de	NATURA 2000, OSPAR	Basic expert material for the assessing EIAs and contribute to spatial planning process
Poland									
Institute of Oceanology, Polish Academy of Science, Sopot (Prof. Natalia Gorska)	Puck Bay, Southern Baltic Sea, Poland	Development of hydroacoustical techniques for monitoring of underwater meadows in Puck Bay (project financed by Polish Government)	2001–2003	Downlooking echosounder, side scan sonar, biological sampling by divers, video recording	a. Based on acoustic algorithms: maps of spatial distribution of underwater meadows, maps of the height of underwater plants, information on vegetation species. b. Based on biological measurements: vegetation species composition, biomass, height of plants.	a. Collection of acoustical and positional data and ground truthing data. b. Development of acoustical algorithms of underwater meadows detection and species identification.	a. reports to the Polish State Committee for Scientific research; b. publications in Aquatic Living Resources and in Hydroacoustics; c. numerous publications in the conference proceedings.	Local (within project)	National and regional authorities, coastal managers, researchers

Organisation, name of contact person*	Geographical coverage (country, region)*	Project title	Date of work, expected year of reporting*	Techniques used (e.g. acoustics, ground-truthing)*	Datasets generated (e.g. bathymetry, physical habitat, biological, photographic)*	Brief description of work (including depth range)	Outputs: Reports, publications, maps, reference lists	Classification used; local (within project), national (state), EUNIS	Targeted end-users
Institute of Oceanology, Polish Academy of Science, Sopot (Prof. Natalia Gorska)	Hornsund Fjord, Svalbard Archipelago, North Atlantic, Norway	The new estimation of macrophytes existence in a fjord as an example of hydroacoustical method application in the environment condition estimation. (Hornsund, West Svalbard Island) (project financed by Polish Government)	2005–2006	Downlooking echosounder, side scan sonar, biological sampling by divers, video recording	a. Based on acoustical algorithms: maps of spatial distribution of marine habitats, maps of the height of underwater plants. b.Based on biological measurements - vegetation species composition, biomass, height of plants.	a. Collecting of acoustical and positional data, ground truthing. b. Development of acoustical techniques of marine habitat detection and classification.	Publications in the conference proceedings (Eighth European Conference on Underwater Acoustics)	Local (within the project)	Coastal managers, researchers, national authorities
Russia									
Atlantic Branch of P.P.Shirshov's Institute for Oceanology, Russian academy of science, Kaliningrad/Vadim Paka	Baltic Proper, Gulf of Finland, the Scagerrak Sea, the White Sea	Federal Target Program "World ocean", EMERCOM of Russia, FP6 INCO project MERCW #013408	1997–2006, reports late 2006	sidescan sonar, towed multiparameter probes, underwater video, grab, bottom corer, Rosette syst., ADCP, moored current meters, microstructure profilers	Sediment&water samples, Hydrographyc data bases (high resolution transects), microstructure databases, video datasets, bathymetry	Hydrographyc description of Baltic, Skagerrak and White Sea subbasins, links with the Baltic inflow events, chemical pollutatnt distribution in CW dumpsites and unexplored wrecks,	Reports, charts, publications	none	Russ.Federal authorities, RAS, Emercom of RF, EC Research Directorate-General

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Atlantic Branch of P.P.Shirshov's Institute for Oceanology, Russian academy of science, Kaliningrad/Elena Ezhova	Russian EEZ in the South-Eastern Baltic Sea, Gulf of Gdansk	Local project of regional fishery agency "Planktic and benthic communities of coastal marine area of Kaliningrad region", Federal Target Program "World ocean"	2001–2003, reports yearly; 2004-–2006, report late 2006	Grab samples, SCUBA diving, underwater foto and video	Physical and biological habitat distributions, biological samples	Description of spatial distribution of bottom communities (0-100 m depth range)	Customer ZAPBALTRYBVOD reports, institute reports, charts, publications	none	Regional fishery agency ZAPBALTRYBVOD Regional authorities
Atlantic Branch of P.P.Shirshov's Institute for Oceanology, Russian academy of science, Kaliningrad/Vadim Sivkov	Russian coastal waters in the South-eastern Baltic Sea	,	August 2005-December 2006, report at the end of 2006	Echosounder-sediment profiler, Sidescan sonar, underwater video, grab samples, ADCP/tow CTD survays, SCUBA diving	Physical habitat descriptions and distributions, video datasets, bathymetry, granulometric data sets, SCUBA diving reports	Details of bathymetry, distribution of bottom sediments, mapping of underwater vegetation	PhD thesis, final report, publications, GIS projects	national	"LUKOIL-KMN" Ltd.
Zoological institute, Russian academy of science, St.Petersburg/ Marina Orlova	Eastern part of the Gulf of Finland	Littoral ecology and invasive species, BSRP	2003-2005 years, BSRP report late 2006	echosounding, SCUBA diving, geobotanical surveys	Transects within 0 to 7 m depth at most important sites, description of bottoms, collection of biological samples for description of communities, mapping of shoreline vegtation	Characteristic of distribution of habitats over depths, communities and dominant species at littoral and shallow water localities, development and establishment of monitoring of biological pollution (invasive species)	Reports, publication in peer review journals, ongoing preparation of reference lists	none	Regional authorities; partners in BSRP project.

ORGANISATION, NAME OF CONTACT PERSON*	GEOGRAPHICAL COVERAGE (COUNTRY, REGION)*	PROJECT TITLE	DATE OF WORK, EXPECTED YEAR OF REPORTING*	TECHNIQUES USED (E.G. ACOUSTICS, GROUND-TRUTHING)*	DATASETS GENERATED (E.G. BATHYMETRY, PHYSICAL HABITAT, BIOLOGICAL, PHOTOGRAPHIC)*	BRIEF DESCRIPTION OF WORK (INCLUDING DEPTH RANGE)	OUTPUTS: REPORTS, PUBLICATIONS, MAPS, REFERENCE LISTS	CLASSIFICATION USED; LOCAL (WITHIN PROJECT), NATIONAL (STATE), EUNIS	TARGETED END-USERS
Zoological institute, Russian academy of science, St.Petersburg/ Alexey Maximov	Eastern part of the Gulf of Finland	State environ-mental monitoring program, invasive species and bioresources projects	Reports to North-West Dep. of Russian ecological monitoring service # 55, 2006	echosounding, box corer, vanVeen and Petersen bottom samplers	Data on spatial and temporal variation of salinity and oxygen saturaion in upper bottom layer of water at deep waters of oligohaline and mezohaline zones, benthic communities	Characteristic of spatial distribution of hypoxic zones and revealing of inpact of short-term hypoxia and intrusion of salt waters into the eastern Gulf of Finland on state of soft-bottom habitats and macrozoobenthos	reports, #55, 2006	local	Regional authorities
Spain									
Secretaríat general de pesca	Spanish continental shelf (10-170 m)	ESPACE	1994–2014	Multibeam echosounder, high resolution seismic, grab sampling, underwater video	Bathymetry, reflectivity, digital terrain model, slope, seabed classification		Three map series: Serie A: Bathymetry and seabed characteristics; Serie B: Environmental management; Serie C: Digital terrain model and geomorphology	National	
AZTI-Tecnalia. Ibon Galparsoro	Basque continental shelf (5-100 m)	Seafloor cartography and marine habitat delimitation of the Basque continental shelf	2005–2007	Multibeam, sidescan sonar, grab sampling, underwater video. Existing datasets	Bathymetry, seabed classification, habitat maps		Annual reports to the Basque Government	EUNIS	Public information
UK									
Refer to www.searchMESH.net for list of marine habitat projects in UK, Ireland, France, Belgium and Netherlands									

Annex 8: National report for USA

Exploration and Characterization of Near Shore Habitats (from five to 1000 meters) within waters in the U.S. Virgin Islands and Puerto Rico

This will mark the third year of an ongoing research project by the biogeography team from the NOAA Ocean Service's Center for Coastal Monitoring and Assessment. Data from the mission will be combined with biological fish census data collected from 2000-2006 to produce maps of the sea floor topography and habitats. The mission also will help NOAA meet its commitment to the U.S. Coral Reef Task Force to map moderate depth coral reef ecosystems and provide new information to update nautical charts covering the U.S. Virgin Islands.

NOAA scientists will explore the type and extent of habitats in selected portions of the project areas using multi-beam sonar and underwater video cameras. During the mission scientists will collect high-resolution bathymetry; habitat hardness and habitat roughness; and complementary video data that will provide information about the seafloor. A Kongsberg EM1002 multibeam echosounder will be used to collect bathymetric depth information and backscatter imagery in depths of five meters to 1,000 meters. A deep-water remotely operated vehicle (ROV) operated by a contractor, will capture underwater video imagery of seafloor habitats in depths down to 1000 meters.

Benthic Habitat Mapping of Florida Coral Reef Ecosystems(2004)

Develop a Mapping Implementation Plan, begin to acquire source imagery, and identify techniques for producing shallow water benthic habitat maps of southern Florida. This is a new project. The southern Florida region has vast areas of shallow water coral reef ecosystems. To date, only portions (approximately 30 percent) of the region have been mapped in detail. These detailed maps available have used different classification schemes and technologies and may not be directly comparable. Also, the Florida Keys benthic habitat maps produced by FMRI and NOS are based on 12 year old source imagery. NOS will undertake a comprehensive remapping of the region. The key products will be a Mapping Implementation Plan, a comprehensive set of source imagery, a complete, updated map, and a classification scheme that is comparable to those of other areas where detailed maps have been completed. In FY04, the Implementation Plan will be completed, the classification scheme will be developed, and source imagery will star t to be acquired. In FY05, source imagery will continue to be acquired and initial mapping efforts will begin. In FY06, the maps will be completed, accuracy assessments will be completed, and final maps will be released.

Benthic Habitat Mapping of Palau and Development of Mapping Plan for the Freely Associated States (2005)

This project will result in shallow-water seafloor benthic habitat maps of a portion of the Republic of Palau and a Plan to develop maps for the Federated States of Micronesia and the Republic of the Marshall Islands.

Design and Implementation of EcoGIS to Support Fisheries Science and Management: A Cooperative Investigation Between NCCOS and NMFS(2004)

NOAA is developing a Geographic Information System (EcoGIS) to support ecosystem approaches to fisheries management in the Atlantic and Gulf of Mexico. This project, a team effort of the National Marine Fisheries Service and National Ocean Service, seeks to more fully develop GIS decision support tools both for use by scientists and managers involved in ecosystem aspects of fishery management. Goals for this project include the development of two types of GIS decision support tools - a management level application geared to simple data visualization and summaries, and a scientific assessment tool to support ecosystem

modeling. To launch the project, NOAA is hosting a workshop to demonstrate the application of GIS to ecosystem based fisheries management, describe the needs of fisheries management and science, and explore available data and modeling capabilities. The project team will set priorities based on the guidance provided by the results of workshop. In the coming year (FY05), the team will compile data on marine and estuarine habitats, fishery-dependent and independent surveys, and managerial boundaries to incorporate into ArcGIS. Data will be analyzed and presented, and analytical models developed. Finally, the team will complete an interim report, and extend capabilities to user groups.

Development of Mapping Plan for the Freely Associated States (2004)

Develop a Mapping Implementation Plan, acquire source imagery, and produce shallow water benthic habitat maps of the U.S. Freely Associated States (Federated States of Micronesia, the Republic of Palau, and the Republic of the Marshall Islands). This is a new project. The U.S. Freely Associated States region has vast areas of shallow water coral reef ecosystems. To date, very little, if any, of the region has been mapped in detail. Maps that have been produced have used different classification schemes and technologies and may not be directly comparable. Also, the maps produced may be based on old source imagery. The NOAA Coral Ecosystem Mapping Team, working extensively with other federal, university and state agencies, will undertake a comprehensive mapping of the region. The key products will be a Mapping Implementation Plan, a comprehensive set of source imagery, a complete, updated map, and a classification scheme that is comparable to those of other areas where detailed maps have been completed. Initial input suggests that the Republic of Palau will be the first area mapped. In FY04, the Implementation Plan will be completed, the classification scheme will be developed, and efforts will begin to collect source imagery. In FY05, source imagery will continue to be acquired and initial mapping efforts will begin. In FY06, the maps will be completed, accuracy assessments will be completed, and final maps will be released.

Pacific Benthic Habitat Mapping in Hawaii (2004)

Project URL: http://ccma.nos.noaa.gov/ecosystems/coralreef/us_pac_mapping.html

Generate detailed shallow-water (0-30 meters) benthic habitat maps for the main 8 Hawaiian Islands. Effort includes gathering new digital imagery, processing and georeferencing imagery, interpreting georeferenced imagery, and map production for main Islands

Seagrass Mapping in Core and Bogue Sounds in North Carolina (2005)

The primary objective of this project is updating our knowledge of the distribution and extent of seagrass in Core and Bogue Sounds, and comparing these data to existing seagrass maps created in the late 1980s and early 1990s to identify areas of change. These are critical coastal management needs. However, mapping Core and Bogue Sounds also provides a unique opportunity to study the impacts on seagrass communities of two divergent coastal development regimes. Bogue Banks, on the ocean side of Bogue Sound, contains high density coastal development, particularly in the areas of Atlantic Beach and Emerald Isle. The mainland side of Bogue Sound in the areas of Morehead City and Cape Carteret are also well developed and experiencing considerable further development. Core Sound, on the other hand, represents a stark contrast to Bogue Sound. Core Banks, on the ocean side of Core Sound has no bridge access, and except for a small group of cabins rented mostly to sportsmen and a few National Park Service buildings, is totally undeveloped. The mainland side of Bogue Sound, except for a few small communities based historically on commercial fishing, has experienced very low levels of coastal residential development. CCFHR personnel will be examining the extent of seagrasses in these sounds, as well as any existing patterns of change, to begin to investigate the potential impacts of coastal development on these seagrass communities.

Habitat Classification Standards

Many management actions by NOAA and its local, state, federal, and international partners are hindered by the absence of a consistent framework for classifying benthic and water-column habitats. Since maps with different ecological resolutions are needed for a wide variety of management and scientific purposes, this framework is needed to systematically relate the existing classification systems. NOAA has taken a critical first step towards this vision by working with NatureServe and others to develop A Coastal/Marine Ecological Classification Standard (PDF, 4MB). This standard is currently being tested by NOAA partners, and information technology needed to support the standard, such as relational databases and geographic information systems, is being planned. Ideally, this framework (or standard) will function as a "Rosetta stone", enabling translation of existing classification systems into a common format. This standard could also be used as a classification system, but its real value and purpose will be to enable compilations and comparisons of data, while preserving specific maps of benthic habitats needed by local users. For more information, contact Becky.Allee@noaa.gov or Pace.Wilber@noaa.gov.

Chesapeake Bay National Estuarine Research Reserve Benthic Characterization

The Chesapeake Bay, Virginia, NERR and the NOAA Coastal Services Center are working together to map benthic habitats within the York River, Virginia. This work is part of a larger effort by NOAA to develop spatial data for key elements of the research reserve system. This mapping effort involves a combination of techniques, including traditional benthic sampling, sediment profiling imagery (SPI), multibeam acoustics, side-scan sonar and a high-resolution video sled. The field portion of this work will be completed by November 2003. For more information, please contact

Apalachicola Bay Oyster, Sediment, and Bathymetric Mapping

The U.S. Geological Survey (USGS) Coastal and Marine Geology Program, the Apalachicola National Estuarine Research Reserve, and the NOAA Coastal Services Center are working together over the next two years to map oysters, geology, and bathymetry within Apalachicola Bay . This mapping effort will integrate side-scan sonar, interferometric swath bathymetry, and seismic reflection acoustic techniques with video imagery and traditional sampling. Fieldwork will occur in spring 2005 and spring 2006. These data sets will fill the local resource management community's need for comprehensive and up-to-date oyster and sediment maps, as well as bathymetric data, for resource management decision making. For more information, please contact Bill.Stevenson@noaa.gov.

South Carolina Oyster Mapping

Approximately 1,500 square miles of digital multispectral aerial imagery is being collected for the purpose of mapping South Carolina's intertidal oyster beds. This acquisition is a follow-on to pilot work conducted by the Center to address a need by the South Carolina Department of Natural Resources' (DNR) Marine Resources Research Institute for an updated oyster reef database. This imagery is currently being collected at 0.25-meter resolution by PhotoScience under extremely tight flight windows constrained by lunar low tides and sun angles greater than 45 degrees above the horizon. In addition to South Carolina's DNR, the state's Office of Ocean and Coastal Resource Management and several local government offices are excited to utilize the tide-coordinated imagery for permitting purposes. For more information, please contact Mark.Finkbeiner@noaa.gov.

Texas Coastal Bend Benthic Mapping Project

NOAA is working with the Texas Parks and Wildlife Department and the Texas A&M University Center for Coastal Studies to support the statewide seagrass monitoring program. Existing digital camera (ADS 40) imagery, originally collected for the National Agriculture Imagery Program, is being used to create benthic habitat maps. The mapping process will use semi-automated methods and will be completed by private industry. The seagrass monitoring program in Texas will use these benthic maps to help locate, monitor, and protect seagrass beds. The first phase of this project covers Corpus Christi Bay, Redfish Bay, Upper Laguna Madre, Baffin Bay, and Aransas and Copano Bays (which include the newest National Estuarine Research Reserve) and is expected to be complete in late 2006. For more information, contact Bill.Stevenson@noaa.gov

Mapping Technology Workshop

A NOAA Advanced Technology Workshop with a focus on seabed mapping will be held tentatively in New Hampshire in fall 2006. Invitees will be international include several lead habitat mappers yet to be determined.

Gulf of Maine Mapping Initiative

The Gulf of Maine Mapping Initiative (GOMMI) is a consortium of federal and state agencies (including NOAA, US Geological Survey, State of Massachusetts and the Canadia Geological Survey) as well as NGOs from the USA and Canada. GOMMI recently completed a large multibeam survey in the Gulf of Maine in cooperation with industry and NOAA's National Ocean Service. GOMMI participants are now planning groundtruthing surveys for this spring and summer. GOMMI is also planning to engage a PhD student funded primarily by the University of Northern Ireland. For more information see http://www.gulfofmain.org/gommi.

GIS and Ocean Mapping Workshop

A workshop on Geographic Information Systems and Ocean Mapping in Support of Fisheries Research and Management will be held at the Massachusetts Institute of Technology on April 11, 2006. The workshop is cosponsored by NOAA's Northeast Fisheries Science Center and the MIT Sea Grant Program. Over 50 attendees are currently registered. For more information see http://web.mit.edu/seagrant/GIS06/

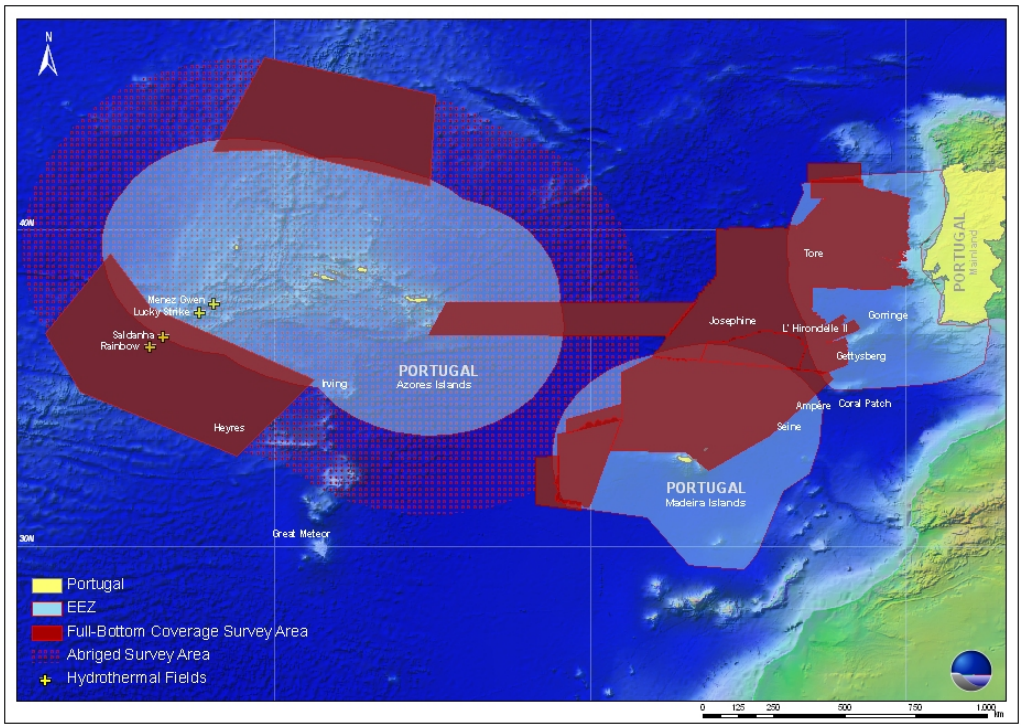
Annex 9: National report for Portugal

Portuguese Continental Shelf Extension Project

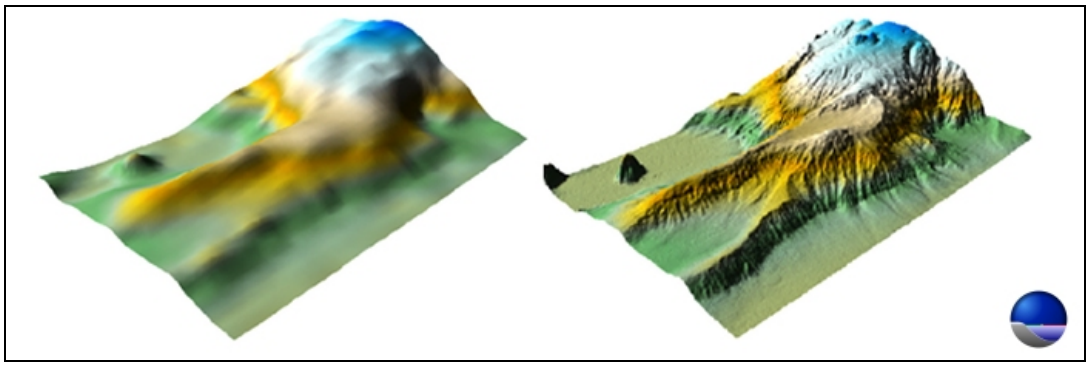
By the Portuguese Task Group for the Extension of the Continental Shelf

The works of the Portuguese Continental Shelf Extension Project involve several hydrographic surveys within and beyond the Portuguese EEZ, in a total area of over 1 500 000 km^2.

All survey activities have been carried out with the contribution of the Portuguese Navy hydrographic vessel *NRP D. Carlos I*, equipped with a set of ultimate data acquisition and processing equipments. By the end of 2006, another Navy vessel, *NRP Gago Coutinho*, will join the project. This ship will be prepared, not only to collect marine geology and geophysical information, but also important biomass data.

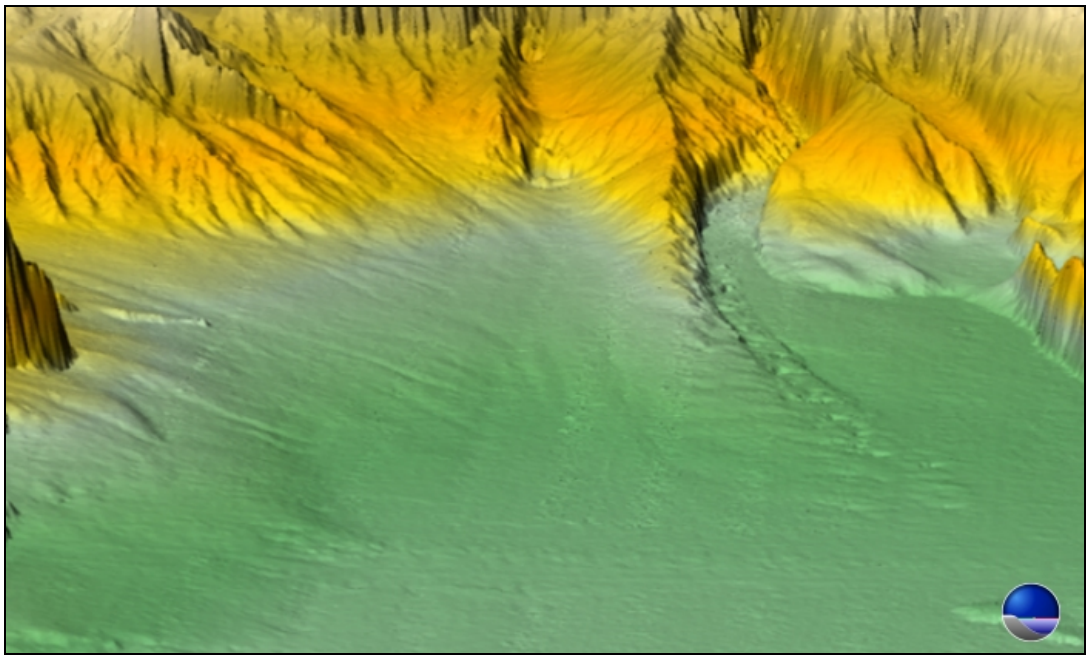


The surveys that have been carried out so far in this project represent a clear progress in comparison with the information available prior to the beginning of the mission. Thus, the current resulting images are of a much superior quality, representing very accurate seabed models.



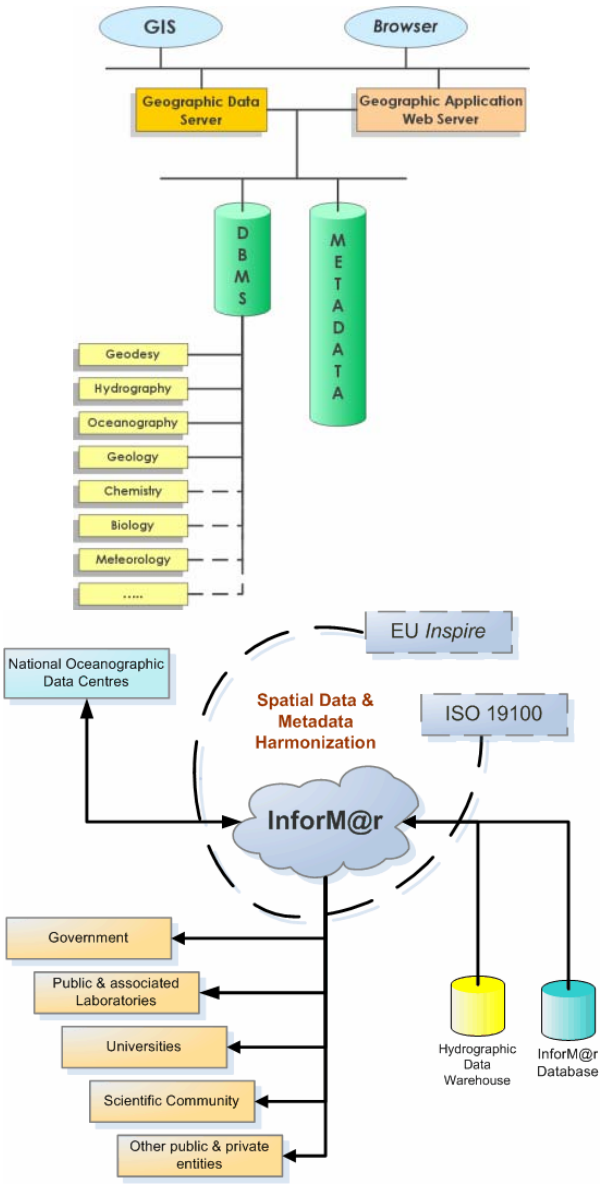
The shape of the sea floor is determined from analysis of bathymetry data. This data is used to produce 2D and 3D maps in shallow and deep water and allows for a seamount inventory where some important habitats are located.

The bathymetry data has great detail and shows the surficial geology. This can be used to study certain habitats to which specific biological assemblages are associated. This information is relevant for the study of the hydrothermal fields – localized features inhabited by unique communities.



An important expected result of this Project is the establishment of a database allowing for the integration of multiple themes such as bathymetry, oceanographic information, geological and biological data.

In order to pursue that, the Inform@r Project was created within the framework of the Task Group for the Extension of the Portuguese Continental Shelf. This Project aims to gather, maintain and publish metadata, using a web accessible digital repository, as well as cooperate and share experience during the development of a marine data management scheme.



Annex 10: National report for Ireland

Prepared by Fiona Fitzpatrick, Marine Institute

Developments in marine resource mapping

Organisation(s) undertaking seabed mapping programmes:

Irish National Seabed Survey Project: Marine Institute & Geological Survey of Ireland.

IMAGIN: Project Partners: Coastal and Marine Resources Centre, University College Cork; Marine Institute, Dublin, Geological Survey of Ireland, Dublin; Geoscience Wales Ltd. Llandudno, Wales.

HABMAP: HABMAP Project Partners: Countryside Council for Wales, Trinity College Dublin, University College Cork, National Museums and Galleries of Wales, University of Wales Cardiff and the Marine Institute (Ireland), with further involvement from EcoServe, British Geological Survey, Aqua-Fact, Ivor Rees and ABPmer.

MESH: Project Partners: Marine Institute, JNCC, English Nature, Envision, NMGW, BGS, CEFAS, Ifremer, University of Gent, DARD NI, Alterra and TNO

Scope of seabed mapping programmes being undertaken in 2005/2006 *(please give a brief description of the survey methods employed and the seabed areas which are being mapped).*

Irish National Seabed Survey. (http://www.gsiseabed.ie/)

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), manages the project and in the last 6 years, over 520 000 km^2 of the Irish Extended EEZ has now been surveyed. During the life of the project, which is now the largest mapping initiative in the world, several vessels and aircraft have been involved. During 2005, four survey legs, on behalf of the Irish National Seabed Survey Project, were undertaken on the R.V. *Celtic Explorer* and two on the R.V. *Celtic Voyager.* Leg 1 on the R.V. *Celtic Explorer* was carried out from 18 April to 24 May off the north coast of Donegal, extending the coverage achieved in previous years (Figure A10.1). From 29 June and 25 July, the survey moved to west Donegal, infilling the area left from previous surveys and covering an area of 2058km^2, over 6810 line kilometres (Figure A10.2). Leg 3 was carried out from 26 July to 24 August; 1370 km^2 were covered (7672 line km) (Figure A10.3). Leg 4 began on 25 August and spent 24 hours surveying in and around Killary Harbour (Figure A10.4) before moving down to Kerry, west of Valentia Island and extending the coverage of the Biologically Sensitive Area, surveyed in 2004 (Figure A10.5). The survey leg concluded on 13 September, having covered a total of 4589 km^2. The first leg of 2005 on the R.V. *Celtic Voyager* was carried out between the 9 and 22 May and located in Killala Bay, County Mayo (Figure A10.6). Later in the year, the second leg was carried out from the 11 to the 16 October, with the vessel surveying the western, navigable channel of Cork Harbour and River Lee (Figure A10.7). INSS surveying operations for 2005 are summarised in Table A10.1.

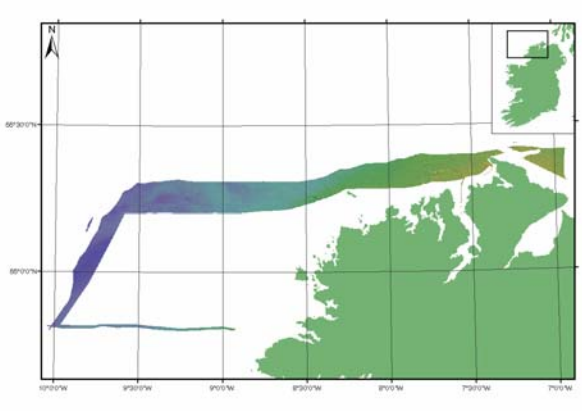


Figure A10.1: Coverage achieved during Leg 1, 2005 - off north Donegal (shaded relief).

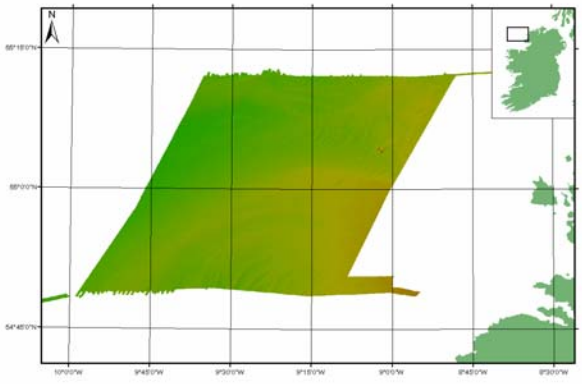


Figure A10.2: Coverage achieved during Leg 2, 2005 - off northwest Donegal (shaded relief).

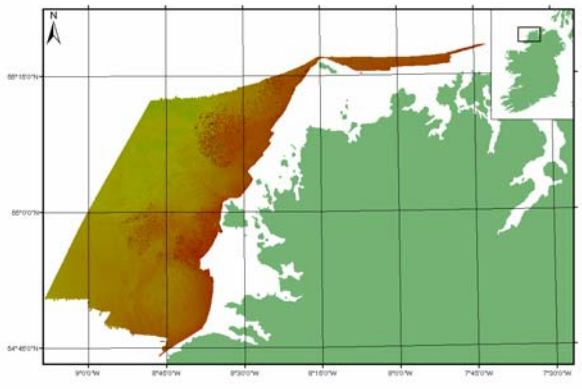


Figure A10.3: Coverage achieved during Leg 3, 2005 - off north Donegal (shaded relief).

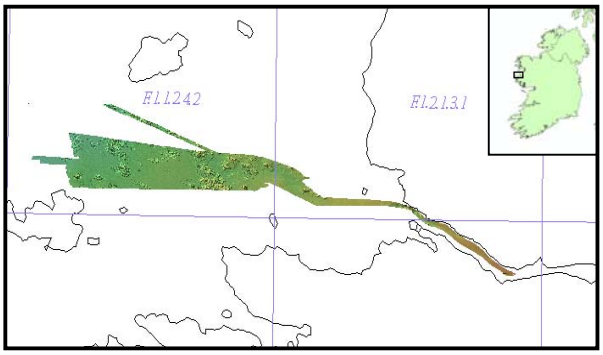


Figure A10.4: Survey leg 4, 2005 - Killary Harbour and approaches (shaded relief).

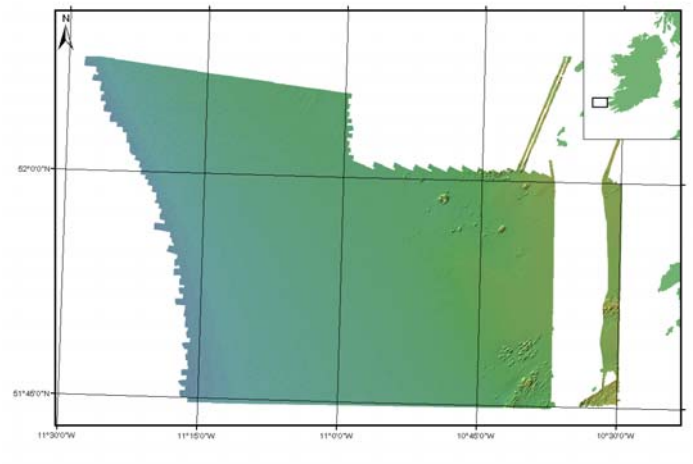


Figure A10.5: Leg 4, 2005 - west of Kerry and Valentia Island.

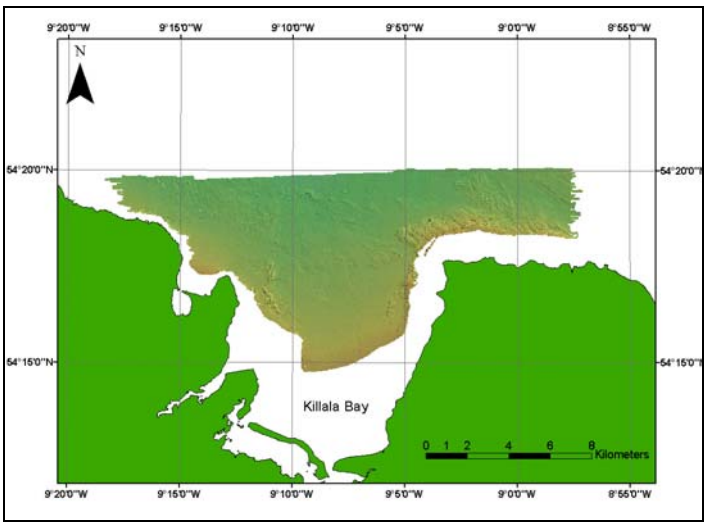


Figure A10.6: Coverage in Killala Bay by the R.V. Celtic Voyager, 2005.

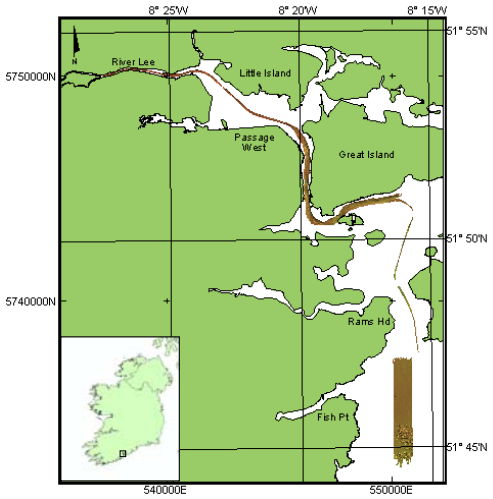


Figure A10.7: Cork Harbour Survey by the R.V. Celtic Voyager.

Table A10.1: Coverage achieved during 2005 on the Irish National Seabed Survey.

COASTAL AREA	DATES	LINE COVERAGE (KM)	AREA COVERED (KM^2)	VESSEL
Leg 1 North Donegal	18 April to 24 May	9185	2062	R.V. *Celtic Explorer*
Leg 2 West Donegal	29 June to 25 July	6810	2058	R.V. *Celtic Explorer*
Leg 3 West Donegal	26 July to 24 August	7672	1370	R.V. *Celtic Explorer*
Leg 4 Killary Harbour, approaches and west Kerry	25 August to 13 September	1931	4589	R.V. *Celtic Explorer*
Leg 5 Killala Bay, Mayo.	9 to 22 May	2718	162	R.V. *Celtic Voyager*
Leg 6 Cork Harbour	11 to 16^{t}October.	458	7.3	R.V. *Celtic Voyager*

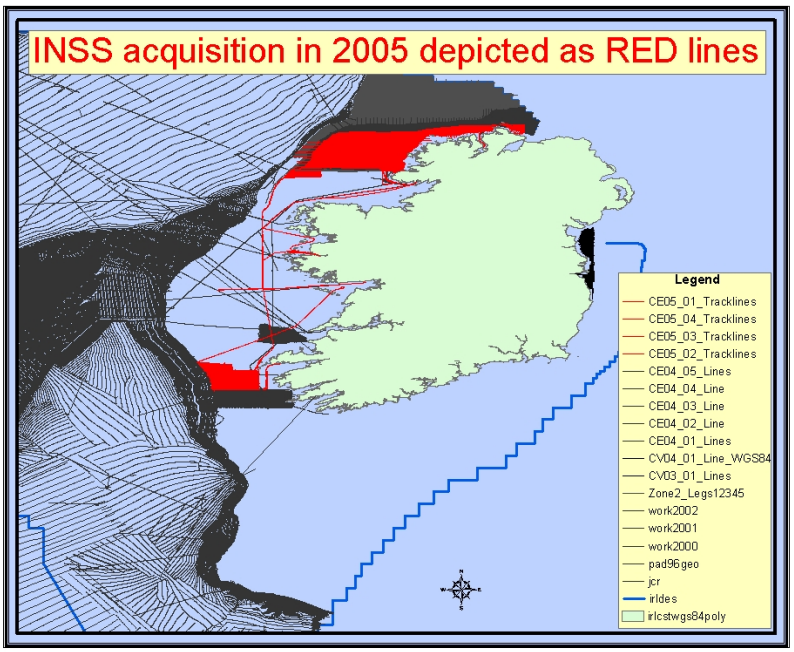


Figure A10. 8: INSS acquisition 2005.

IMAGIN Project. (http://www.imagin-eu.org/).

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

The stated aim is being strongly supported by detailed geo-biological habitat mapping of study areas together with morphodynamic modelling (Figure A10.9). The study areas were selected on the basis of prior assessment of existing archival data (courtesy of the Geological Survey of Ireland, Irish Petroleum Affairs Division, British Geological Survey, and other online and literature sources). They were also chosen to correspond with areas of seabed that may be more appropriate than others for aggregate extraction (e.g. relatively free from interactions with infrastructure & environment) between 20m and 60m water depth contours.

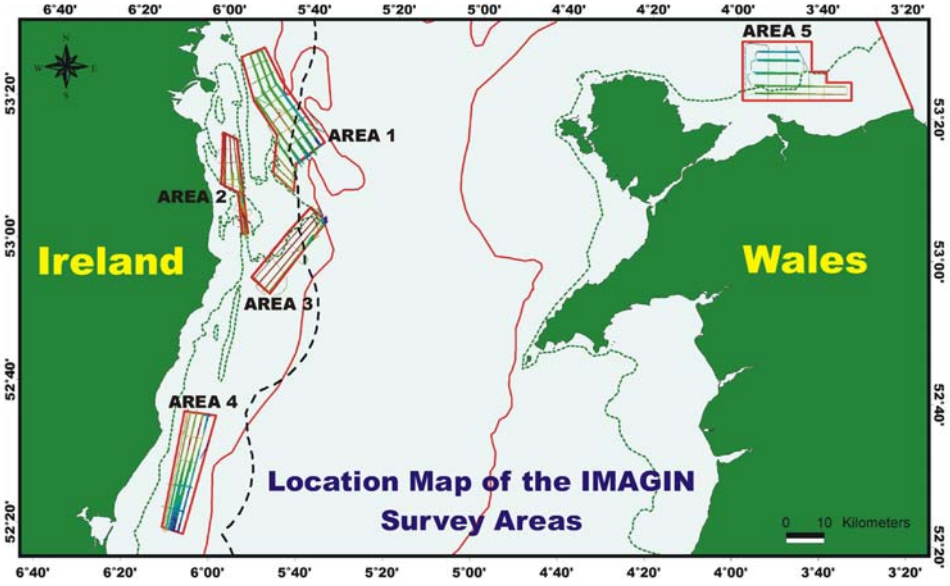


Figure A10.9: Location map of the IMAGIN survey areas (Area 1 to 5). Green dashed and red solid lines correspond to 20m and 60m depth contours respectively. The dashed black line indicates the Ireland's 12-mile territorial limit.

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

All collected and derived datasets have been integrated within GIS (Geographical Information System) in order to simplify data management and manipulation processes, thus facilitating understanding of the geoenvironmental setting and resource potential (Figure A10.10).

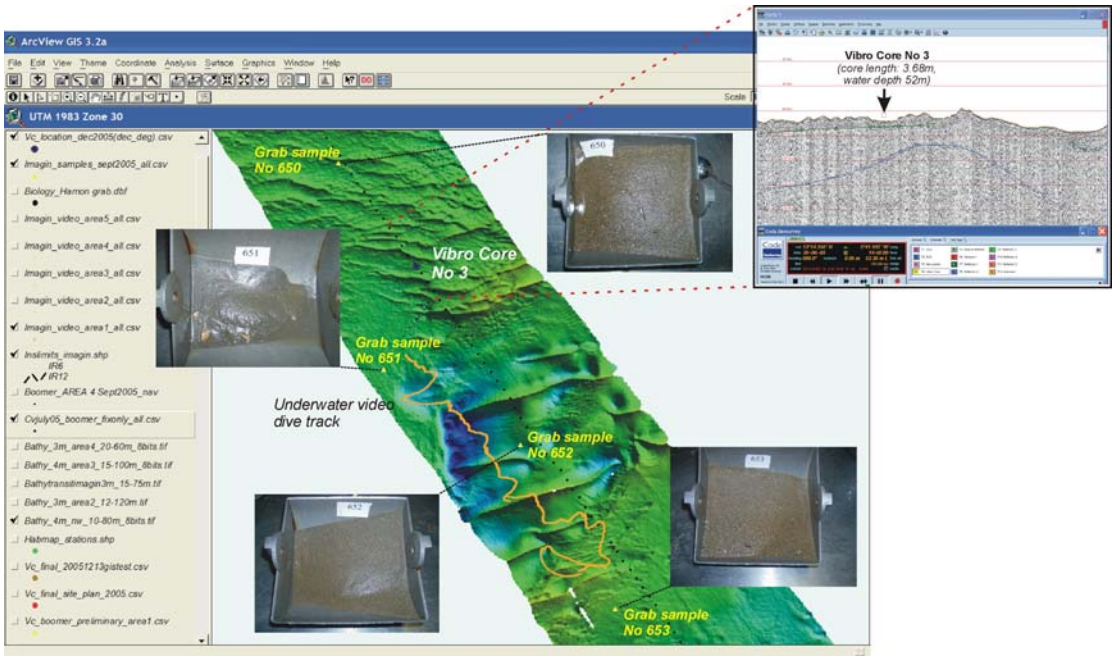


Figure A10.10: Screen grab of the GIS showing the southern part of the study Area 1 (see Figure A10.9) with seabed surface morphology as imaged by multibeam. Boomer seismic tracks (black dotted line), underwater video transect, and showing location of the grab and vibrocore sediment samples are overlain. Upper right outset shows screen grab from CODA GeoSurvey software suite showing fragment of the Boomer line together with vibrocore location sited between adjacent sandwave crests.

Further information can be obtained from the project website at www.imagin-eu.org, partners or project manager Gerry Sutton, CMRC. (gerry.sutton@ucc.ie).

HABMAP Project. (http://www.habmap.org/)

Lead Partners Ireland: Jim Wilson, Trinity College Dublin, jwilson@tcd.ie. Wales, Kirsten Ramsey, Countryside Council for Wales. k.ramsay@ccw.gov.uk

The seabed of the Southern Irish Sea contains a diverse range of habitats and species, from algae dominated rocky reefs to deep muddy areas inhabited by burrowing animals. To varying degrees all of these habitats can be utilised by mankind, through activities such as fishing, aggregate extraction and development of renewable energy resources offshore. In addition, some are priority habitats or contain listed species under EC and international legislation. The project will produce working habitat maps of the seabed of the southern Irish Sea, which will help provide a sound basis for managing the seabed, for example by mapping areas that may be sensitive to particular activities.

Data collation and modelling

This three-year project brings together existing information on seabed habitats for the southern Irish Sea. Relationships between physical data (e.g. sediment type, tidal currents) and biological data will be examined to develop a model to predict biological community type based on physical parameters.

Survey work

Data were collected to fill in knowledge gaps and to test the model during two surveys in summer 2005. The data will include acoustic surveys to gather information about the shape

and properties of the seabed, video surveys and biological surveys of the animals living in sediments. Survey coverage is outlined in Figure A10.11.

A number of factors were taken into consideration during the adoption of HABMAP survey areas: Area near the N. Arklow Bank: potential for Modiolus beds, southern extension along the west of Arklow Bank for sediment transport analysis. Area from S-St-Georges Channel: This strip covered (according to the BGS seabed sediments maps) a range from gravel in the north to mud in the south of interest for habitat modelling purposes Also the area in which the Celtic Tidal Front moves in and out the Irish Sea, to examine potential seabed/habitat responses to the partition/interchange between stratified and mixed water masses. Two areas on the outer limits of Cardigan Bay: strips that BGS data showed to be composed of varied and heterogenous sediment transitions. (from west to east, gravel - sand and sand waves – gravel). Caernarfon Bay: Poorly studied, partly covered Pen Llyn a'r Sarnau, SAC; previous SSS survey revealed Modiolus mussel beds; BGS data indicated undifferentiated bedrock lithology.

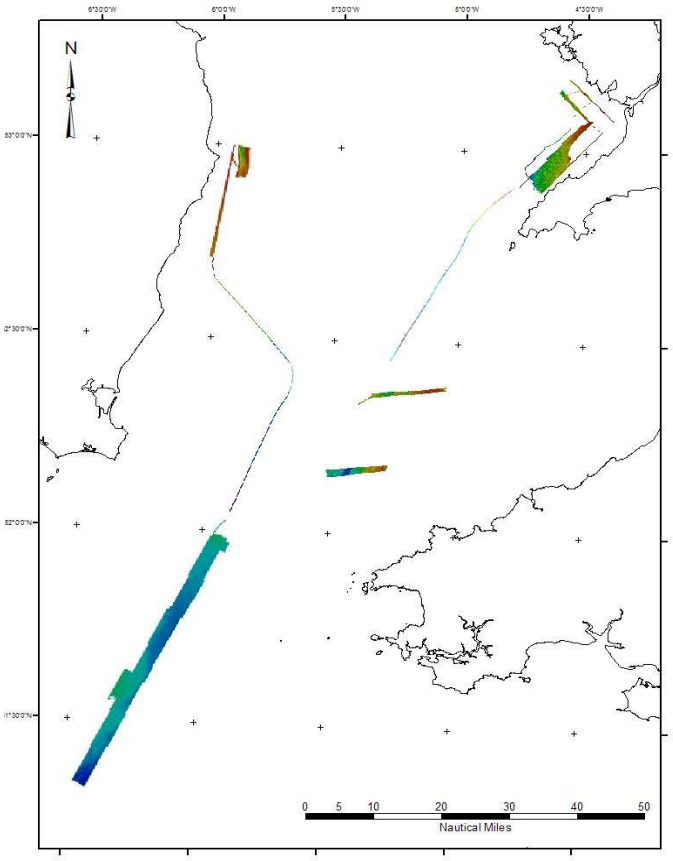


Figure A10.11. HABMAP Areas, as outlined by multibeam sonar.

MESH. (http://www.searchmesh.net/)

The Marine Institute of Ireland is a partner in the European Commission INTERREG funded international marine habitat mapping programme - development of a framework for Mapping European Seabed Habitats (MESH), which commenced in May 2004. The Marine Institute have entered into a strategic partnership with DARD NI and the BGS in order to fulfil the requirements of WP2 and WP3, which deals with the development of habitat mapping protocols. The area selected for survey was required, under the INTERREG regulations, to be cross-border or partially cross border. It was decided to concentrate work on the area of the Donegal Shelf, off Northern Ireland/Donegal extending eastward to the Rathlin Trough in the Northern Irish Sea and northwards to the Southern Hebridean shelf. Survey work for 2005 concentrated in the Irish Channel (UK waters) and the Hempton's Turbot Bank and Greencastle Codling Grounds, which are located to the east of Inishtrauhull Island 18 km off the coast of Donegal. Survey in 2005 was designed to concentrate mapping effort at 13 locations, with the principal objective of the survey was to provide or improve the geological and ecological knowledge of several sites using different techniques, like multibeam swath bathymetry (MBES), single beam echo sounder (SBES), pinger sub-bottom profiler, side scan sonar (SSS) systems, ECHOPlus acoustic ground discrimination system (AGDS), video camera and sea floor substratum samples.

The Hemptons Turbot Bank comprises both a major sand bank and a series of large and smaller sand waves spalling off the bank. The bank has a horizontal base and reaches 24m in vertical thickness. Sand waves are present on the top of the bank and occupy a zone of about 8km. There are four well-defined 20 m in height and many small ones. Although predominantly asymmetrical in aspect, the large sand waves in the centre of the bank appear symmetrical. The waves at the eastern end of the bank and beyond face northwest. Internal reflectors can be seen in some sand waves and they tend to parallel the steeper face of the wave. At the western end of the bank a thin sequence of westerly dipping fine layering abutting the sand bank. The base of the bank is characterised by slightly uneven topography, particularly noted under the eastern and north east of the bank. The unconformity has a strong acoustic signature and is considered to be zone of winnowing of outcropping glacial material, possibly morainic in origin considering the few internal reflectors seen below and their irregular shape. Beneath most of the sand bank and to the west a series of gently westerly dipping reflectors are observed. These appear to overlie an extension of the irregular morainic (?) material. A similar sequence of dipping reflectors is seen in the northeast corner dipping to the north. Bedrock varies from 60 to 120ms below seabed and shows internal reflectors dipping to the north. In a few places there is evidence that these reflectors influence the geometry of the bedrock unconformity. A total of fifteen grab sample stations were collected. (see Figure A10.12).

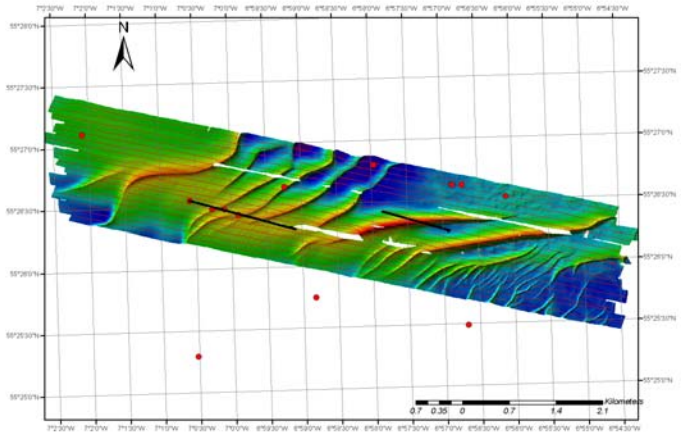


Figure A10.12: Track location and surveyed area on Hemptons Turbot Bank

Cross Service Pilot Project

The Marine Institute comprises seven service groups, including fisheries, aquaculture and ocean sciences, etc, combining a wide and diverse range of specialisations. In order to maximise the value of sea time and obtain 3D data sets, more applicable to biodiversity studies, it was decided to test integrated cross service work in a specially-designed programme, which would combine measurements of the water column, seabed and benthos. A shallow site was selected off the coast of southern Ireland in a know herring spawning area. The site also includes a harbour-dredge spoil site and comprises areas heavily trawled for scallops. In December 2004 and February 2005, survey work was carried out from the R.V. Celtic Voyager in two week-long cruises. Initially the area was mapped using multibeam echo sounder, single beam echo sounder combined with an EchoPlus ADGS system and pinger sub bottom profiling. Video traverses were then carried out, over areas identified by backscatter analysis. Grab and dredge samples were also taken. Vertical plankton samples and CTD profiles were also obtained during the surveys.

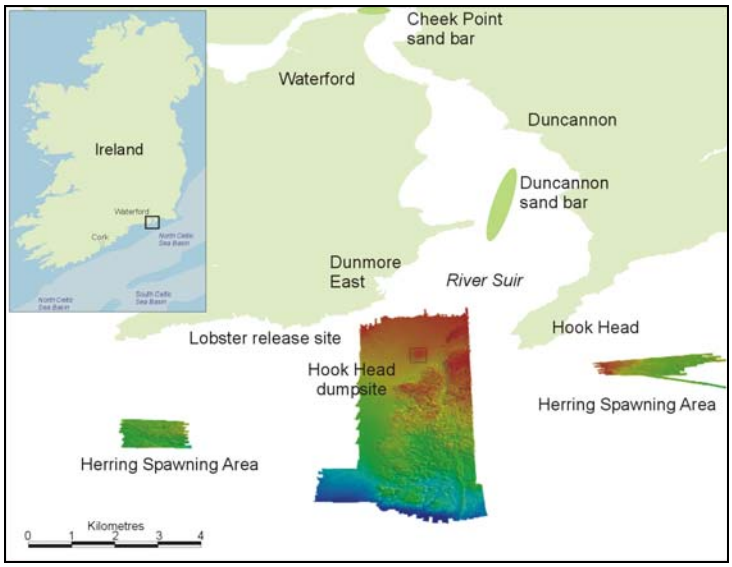


Figure A10.13: Location of Dunmore East and the survey area, showing a multibeam bathymetry image of the areas covered during the two surveys.

Corrected water depths within the Dunmore East survey site ranged from a minimum of 11.8 m in the northernmost section to a maximum of 44.7 m in the southernmost part of the site. The seabed slopes gently south southwestward with an average gradient of 1:277. Topographically, the sea floor shows a rocky extension to the Hook Head promontory with a southwest–northeast orientation. Rocks are also present on the sea floor immediately southward of Swines Head, concurrent with outcrops identified on previous surveys and as described on the Admiralty chart. The Channel, a flatter smoother sediment trough, which hosts the Hook Head dumpsite to the north of the survey area, separates the rocky outcrops. The dumpsite is circular in aspect, with a 50 m central depression and shoals 2 m above the surrounding ambient water depths of 19 m. The dumpsite has a diameter of 1 km.

Considering the surface roughness, the sea floor can be classified into five broad province types. The undulating rocky outcrops, situated to the eastern and southern side of the dumpsite show an average rugged relief of 1–2 m and the outcrops are dissected by a series of gullies and fractures. The margins of the rocky outcrops and the southernmost section of the outcrop are characterised by smooth flat-surfaced rock. Infilling the channel are three distinct topographic provinces: a flat smooth seabed separating low (<1m) starved lunate sand wave to the north and sub parallel 25 cm high sand waves in the south (Figure A10.13).

The geological characteristics of the survey area were identified by a combination of backscatter and multibeam interpretation, combined with the returns form the sediment sampling and direct observation from the UWTV. Interpretation of the backscatter, shows five distinct acoustic provinces: rock outcrops and subcrops, low reflectivity transgressive sediment veneers associated with spoil dumping, highly reflective gravelly surfaces and moderately reflective transgressive sand bodies in the southern part of the survey area .

1) Dredge spoil site. The dredge spoil site is characterised by a veneer of very fine grey silty sand (2.5Y 4/1). The median grain size is 3.5Φ and the graphical mean 3.65Φ (very fine sand). The samples are very well sorted and the skewness values indicate a symmetrical curve. The dredge spoils median diameter shows a distinct fining northward and westward and an increase in grain size southward. The effects of the spoil site are clearly seen in Figure A10.13, with the fine sediments blanketing the coarser grained deposits.

2) Gravels. Coarse-grained gravels are present in the southern section of the central channel. The gravels are well to moderately sorted and comprise well-rounded pebbles, with a thick covering of epibionts, including serpulids and seaweeds. Graphically, the gravels show a fine tail, which comprises coarse sands. The pebbles are mostly spherical or oblate and have chiselled chattermarks. The lithic component is very mixed and includes sandstones, brown-stained quartz pebbles, shales and grey limestones. Occasional broken and worn and stained oysters shells or medium well-rounded shale cobbles are present. The gravels can be subdivided into two provinces: a southern shellier and poorly sorted cobbly pebbly gravel with a high percentage of broken shells and a northern well to moderately sorted gravel with large cobbles and a high coarse sand/granule component. The boundary is poorly defined, but appears to be related to bathymetry and occurs at about 25 to 26 m.

3) Shelly sands. Well-sorted shelly sands are present 1km northwestward of the Hook Head Dumpsite. The sands are light olive brown in colour (2.5Y 5/3), and comprise over 30% broken and worn bioclasts, including gastropod and bivalve fragments. Brown shales dominate the lithic component and the grains are well rounded and oblate to spherical in shape. Graphically, the sands are characterised by a medium to fine grain size and show a negative skewness. The sands are clean washed.

4) Sandy muddy silts. Sampling was carried out in the entrance channel between Dunmore East and Hook Head in an attempt to map the extent of the dredge spoil material. Sediments within the channel entrance are characterised by a very dark grey (2.5Y 3/1) sandy muddy well-sorted silt. The silts show a mean grain size of

4.25Φ and are very well sorted with a very finely skewed graphical tail. The silts show little differentiation within the channel entrance.

5) Gravelly sands. Limited sampling was carried out on the rocky areas, with sampling being restricted to the gullies in the southernmost section of the survey area. The sediments in the gullies are characterised by poorly sorted shelly gravelly medium to coarse sands. The grains mostly comprise broken shells with some shale and limestone granules. The sands are clean washed.

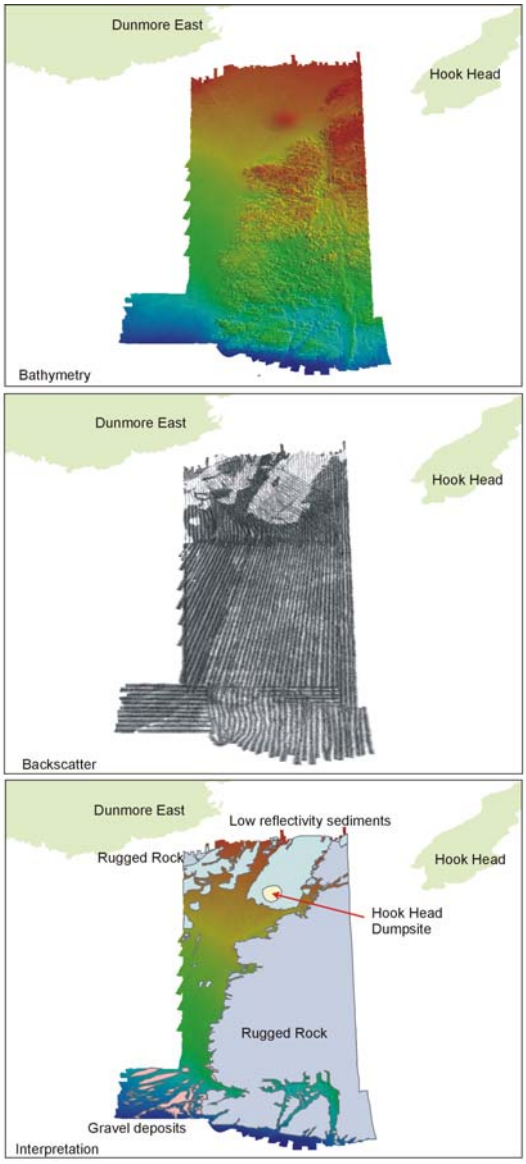


Figure A10.14: Multibeam images showing the topographic variation over the survey area with geological interpretation overlain.

In total, 36 video transects were run over the course of the two surveys. The habitats were classified according EUNIS Level 4 and particular attention was paid to those areas where transitions were indicated from the multibeam backscatter output. A table indicating these particular locations is provided (Table A10.2). A visual comparison was carried out using the transects overlaid on the backscatter image. For sites indicating homogenous backscatter locations, the video indicated a similar habitat throughout and was not included in Table A10.2. Three categories were used to assign a match between the video and backscatter:

1) ‘Not Good’, video does not correspond with backscatter.
2) ‘Good’, video and backscatter roughly correspond and,
3) ‘Very Good’ very good correspondence between video and backscatter.

It must be noted that the degree of correspondence was in relation to the presence or absence of transitions in broad sediment type and was not a comment on specific habitats found on the seabed. Of the 14 transects analysed, 1 was a very good match (Transect 23), whereby 4 transitions indicated from the backscatter were closely matched to the video analysis. Both indicated a transition from mixed sediment (harder) to finer material (low reflectivity) back to mixed and finishing with fines again. Of the other 13 transects, two were not a good match and 11 indicated a good match whereby a single transition indicated by the backscatter was detected by the video.

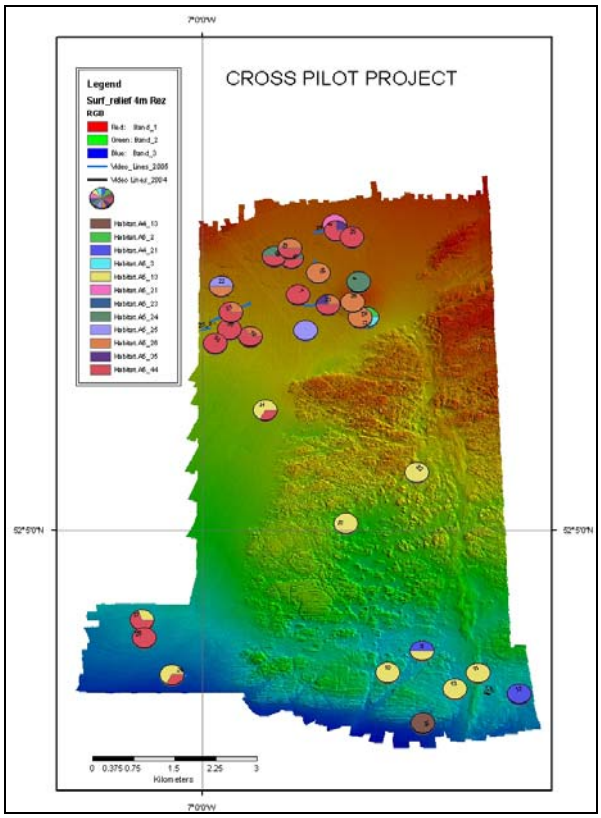


Figure A10.14: EUNIS Level 4 and 5 habitat classifications, as defined from the UWTV transects.

Table A10.2: EUNIS Classification at 5 min Intervals

STATION	T-0	T-5	T-10	T-15	T-END	BACKSCATTER MATCH	COMMENT
15	A5.44	A5.26			A5.26	Not Good	Mixed; muddy sand
16	A5.35	A5.35	A5.44	A5.44	A5.44	Good	Sandy Mud; Mixed
17	A5.26	A5.26	A5.26		A5.44	Good	Muddy Sand; Mixed
19	A5.26	A5.44	A5.44		A5.44	Good	Muddy Sand; Mixed
20	A5.44				A5.44	Good	Mixed
21	A5.44	A5.26	A5.44	A5.44	A5.44	Not Good	Mixed; Muddy Sand; Mixed
23	A5.44	A5.26	A5.44	A5.35	A5.26	Very Good	Mixed; Muddy Sand; Mixed; Sandy Mud; Muddy sand
24	A5.35	A5.44	A5.44	A5.44	A5.25	Good	Mud; Mixed; Fine Sand
26	A5.26	A5.26			A5.26	Good	Muddy Sand
27	A5.13	A5.44			A5.44	Good	Coarse Sediment; Mixed
28	A5.44	A5.44			A5.44	Good	Mixed
29	A5.13	A5.44			A5.13	Good	Coarse; Mixed; Coarse
30	A5.44	A5.44			A5.44	Good	Mixed
31	A5.13	A5.13			A5.44	Good	Coarse; Mixed

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	
A Marine Habitats	**A4** Circalittoral rock and other hard substrates	**A4.1** Atlantic and Mediterranean high energy circalittoral rock	**A4.13**	Mixed faunal turf communities on circalittoral rock
		A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	**A4.21**	Echinoderms and crustose communities on circalittoral rock
	A5 Sublittoral sediment	**A5.1** Sublittoral coarse sediment	**A5.13**	Infralittoral fine sand
		A5.2 Sublittoral sand	**A5.21**	Sublittoral sand in low or reduced salinity
			A5.23	Infralittoral fine sand
			A5.24	Infralittoral muddy sand
			A5.25	Circalittoral fine sand
			A5.26	Circalittoral muddy sand
		A5.3 Sublittoral mud	**A5.35**	Circalittoral sandy mud
		A5.4 Sublittoral mixed sediments	**A5.44**	Circalittoral mixed sediment

ROV Investigations of Cold-Water Coral Habitats in the Porcupine/Rockall off the west coast of Ireland

Project leader: Anthony Grehan - Department of Earth and Ocean Science, NUI, Galway.

The Irish National Seabed Survey (INSS) has already achieved 100% swath coverage of over 600 000 km^2 of Ireland's seafloor territories. Initial map products were produced at a scale of 1:250,000 however further processing of the raw multi-beam data is revealing features, hitherto unknown, with potential as cold-water coral habitat.

During June 2005, a team from the Earth and Ocean Science Department in NUI, Galway carried out the first ever Irish led ROV habitat mapping survey of a number of these areas (Figure A10.15). The survey took place aboard the R.V. *Celtic Explorer*. The Bathysaurus ROV was hired in from Argus Ltd., a Norwegian firm based in Bergen. A number of days at the beginning of the cruise were spent in Galway Bay with several trips to port during system integration trials of a high resolution acoustic mapping module acquired as part of a national marine infrastructure programme (the Higher Education Authority Programme for Research in Third Level Institutions). The module consisted of an ROV mountable RESON 8125 multi-beam (soon to be upgraded for the 7125) and onboard high performance position and motion reference system (IxSEA PHINS fibre-optic gyro-compass), RDI Doppler Velocity Log and CDL Microbath digi quarz depth guage with altimeter). Collaboration with the Marine Robotics group in the University of Limerick provided the essential engineering input necessary for the instrument integration and the subsequent operation of the navigation system during the cruise.

A number of ROV surveys of previously unexplored mound features provided new records of coral occurrence and assemblage variability. A partial video re-survey took place at Theresa Mound.

Some of the highlights of the exploratory surveys included the discovery of living coral on a number of small mounds along the southern margin of the Porcupine Bank which has been named the Arc and Explorer Mounds, and that an extensive area of shallow (350 m deep) mini-mounds, had at one time supported living coral - the mounds in a heavily trawled area, now only contain a covering of coral fragments. Further work is needed to determine whether the coral on these mounds are fossil or recent. The mini-mounds, not visible on standard INSS charts, were identified following re-gridding of the raw multibeam data.

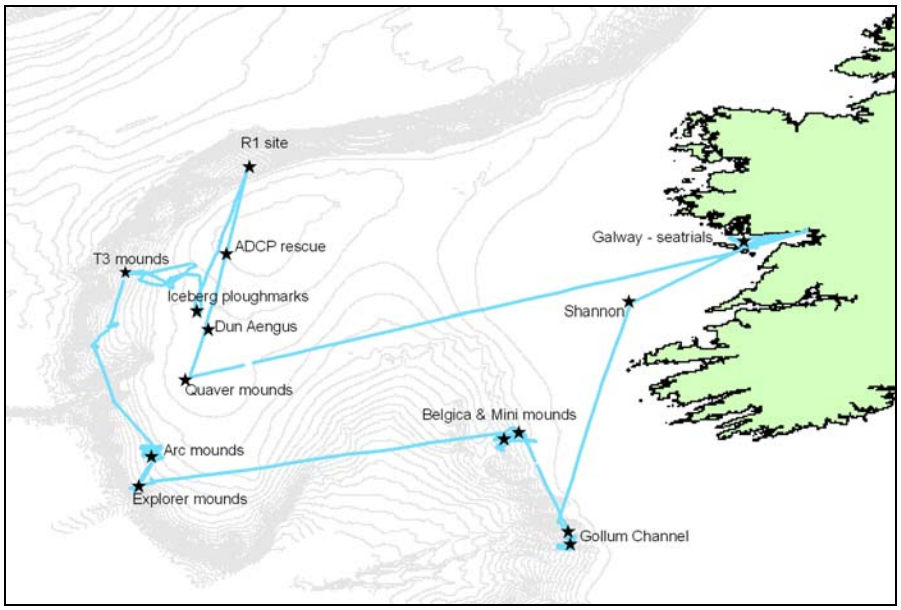


Figure A10.15: CE0505 cruise track

Published seabed resource maps in 2005/2006 (*please provide details of any seabed resource maps, which have been published in 2005/2006).*

Marine aggregate resource maps for the study areas are currently in production.

Bathymetric maps representing 2° x 1° sheets at a scale of 1:250,000 and digital data are

available for purchase from the GSI. (http://www.gsiseabed.ie/)

a) **Future marine resource mapping programmes** (*please provide details of any planned seabed resource mapping initiatives*).

The Government of Ireland have ratified and will fund a second seabed survey project, INFOMAR (Integrated Mapping for the Sustainable Development of Ireland's Marine Resource). INFOMAR will start in 2006, and extend mapping work into the inshore zone around Ireland. The Project will be carried out in partnership by the Marine Institute and the Geological Survey of Ireland.

b) **Other information** *(please add any further information which you would like to be included in this review).*

Annex 11: National report for UK (Cefas)

CEFAS are engaged in a number of projects dealing with the impacts of aggregate extraction in U.K. waters. New extraction licences in the Eastern English Channel (EEC) have prompted the initiation of a habitat mapping programme in the area. CEFAS, in conjunction with BGS, JNCC and MES are currently collecting historic and new data with the aim of producing habitat maps of an area which encompasses the licensed sites. The aim of the project is to place the habitats which exist within and immediately surrounding the extraction sites into a wider spatial context.

Existing data for the region has been gathered within a project GIS and includes a wide range of data types including sediments, geology, fin- and shell-fisheries, and hydrodynamics amongst many others (Figure A11.1).

Figure A11.1. Example of some of the datasets contained within the project GIS.

In early 2005, geophysical survey work was carried out along 21 corridors (three acoustic lines per corridor) generating over 4000 km of acoustic (sidescan, multibeam, boomer) data. The geophysical data was groundtruthed later in the year using 150 grabs, 40 beam trawls and 40 video tows (Figure A11.2) to provide quantitative information relating to infauna and epifauna, sediment type and other environmental variables. The biological, geophysical and environmental data will be analysed to generate habitat maps of the seabed over the survey area at the conclusion of the project in 2007. These maps will be used to assist in the mnagement of potential anthropogenic impacts in the region.

CEFAS are also engaged in a partnership with JNCC, Envision Mapping, GeoTek and Ivor Rees to determine best methods for the identification and mapping of *Sabellaria spinulosa* and cobbly reefs. This project will assist the aggregate industry and advisoy bodies in the selection of appropriate tools to assess this EU Annex 1 habitat.The partners have conducted a review of the status and ecology of these habitats in U.K. waters and also those methods which have

been used to date to identify them. The team have also conducted pilot suvey work to assist in the selection of appropriate tools for testing later in the project (Figures A11.3 and A11.4).

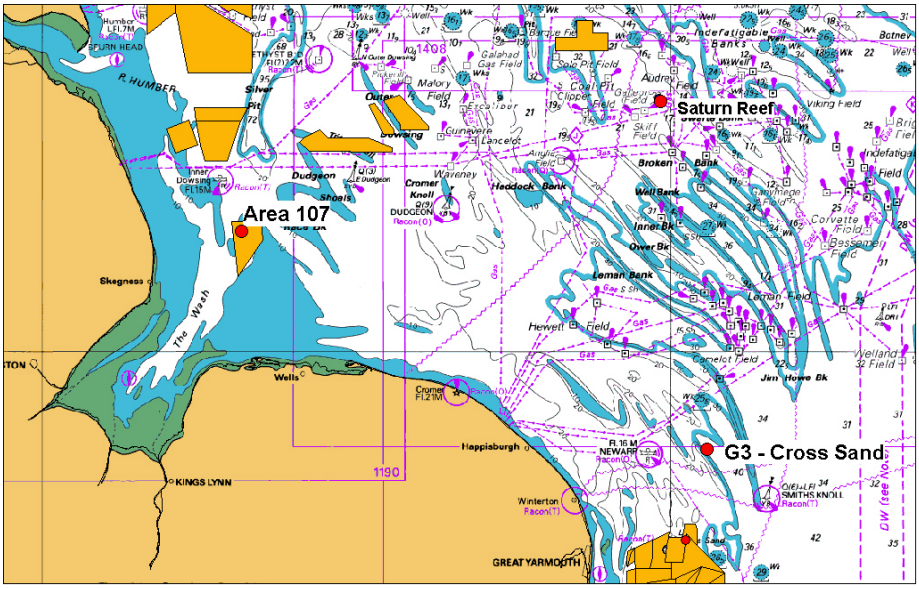


Figure A11.3. Pilot study sites surveyed in 2005.

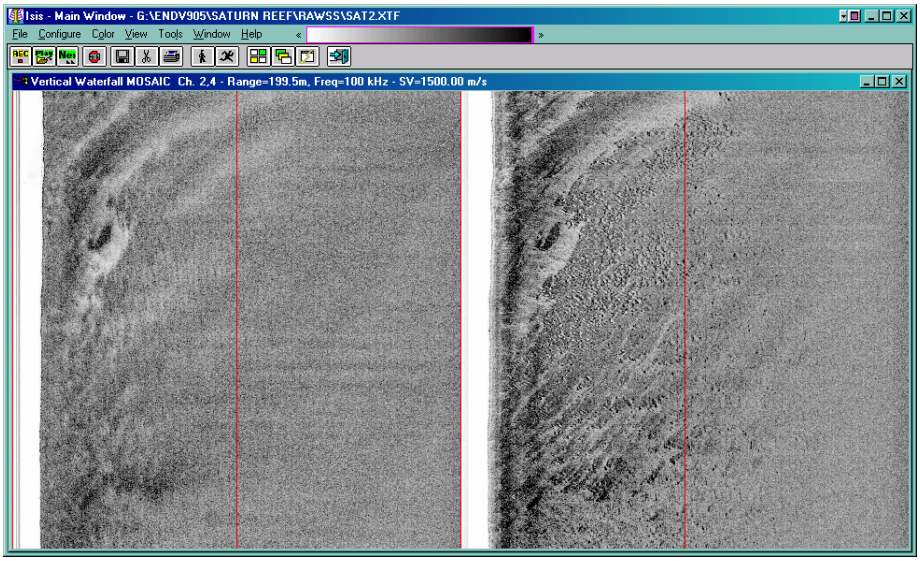


Figure A11.4. Sidescan images of *Sabellaria spinulosa* reef using low frequency (left) and high frequency (right) systems.

A number of acoustic, photographic and direct sampling methodologies will be further tested in the final year of the project. It is likely that this toolbox will include, but not necessarily be limited to:

- Sidescan sonar;
- AGDS;
- Multibeam bathymetry;

- Interferometric bathymetry;
- Scanning sonar;
- Video sledge;
- ROV;
- Sediment profile imagery;
- Grabs;
- Trawls.

The outputs from this project will inform the production of subsequent guidelines for the mapping of these habitats.

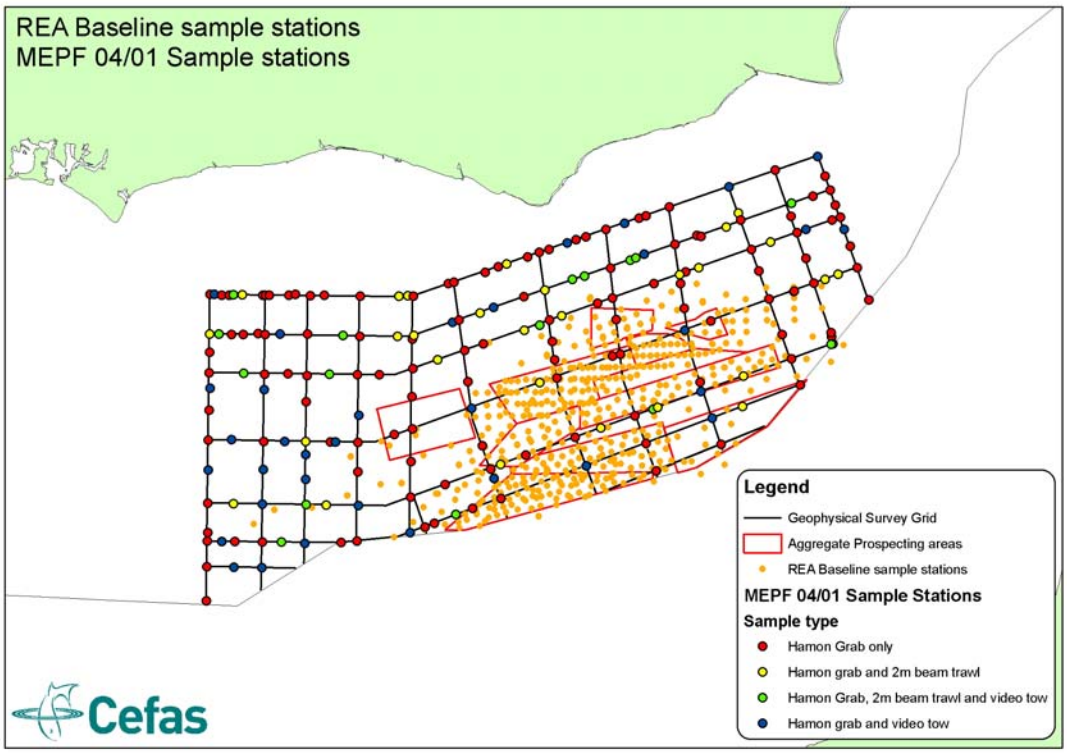


Figure A11.2. Groundtruthing datapoints with acoustic corridors and industry (REA) sampling stations.

Annex 12: National report for Denmark (use of GIS mapping)

Prepared by Kirstein Geitner, DIFRES

Use of GIS mapping in the TEMAS project

In connection to the TEMAS project a number of templates to create GIS-maps of the fisheries in the North Sea, the Baltic and the Skagerak/Kattegat, have been developed by Rasmus Nielsen in co-operation with Anne-Marie Rolev.

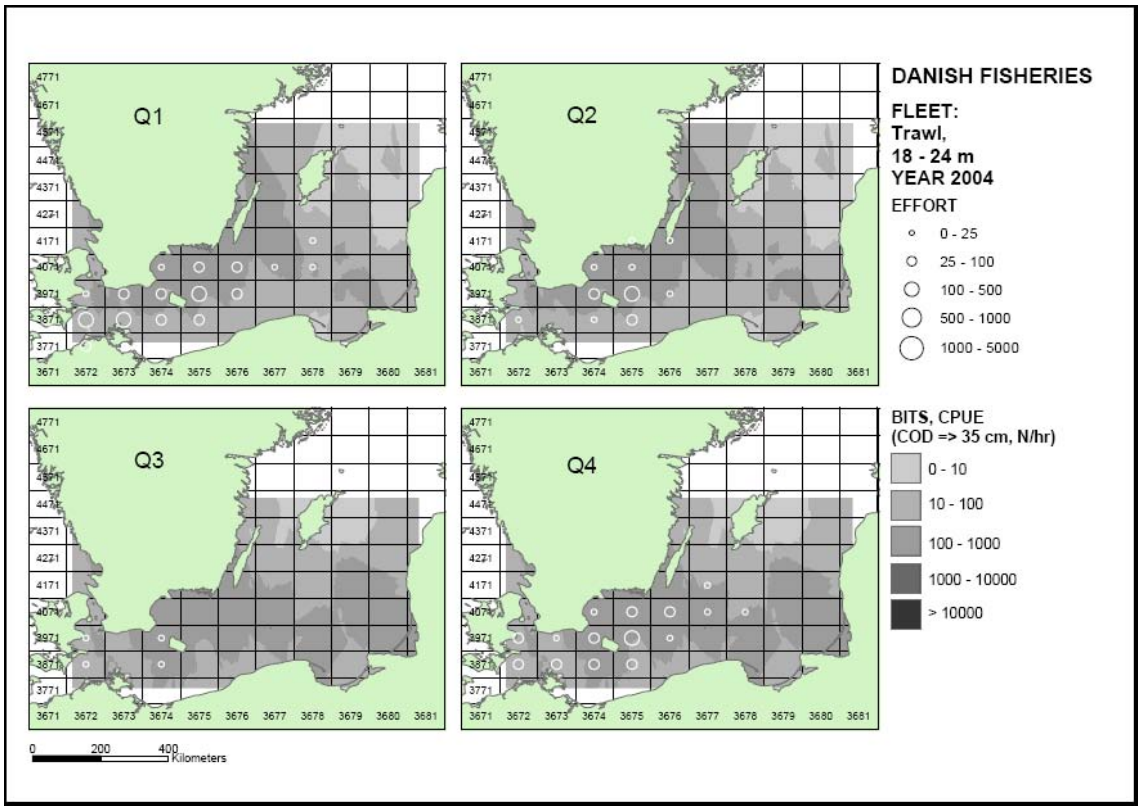
The objective of the maps/templates is to give a description of the fisheries, by visualising the commercial fishing effort in relation to survey data from the area or in relation to the fisheries own Catch Per Unit Effort (CPUE) or Value Per Unit Effort (VPUE).

The templates currently used in the TEMAS project are used to create maps of the Danish, Swedish, Polish and Latvian fishery aimed towards Cod in the Baltic Sea, in the period 1995-2004. The maps are used to illustrate and describe different fisheries based on e.g. fleet, gear or rigging.

An example is the maps which display a chosen fleets' effort allocation in ICES squares and the associated CPUE. When maps from a number of years are compared, not only the general trend is visualised, but also the quarterly variations in fishing effort and preferred fishing ground (square). The technique used is simple; the data layer containing the CPUE value are joined to the layer containing square numbers, then the symbology is chosen and the whole square is classified according to the CPUE value.

Another example only made for chosen fleets or gear types is fishing effort in relation to survey data (BITS), where the catches of cod > 35 cm at the different survey stations are interpolated by kriging to illustrate an overall distribution pattern. This is used to estimate if an immediate relation between high fishing effort and high survey findings of cod can be found. (see example below)

The templates are expected to be used in future projects where descriptions and visualisations of the fishery in the North Sea, the Baltic Sea and/or the Skagerak/Kattegat are needed, e.g. EFIMAS.



The Danish trawl fleet's (18–24 m) effort allocation in the fishery for Cod in the Baltic, plotted against the interpolated survey data (BITS) of catches of Cod > 35 cm.

GIS used in "Pilot project Læsø National Park"

GIS maps was used in the Pilot project Læsø National Park to illustrate, where and what time a year the data used to describe the marine life, was sampled.

Mapping North Sea Sandeel fishing grounds

Objective

Monitoring Danish Sandeel fishery in the North Sea. Mapping the fishing grounds to improve the knowledge about the spatial distribution of Sandeels and Sandeel fishery.

Data

GPS locations of fishing grounds have been collected by Danish fishermen for at least 20 years. Further, information about individual trawl hauls has been collected by Danish fishermen since 1999. This information is now available for the sandeel work at DIFRES.

VMS data for a selection of the Danish industrial fleet for the years 1999 to 2004 have been made available for the sandeel work at DIFRES.

Method

Kernel density analysis was performed with ESRI ArcGIS and Spatial Analyst. Raster calculation of grid cells with a high density of points. Reclassification and conversion to shapefile. Adjustments and evaluation by Sandeel fishermen.

Result

The map is very useful not only for the fisheries management of sandeel but also for the fishermen. By relating the fishing grounds to other kinds of spatial data e.g. hydrological data, bathymetry data and zooplankton abundances (sandeel food) it will be possible to determine the influence of these important parameters on the sandeel populations and the pattern of the fishery.

Mapping Kattegat fishing grounds

Objective

Locating fishing grounds in the Kattegat

Data

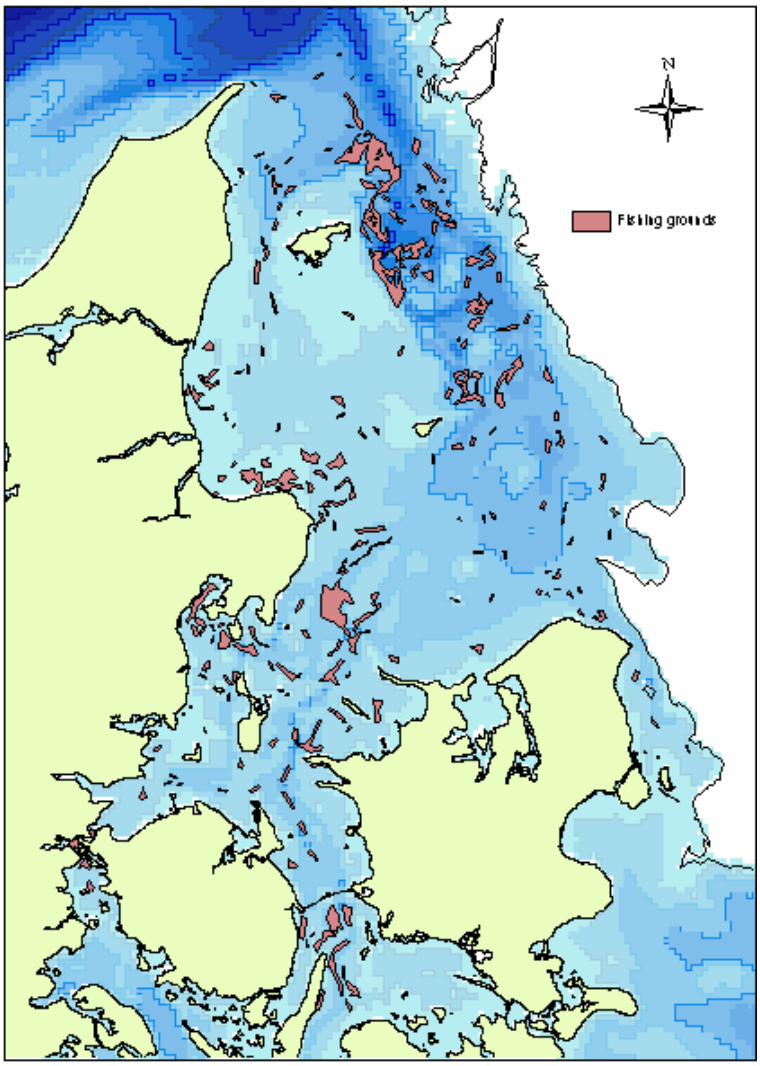
GPS locations were collected by Danish fishermen and represents hundreds of individual trawl hauls since 1995.

Method

Kernel density analysis was performed with ESRI ArcGIS and Spatial Analyst. Raster calculation of grid cells with a high density of points. Reclassification and convertion to shapefile. Adjustments of polygon shapes.

Preliminary results

The Kattegat fishing grounds indicate the behavior of the fishermen and the location of various fish species.


N
Fishing grounds

Annex 13: Mapping of the Danish exploited shellfish stocks

ICES paper for the Working Group Meeting in Galway April 2006.

Mapping of the Danish exploited shellfish stocks

By Per Sand Kristensen*, Kerstin Geitner**, Peter Sandbeck** and Rasmus Borgstrøm**.

**The Danish Institute for Marine Fisheries Research, Department of Marine Fisheries, and ** Dept. of Information Technology and Techniques, Charlottenlund Castle, DK 2920 Charlottenlund Castle. Denmark.*

Abstract

Shellfish stocks in different Danish waters have been exploited for decades. The most important species are mussels (*Mytilus edulis*), cockles (*Cerastoderma edule*), clams (*Spisula solida*) and European flat oysters (*Ostrea edulis*). Other bivalves and gastropods of different species are sporadic caught and landed in small amounts among others i.e. queen scallops (*Chlamys opercularis*) and whelks (*Buccinum undatum*). The main fishing areas for mussel are Limfjorden, Kattegat and Little Belt and the Wadden Sea. Cockles are fished in the Danish Wadden Sea both east of the islands and outside the Wadden Sea in the coastal area. Clams and cockles have been landed from Horns Reef and Roede Klit Sand for almost 10 years. The oyster landings from Limfjorden have the last three years been around 1,000 tones annually an ancient fishery previously as a Royal prerogative. The management and exploitation advice have been based on traditional biological parameters. Introduction of GIS has made it possible to improve the exploitation advices by mapping the stock abundance and biomass for smaller subdivisions that the fishing waters have been divided into for limiting the fishing effect to only the most productive beds among the different shellfish stocks. Local stock variations and mortality rates and growth conditions can be mapped and used in the advice of the authorities to keep the exploitation of the Danish shellfish stocks on a sustainable level. The paper presents the traditional biological tools and the more modern GIS tools applied in the management of exploited Danish shellfish stocks the last twenty years. The advantage of applying GIS mapping is discussed.

Annex 14: National report for Finland

VELMU – The Finnish Inventory Programme for the Underwater Marine Environment

Anna Nöjd and Madeleine Nyman

Finnish Environment Institute

Anna-leena.nojd@ymparisto.fi, Madeleine.nyman@ymparisto.fi

Aims and Objectives

VELMU is a joint initiative between various government institutes, universities and other stakeholders set up to bring about an inventory of marine biodiversity in the Finnish waters. The timeframe was set to be 10 years, and currently the inventory is conceived to finish in 2014. Several goals have been set for VELMU to reach before this date. The main aims and objectives are listed below.

To produce a satisfactory inventory of marine nature values by 2014. The first stage of the inventory, has been to determine the potential users of marine nature information, and the kind of information they need, in order to direct the inventory effort in a way that serves as many end users as possible. This will be followed by a search for currently existing information and an evaluation of its availability and usefulness in VELMU. The field surveys themselves will be split into five regions: the Archipelago Sea, the Quark, the Gulf of Finland, the Bothnian Bay and the Bothnian Sea. Five years of survey work will be allocated to each area. As part of the inventories, methodology will be developed and improved upon.

To develop and bring into operation tools for data management and dissemination, such as databases and a web portal through which information about marine nature and both spatial and survey data will be available. The databases will include survey data and relevant GIS data as well as metadata. Metadata will also be available on data not available through the portal. The portal will include an interactive map interface, where GIS data can be displayed online.

To increase knowledge and understanding of marine nature by promoting marine biodiversity research and teaching, as well as offering training for government administrative bodies. VELMU also aims to strengthen the general public's awareness of marine nature by reporting on the inventory and it's associated research initiatives in the media and through other ways of dissemination.

To build a basis for continuing marine survey work. VELMU will produce guidance documents to provide protocols for future survey work. VELMU will also aim to leave behind a functioning network of actors in the marine biodiversity field, who will continue the established co-operation.

The expected final products and outcomes of VELMU are:

- A database with data on the marine nature in Finnish waters;
- Maps of several levels of detail featuring the seafloor and marine habitats at different scales;
- Other thematic maps describing the Finnish waters, such as maps of marine species distribution;

- Increase in the number of experts on marine nature in Finland;
- Increased public awareness of the Finnish marine nature;
- Better utilization of marine nature information in management and decision making;
- More efficient national and international networks of excellence and increased co-operation.

Project Structure

Attaining the ambitious goals set for VELMU requires extensive co-operation. The programme is implemented as a collaboration of 5 government institutes with various universities and other bodies taking part. To work effectively, the co-operation needs the support of a set framework and agreed approach to working together. There is a need for a co-ordinating body and effective mechanisms for communication.

The implementation of VELMU is organised on two levels: the steering and evaluation level and the operational level.

1) At the steering level are the steering group and a stakeholder group, as well as the Ministry of Environment, who assess the progress made in VELMU.
   - **The Steering Group** consists of the representatives from each of the Ministries taking part in VELMU, namely The Ministry of Internal Affairs, The Ministry of Defence, The Ministry of Education, The Ministry of Agriculture and Forestry, The Ministry of Transport and Communications and the Ministry of Environment. The steering group was set up to steer and evaluate the process as well as find resources for the initiative.
   - **The Stakeholder Group** is made up of the representatives of all the bodies with an interest in marine nature, including the institutes taking part in VELMU, various NGOs and interest groups as well as local and regional administration. The group was set up to ensure effective information sharing and to disseminate information from the operational part of VELMU to all stakeholders.

2) At the operational level, responsibility for the practical implementation of the VELMU programme and the co-ordination of efforts between different regional areas and institutes was given to an Operational Project Group working together with Regional Stakeholder Groups.

The Operational Project Group consists of a project co-ordinator, the chairmen of the five **Regional Stakeholder Groups** and the leaders of the five **Work Packages**. The Work Packages are as follows:

1) *Data Management*: responsible for providing data management tools for storing and distributing survey data, and associated geographical data. The leading institute: Finnish Environment Institute.

2) *Research and Education*: responsible for promoting research and providing access to courses on to marine biodiversity and survey related subjects. The leading institute: Åbo Akademi.

3) *Geophysical Field Inventories*: responsible for producing data on geology, submarine features and other habitat structuring factors. Lead institute: The Geological Survey of Finland.

4) *Biological Field Inventories*: responsible for collecting data on species and habitats, as well as fish spawning and nursery grounds. Lead institutes: Natural Heritage Service and the Game and Fisheries Research Institute.

5) *Maps, Modelling and Remote Sensing*: responsible for producing maps based on data from the field inventories and other existing data, and identifying potential habitats based on modelling and remote sensing data. Lead Institute: Finnish Environment Institute.

All of the Work Packages work together and necessarily have overlaps. The Project Group is responsible for making sure the Work Packages work compliments each other and that the flow of information between the groups is active. The Work Package leaders are responsible for reporting on the Work Packages progress to the Project Group. The Project Group jointly reports to the Steering Group and informs the Stakeholder Group on progress in the whole project.

The Regional Stakeholder Groups include both marine survey data producers and end users as well as relevant experts from their particular sea area. The Groups choose the areas they feel are priority areas for inventories in their region. They also discuss issues relevant to their area to ensure that each area's specific need will be met. They will also co-ordinate field efforts in their region and seek additional regional funding for field work.

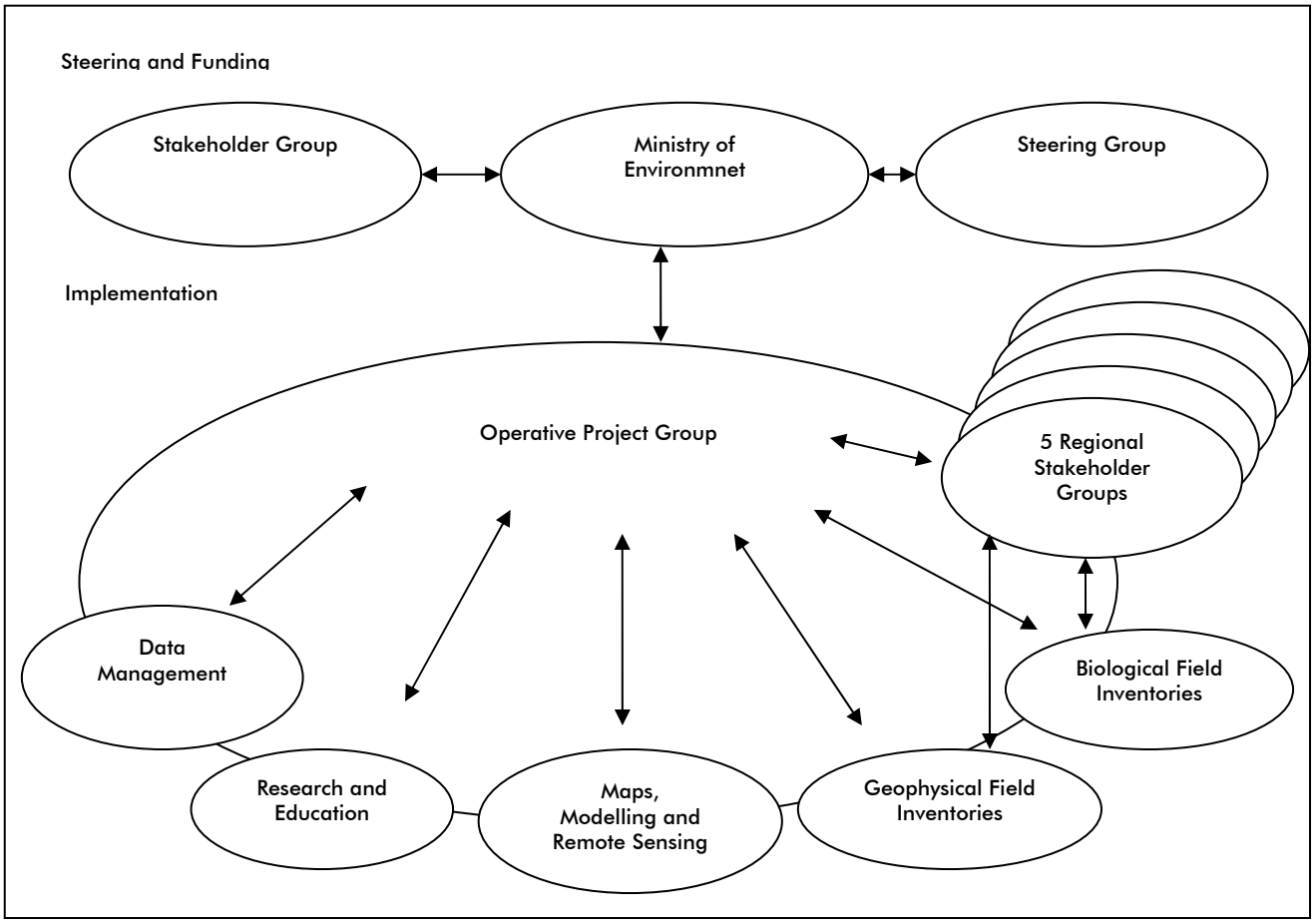


Figure A14.1. VELMU Organisation.

Participating Institutions

The Geological Survey of Finland has a national programme on mapping marine geology. They have been able to match the needs of this programme and VELMU very successfully, and are committed to doing so as far as possible in the future. Participation in VELMU pilot projects has facilitated more detailed surveys that are not included in the marine geological mapping programme. Continuing these would require more funding, or further participation in VELMU-related research projects.

The Natural Heritage Service has a duty to develop management plans for Natura 2000 areas, and are in the process of collecting information on marine nature in the government-owned marine areas. Their needs and the needs of VELMU match up very well, and they are a key player in the inventory of state waters down to 20 m depth.

The Game and Fisheries Research Institute largely take care of the inventory of fish breeding grounds, with input from universities.

The Finnish Marine Research Institute has an interest in soft bottom fauna and hydrodynamics and will largely be participating with contributions relating to these. They will complement the more coastally orientated dive and video surveys with offshore data.

The Finnish Environment Institute is the holder of many national environmental databanks, e.g. on water quality, bottom fauna and endangered species, and will be responsible for developing the data management in VELMU. They also have a specialised GIS department and will lead the map production effort.

Åbo Akademi is a university with a specific interest in marine research. They have taken the responsibility of leading the education side of VELMU. They will also gather together a group of experts on marine biodiversity to suggest areas of research the should be associated to VELMU.

In addition to the government institutes many other players are involved through research projects, including many universities, the Regional Environment Centres and consultants. Many other government institutes, such as the Maritime Administration, local and regional administrative bodies and NGOs participate in the Stakeholder Group.

End users

The information gathered under VELMU will be of central importance both for the planning of nature conservation and the exploitation of natural resources. There are people who are dependent on coastal and marine resources for their livelihoods, and for them a marine environment with a high diversity is necessary to support these livelihoods. The acquired information will also be used for integrated coastal zone management plans that are drawn up for coastal zones within the European Union, and for environmental impact assessments. More information on valuable nature areas is also needed for planning oil and chemical spill combating and clean up.

VELMU produces information on many levels. Information will be available in various formats ranging from raw data to interpreted data and thematic maps. The end users will range from government officials, advisors to the government and environmental administration to NGO's and the general public.

International co-operation

VELMU does not operate in isolation. The best result can be obtained in co-operation with other countries tackling the same issues and challenges. Practically, this international co-operation will be achieved through the international initiatives that its participants take part in.

Current examples are BALANCE and ENVIFACILITATE projects. VELMU will also be presented to experts at e.g. scientific conferences and other international fora to evaluate and improve the program along the way.

Scope of the Inventory

The area of the inventory includes the Finnish territorial waters and EEZ. The inventory will initially concentrate on the benthos, but given adequate resources will also include aspects of the water column. Fish breeding grounds will also be mapped as part of the programme. Inventory levels will be set to determine how much detail will be included in surveys at each level. This will enable larger areas to be covered in less detail supplemented with detailed information from small areas within the large area.

The inventory itself does not include research on ecology, but closely associated research projects that will complement the inventory data will be encouraged.

Timetable

The programme started in 2003 with a pilot phase. The pilot phase was intended to test and develop field survey methods and create a data management system. Furthermore, it aimed at building up a network of actors from various different sectors to operate together. Although the development of a data management system was found to require much work still, and the methods are also still under consideration, the pilot projects provided invaluable information on which future work in the inventory programme is based. Methods will be defined at the beginning of the operational phase, and developed into a guidance document during 2006.

The detailed surveys will be carried out regionally in a staggered way. The Inventories began in the Archipelago Sea in 2005, as a continuance of the pilot projects that had operated in that area. According to the initial timetable the Quark area inventory will begin in 2006, Gulf of Finland in 2007, Bothnian Bay in 2008 and Bothnian Sea in 2009. For each area the first year is the year when they will receive the most input from the national level co-ordination. During this year the Regional Stakeholder Group is set up, and they will begin by assessing the current level of knowledge in the area and identifying knowledge gaps. They will prioritise areas for field surveys, and get this effort organised. In the following four years the group will continue to co-ordinate the field inventories in their area. The possible inclusion of Åland in the inventory is under discussion with the autonomous authorities in Åland.

It has been estimated that the VELMU inventory in each area should be completed in five years. This would mean the programme comes to an end in 2014. However, it is expected that the networks and funding sources put together during VELMU will continue on with the inventories following the framework set by VELMU.

Funding

The inventory programme will be mainly based on budget funding, through the individual institutes own budget funds. Each of the Government Institutes that work on VELMU do so partly using their annual budget funding and partly through outside funding, eg. research funding. This requires each of the participating institutes to include the programme in their strategic plans. Other participants, such as universities are wholly reliant on research funding. In the future, the level of budget funding should be increased to achieve a consistent inventory programme, that is not reliant on many separate research and development projects. The research funding could then support associated marine ecological research, which will provide information not produced by the inventories.

The staggered approach to inventories in different regions also enables funds to be directed to a limited number of areas at a time.

The main responsibility for research funding rests with the Ministry of Environment. The other Ministries taking part in the programme may assign some additional research funding but mainly will contribute through the budget funding on the institutes under them.

The funding currently available is not sufficient to carry out an extensive and demanding programme such as this inventory programme within the suggested timeframe. Extra budget funding and substantial external funding is needed for it to be feasible to complete the planned work. Consequently, one of the most important tasks facing both the Project Group and the Regional Stakeholder Groups will be to identify sources of external funding and co-ordinate efforts to secure it. These sources can be regional national or European.

Currently the prohibitive cost of some marine data even between government institutes as well as tight copyright laws limit the opportunities for data sharing. Changes to the situation are possible in the future with the oncoming information infrastructure directive (INSPIRE), which would improve data sharing possibilities. VELMU aims to make all data gathered in its framework freely available.

Dissemination

The Project Group and Steering Group discuss and decide on press releases regarding the main VELMU programme. Additionally the Regional Stakeholder Groups, as well as individual participating institutes can give out press releases relating to their work. In addition to exposure in the media, VELMU aims to bring information to people via the VELMU-website, leaflets and posters.

Annex 15: The terms habitat and marine landscape

The ICES Working Group on Marine Habitat Mapping advocates the following definition of the term **habitat** for use in the context of marine habitat classification and mapping:

Habitat: "A particular environment which can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular but dynamic spatial and temporal scales in a recognizable geographic area."

This definition is not intended to alter the classical definition of habitat – which has long been defined as:

Habitat: "The locality in which a plant or animal naturally lives."

(Darwin 1859)

Rather, the WGMHM definition is intended to extend the classical definition to address ambiguities surrounding the term in the context of marine habitat mapping. Within the marine mapping context, three useful definitions that express the inclusion of varying degrees of biotic and abiotic elements are as follows:

Habitat: "An identifiable and distinct association of physical characteristics and associated biological assemblage used by an organism or community."

Allee *et al.* (2000):

The European Nature Information System (EUNIS) definition of habitat places even more emphasis on biotic communities, but continues to recognize the abiotic elements:

Habitat: "Plant and animal communities as the characterizing elements of the biotic environment, together with abiotic factors (soil, climate, water availability and quality, and others), operating together at a particular scale."

(EUNIS 2002)

In a departure from the emphasis on biotic elements, other definitions of marine habitat place more emphasis on what can be readily mapped, with particular focus on physical elements from benthic surveys. Kostylev *et al.* (2001) and Valentine *et al.* (2005) define habitat as:

Habitat: "Spatially recognizable areas where the physical, chemical, and biological environment is distinctly different from surrounding environments."

These types of variation in the definition of the term habitat, with degrees of biological or species inclusion, reflect the different objectives and applications of the term. The Allee *et al*. (2000) definition is tied to U.S. habitat mapping programmes where *Essential Fish Habitats* are a high priority. The EUNIS system has been extensively applied to terrestrial environment where vegetation is the main driver for classification. The definitions proposed by Kostylev *et al.* (2001) and Valentine *et al.* (2005) have been used in studies of the Gulf of Maine, North America, in which several large tracts of multi-beam acoustic mapping have been completed.

The definition of habitat advocated by WGMHM is built upon the following assumptions:

1) The classical ecological and biological definition of the term habitat, as given above, conveys the central intent and meaning of the term.

2) Whilst dependencies exist between individual species and their environment, maps of physical environmental features without reference to past or current biotic presence are not considered to be habitat maps, but rather are more appropriately described as physiotope maps or maps of marine physiographic conditions. Geological maps of the seafloor are one example of this type of map.

3) Some authors prefer to more clearly distinguish the physical habitat from the species or group of species which occur within it, referring to habitat strictly as the physical environment of the species or group of species and the combination of habitat and species (generally as groups of species in a community) as a biotope. This distinction has merit, although longstanding convention has established habitat as a synonymous term for biotope (Connor et al. 2004).

4) From a practical standpoint, marine mapping based largely on physical characteristics of the seabed is often a good surrogate for habitat maps; however in such maps the correlation between physical habitat and the biota usually requires extensive validation work and biotic surveys before evolving into true habitat maps.

5) Mapped habitats, like all map features, are dependant on the spatial domain and grain employed. At coarse map grain, the thematic habitat descriptions will tend to be generalized. For example, a rocky intertidal habitat mapped at one (broader) map scale can be mapped as a series of discrete habitats within tidal zones at another (finer) spatial scale. In this sense, habitats can be defined in a hierarchical manner, and the generic term habitat can be used at any scale, provided the feature mapped can be distinguished from surrounding features (i.e. other habitats). Over very small areas, other terms such as niche and biotope are more suitable, and for larger areas terms such as “seascape” (see below) and “ecoregion” are more appropriate. Habitats defined solely by physiographic features allow the cartographer to map habitats at any spatial or temporal grain and domain. By including the species or community, appropriate scales are clarified, and the value of the marine habitat map concept is enhanced.

6) Historic species range, ecoregion boundaries, as well as internal heterogeneity serve to define the habitat domain and limit the extent of physiographic extrapolations. For example, two seemingly identical habitats that occur in different ecoregions should be independently validated for species composition and ecological function.

7) Temporal changes in habitats (both their physical character and their biotic character) occur over differing time scales (hours to thousands of years). Understanding temporal dynamics is important in the application of habitat maps. For instance, a highly dynamic estuarine drainage channel might change position on a daily basis and its biota are highly ephemeral, whilst most rocky habitats may vary little in physical character over hundreds/thousands of years, but their biota change seasonally/annually through community dynamics and climatic variation. Understanding temporal dynamics is important in constructing habitat classifications; temporal variations in a habitat (e.g. communities present in particular years or seasons) can be placed within a more broadly-defined habitat type that encompasses such variation. In this way, a good hierarchical classification should encompass temporal change by including more dynamic elements in lower parts of the classification and more functional habitat types higher in the classification.

Related terms

Seascape: in general use and as a legal term in some countries, this term is often used to describe a view or picture of the sea (i.e. the view at the sea surface). In the context of marine habitat mapping, the term is more specifically used to describe seabed character but, because of confusion with the ‘surface view’ definition, an alternative term **marine landscapes**, has been used in some countries (for instance, the UK).

Seascape/marine landscape implies a large area of integrated landforms and biota. Within this area is a mosaic of habitat patches. In this sense, seascapes/marine landscapes imply a spatial extent larger than habitats, and smaller than large marine ecosystems and marine ecoregions. As with the term “habitat”, some authors focus on the physiographic and oceanographic elements of seascapes, excluding biotic structure.

References

Allee, R.J., Dethier, M., Brown, D., Deegan, L., Ford, R.G., Hourigan, T.F., Maragos, J., Schoch, C., Sealey, K., Twilley, R., Weinstein, M.P., and Yoklavich, M.M. 2000. Marine and Estuarine Ecosystem and Habitat Classification. NOAA Technical Memorandum NMFS-F/SPO-43, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

Connor, D.W., Allen, J.H., Golding, N., K. L. Howell, L. M. Lieberknecht, K. O. Northen, and J. B. Reker. 2004. The National Marine Habitat Classification for Britain and Ireland. Version 04.05. Introductory Text. Joint Nature Conservation Committee, Peterborough, UK (Internet version: www.jncc.gov.uk/MarineHabitatClassification).

Darwin, C. 1859. On the Origin of Species by Means of Natural Selection (6th Edition). John Murray, London.

EUNIS. 2002. EUNIS Habitat Classification. European Environment Agency, http://eunis.eea.eu.int.

Kostylev, V.E., Todd, B.J., Fader, G.B.J., Courtney, R.C., Cameron, G.D.M., and Pickrill, R.A. 2001. Benthic habitat mapping on the Scotian Shelf based on multibeam bathymetry, surficial geology and sea floor photographs. Marine Ecology Progress Series, 210: 121–137.

Valentine, P.C., Todd, B.J., and Kostylev, V.E. 2005. Classification of marine sublittoral habitats with application to the northeastern North America region. Ed. by P.W. Barnes and J.P. Thomas. *In* Benthic Habitats and the Effects of Fishing. American Fisheries Society Symposium, 41. American Fisheries Society, Bethesda, Maryland. Pages 183–200.

Annex 16: Multibeam calibration procedures

Field calibration procedures for multibeam sonar systems

Multibeam sonar systems are the latest advancement in hydrographic surveying technology. The ***swath*** or ***multibeam sonar*** system has a single transducer, or pair of transducers, that continually transmit numerous sonar beams in a swath or fan-shaped signal pattern. They are ideal systems for mapping large areas rapidly, with essentially 100% bottom coverage. Multibeam signal backscatter information can be used to generate side scan-equivalent (85–95 kHz) data for imaging bottom features and targets in a wide variety of water depths. The coverage area of these systems is a direct function of water depth. Most systems provide coverage ranging from two to approximately seven times the water depth. The number of beams also varies with the manufacturer and ranges from 30 to more than 200; however, the outer beams on each side of the swath are subject to more errors and may not be useful. Considering the density of soundings, it is possible, with proper calibration and adjustments, to detect and resolve small objects on the bottom.

With this improved resolution and coverage comes the need for much greater control and calibration to ensure that the sounding is recorded from the correct position on the seafloor. The system accuracy is comprised of the multibeam sonar accuracy and the various components that make up the total system. This is accomplished by using a high accuracy differential GPS, heave-pitch-roll (HPR) sensor and a gyrocompass. The time synchronization for all these components is critical. Overall quality control assessment must be performed in the field because empirical data are necessary for validation.

Sources of Errors. Several sources of errors and biases exist in multibeam survey.

- *Static offsets of the sensors* - the distances between the sensors and the reference point of the vessel or the positioning antenna.
- *Transducer draft* - the depth of the transducer head below the waterline of the vessel.
- *Time delay between the positioning system, sonar measurement and HPR sensor* - the delay, or latency, and must be accurately known and compensated for in the processing of the hydrographic data.
- *Sound velocity measurement* - the velocity of sound in the water column required so the correct depth can be measured.
- *Acceleration and translation measurements of the HPR* - critical for corrections to the vessel's roll and pitch.

These parameters must be measured and corrected in the multibeam sonar system. It is assumed that the software used in the processing will accommodate these inputs and that the correct sign is used when entering the offsets and corrections. Single beam transducers are traditionally calibrated by bar check coupled with a velocity cast. With the bar lowered to a given depth, the depth recorder signal output can be adjusted to match the known bar depth. The velocity cast gives the speed of sound in the water column, and the proper speed can be applied to the echo sounder. With multibeam sonars, bar checks are not feasible with the fan-shaped array of the pulse and the difficulty of measuring the outer beams; however, the vertical beams can be checked using the bar. The velocity cast is still critical and must be recorded for each survey and when there are significant water characteristic changes. The field procedures necessary for proper calibration are the alignment of each sensor, the patch test, and the performance test. These measurements are discussed overleaf.

ALIGNMENT AND STATIC OFFSETS

The process of physical alignment of the vessel platform, transducers, gyrocompass, and HPR sensor is referred to as the static offsets. This process ideally takes place with the vessel stabilized on a trailer, or on blocks where more exact measurements can be made (dry dock). This stability will minimize errors in the positioning of the sensors and, with the proper offsets applied, the static corrections can be determined. The sensors should be measured from a reference point in the vessel, or datum point - typically the centre of gravity (CoG) or the intersection of the pitch and roll axis. The centre of gravity will change with varying load conditions of the vessel, and must be chosen to represent the typical conditions expected while surveying. This information can be obtained from the blueprints of the vessel. The reference point should be a place that is easily accessible and from where measurements to the sensors will be made.

The sensor offsets are measured distances from the datum point to the centre of each sensor. The centre of the sensor can be found in the manufacturer's schematic of the sensor, or can be accurately measured with a survey tape. The magnitude and direction of the measurement should be verified and recorded.

HPR Sensor

If possible, the HPR sensor should be placed on the centreline of the vessel as close as possible to the CoG (Figure A16.1), with the same mount angles used for the transducer. The x-axis of the HPR should match the x-axis of the transducer (x-axis is defined as the bow-stern axis of the vessel while the y-axis is the beam axis of the vessel). Azimuthal misalignment of the HPR sensor will result in the depth measurements being in error proportional to the water depth.

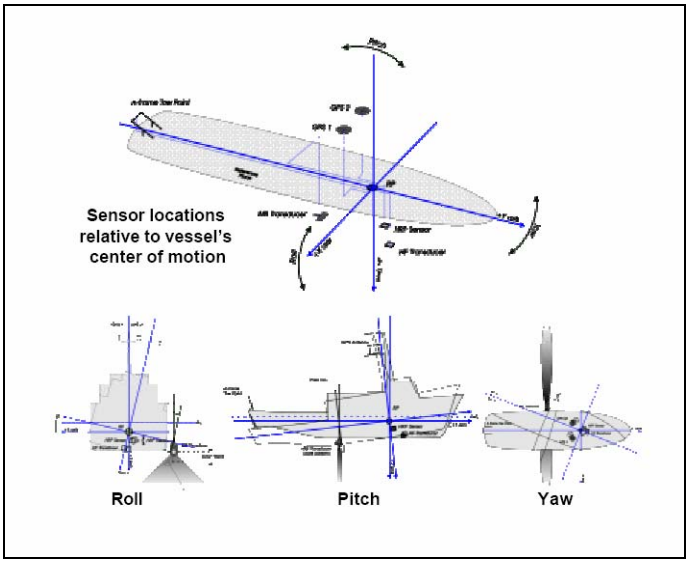


Figure A16.1. Rotation axes of vessel (from USACE report).

Transducer

The transducer should be installed as near as possible to the centreline of the vessel and level about the roll axis and should be aligned with the azimuth of the vessel (Figure A16.2). The beam-mounted technique that allows for raising the transducer at the end of each day of operations and lowering it at the start of the next day's survey should be periodically checked for correct alignment (weather conditions, vessel draft). Hull mounted transducers are generally fixed in place and will not need to be checked as frequently. The angle of the transducer mount must be determined and recorded. Since most vessels underway will be

lower in the stern, the transducer will generally need to be rotated aft along the centreline axis to compensate for this angle. The patch test is used to check the transducer angle for the pitch offset. After alignment, the resulting beam should then project normal to the sea floor while conducting surveying operations.

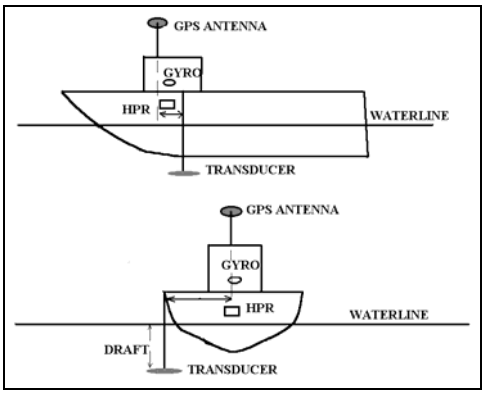


Figure A16.2. Offset locations of sensors.

Gyro

The gyro should be aligned with the x-axis of the vessel using a total station and geodetic control points. This measurement is usually made with the vessel on a trailer, or secured tightly against a pier where there is minimal wave action. The gyro should be warmed up and, if necessary, the proper corrections for latitude applied. By locating two (2) points on the centreline of the vessel and placing a target on each, the two targets can be observed with the total station, and are then synchronised with the gyro readings. Several readings are needed for redundancy. The vessel's azimuth is computed and compared with the gyro readings. Following analysis of the mean and standard deviation, if the offset is more than 1° at 95% percent confidence level, the gyro must be realigned with the centreline and the observations repeated. If less than 1° degree, the correction is within the specified tolerance and can be applied to the gyro output.

Time Delays

Time delay in the attitude sensor will result in roll errors, which greatly affect the orientation of the outer beams. Horizontal accelerations in cornering also can affect the HPR measurements, which will result in errors in the depth measurements. The time delay measurement can be made from the bathymetric data and is seen as short period changes in the across track slope of the seafloor when surveying flat and smooth areas.

Time delays in the positioning system are the time lags between when the time positioning data are first received by the system and the time the computed position reaches the logging module. This difference results in a negative along-track displacement of the depth measurements. While surveying at slow speeds, this displacement will be small. In general, the processing time for the position will vary with the number of observations used in the final GPS solution. If the time tag embedded in the GPS message will be used, then the correct synchronization between this time and the transducer or signal processing clock must be ensured.

PATCH TEST

The patch test or calibration survey is important and must be performed carefully to ensure that the data collected is accurate and reliable and to calibrate the system. The test comprises a

short survey with several lines that are surveyed in order to check and correct the following potential biases:

1) Residual pitch offset;
2) Residual positioning time delay;
3) Residual roll offset;
4) Residual azimuthal offset.

Patch tests should be performed whenever there is a significant change in the survey area. In general, the tests should be performed at the start of each new survey or when a significant change in the water mass (i.e. temperature, salinity) has occurred. The values for the correction parameters discussed in the previous section should be verified and entered with the proper sign. It is assumed that the positioning instruments used will be survey quality DGPS. The weather should be calm enough ensure good bottom detection and minimal vessel motion. As most of the lines are reciprocal, it is important to have capable vessel steering and handling. The lines should be surveyed in water depths comparable to the typical survey areas encountered. The order in which the lines surveyed is not important although it is recommended that at least two sets of reciprocal lines are surveyed for redundancy. Although the outer beams of multibeam sonar are subject to a larger grazing angle, these beams should provide good data if the appropriate corrections are applied from the patch test.

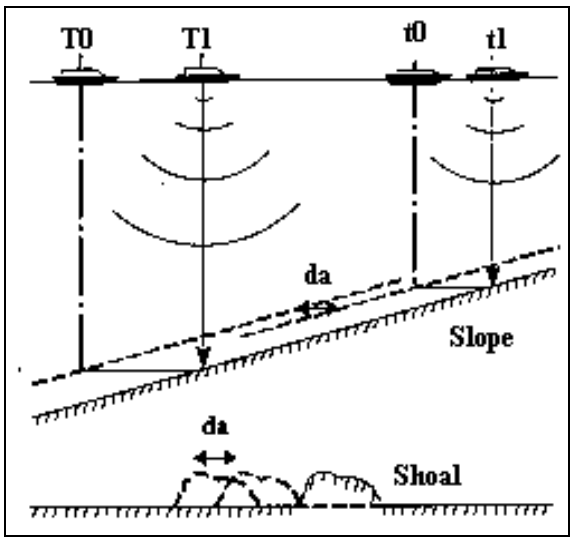


Figure A16.3. Profile view of two lines surveyed over a slope at the same speed and in opposite directions showing along-track displacement, da, in the apparent seafloor (dashed lines) caused by positive pitch offset. (Figure courtesy of A. Godin.)

Pitch Bias and Positioning Time Delay

Lines should be surveyed in an area with a slope of 10° to 20° if possible (Figures A16.3 and A16.4). At least two pairs of reciprocal lines should be surveyed up and down slope. If possible, a conspicuous bathymetric feature should be surveyed to assess the time delay (but it must be covered by the beam at nadir). The slope should be at least 200 m long in order to obtain good samples. The lines should be surveyed at two different speeds to assess the time delay.

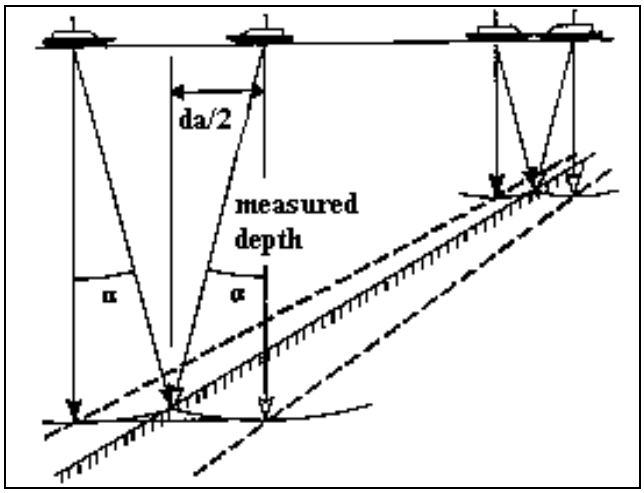


Figure A16.4. Profile view of a line run at two different speeds along a slope or shoal, showing along-track displacement, da, in the apparent seafloor (dashed lines) caused by positioning time delay. (Figure courtesy of A. Godin.)

Roll bias lines

In an area of flat topography, at least one pair of lines should be surveyed for testing the roll bias. Figure A16.5 shows a schematic of a vessel with a roll to port of 5° exaggerating a roll bias. If possible these lines should be surveyed in deep water where it is easier to test for roll errors with the outer beams. Depending on the type of multibeam system, these lines should be surveyed in a method that ensures significant overlap of the beam footprint (the required beamwidth can be found in the manufacturer specifications).

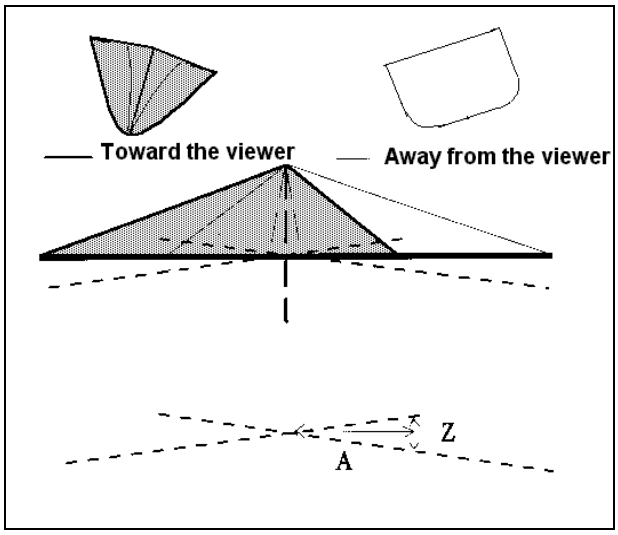


Figure A16.5. Profile view of two reciprocal lines run over a flat seafloor. The apparent across-track profiles (dashed lines) show a roll offset of 5 degrees. The depth difference Z and across-track distance A can be used to compute the roll offset. (Figure adapted from A. Godin.)

Azimuthal Offset Lines

Two adjacent pairs of lines should be surveyed on each side of a prominent bathymetric feature, such as a shoal. Features with sharp edges, such as wrecks, should be avoided as there is more ambiguity in the interpretation. The adjacent lines should have an overlap of about 15% and the feature should be wide enough to ensure adequate sampling (x3 swath widths). These lines should be surveyed at a speed to ensure significant overlap of the beam footprint.

Data Processing

The procedure uses the entire data set collected from the patch test lines without gridding. Visualization of the bathymetric data is important. In addition, the position and attitude data should be checked for errors, especially noting any time tag errors. Cleaning of the bathymetry is not necessary as the individual soundings will not be adjusted, but rather clusters of data points will be analysed. The procedures to process the patch test data should be followed in the sequence below.

PositioningTime Delay. This delay can be computed by measuring the along-track displacement of soundings from a pair of coincident lines run at different speeds over a slope or over a prominent topographic feature. Lines run in the same direction should be used so as to avoid the effect of pitch offset errors. The equation to compute time delay is :

$$TD = \frac{d_a}{v_h - v_l}$$

where *TD* is the time delay in seconds; d_a is the along-track displacement; v_h is the higher vessel speed; v_l is the lower vessel speed

The survey lines are processed, plotted, and compared while ensuring that no corrections are made for positioning time delay, pitch error, roll error, and gyro error. The time delay is then averaged by getting several measurements of the displacement in the along-track direction. This process is performed iteratively until the profiles match or achieve a minimum difference.

Pitch Offset. The pitch offset is measured from two pairs of reciprocal lines run over a slope at two different speeds. The important characteristic of pitch offset is that the along-track displacement caused by pitch offset is proportional to water depth. Thus, the deeper the water the larger the offset. The pitch offset can be computed using the following equation:

$$\alpha = \tan^{-1}\frac{(d_a/2)}{depth}$$

where α is the pitch offset; d_a is the along-track displacement; *depth* is the water depth

The lines are processed while only applying the positioning time delay correction and the static offsets of the sensors. The pitch offset is then averaged by taking several measurements of the displacement in the along-track direction. This process is performed iteratively until the profiles match or reach a minimum difference.

Azimuthal Offset. The same two pairs of lines that are run adjacent to a bathymetric feature will be used for the measurement of the azimuthal offset. One pair of adjacent lines run at a time, in opposite directions, is processed to remove any potential roll offset. The azimuthal offset can be obtained from the following equation:

$$\gamma = \sin^{-1}\frac{(d_a/2)}{X_i}$$

where γ is the azimuthal offset; d_a is the along-track displacement; *X* is the relative across track distance for beam

The survey lines are processed with only the positioning time delay and pitch offset corrections and static sensor offsets. The azimuthal offset is averaged by making several measurements of the displacement d_a over the feature, and by knowing the across-track distance X at the location of the measurements. This process is performed iteratively until the profiles match or achieve a minimum difference.

Roll Offset. The lines used for the roll offset are reciprocal lines run over a flat area. Generally, this offset is the most critical in deeper water and should be carefully measured. For small angles of less than 3 degrees, the roll offset can be estimated by the following equation:

$$\theta = \frac{\tan^{-1}(d_z / d_a)}{2}$$

where θ is the roll offset; d_z is the depth difference; d_a is the across-track distance

The survey lines are processed while applying the positioning time delay, pitch offset, gyro offset corrections, and static sensor offsets. The roll offset is averaged by several measurements of the across track displacement d_a along the test swaths. This process is performed iteratively until the profiles and contours match or achieve a minimum difference. (This is summarized in Table 1)

The above patch test and data processing procedures are based on the CHS methods and from Godin, 1996. The equations are used to approximate the offsets encountered when running shallow water multibeam surveys.

PERFORMANCE TEST and a REFERENCE SURFACE

A final performance test is usually carried out to check the above offsets to verify whether the data meet the accuracy requirements for the survey. This test is essentially a small survey carried out over a flat area in water depths of not more than 30m. Four parallel lines are surveyed with at least 150% overlap. Four or five parallel lines are then surveyed perpendicular to the previous lines with the same swath and overlap. The speed over ground should be the same on both sets of lines. A velocity cast should be made in this area and the corrections applied. The performance test should be carried out when the sensors are initially installed and whenever there is a major change in the conditions of the survey vessel (*i.e.*, overhaul in drydock, change in vessel characteristics).

A pair of parallel lines should then be surveyed inside the reference surface. Overlap as described above is not needed. The vessel speed is the same as for the reference surface. The data processing for these lines should follow the general rules outlined below.

The reference surface should be cleaned of outliers. This procedure should be performed manually, and adjustment of positions, attitude, and bathymetry made to ensure clean data. No smoothing or thinning of data must be carried out. A digital terrain model (DTM) of the reference surface is created from the cleaned data, and an averaging gridding algorithm is used to smooth the data. The gridding size should be no larger than the average footprint of the inner beams. Using large vertical exaggeration, the DTM should be observed on 3-D visualization software. Check lines are then processed individually and each beam depth reading is compared to the reference surface. A difference surface between the reference DTM surface and the check lines is then created and contoured, and statistics are computed to assess overall performance. Statistical parameters to be noted are (a) the beam number, (b) maximum difference, (c) minimum difference, (d) mean, (e) standard deviation, and (f) percent difference. From these differences, corrections to the system can be checked against the criteria in Table A16.2.

It should be noted that the installation of the multibeam transducer and the sensors associated with it require time and patience to assure that valid data will be collected. The patch test will only be necessary after installation, and when surveying in a new area with different water environment conditions or anytime the software is updated, either in the acquisition or the processing, the tests should be repeated.

DEPTH DETERMINATION – SOUND VELOCITY CORRECTION

Definitions

A number of environmental factors influence the propagation of the sonar echo through the water column, the most important are temperature, salinity and pressure. These properties are measured with a CTD cast (Conductivity, Temperature and Depth), which involves dropping a calibrated instrument through the water column at a constant speed to the sea floor and recovering it. The measurements are downloaded and a speed of sound index calculated. This correction factor is entered into the multibeam equipment.

Temperature: The temperature at the sea surface varies with the geographic position on the earth, with the season of the year and the time of the day. The temperature field distribution is a complex one and cannot be predicted. Such unpredictability necessitates a comprehensive distribution of sound velocity profile casts, both temporally and spatially, to maintain a representative currency of the sound velocity profiles for the survey area. The depth measurement is quite sensitive to variations of the sound velocity profile; a variation of one degree Celsius in temperature translates to approximately 4.5 m/s in sound velocity variation**.**

Salinity: is a measure of the quantity of dissolved salts and other minerals in sea water and is defined as the total amount of dissolved solids in sea water in parts per thousand (ppt or ‰) by weight. In practice, salinity is not determined directly, but is computed from chlorinity, electrical conductivity, refractive index or another property whose relationship to salinity is well established. As a result of the Law of Constancy of Proportions, the level of chlorinity in a seawater sample is used to establish the sample's salinity[1]. The average salinity of seawater is around 35‰. The rate of variation of sound velocity is approximately 1.3ms for a 1‰ alteration in salinity.

Pressure also impacts significantly on the sound velocity variation. Pressure is a function of depth and the rate of change of sound velocity is approximately 1.6ms for every alteration of 10 atmospheres, *i.e.* approximately 100m of water depth. The pressure has a major influence on the sound velocity in deep water[2.]

Water Density is dependent upon the previous parameters, i.e. temperature, salinity and pressure. Fifty percent of the ocean waters have a density between 1027.7 and 1027.9 kg/m3. The largest influence on density is compressibility with depth. Water with a density of 1028 kg/m3 at the surface would have a density of 1051 kg/m3 at a depth of 5000m.

Salinity, Temperature, and Sound Velocity Determination

This subsection describes the instrumentation used for salinity, temperature and sound velocity determination as well as their operating principles and the calculation for mean sound velocity.

Instrumentation

Sound Velocity Profiler is the most common instrument used to measure the sound velocity profile through the water column. This instrument has one pressure sensor to measure depth, a transducer and a reflector a certain distance, d, apart. The sound velocity is calculated by the

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1 A joint committee (IAPO, UNESCO, ICES, and SCOR) proposed the universal adoption of the following equation for determining salinity from chlorinity: S = 1.80655 Cl.

2 This is derived by the hydrostatic principle, i.e., p(z) = p0 + gz

equation $c = 2d/\Delta t$, where Δt is the two-way travel time of the acoustic signal between the transducer and the reflector (similar to the depth measurement performed by echo sounders).

CTD is an electronic instrument with sensors for conductivity, temperature and depth. This instrument records the salinity by directly measuring the electrical conductivity of the seawater. Sound velocity in the water varies with the medium's elasticity and density, which are dependent upon the salinity, temperature and pressure. With the information from the CTD (salinity, temperature and pressure) it is possible to calculate the sound velocity in the water based on empirical equations.

Thermistors are elements whose electrical resistance depends on their temperature, which depends on the amount of heat radiation[3] falling on it from the sea. Thermistor chains are used to measure the water temperature at several depths through the water column. These chains, usually moored, consist of several thermistor elements, regularly spaced along a cable. A data logger samples each element sequentially and records the temperatures as a function of time.

Instrument operation

In order to achieve a successful operation of a sound velocity profiler, before deployment, the profiler should have the correct parameters entered with the required recording settings and be calibrated with the correct atmospheric offset in order to generate reliable depth measurements. This calibration should not be carried out in a pressurized compartment. In practice, before deployment, the profiler should be in the water for approximately 15 minutes for thermal stabilization and during a sound velocity cast, it is recommended a constant deployment speed is maintained.

Data recording and processing

Sound velocity profiles should be edited and carefully checked for anomalous depths and sound velocity readings.

In general, velocity profilers record both depth and sound velocity, both downwards and upwards. The two profiles should be compared to confirm they are similar, after which the profiles are generally combined and meaned to create the final profile.

Sound velocity computation

After the sound velocity profile has been validated, it can be applied to the survey file. The computation is used to correct depth measurements with sound velocity profile data. For beams near the vertical (*i.e.* single beam echo sounders and nadir beams) it is accurate enough to use the average sound velocity in the water column. However, away from nadir, it is necessary to perform ray tracing to take account of the beam curvature due to any refraction phenomenon encountered; this procedure is calculated in either the multibeam system itself or the processing software.

3 The heat radiation rate is given by Stefan's Law which states that the rate of emission of heat radiation from an object is proportional to the fourth power of its absolute temperature.

Table A16.1: Patch test procedures and computations

	POSITIONING TIME DELAY	PITCH OFFSET	AZIMUTHAL OFFSET (GYRO)	ROLL OFFSET
LINES REQUIRED	2 on same heading over slope or shoal	2 pairs on reciprocal headings at 2 speeds	2 pairs over bathymetric feature	2 reciprocal lines over flat area
PRIOR CORRECTIONS APPLIED	None, other than static offsets	Positioning time delay	Positioning time delay and pitch	Positioning time delay, pitch and gyro
COMPUTATION METHOD	Average of displacements in along track direction	Average of displacements in along track direction	Average of displacements in across track direction	Average of displacements in across track direction
VISUAL METHOD	Match profiles and contours	Match profiles and contours	Match profiles and contours	Match profiles and contours
EQUATION	$TD = \frac{d_a}{Vh - Vl}$	$\alpha = \tan^{-1}\frac{(d_{a/2})}{depth}$	$\gamma = \sin^{-1}\frac{(d_{a/2})}{X_i}$	$\theta = \tan^{-1}\frac{(d_s/d_a)}{2}$

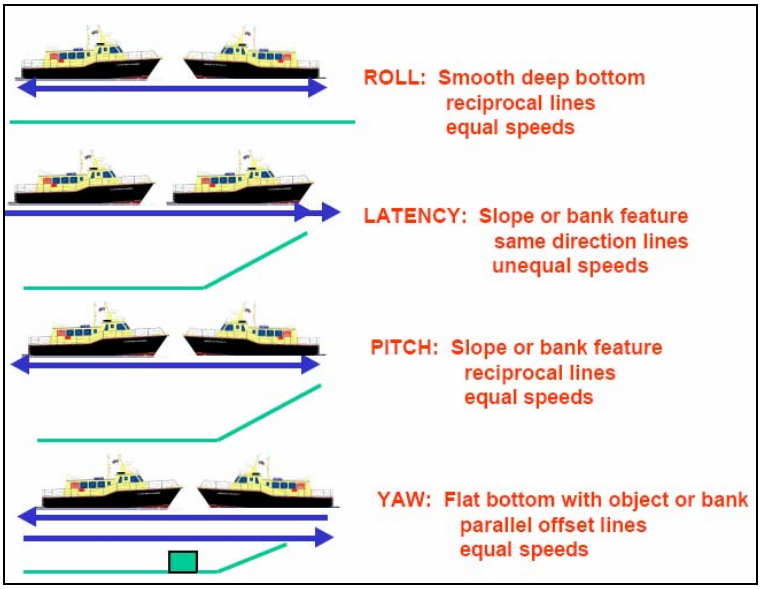

Figure A16.6. Summary of patch test runs (from USACE report).

Table A16.2: Summary of Multibeam Sonar Calibrations and Criteria

	FREQUENCY OF MEASUREMENT	CALIBRATION PROCEDURE	ALLOWABLE TOLERANCE 95 PERCENT	CORRECTIVE ACTION
SENSOR ALIGNMENT/OFFSETS				
Transducer	Initial installation	Levelling, Total Station	0.5°	Remount
Gyro	Initial installation	Self calibration	Manufacturer's specifications	Replace
HPR	Start of project	Self calibration	0.1°	Remount
GPS Antenna	Initial installation	Levelling	0.03 m	Remount
Squat	Start of project	Transit, level, GPS	0.03 m	None
Dynamic draft	Start of project	Transit, level	0.03 m	None
ACOUSTIC DRAFT AND VELOCITY				
Bar Check	Start of project	Bar under centre beam	0.06 m	Stop survey and redo
Velocity Probe	Twice daily or more	Self calibration	0.01 m/s	Stop survey and redo
PATCH TEST				
Pitch	Start of project	2 pairs of reciprocal lines on slope	0.06 m	Apply correction in software
Roll	Start of project	1 pair of reciprocal lines over flat area	0.06 m	Apply correction in software
Time Delay	Start of project	2 pairs of reciprocal lines on slope	0.06 m	Apply correction in software
Azimuth	Start of project	2 pairs of adjacent lines over shoal	0.06 m	Apply correction in software

References

Field Procedures for the Calibration of Shallow Water Multibeam Echo-Sounding Systems, André Godin, Canadian Hydrographic Service, Canadian Hydrographic Conference, Halifax, Nova Scotia, Canada, 1996.

HYSWEEP User's Manual, Coastal Oceanographics, Inc., 1996.

Manual on hydrography. Publication M-13. May 2005. International hydrographic Organization

U.S. Army Corps of Engineers, Engineer Manual EM 1110-2-1003, Hydrographic Surveying, 31 October 1994.

Annex 17: Survey of Metadata Methods Original

Common data	Example entry	database entry
Survey		
Name of vessel/aircraft	RV *Aplysia*	15 characters
Survey date	30032006	DDMMYYYY
Survey name	Mesh cruise	15 characters
Ellipsoid	WGS84	15 characters
Datum	Zone 30	15 characters
Primary Navigation	Fugro HP	20 characters
dGPS Beacon used & Accuracy	Port Lynas	15 characters
Secondary Navigation	Seapath	20 characters
dGPS Beacon used & Accuracy	Port Lynas	15 characters
Gyro	Seatex Seapath	20 characters
Time (eg GMT +/-)	7 characters	GMT, GMT +1, GMT -1, GMT +2, GMT -2
Survey QA		
Gyro calibration	date	DDMMYY
Gyro offset	degree	3 numbers
Vessel survey	date	DDMMYY
Heave compensation	type	20 characters

Grab Sampling*	measurement/example	database entry
System settings		
Sample device used	Name	Day Grab, Van Veem, Shipek, Hydraulic
Device area (sq m)	m2	2 numbers
Use of camera on grab		Yes, No
USBL/trisponder		Yes, No
METHOD		
Replicate Reference	1	1of 1, 2 of 2, 3 of 4, 6 of 6 etc
Total area sampled	m2	5 characters
Record validity		full, half full, empty, leaked
Total area sampled	m2	5 characters
Penetration depth (cm)	cm	5 characters
Weather/Sea conditions		
Time	hrs	MMHH
Wind strength	Beaufort	Force 1, Force 2, …Force 10
Direction	Degrees	N,NNE, NE, ENE, E etc
sea conditions		calm, 1m sw ell, 2m sw ell, 3m sw ell,…6m
Processing		
Date		DDMMYYYY
Species data type		100 numbers
Sample storage medium (eg Formaldehyde)		15 characters
Sieve mesh size (mm)	mm	2 numbers
Volume (litres)	litres	4 numbers
Storage		
Sample storage reference number		10 characters
Photographic reference		10 characters
Format		10 characters

Benthic trawl/dredge	easurement/examp	database entry
System settings		
Type	m	1m, 2m, 3m, 4m
Size	m	
Use of positioning beacon on trawl/dredge (UBSL)		yes, no
Survey methodology		
Method		Beam Trawl, Dredge
Tow reference		1 of 1, 1of 2 etc 6 of 6
Orientation of survey line	degrees	3 numbers
Time of tow start		HHMMSS
Time of tow end		HHMMSS
Lat at SOT (start of Tow)		DDMMSS
Long at SOT start of Tow)		DDMMSS
Lat at SOT (end of Tow)		DDMMSS
Long at EOT (end of Tow)		DDMMSS
Average water depth (metres)	m	10 numbers
Length of tow	m	10 numbers
Total area sampled	m2	10 numbers
Validity (was trawl/dredge successful)		yes, 50%, no
Weather/Sea conditions		
Time	hrs	MMHH
Wind strength	Beaufort	Force 1, Force 2, …Force 10
Direction	Degrees	N,NNE, NE, ENE, E etc
sea conditions		calm, 1m swell, 2m swell, 3m swell,…6m
Processing		
Date		DDMMYYYY
Record quality		good, incomplete
Sample storage medium (eg Formaldehyde)		15 characters
Species data type		15 characters
Storage		
Sample storage reference number		10 characters
Photographic reference		10 characters
Format		10 characters

UWTV	measurement/exampl	database entry
System		
Make & model (1)		DCR-VX, Sony
Instrument type (1)		Digital stills camera, video camera, diver held camera
Make & model (2)		NR 2000, Nite-Rider Lighting Systems
Instrument type (2)		Underwater lamps
Use of positioning beacon on sledge/camera (UBSL)		yes, no
Layback	m	5 numbers
Survey methodology		
Method		towed video sledge, drop camera
Line (filing code)		10 numbers
Orientation of survey line	degrees	3 numbers
Time of line start		HHMMSS
Time of line end		HHMMSS
Lat at SOT (start of Tow)		DDMMSS
Long at SOT start of Tow)		DDMMSS
Lat at SOT (end of Tow)		DDMMSS
Long at EOT (end of Tow)		DDMMSS
Average water depth (metres)	m	10 numbers
Length of tow	m	10 numbers
Weather/Sea conditions		
Time	hrs	MMHH
Wind strength	Beaufort	Force 1, Force 2, …Force 10
Direction	Degrees	N,NNE, NE, ENE, E etc
sea conditions		calm, 1m swell, 2m swell, 3m swell,…6m
Processing		
Date		DDMMYY
Validity (video quality)	Good	poor,good,excellent
QA depth & position	yes	poor,good,excellent
Vertical Datum	LAT	MSL,LAT, none
Storage		
Sample storage reference number	1	10 characters
Photographic reference	23	10 characters
Format		10 characters
Media type		10 characters
Storage		
Media	Digital video cassette, Mini DV	10 characters
Format	mpeg	10m characters
Video Cassette filing code	xsdffgv	10 characters

CASI/Satellite imagery/LIDAR	measurement/example	database entry
System		
Make & model		15 characters
Instrument type		15 characters
Band widths	nm	
Flying height (m)	m	
Orinetation of survey lines	degrees	3 numbers
Operating parameters		
Weather/Sea conditions		
Time	GMT	HHMMSS
Wind strength	Beaufort	Force 1, Force 2, …Force 10
direction	degrees	N,NNE, NE, ENE, E etc
% Cloud cover	octa	3 numbers
sea conditions	m	calm, 1m swell, 2m swell, 3m swell,…6m
Processing		
Wavebands used	nm	
Vertical accuracy (m)	m	3 numbers
Vertical datum		LAT,MSL
Horizontal resolution	m	3 numbers
Horizontal accuracy	m	3 numbers
land cover map classification method	name	15 characters
% accuracy of land cover map		3 numbers
RMSE error	m	3 numbers
Model used to generate value	name	15 characters
warp model used/georeferencing	name	15 characters
groundtruthing x ref to sample data	yes/no	yes, no
Storage		
Sample storage reference number		10 characters
Photographic reference		10 characters
Format		10 characters
Media type		10 characters

AGDS	example entry	database entry
System		
Make & Model	RoxAnn	15 characters
Echo-sounder	JVC 2000	15 characters
Transducer type: hull or side mounted	hull	hull, overside, beam
depth of sounder below surface	m	3 numbers
Beam width and shape (footprint)	m2	3 numbers
Sv (speed of sound used in echosounder)	ms-1	4 numbers
Ship track logging softw are used	Microplot/QTC View	15 characts
Orientation of survey line	degrees	3 numbers
Time of line start		HHMMSS
Time of line end		HHMMSS
Lat at SOL (start of line)		DDMMSS
Long at SOL (end of line)		DDMMSS
Lat at EOL (start of line)		DDMMSS
Long at EOL (end of line)		DDMMSS
Survey box (grid) (upper left/bottom right)?	??	
Track spacing	m	4 numbers
point save frequency	s	4 numbers
Average water depth	m	10 numbers
dGPS offset from transducer mount (+/- ref to datum point)	m	3 numbers
Operating parameters		
Operating frequency	kHz	4 numbers
Operating power (range setting)	marked/500	4 numbers
Vessel speed	knots	2 numbers
Weather/Sea conditions		
Time		HHMMSS
Wind strength	Beaufort	Force 1, Force 2, …Force 10
direction	degrees	N,NNE, NE, ENE, E etc
sea conditions	m	calm, 1m swell, 2m swell, 3m swell,…6m
Processing		
Date		DDMMSS
Time and date of each data point (for tidal correction)	Yes	HHMMSS
Number of separate track files in dataset	6	15 numbers
Separate track files amalgamated	yes	yes, no
Total size of dataset	24,500 records	15 numbers
Depth correction	Yes	yes, no
Nearest port used	Greenwich, London	20 characters
Time interval for depth correction	mins	MM
QA depth & position	yes	yes, no
Number of data marked as dubious/removed	marked/500	15 characters
E1E2 standardised	yes	yes, no
E1E2 standardised percent	95	3 numbers
Grid format	ASCII XYZ	15 characters
Software used	Surfer/Spatial Analyst/Ve	15 characters
Grid spacing	300 metres	4 numbers
Interpolation algorithm	Inv distance/kriging	15 characters
Details of model	Power 2/exponential	15 characters
Search radius (distance over which interpolation is done)	m	4 numbers
Type of search	Quadrant	15 characters
Max points used	8/quadrant	15 characters
Smoothing factor if used	not used/20 etc	15 characters
Vertical Datum	LAT	4 characters
Vertical Accuracy of data	m	3 numbers
Horizontal Accuracy of data	m	3 numbers
Storage		
Media	SEGY	15 characters
Track point data fromat	Excel/ ASCII txt	15 characters
Raw RoxAnn files available	yes/with surveyor/no	15 characters
QTC: FFV & CAL files available	yes/with surveyor/no	15 characters
QTC: Q values available	yes/with surveyor/no	15 characters
Groundtruthing x ref to sample data		15 characters

Side-Scan Sonar	example entry	database entry
System		
Make & model of tow fish	EdgeTech 270 TD tow fish	20 characters
Make & model of topside recording device	EG&G 260	20 characters
Softw are version	Octopus 461	20 characters
Use of positioning beacon on tow fish (UBSL)	no	yes, no
correction to tow fish	layback	15 characters
Survey		
Ship track logging softw are used	Microplot/QTC View	15 characts
Orientation of survey line	degrees	3 numbers
Time of line start		HHMMSS
Time of line end		HHMMSS
Lat at SOL (start of line)	30	DDMMSS
Long at SOL (end of line)	11 30.50000	DDMMSS
Lat at EOL (start of line)	30	DDMMSS
Long at EOL (end of line)	11 30.50000	DDMMSS
Track spacing	m	4 numbers
Direction	degrees	3 numbers
Average w ater depth (metres)	150m	5 numbers
NB If the survey uses multiple parallel lines to produce a mosaic of an area, give positional data to delineate		
the area surveyed (e.g. NW & SE corners), the total number of lines used and the track spacing betw een lines		
Operating parameters		
horizontal beam w idth	m	3 numbers
beam depression angle	m	3 numbers
Operating frequency (kHz) (or specify dual freq)	kHz	4 numbers
vessel tow speed (knots)	knots	2 numbers
Range setting (m)	m	3 numbers
Dynamic range of system	m	3 numbers
Sw athe w idth (tw ice range)(m)	m	3 numbers
Weather/Sea conditions		
Time		HHMMSS
Wind strength	Beaufort	Force 1, Force 2, …Force 10
direction	degrees	N,NNE, NE, ENE, E etc
sea conditions	m	calm, 1m sw ell, 2m sw ell, 3m sw ell,…6m
Processing		
Date		DDMMYY
Method		15 characters
Has data been corrected for speed of vessel over ground (Y/N)		yes, no
Slant range corrected (y/n)	yes	yes, no
Tow fish layback (metres) (from datum point)	m	5 numbers
has data been geo-referenced (Y/N)	yes	yes, no
gain correction (auto/can true backscatter be recovered)	auto	yes, no, auto
Vertical Datum	LAT	3 characters
Vertical Accuracy of data	m	4 numbers
Horizontal Accuracy of data	m	4 numbers
Navigation file name	name	20 characters
Storage		
Media	DDS3	10 characters
Format	Q'Mips	10 characters
Hard copy available (print-out)	no	10 characters

Multi-beam sonar*	example entry	database entry
*aw aiting information on ISO standard fields		
System		
Make & Model	Kongsberg Simrad EM1002	20 characters
Transducer type	1002	20 characters
Transducer mount	Drop keel	drop keel, overside, tow ed, ROV
Transceiver type	1002 Vers.02	10 characters
Softw are version	K-S CE Ver.05	10 characters
Mode	Shallow	shallow , deep w ater
Bottom detection	AMP+Phase	10 characters
Survey		
Ship track logging softw are used	Microplot/QTC View	15 characters
Orientation of survey line	degrees	3 numbers
Time of line start		HHMMSS
Time of line end		HHMMSS
Lat at SOL (start of line)	52 20.20000 11 30.00000	DDMMSS
Long at SOL (end of line)	52 20.20000 11 30.50000	DDMMSS
Lat at EOL (start of line)	52 20.20000 11 30.00000	DDMMSS
Long at EOL (end of line)	52 20.20000 11 30.50000	DDMMSS
Track spacing	m	4 numbers
Direction	degrees	3 numbers
Average w ater depth (metres)	150m	5 numbers
Operating parameters		
Beam angle port/starboard	65/65	10 characters
Operating frequency	95kHz	5 numbers
Samples per sw eep	111	5 numbers
Backscatter	On	on off
SSS points per sw eep	6000	5 numbers
Sound velocity correction mode	AML SVP 12plus	20 characters
Number, date, time	SVP-001-010103-00:00	30 characters
Weather/Sea conditions		
Weather/Sea conditions		
Time		HHMMSS
Wind strength	Beaufort	Force 1, Force 2, …Force 10
direction	degrees	N,NNE, NE, ENE, E etc
sea conditions	m	calm, 1m sw ell, 2m sw ell, 3m sw ell,…6m
Processing		
Date		DDMMYYYY
Method	CARIS HIPS SIPS	20 characters
Tide	Predicted POLPRED	20 characters
Vertical Datum	LAT	3 characters
Vertical Accuracy of data	m	3 numbers
Horizontal Accuracy of data	m	3 numbers
Storage		
Media	DDS3	10 characters
Format	Ascii raw ; ascii proc	10 characters

Annex 18: Draft Terms of Reference for WGMHM 2007

The **Working Group on Marine Habitat Mapping** [WGMHM] (Chair: D. Connor, UK) will meet in Woods Hole, USA from 17–20 April 2007 to:

International programmes

1) Review progress of international mapping programmes (including MESH, EEA, OSPAR, BALANCE and HERMES).

2) Review available habitat maps for the North Sea and their methodologies and make recommendations on how these maps may be further developed.

National programmes (National Status Reports)

3) 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 10 minutes per country; posters welcomed; NSR entries to be circulated BEFORE meeting; outline map of study areas in shape-file GIS format)

Mapping strategies and survey techniques

4) Assess recent advances with acoustic techniques for marine habitat mapping, with particular reference to techniques used in combination to develop maps and frameworks used for ecosystem-based management.

Protocols and standards for habitat mapping

5) Review and critique guidelines for habitat mapping, including protocols and standards for habitat mapping developed under relevant initiatives (e.g. MESH, HERMES).

6) Develop approaches for the assessment of accuracy and confidence in habitat maps, and validation requirements.

7) Review standards for calibrating survey systems (single beam echo sounder, AGDS, underwater video).

8) Review progress in the development of 'discovery' and 'survey/method' metadata standards for marine habitat mapping, illustrated with worked examples (e.g. from MESH).

Uses of habitat mapping in a management context (human activities; implementation of Directives and Conventions) and its relevance in understanding ecosystems

9) Review the application of and needs for habitat maps in an ecosystem-based management context.

WGMHM will report by ?? 2007 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 and relation to Action Plan	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 those of NIVA for the EEA, 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. WGMHM has considered the production of habitat maps for the North Sea for several years. Several mapping projects covering all or part of the North Sea (e.g. the EEA's EUNIS map, the UKSeaMap project and ongoing MESH modelling work) will become available during 2006. Each of the studies uses different approaches and datasets, leading to differing maps; WGMHM should consider their relative merits, particularly in the light of ongoing ICES needs for North Sea maps (e.g. by REGNS), and comment as appropriate. 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 and 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 during 2006 and WGMHM should provide peer review of the work on the basis of its wider expertise, and assess any requirement for further development. 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. As part of the development of standards, an assessment of the needs for calibrating survey systems is required, again to promote best practice in use of this equipment. Calibration for these three techniques would compliment the paper completed in 2006 on multibeam systems. Sound data management is important in the archiving and distribution of data sets. There is a need to clarify the relationship between data types, including through illustrated examples, and to learn from data management approaches adopted in other sectors. 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.
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	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
Secretariat Cost share	

Annex 19: Recommendations and actions

RECOMMENDATION OR ACTION	ACTION
1. Seek release of reports and maps for the North Sea to contribute to the REGNS request (EEA map, UKSeaMap, MESH modelling)	David Connor by 13 May 2006
2. Circulate details of MESH subtidal survey workshop to WGMHM members	Fiona Fitzpatrick by 15 May 2006
3. Review maps available for the OSPAR habitat mapping programme (www.searchnbn.net/hosted/ospar/ospar.html), and advise of any data gaps, supplying additional data where possible	All WGMHM members by 31 July 2006
4. Circulate details of ICES Fisheries symposium in Galway to WGMHM members	Fiona Fitzpatrick by 30 October 2006
5. Circulate for review MESH protocols and Standards framework documentation	MESH (Action 2) – as it becomes available during 2006
6. Prepare paper on accuracy and confidence assessment for WGMHM 2007 meeting.	MESH (Action 2) by 31 January 2007
7. Draft reviews of calibration requirements for single beam echosounders, AGDS and underwater television/video.	Fiona Fitzpatrick/Marine Insitute & Matt Service by 31 January 2007
8. Initiate work and prepare paper on focal topic: Role of marine habitat mapping in ecosystem-based management	Chris Cogan, Anthony Grehan by 31 January 2007
9. Initiate work and prepare paper on focal topic: Accuracy assessment and validation for marine habitat maps	Lead person TBA by 31 January 2007
10. Initiate work and prepare paper on focal topic: Issues and advances with acoustic techniques for marine habitat mapping	Fernando Tempera, Fiona Fitzpatrick by 31 January 2007
11. Further develop requirements for standard metadata fields for mapping techniques	David Connor by 31 January 2007
12. Review methodologies and maps for available maps of the North Sea (EEA, UKSeaMap, MESH)	Brian Todd, David Limpenny by 31 January 2007
13. Provide revised guidance on National Status Report reporting format	David Connor by 31 January 2007