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

19–23 May 2014

San Sebastian, Spain

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the Exploration of the Sea

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Contents

Executive summary

The Working Group on Marine Habitat Mapping (WGMHM), chaired by Pål Buhl-Mortensen, Norway, convened at AZTI-Technalia in San Sebastian, Spain, from 19-23 May 2014.

Two essential topics that were dealt with during the meeting were habitat mapping relating to management ToR (d) and the use of habitat mapping for monitoring (ToR e). Experts also presented statuses on both on national and international mapping projects (ToRs a) and b)).

After reviewing the ToRs at the beginning of the meeting it was agreed that WGMHM should seek contributions to the ToRs for next year from outside the group. Some suggestions were received after the meeting from the Norwegian Environment Agency and the Norwegian Directorate of Fisheries.

These inputs have been incorporated in ToRs for next year: ToR d - to recommend general mapping strategies at three different levels of detail, with guidelines for selection of methodologies, sampling densities etc., and ToR e - Mapping of vulnerable habitats.

During discussions of issues under ToR c (Habitat mapping and technology) much focus was on the importance of incorporation of hydrophysical parameters in habitat modelling. This is reflected in chapter 5.1.

It was agreed during the meeting that WGMHM submit a proposals for theme session for the Annual Science Conference (ASC) 2015. This theme session should focus on habitat mapping in relation to environmental management and monitoring. These issues are highly relevant and have been discussed and reported the last years by WGMHM.

WGMHM chaired by Pål Buhl-Mortensen, Norway, will meet at the Marine Research Institute in Reykjavik, Iceland, on 18–22 May 2015.

1   Opening of the meeting

The meeting was held at AZTI-Technalia, in San Sebastian, Spain, on 19–23 May 2014. The meeting was attended by 13 delegates from 9 countries. Apologies were received from several of the members that were not able to attend.

Figure 1. Some of the members of WGMHM that participated in San Sebastian. From left: Julian Burgos (Iceland), Claudia Propp (Germany), Ola Hallberg (Sweden), Ibon Galparsoro (Spain), Mickael Vasquez (France), Helen Ellwood (UK), Fergal McGrath (Ireland), Kerstin Geitner (Denmark), Pål Buhl-Mortensen (Norway) and Steinunn Hilma Olafsdottir (Iceland). Trine Bekkby (Norway), Anthony Grehan (Ireland), and Roland Pesch (Germany) were not present when the picture was taken.

The meeting was chaired by Pål Buhl-Mortensen and kindly hosted by Ibon Galparsoro on behalf of Azti tecnalia.

2 Adoption of the agenda

The Terms of Reference for the meeting were reviewed and are given in Annex 2. The meeting agenda (Annex 3) was reviewed and revised at the start of the meeting before it was accepted by the group.

3 Progress in international mapping programmes

ToR a) – Report on progress in international mapping programmes (including OSPAR and HEL-COM Conventions, Emodnet, EC and EEA initiatives, CHARM, and Mesh-Atlantic projects)

3.1 OSPAR habitat mapping programme

Helen Ellwood – JNCC

The OSPAR habitat mapping programme collates existing data on the presence of OSPAR listed threatened and/or declining habitats in the north-east Atlantic – these are also listed as 'special habitats' under the Marine Strategy Framework Directive. It is part of a wider programme to enable Contracting Parties to identify appropriate measures for the protection of these habitats. The programme is led by the UK Joint Nature Conservation Committee (JNCC) and requires Contracting Parties to collate, standardise and submit habitat records to a single, common geo-database (Figure 2), which is freely available online through the MESH Atlantic online interactive map (www.searchMESH.net/webGIS).
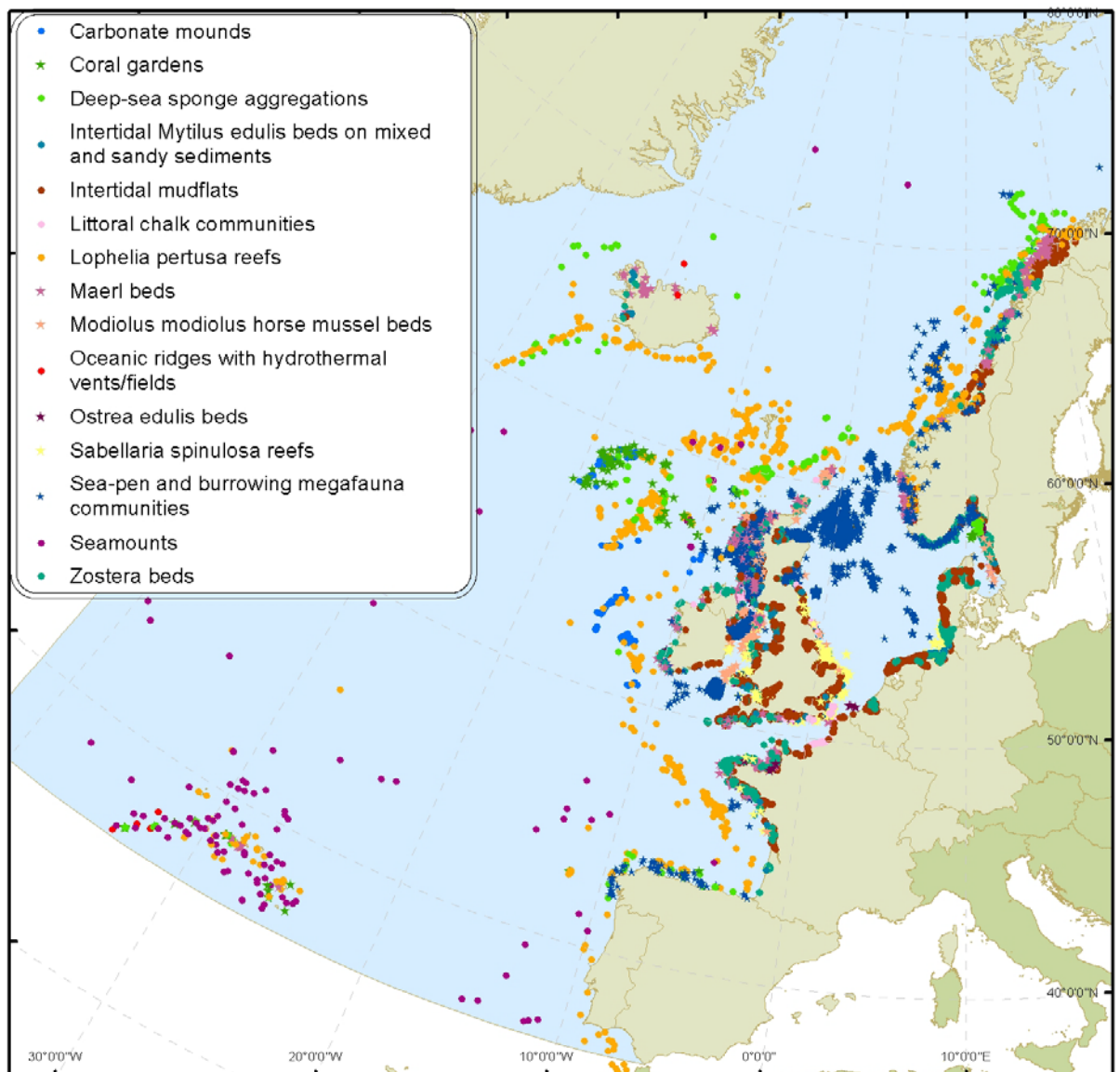
Figure 2. Map showing the distribution of 15 habitats on the OSPAR list of threatened and/or declining species and habitats, as supplied by Contracting Parties and other sources up to January 2014. Note that data for Cymodocea meadows are not yet available.

Data on the distribution and extent of these habitats are used for habitat assessments undertaken as part of the OSPAR joint assessment and monitoring programme. It is also envisaged that this combined, standardised dataset will prove useful for regional habitat status assessments required by the Marine Strategy Framework Directive. In addition, the data were used in a pilot assessment of the ecological coherence of the OSPAR MPA network in the English Channel. Annually since 2012 the data have fed into the ICES database of potential Vulnerable Marine Ecosystems which provides the evidence behind conservation advice made by the ICES Working Group on Deep Sea Ecology.

In 2014 JNCC plan to review the usefulness of, and resources required for the programme, including potential additional parameters, such as information on habitat condition.

3.2 The EUSeaMap2 project

Mickael Vasquez – IFREMER

EuSeaMap2, the seabed habitat lot of Emodnet, aims at creating a full coverage broad-scale map of seabed habitats accross Europe. The gaps left by EUSeaMap (ur-Emodnet) and MeshAtlantic, i.e. the Black, Adriatic, Ioanian and Aegian-Levantine Seas, and the Canary islands will be filled (Figure 3). The areas that were covered by those projects will be updated in order to take into account improvements in the input data that are seabed substrate, current- and wave-induced energy. Kick-off meeting took place in September 2013 in Rome.
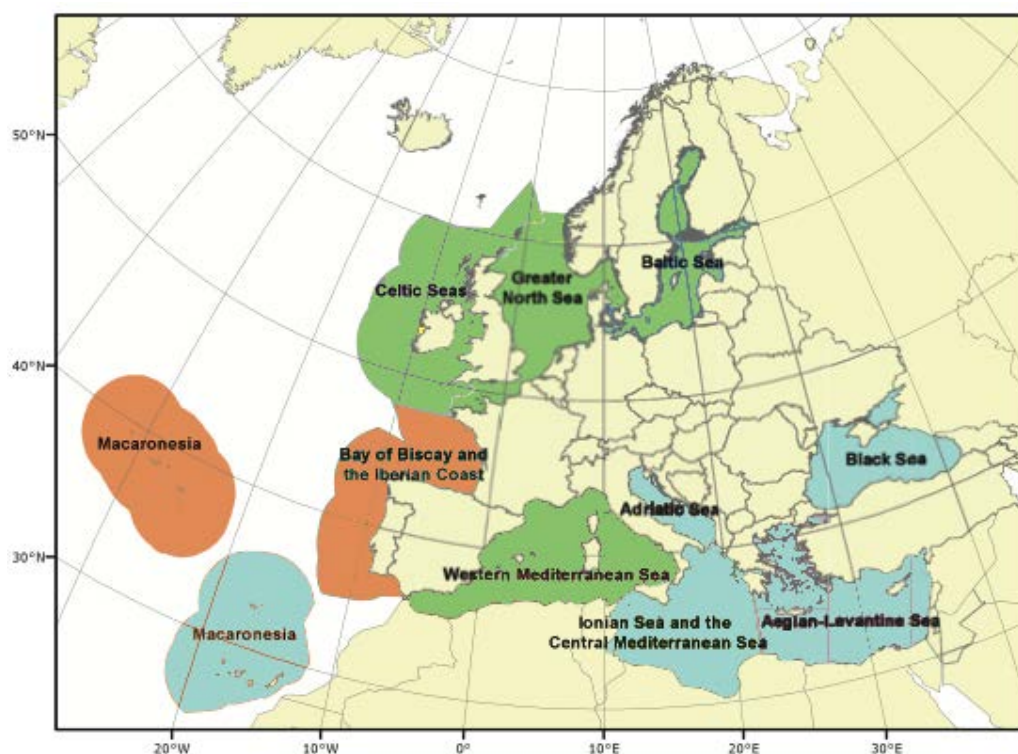
Figure 3. Areas covered by EUSeaMap. In Green are the areas that were mapped by the EU-SeaMap project, in orange those that were mapped by MeshAtlantic, and in blue the new ones.

A classification review is being undertaken for the eastern Mediterranean and the Black Sea in order to define which EUNIS habitat types can be mapped at broad-scale for those regions and to define the abiotic factors that determine their distribution. The project will get seabed substrate and bathymetry data from other Emodnet lots, respectively Geology and Hydrography. Other datasets which are required for mapping, namely light kdpar, exposure to hydrodynamics and oxygen conditions will have to be prepared by the project.

A particular effort will be dedicated to the calculation of the thresholds that allow for the classification of physical variables continuous GIS layers into the environmental categories that are considered by EUNIS. Presence/absence sample data of species carateristic of a given category, e.g. specific of the "high energy" or the "infralittoral" categories, is required to carry out this task. Those datasets will have to be collated by the project from existing databases.

Maps for the Adriatic Sea and the Canary islands will be delivered in September 2014.

3.3   MeshAtlantic project achievements

Mickael Vasquez – IFREMER

The Interreg IV MeshAtlantic project, whose area of interest was Irish, Bay of Biscay, Iberian Peninsula and the Azores waters (Figure 4), ended in 2013. The elements presented below are considered as key products of the project.

- The contribution to EUNIS classification, first by the organisation of a conference in San Sebastian which acted as a catalyst for the global revision of the classification which is being carried out by the European Environment Agency, and secondly by the submission of 41 new habitats for the Atlantic area and the Azores islands. These are described into two documents[1,2].

- The inventory and collation of existing habitat maps: 37 maps were collated, made homogeneous across countries using the Eunis classification, and put into the ICES habitat mapping metadata catalog[3], from which they are available for download. They can also be viewed in a web mapper[4].

- The creation of a broad-scale map, an initiative that fed into the global initiative for a pan-European map initiated by the ur-Emodnet EUSeaMap project. In order to get results compatible with those of EUSeaMap, the same methodology for generating a broad-scale map was used. The map is available for download on the meshAtlantic webGIS[4].
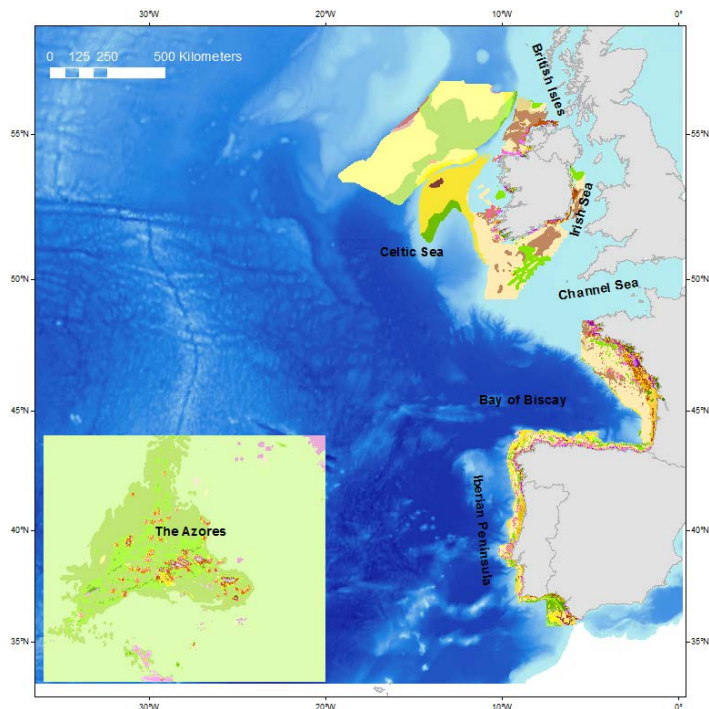
Figure 4. The survey of eleven key sites, from which resulted very fine-scale habitat maps. The selection of the sites was made on the base of marine protected areas already in place or natural areas of singular importance with great prospective to integrate the Natura 2000 network. The reports on Scoping of Habitat mapping Surveys and Surveys Reference briefly describes the approaches taken by each of the project partners in carrying out new surveys.
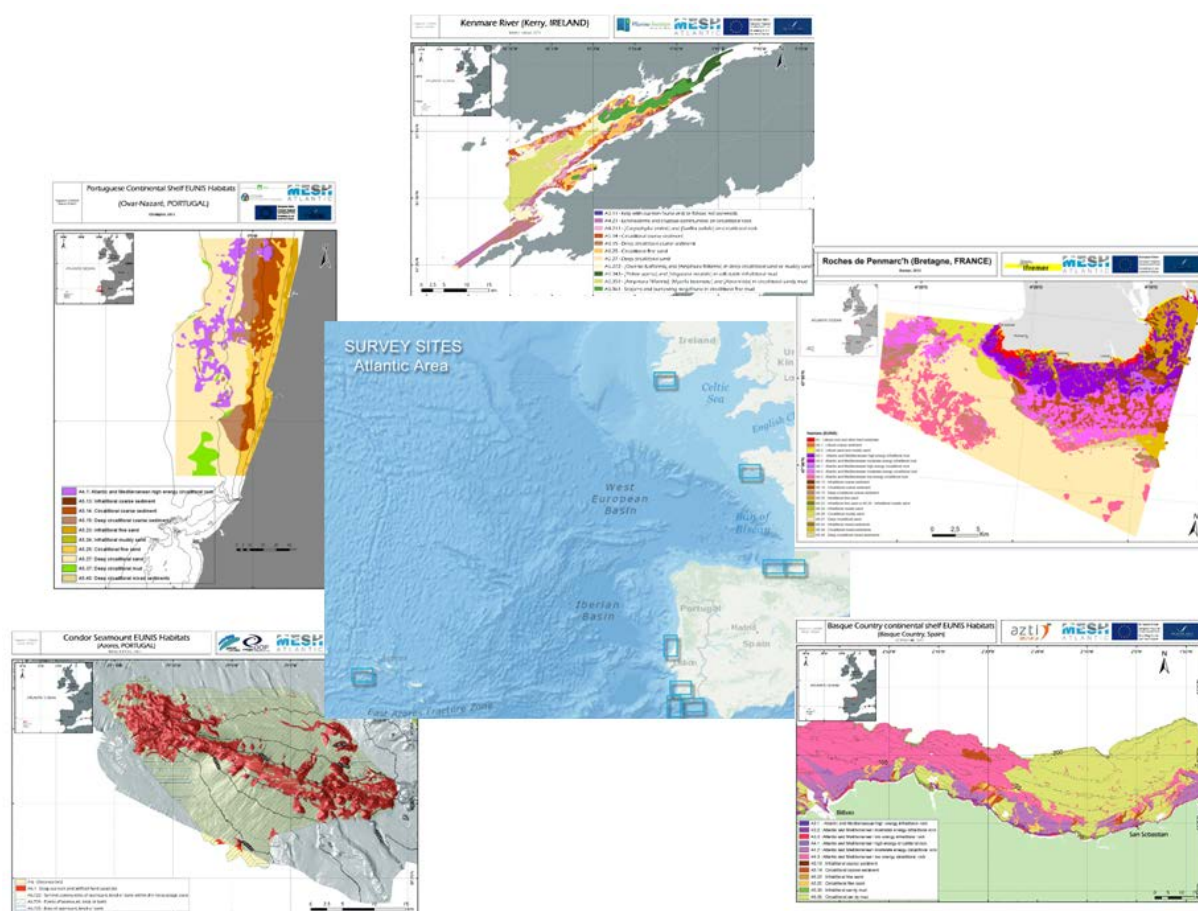
Figure 5. An exhibition about habitat mapping was designed and was first presented for three month at the Aquarium of San Sebastian. This has since been presented in Portugal and there is prospective to make it travelling across France.

Main documents were gathered into the "bluebox" and are available for download at the following address: http://www.meshatlantic.eu/index.php?id=252

[1]*Atlantic Area Eunis Habitats: Adding new habitat types from European Atlantic coast to the EUNIS Habitat Classification*

[2]*Atlantic Area Eunis Habitats:* **Adding new Macaronesian habitat types from the Azores to the EUNIS Habitat Classification**

[3] **http://geo.ices.dk/geonetwork/srv/en/main.home**

[4] **http://www.searchmesh.net/webGIS**

3.4 EMODNET – Geology

Ola Hallberg – Swedish Geological Survey

The European Marine Observation and Data Network (EMODnet) aims bring together and make available fragmented and hidden marine data resources in a uniform way. This is done in order to to facilitate investment in substainable coastal and offshore activities. EMODnet is funded by the European Commission (DG-MARE).

The EMODnet - Geology lot went into its second phase in January 2014. In this phase, the area coverage is expanded to include all European sea areas. The number of partners have increased from 14 in the ur-EMODnet-Geology project to now include 36 partners from 30 different countries. As in ur-EMODnet-Geology the project is coor-

dinated by the National Environmental Research Council (UK) and the Brittish Geological Survey. The project will end by the end of 2016.

Data products that will be produced include seabed substrate, sediment accumulation rates, sea-floor geology, bedrock (lithology, stratigraphy), geological events (submarine landslides and earthquake epicenters, volcanic centres), mineral resources (oil and gas, aggregates, and metalliferous minerals), and coastal migration. For phase two, data resolution is increased from 1:1 000 000 scale to 1:250 000 scale. EMODnet-Geology will provide EMODnet-Seabed Habitat (EUSeaMap) with seabed substrate information. Data will be made available through the 1G-E portal and may also be viewed through the EMODnet-Geology portal (Figure 6).

Figure 6. Dataviewer available at the EMODnet-Geology portal.

3.5   BiodiversityKnowledge – marine biodiversity

Trine Bekkby – NIVA/UiO

The aim of the project BiodiversityKnowledge – marine biodiversity (under EU7FP) is to report to EU on the status on European kelp forests and effects of changes on fisheries. This is being done through an expert consultation exercise and through classifying the status and trends of the kelp forests in GIS. CIIMMAR is coordinating the project. See more at www.biodiversityknowledge.eu/progress-and-results/testing-the-nok/marine-biodiversity
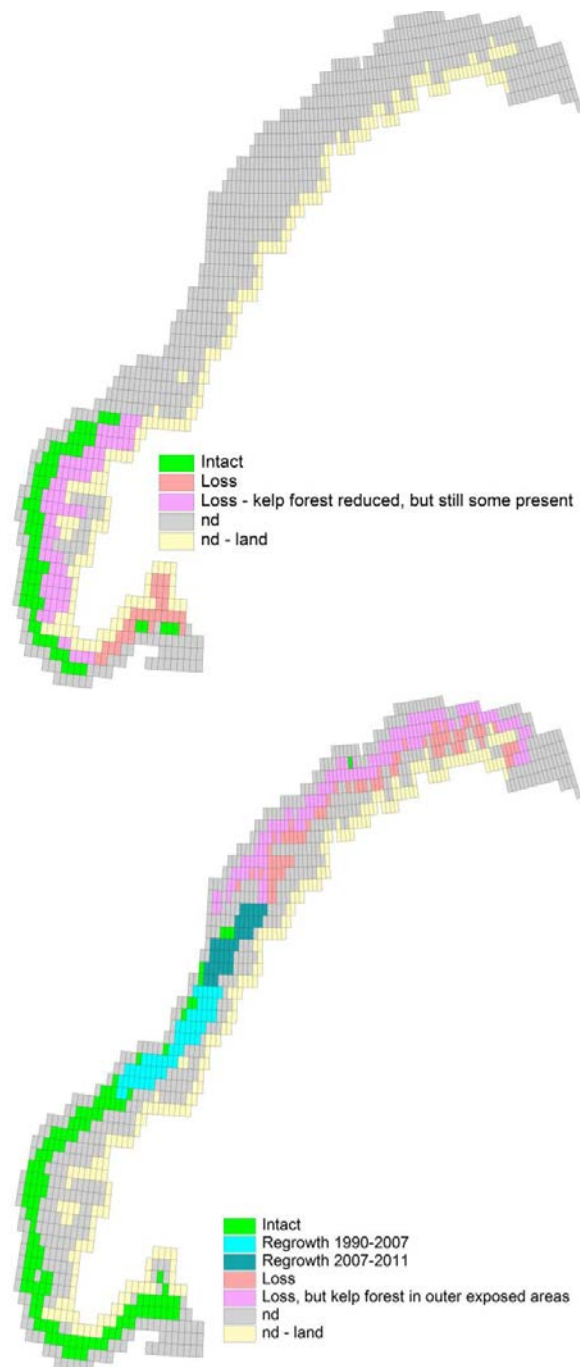
Figure 7. Status of the kelp forest (left: Saccharina latissima, right; Laminaria hyperborea) for of Norway, classified into predefined cells based on information from points, models and expert judgement.

4   National habitat mapping programmes (National Status Reports) – ToR b)

ToR b) - Present and review important results from national habitat mapping during the preceding year, as well as new on–going and planned projects focusing on particular issues of relevance to the rest of the meeting. Provide National Status Report updates in geographic display in the ICES webGIS

4.1   National programme report for Ireland

Fergal McGrath (INFOMAR Programme)

4.1.1   National Mapping Programme – INFOMAR

INFOMAR (Integrated Mapping for the Sustainable Development of Ireland's Marine Resource) was launched in 2006 as a follow on the successful Irish National Seabed Survey (INSS) which ran from 1999–2005. The INSS mapped over 80% of Irelands offshore EEZ using MBES, sub-bottom profiler, and opportunistic sampling. The current coverage map, comprising INSS and INFOMAR is presented in Figure 8.
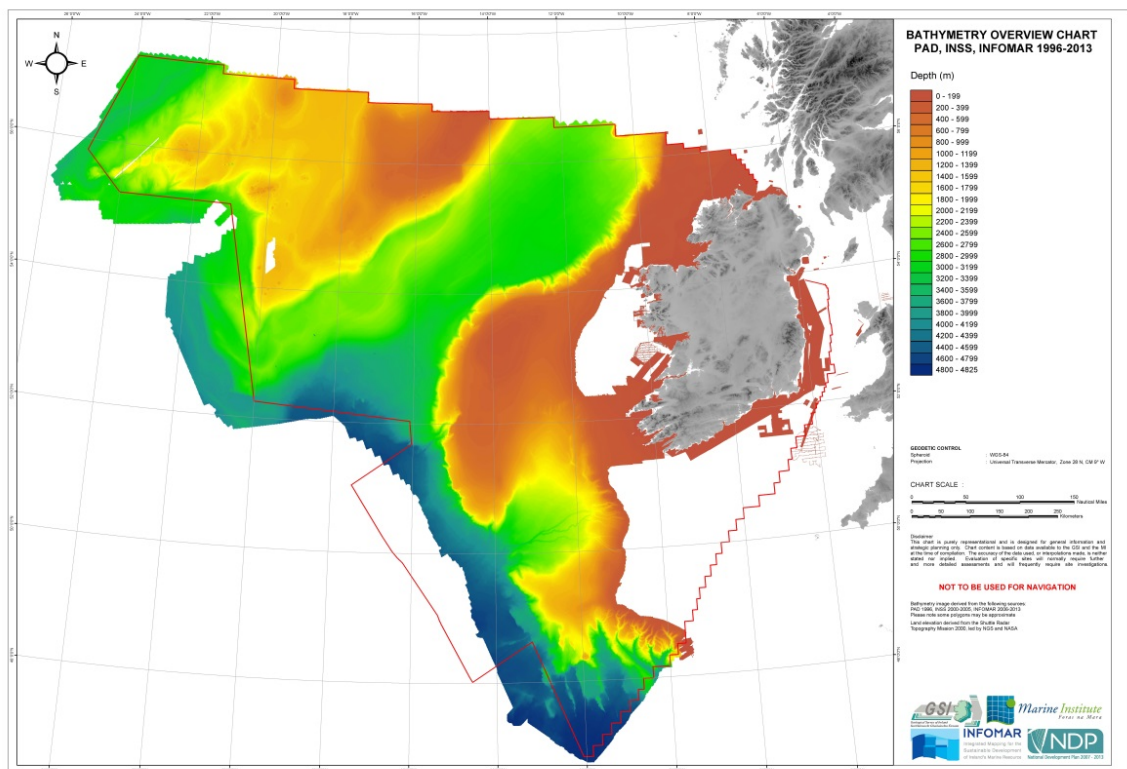
Figure 8. Coverage of mulitibeam bathymetry around Ireland.

INFOMAR is a joint venture between the Marine Institute and the Geological Survey of Ireland (www.infomar.ie). Current annual funding for this programme is €2.9m. INFOMAR is a 20-year programme, which aims to carry out integrated mapping over the entire shelf and coastal waters of Ireland. Through extensive stakeholder consultation 26 Priority Bays and 3 Priority Areas have been identified for mapping during the first 10 – year phase of the project (2006–2016). A mid phase 1 review was carried out in 2013. The result of this was generally favourable with some critical points

raised. It was felt that the value added exploitation component of the programme could be developed better through a business development mechanism. This was instigated at the end of 2013. The programme is achieving its target metrics for this period and it is approved to 2016.

The mapping programme includes acquisition of multibeam bathymetry and backscatter data together with an opportunistic geological sampling programme. Equipment used includes MBES (EM3002, EM204, R2S0nics2022, Reson 7101), EA400, OLEX, Hull Mounted Pinger, Magnetometer, GeoSpark 200, underwater video, ROV, box corer, grab, and vibrocorer. Mapping outputs from the project include bathymetric data and geological maps. All results and raw data from INSS and INFOMAR are available for download and can be accessed at www.infomar.ie.

4.1.2 INFOMAR Activities

By the end of 2013 INFOMAR had acquired data off West Clare Coast, the South West Coast and the South Coast onboard the R.V. Celtic Voyager. Data from Dundalk Bay, East Coast, Dingle Bay and the Blasket Islands, and the River Shannon, were acquired by the R.V. Keary, the R.V. Geo and the newly re-commissioned M.V. Cosantoir Bradain operating in tandem. Significant additional data acquisition was undertaken as part of the Value Added Exploitation Programme including the following;

- Hydrographic, geophysical and geotechnical data acquisition offshore Clare for SEAI's Atlantic Marine Energy Test Site onboard the R.V. Celtic Voyager.
- Hydrographic survey offshore Dundalk under the INTERREG IVA INIS Hydro Project.
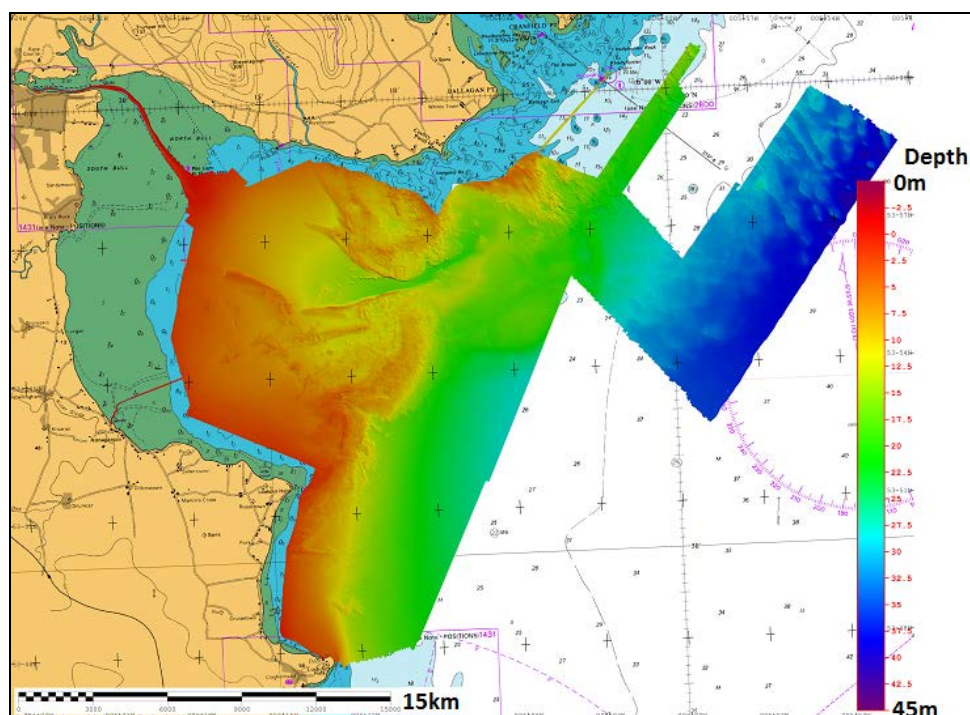
Figure 9. INTERREG IVA INIS Hydro Coverage.

In addition, INFOMAR supported the co-ordination of the WestWave site surveys for ocean energy device site near shore Killard, Co. Clare for SEAI (Table 1).

Table 1. Overview of multibeam acquisition carried out by INFOMAR.

Name	Acquisition	Platform/Dates
Clare Coast (SEAI)	MBES	Celtic Voyager Q2 2013
Shannon	MBES	Geo 02 2013
Clare (SEAI)	MBES	Keary Q2 2013
Dundalk	MBES	Keary / Geo/ Cosantoir Bradain Q2/Q3 2013
Dingle/Blaskets	MBES	Keary / Geo/ Cosantoir Bradain 03/2013
East Coast	MBES	Keary / Geo/ Cosantoir Bradain Q3 2013
S Coast South Priority Area	MBES	Celtic Voyager Q3 2013
SW Coast South Priority Area	MBES	Celtic Voyager Q3 2013

The annual INFOMAR seminar was hosted in University of Limerick in October 2013 which demonstrated the cross government and industry support for the programme outputs, support and infrastructure. Over 100 attendees were present, with representatives from academia, government agencies and departments, and Irish and international industries, ranging from oil and gas, environmental, survey technology manufacturers and personnel suppliers.

4.1.3 Habitat Maps

Through the Mesh Atlantic project, comprehensive collation and standardisation of existing bathymetric data and existing substrate data in Ireland has been carried out. Existing seabed classification maps created by the INFOMAR programme and other national agencies / projects have been collated and translated into EUNIS classification. The Kenmare Bay area was surveyed and the data interpreted. One of the products is a physical habitat map at EUNIS Level 6 (Figure 10). Acquired data were used to refine the existingphysical habitat map into a higher level EUNIS habitat map, generating 12 EUNIS habitats, 6 of which are classed to EUNIS level 5. A reef profile was also created.
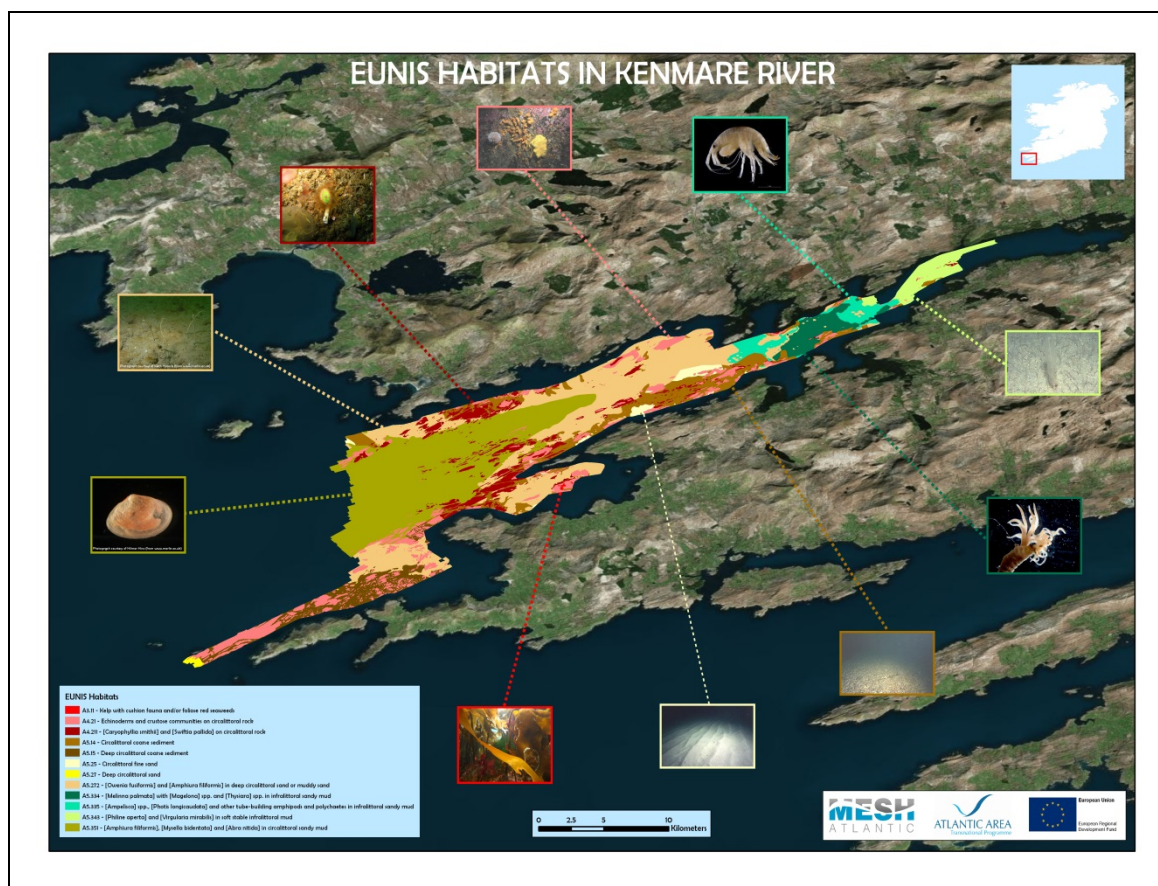
Figure 10. INTERREG IVB MESH Atlantic Kenmare EUNIS Habitat Map.

4.1.4   Other Programme Activities

MESH Atlantic: Mapping Atlantic Area Seabed Habitats For Better Marine Management. The Marine Institute participated in this IFREMER led INTERREG IV project. The final conference was held in Aveiro, Portugal in September 2013. The general objective of Mesh Atlantic is to provide harmonised seabed habitat mapping over the coastal and shelf zones of the Atlantic Area in order to help informed spatial planning and management

INIS Hydro: Ireland, Northern Ireland, & Scotland Hydrographic Survey. The Marine Institute is participating in this MCA led INTERREG IV project. There are 6 European partners in the project, which started in March 2011 and had its final conference in Belfast in December 2013. The objective of INIS Hydro is to provide a standardised seabed survey specification, and high-resolution seabed mapping data in key geographical areas, sensitive bays and inlets on the coasts of the bordering regions. It will also serve up the freely available results via the web.

4.2   National status report for Denmark

Kerstin Geitner – DTU Aqua

Mapping of sandbanks and reefs in 38 coastal marine Natura 2000 sites in 2012

English summary excerpted from the report Marin habitatnaturtype-kortlægning 2012, GEUS/Orbicon 2013, published by The Danish Nature Agency.

Full report available here:

http://naturstyrelsen.dk/publikationer/alle-publikationer/2013/dec/marin-habitatnaturtype-kortlaegning/

"In 2012, Orbicon in collaboration with GEUS carried out substrate- and habitat type mapping for the Danish Nature Agency in 38 coastal marine habitats located in waters of: the Limfjord, the Kattegat, the Belt Sea, the Sound and the western Baltic (Fig 11).

The overall objective of the 2012 study is to provide basic information about the seabed for use in the substrate- and habitat type maps to be used in the implementation of the EU Marine Strategy Framework Directive and the management of SACs (Special Areas of Conservation) in relation to the Habitats Directive. For this purpose, a number of independent sub-objectives have been sought attained through this investigation and subsequent reporting.

A more detailed and precise mapping of protected marine habitats in SACs has been obtained through this study. The basis for this mapping has inter alia been the Danish Nature Agency's Danish interpretation of habitat types (draft). There has been a specific focus on generating knowledge about the extent and distribution of the habitat types Sandbanks which are slightly covered by sea water at all times (1110), Reefs (1170) and Submarine structures made by leaking gases (1180). Mapping efforts within individual SACs have been prioritized in areas where the above habitat types are most likely to occur.

It has also been a goal is to carry out the required amount of point investigations with visual documentation to ensure verification of the above habitat types. Sediment composition in areas with different characteristics have also been mapped in order to conduct qualitative descriptions, some of which are used to identify, define and describe the SAC sites after the EUNIS system. Reporting of the geophysical and biological mapping is carried out so that it meets the Danish Nature Agency's desire to use it for the preparation of Natura 2000 plans etc.

In 2012 there was collected approx. 2830 line kilometers of data with sonar, sediment sounder and side scan sonar. Furthermore, there has been employed around 4519 line kilometers of seismic and acoustic archive data from existing studies. The acoustic and shallow-seismic data has been interpreted in order to map surface sediment composition and the geological units in the seabed. In shallow water, side scan sonar acquisition can be problematic, and is here substituted with high resolution orthophotos and satellite data. The first order interpretations are subsequently visually investigated in a number of verification points by means of 384 ROV (Remotely Operated Vehicle) dives. Archive data from 1388 bottom samples (GEUS' Jupiter database) and 355 bottom verifications (Aquabase) have also been included. Based on the total amount of data, the seabed sediment types have been classified and are presented in a number substrate type maps (Appendix A5).

The studies demonstrate a clear correlation between the distribution of underlying geological units and the distribution of the substrate types. This exemplifies that an understanding of the geological evolution of the seabed in the Limfjord, the Kattegat, the Belt Sea, the Sound and the western Baltic Sea (particularly in the period following the last ice age) along with an elucidation of contemporary sediment transport patterns - is essential background information for habitat mapping.

The habitat mapping comprises partly the Natura 2000 elements defined by the EU Habitats Directive and partly the EUNIS classification, which is designed to harmo-

nize habitats across Europe. Both classifications are based on substrate types and are supplemented with information including the morphology, the deposition environment, salinity and light conditions as well as supplemental information about the flora and fauna communities associated with the different substrate types.

For the purpose of verifying the various flora and fauna communities, the video recordings from the ROV dives performed in 2012 have been reviewed and all identified species have been noted. The biological conditions recorded in relation to the different substrate types within each SAC site are described within the report. These data form part of the basis for the EUNIS maps.

The reporting data format is optimized with an HTML report structure, which provides easy access to the underlying data. On digital maps it is thus possible to present individual map themes, and with a mouse click to access test positions, ROV video sequences, logs, acoustic samples and sediment data.

Comments

The newly defined habitat nature types in Natura 2000 areas have ‚amongst other things, resulted in the definition of areas where fishing with trawling gear is forbidden. These areas are based on a 200 meter buffer around the areas defined as reefs, modified to be composed by fewer points to be apliccable in practice. This definition has been achieved by the Danish Ministry of Food, Agriculture and Fisheries with consultation of fishing industry representatives, NGO's etc.
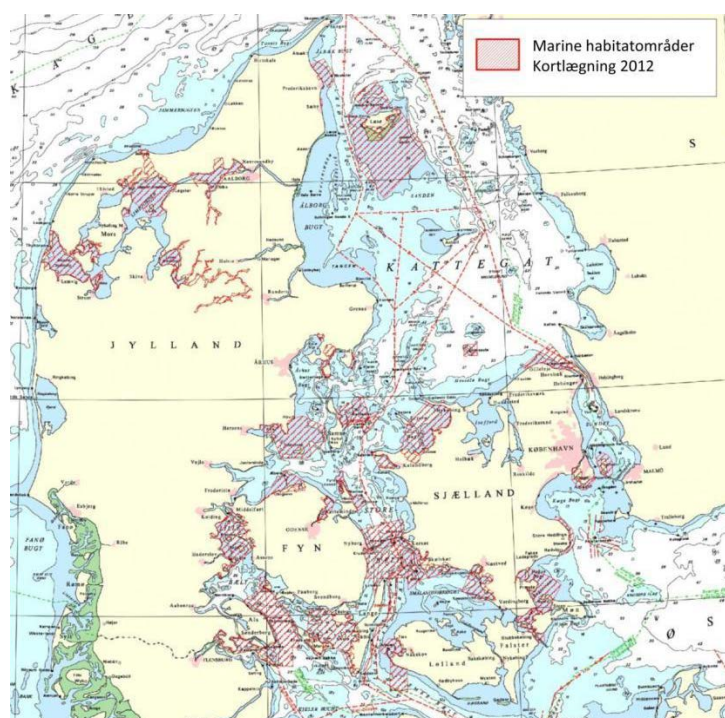

Figure 11. Overview map of the 38 habitat areas that were mapped in 2012.

4.3 National programme report for Germany

Roland Pesch – Bioconsult & Claudia Propp – BSH

The implementation of environmental policies in the German North and Baltic Sea requires biotope maps that sufficiently characterise and represent the biotic condi-

tions at the sea floor. Therefore, the project "Mapping and registration of marine biotopes in Germany's Exclusive Economic Zones", initiated by the German Federal Agency of Nature Conservation, aims to stepwise map biotopes in the German Exclusive EEZ in the North and Baltic Sea. The mapping thereby relies on both already existing and newly collected benthos and sediment data. The data is to be structured and classified by international, expert-based classification systems namely *EUNIS*, *Underwater Biotope and Habitat Classification System (HUB)* of HELCOM as well as by classification criteria given by the *Red List Biotopes* by Riecken *et al.* (2006) and mapping recommendations regarding three §30 biotopes[1]. Furthermore predictive modelling techniques are applied to map the spatial distribution of benthic species and communities in the study regions.

The project is subdivided into two subprojects, A and B. Subproject A focuses on the biological investigations, the data management and the biotope mapping and is carried out by the University of Vechta (lead), the company Bioconsult (Coordination, Data administration, Biotope modelling and Benthic Sampling North Sea) and the Leibniz Institute for Baltic Sea Research Warnemünde(Benthic sampling Baltic Sea). Subproject B aims at an area covering sediment mapping by use of hydroacoustical data and is performed by the Federal Maritime and Hydrographic Agency of Germany, Hamburg, in cooperation with the Alfred Wegener Institute - Helmholtz Centre for Polar and Marine Research Bremerhaven, the Institute of Geosciences - Christian Albrecht University of Kiel; Senckenberg Institute – Wilhelmshaven and the Leibniz Institute for Baltic Sea Research – Marine geology Department.

Since the beginning of the project in June 2012 mapping activities concentrated on the marine protected areas according to the EU Habitats Directive (Natura 2000 sites). Benthos surveys have been carried out in the Natura 2000 sites *Sylt Outer Reef, Borkum Reef Ground* and *Dogger Bank* in the North Sea as well as *Fehmarn Belt, Kadet Trench, Adler Ground* and *Odra Bank* in the Baltic Sea. Hydroacoustic surveys were conducted in the Natura 2000 sites *Sylt Outer Reef, Borkum Reef Ground* in the North Sea and *Kadet Trench* and *Odra Bank* in the Baltic Sea. The mapping of the *Borkum Reef Ground* could be completed.

So far, all resulting data and other relevant spatial information were organised in a *GIS Registry Biotope Mapping* based on ESRI ArcGIS 10.0. Furthermore an extended draft of a methodological handbook including mapping guidelines for the existing biotope types in the German EEZ was finished. Criteria were defined for the reproducible differentiation of sediment types from the hydroacoustical data, followed by verification processes. These tasks could be completed with exception of the operational definition of stone fields. Based on the defined criteria and the existing side scan data a systematical mapping of sediments could be started.

The full coverage biotope mapping in the Baltic EEZ relies on the classification rules of the *Underwater Biotope and Habitat Classification System (HUB)* of HELCOM, the same is done for the North Sea with help of a modified version of the *European Nature Information Systems (EUNIS)*. Both classification systems are structured into six hierarchical levels of which the upper three levels are based on abiotic and the lower three levels on biotic criteria. For both the North and the Baltic Sea, levels 2 and 3 were mapped in terms of biological zones and habitat-related substrate classes by use of data on bathymetry, photic zones and sediments. Additionally, level 5 classes were assigned to benthos stations in terms of biotope types in each case. So far, sub-biotope types of level 6 were assigned to benthos stations of the Baltic Sea only.

Until the end of the first project phase in October 2014 the remaining tasks are the mapping of levels 5 and 6 by use of predictive modelling techniques, the intersection of the resulting maps with the existing level 2 and 3 maps and their statistical description. Additionally, the methodological handbook including a full set of mapping guidelines for biotope types of the North and the Baltic EEZ will be worked out. Further works will concentrate on spatial suggestions for future benthos biological samplings in the next project phase.

[1] legally protected biotopes according to §30 of the Germany's Federal Nature Conservation Act (BNatSchG)

References

Riecken, U., Finck, P., Raths, U., Schröder, E., Ssymank, A. Rote Liste der gefährdeten Biotoptypen Deutschlands. Zweite fortgeschriebene Fassung. In Na Bi V 34. Edited by Bundesamt für Naturschutz. Bonn; 2006:318.

4.4 National status report for Norway

Trine Bekkby – NIVA/UiO & Pål Buhl–Mortensen – IMR

4.4.1 The National Program for Mapping of Biodiversity – Coast

The program is ongoing. Spatial predictive modelling is an important tool for mapping kelp forest, carbonate sand etc. Some important aspects are

- GIS-layers on substrate are important and are often lacking
- More detailed current speed models are needed (which also should include information on temperature and current speed)
- Water flow is not just water flow. Wave exposure and currents speed have different mode and may affect species differently.
- Data quality and resolution – high quality, high resolution bathymetric data is essential for getting good models and maps, also because a lot of other base models use bathymetry as an input. Doing something with the classification of high resolution data is therefore important
- Data coverage and quality – Only 26.5 % of areas 0-20 m are covered by multibeam, there is no holistic no land-sea-models, Norway has three different zeros (i.e. definitions of the coast)

4.4.2 Nature index of Norway

The aim of the Norwegian nature index is to document overall trends for the state of major ecosystems throughout Norway, and to provide a readily available overview of whether Norway is making progress towards its goal of halting the loss of biodiversity. It is calculated using a large number of species and ecosystem indicators. The index is included in the official statistical indexes, and methodology inspired by the Natural Capital Index (NCI), the Biological Intactness Index (BII) and the Water Frame Directive (WFD). The index requires knowledge on reference conditions, and NIVA showed several examples of modelling reference conditions as part of the index. Only natural, no alien, species are included.
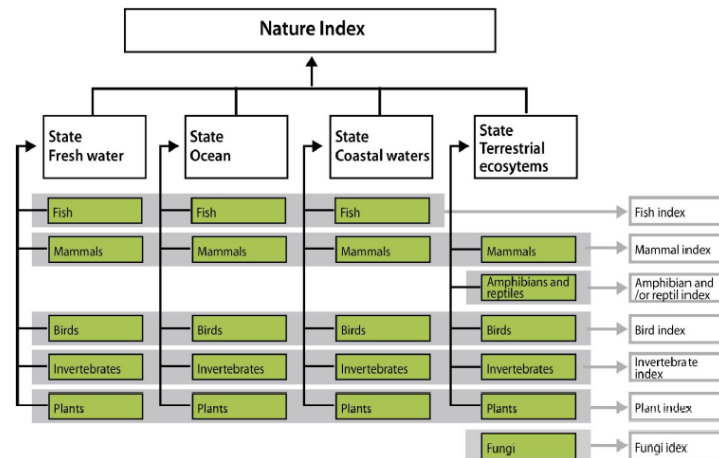
4.4.3 Norwegian nature types (NiN)

"Norwegian nature types" (NiN) was initiated in 2005 by the Norwegian Biodiversity Information Centre. A second phase of NiN development was initiated in 2012, and the marine part is changing substantially. The classification and typification system

- focuses on classification of types at two primary nature diversity levels: nature system and landscape
- is based on knowledge, principles and reproducible criteria

NiN uses «ecological distance units» (illustrated with figure 12), i.e. generalised species lists area used to the ecological distance based on differences in species composition. At least ¼ of the species need to be replaced in order to be a different type.
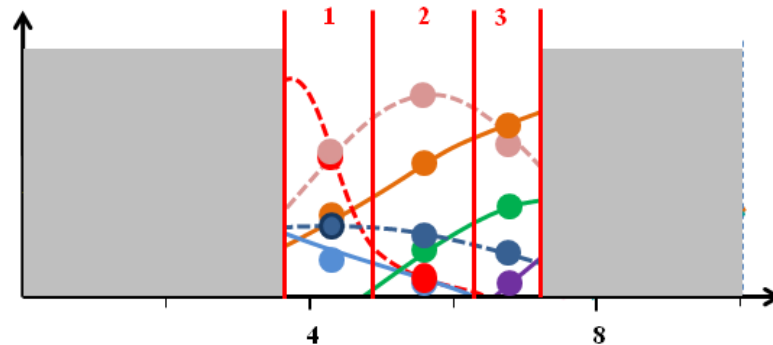
Figure 12. Schematic illustration of ecological distance units.

4.4.4 MAREANO – progress 2013

The programme started in 2005 as one of the tools for the process of developing a plan for the integrated management of the marine environment of the Barents Sea. MAREANO aims to map terrain, sediments, benthic habitats, species diversity and sediment pollutants. It is a multi-disciplinary collaboration between the Institute of Marine Research (IMR), the Geological Survey of Norway (NGU), and the Hydrographic Service (SKSD). In addition to collecting new data, the partners collate existing information and present it integrated in the web portal www.mareano.no.

The coverage of video-transects is close to 1 per 100 km² and for sampling stations 2 per 1000 km². Faunistic results from seabed videos are used to classify sampled locations. Together with predictors derived from multibeam echosounder data (terrain variables and backscatter) these results are used to predict biotopes and habitats.

At the end of 2013, 131 000 km² have been mapped with multibeam echosounder (Figure 13), and 131 125 km² has been sampled (sediments, fauna and pollutants) using MAREANO's standard density of sampling stations during 15 sampling surveys.
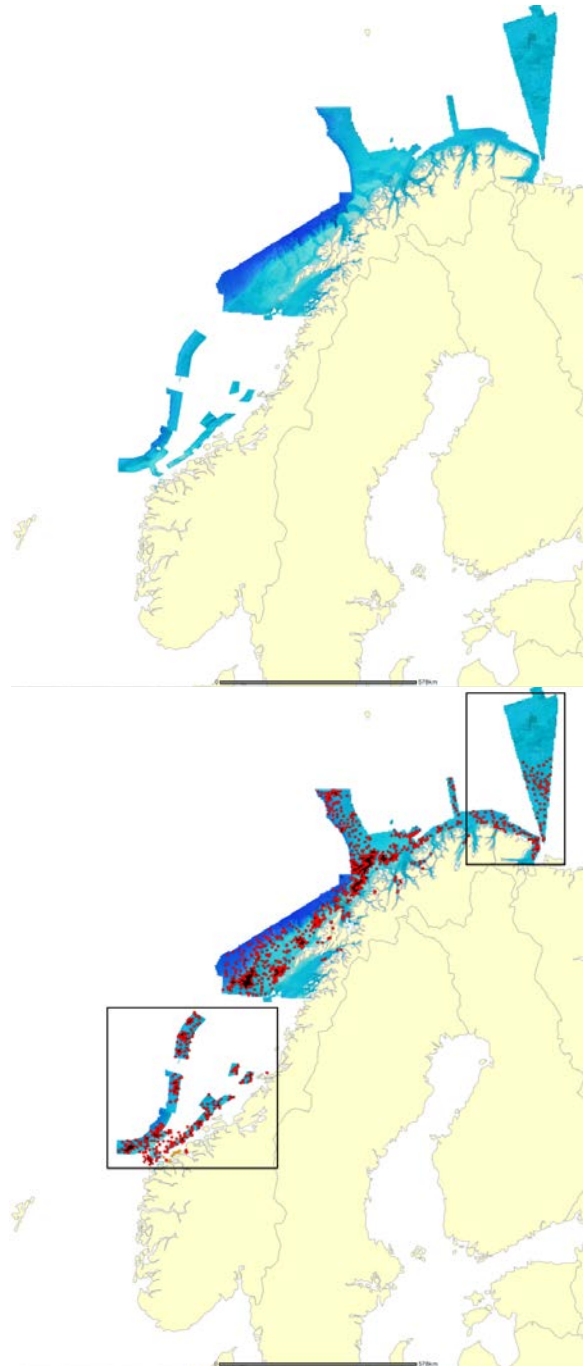
Figure 13. Coverage of bathymetric mapping with multibeam echosounding (left map) and the survey location areas in 2013 and 2014 outlined in the map to the right (maps from: www.Mareano.no).
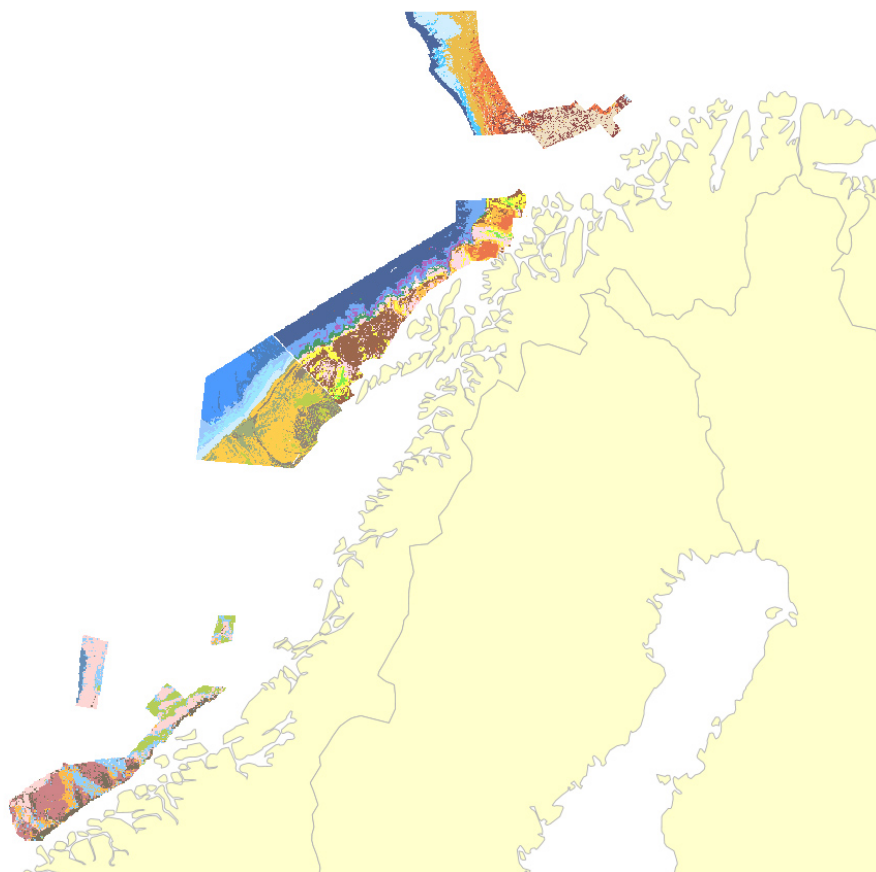
Figure 14. Biotope maps for parts of Northern Norway. The areas with different colors represent modelled biotopes from training data identified from grouping patterns in ordination plots (DCA) of quantitative megafauna data from video analysis (map from: www.Mareano.no).

The MAREANO programme has in 2013 given priority to the following tasks:

- Collection of **bathymetric** data in the new Norwegian areas in the Barents Sea and at the mid-Norwegian shelf in the Norwegian Sea (Figure 1).
- Collection of geological, biological and chemical data at the mid-Norwegian shelf within the Norwegian Sea (Figure 2).
- Reporting of results through the MAREANO web site www.mareano.no, www.geonorge.no.

Bathymetric data was sampled from a total area of 26 805 km^2 (in the mid Norwegian shelf and Barents Sea. In total 28 925 km^2 were sampled relative to geology, biology and chemistry in 2013, of which 12 000 km^2 from the southeast of the Barents Sea, 16925 km^2 from MAREANO's originally planned field activity. Additionally, 6000 km^2, planned to be surveyed in 2015–2016, were sampled off Finnmark County (the Barents Sea) and the mid-Norwegian shelf areas due to good weather conditions that increased the field capacity significantly in 2013 (Figure 13).

Much effort has been allocated to produce biotope maps (Figure 14) based on classified samples from quantitative videoanalysis using DCA and Maxent. The challenge is to find a method to combine maps from adjacent regions that has been analysed separately.

Sensitive biogenic habitats (Habitats recognized as Threathened and/or declining by OSPAR) have been modelled by applying threshold values of the abundance of spe-

cies comprising the habitats before modelling using conditional inference modelling (Figure 15).
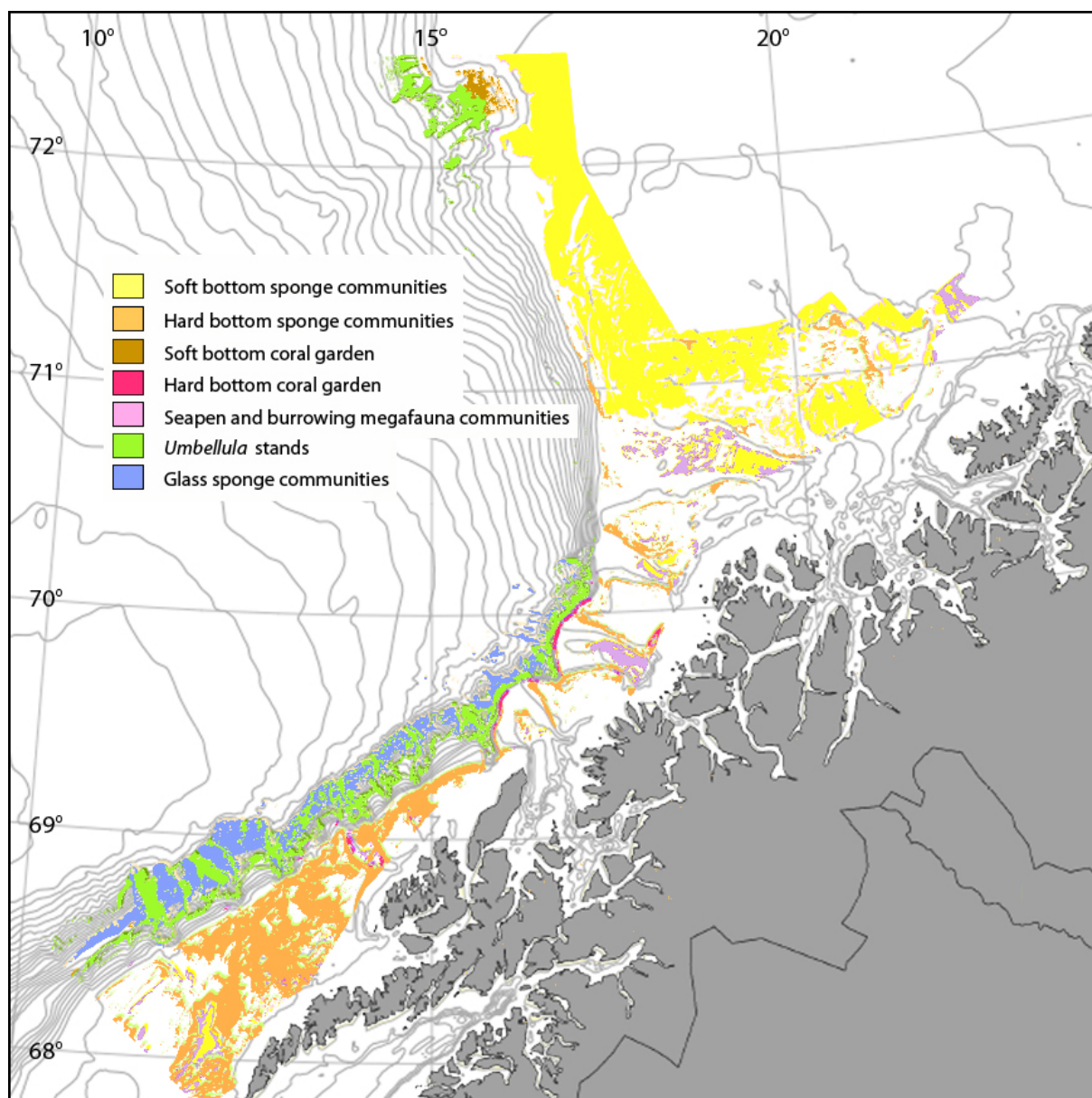
Figure 15. Predicted distribution of vulnerable biotopes in the MAREANO areas Nordland VII, Troms II and III, Tromsøflaket and Eggakanten.

4.4.5 Coast–MAREANO, a program in the making

The initiative for getting a Coastal MAREANO, with the aim to collect and disseminate management-related knowledge in a cost-effective manner, has been sent from NIVA, IMR, NGU and the Mapping Authority to the different Ministries. The plan for the group is that the program should start in 2015 and last for 15 year. The suggested budget is 2.6 bill. NOK.

4.5   National status report for France

4.5.1   CARTHAM

Mickaël Vasquez – IFREMER (on behalf of Benjamin Guichard, French MPA Agency)

CARTHAM is a marine habitat mapping program which has been coordinated by the French MPA Agency since 2009. The survey sites are located all along the French shore, mainly in marine protected areas: 70 Natura 2000 sites and five existing or upcoming marine nature parks. Surveys were carried out by 41 private companies and led to 12000 point data samples, 2000 hours of diving, 4000 km² of sonar and 10000 pictures. Reports and validated maps are available on the website of the French MPA Agency at http://cartographie.aires-marines.fr/?q=node/43

4.5.2   Modelling the spatial distribution of kelp forest for the Molène Archi‐pelago

Mickaël Vasquez – IFREMER (on behalf of Sébastien Rochette, IFREMER)

The Iroise Marine park asked Ifremer to evaluate the stock of the Molène Archipelago Laminaria digitata forest, which is highly harvested (40 of the French 48 vessels for kelp work there). This was done via a statistical model which was fed by sample data of biomass and raster predictors like kdpar, temperature or current-induced energy and. The model gave results that were in agreement with the knowledge of experts and showed that within the harvested area 70% of the potentially available biomass is harvested.

4.6   National status report for Spain

Ibon Galparsoro – AZTI (on behalf of Francisco Sánchez, IEO)

4.6.1   LIFE+ INDEMARES LIFE+ "Inventory and designation of marine Natura 2000 areas in the Spanish sea"

The main objective of the LIFE+ INDEMARES project is to contribute to the protec-tion and sustainable use of the biodiversity in the Spanish seas through the identifica-tion of valuable areas for the Nature 2000 Network. Specific objectives of this project are:

- To suggest a listing of places to the European Commission to be included in the marine Natura 2000 network.
- To promote the participation of all parties involved in the research, con-servation and management of sea and its resources.
- To provide management guidelines for proposed sites.
- To contribute to the strengthening of Regional Sea Conventions signed by Spain (OSPAR and Barcelona).
- To raise public awareness about the importance of conservation and sus-tainable use of marine biodiversity.

Some of the of this project include studies for the identification and mapping of habi-tats in ten areas selected as being representative of the main ecosystems and candi-dates to be declared under Natura2000 MPA network.

Figure 16. Location of the ten areas selected as being representative of the most important marine ecosystems which could be integrated within the Natura2000 Network.

For the effective design of MPAs, one of the main objectives of this project is identifying and charting the habitats and the biological communities that inhabit them. However, the EUNIS hierarchical habitat classification system is still not well developed for the characteristics of several ecosystems and, in general terms, it presents important discrepancies in their design.
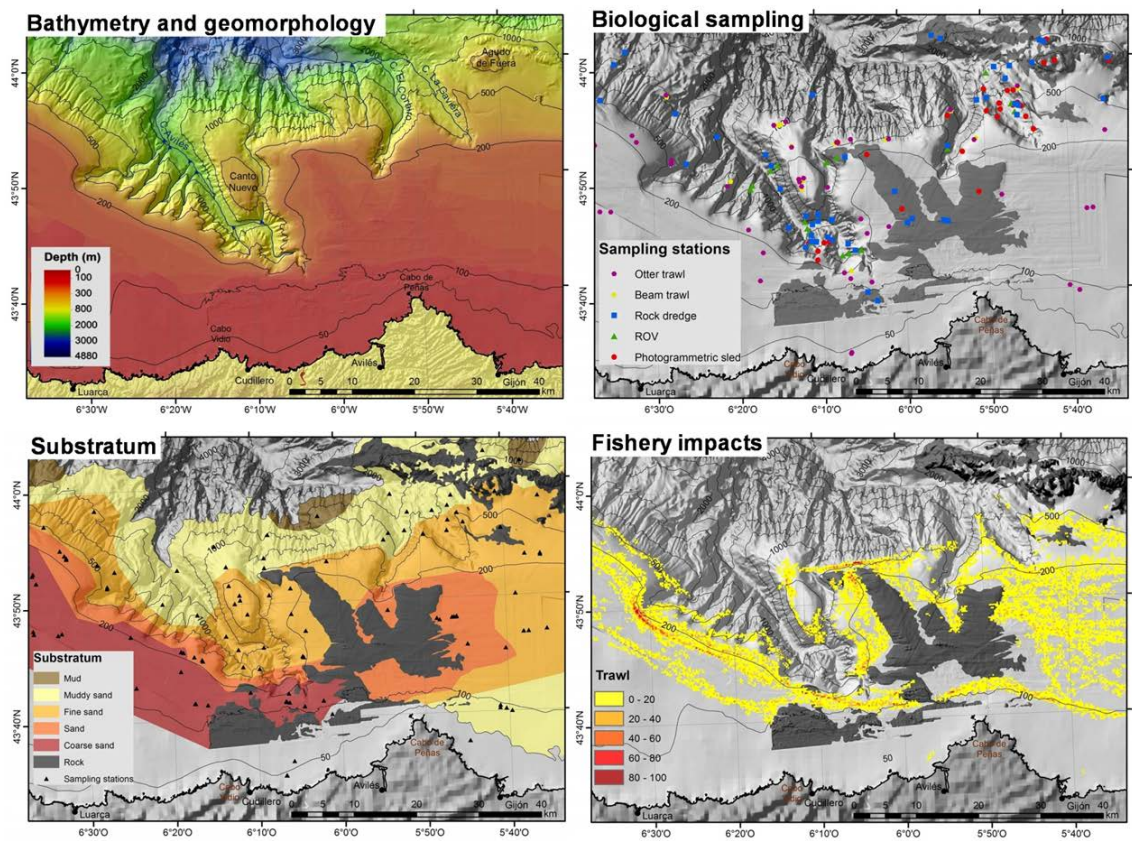
Figure 17. Example of the type of datasets collected in the Aviles Canyon system.
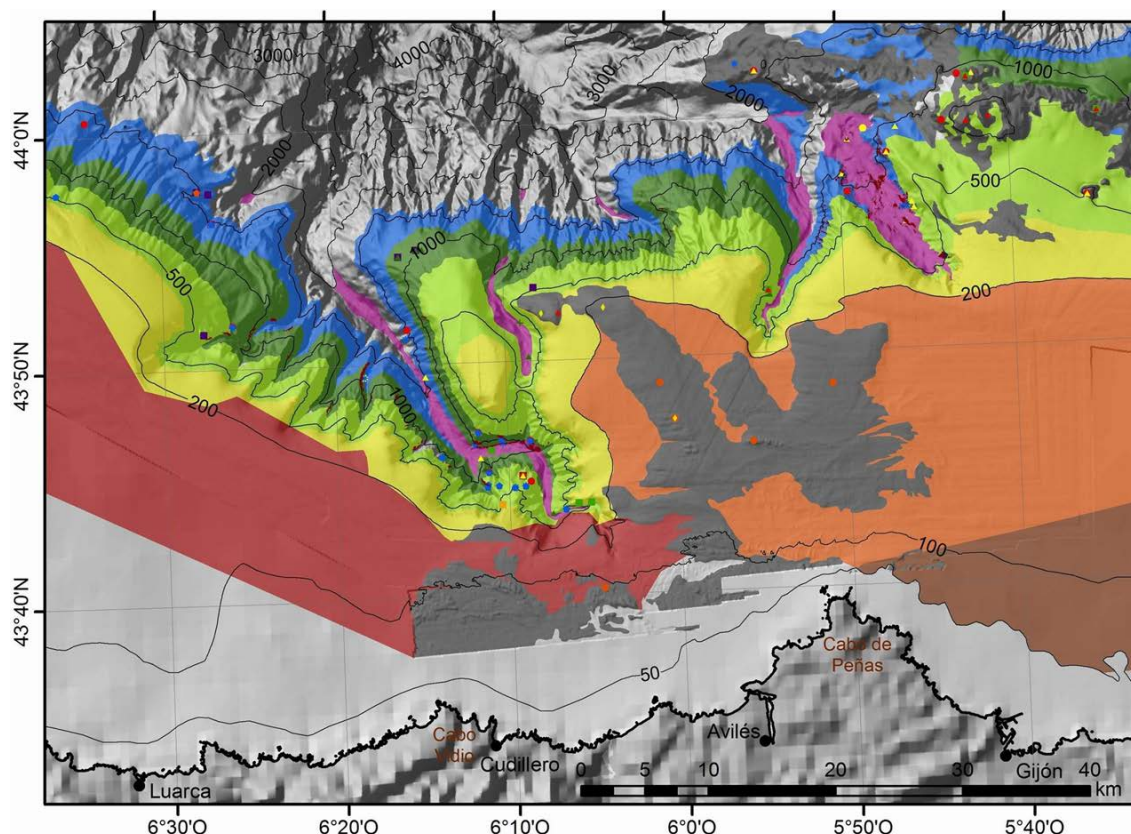
Figure 18. Interpreted benthic habitat map in the Aviles Canyon System. 21 habitat types were identified in this area.

The results show that the criteria for the classification of the habitats according to EUNIS does not seem to be suitable (shown in red in Table 2) for the particular habitats found in the area, especially on the deep-sea, where in some cases it was possible to reach the third level of the hierarchy. The use of two different levels of aggregations on the deep-sea habitats, following two different criteria (substrate or geomorphology -canyons, trenches, etc.) imply that the same habitat can be classified into different levels. Also, there is a strong fishing pressure and nearly 400 vessels currently operate in the area. Consequently, some of the habitats are altered to a greater or lesser extent by fishing activities. Particularly the habitats located in sedimentary grounds, between 100 and 600 m depths, are extremely disturbed by trawlers and have very altered biological communities.

Table 2. Identified habitat types in the Aviles Canyon System according to EUNIS habitat classification.

	Habitat identified		EUNIS habitat		Level
•	Circalittoral rock dominate by *D.cornigera* and *P.ventilabrum*	A4.121	(Phakellia ventilabrum) and axinellid on deep circalittoral rock	1	4
	Deep circalittoral coarse sediment	A5.15	Deep circalittoral coarse sediment	2	3
	Deep circalittoral sand	A5.27	Deep circalittoral sand	3	3
	Circalittoral sandy mud	A5.35	Circalittoral sandy mud	4	3
˙	Mixed sediments dominate with *Leptometra celtica*	A5.45	Deep circalittoral mixed sediments	5	3
•	Deep-sea mixed substrata with Brisingida starfish	A6.2	Deep-sea mixed substrata	6	2
	Break shelf bathyal sand	A6.3	Deep-sea sand	7	2
	Deep-sea sand with leather sea-urchins	A6.3	Deep-sea sand	8	2
	Upper slope bathyal muddy sand	A6.4	Deep-sea muddy sand	9	2
•	Bathyal mud with *Flabellum*	A6.5	Deep-sea mud	10	2
■	Bathyal mud with *Acanella arbuscula*	A6.5	Deep-sea mud	11	2
■	Bathyal rock with *Dendrophyllia cornigera*	A6.61	Communities of Deep-sea corals	12	3
•	Bathyal rock with white corals (*Solenosmillia, Enallopsammia*)	A6.61	Communities of Deep-sea corals	13	3
˙	Bathyal rock with black corals (*Leiopathes, Antipathes*)	A6.61	Communities of Deep-sea corals	14	3
●	Bathyal rock with *Callogorgia verticillata*	A6.61	Communities of Deep-sea corals	15	3
	Deep sea *Lophelia pertusa* and/or *Madrepora oculata* reefs	A6.611	Deep-sea (Lophelia pertusa) reefs	16	4
•	Death coral reef mounds (coral framework)	A6.6	Deep-sea bioherms	17	2
▲	Bathyal rock with Litistida sponge	A6.62	Deep-sea sponge aggregations	18	3
■	Bathyal rock with big Desmospongiae (Geodidae)	A6.62	Deep-sea sponge aggregations	19	3
+	Bathyal roch with hexactinellid sponge (*Asconema*)	A6.62	Deep-sea sponge aggregations	20	3
˙	Bathyal mud with carnivorous sponge (*Chondrocladia* sp.)	A6.62	Deep-sea sponge aggregations	21	3
	Bathyal mud with *Pheronema carpenteri*	A6.621	Facies with Pheronema grayi	22	4
	Rippled mixed sediments on canyon floor	A6.81	Canyons,channels,slope failures and slumps on the continental slope	23	3
▲	Mixed sediments on marine canyons with *Phelliactis* sp.	A6.81	Canyons,channels,slope failures and slumps on the continental slope	24	3

4.6.2   Study of the Spanish Continental Shelf and Slope

Ibon Galparsoro – AZTI

This Project started in 1999 by the General Secretariat of the Sea (Spanish Ministry of Agriculture, Food and Environment) and, at present, is being conducted by TRAG-SATEC. Surveyed area includes Atlantic and Mediterranean continental shelf between 10–130 m water depths (Figure 4) by means of multibeam echosounder, seismic profiling and grab sampling.

The main objective of the programme is to produce base cartographic information for nature conservation, fisheries and other activities management such as pipelines and marine renewable energy facilities installation. The techniques used include swath bathymetry, backscatter, seismic, ground-truthing with grab samples and underwater photo and video. Final results are being produced in GIS format and paper maps are being edited at 1/50000 and 1/100.000 scales. (http://www.magrama.gob.es/es/pesca/temas/cartografiado-marino/default.aspx)

Figure 19. Distribution of map sheets in the Iberian Peninsula and Canary Archipelago. Green rectangles, indicate published maps; red colour indicate that the datasets have being processes; pink rectangles refer to surveyed areas; and blue rectangles indicate areas not surveyed.

On the other hand, mapping of the Spanish EEZ is being conducted by the Spanish Ministry of Agriculture, Food and Environment and conducted by TRAGSATEC. Surveyed area includes Atlantic and Mediterranean. The techniques used include swath bathymetry, backscatter, seismic, ground-truthing with grab samples and underwater photo and video.
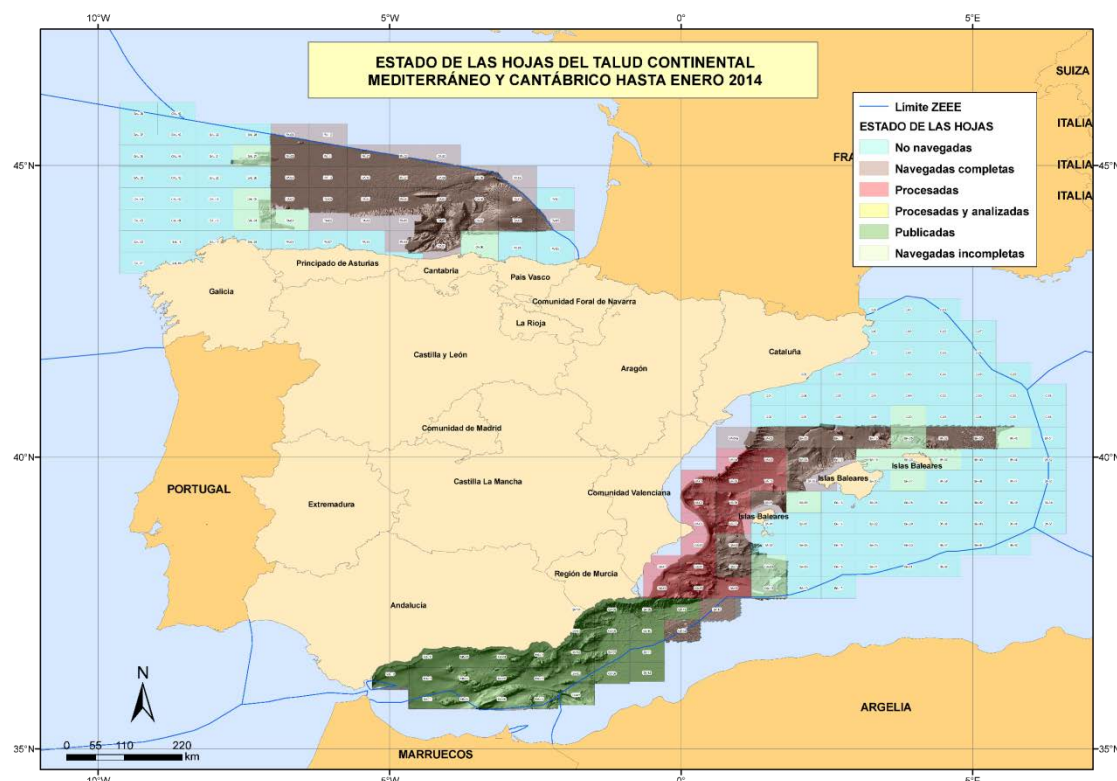
Figure 20. Distribution of map sheets within the Spanish EEZ. Green rectangles indicate published maps; yellow ones, areas where data have been processed and analysed; red ones, indicate areas of processed data; grey areas represent surveyed areas, and light green zones correspond to areas not completely surveyed; and finally, blue rectangles indicate zones not surveyed.

4.7 National report for Iceland

Julian Burgos & Steinunn H. Ólafsdóttir (Marine Research Institute)

The Marine Research Institute in Iceland has an ongoing project to map benthic habitats in the Icelandic waters. The objectives of the project are to identify and map the distribution of habitats, focusing on vulnerable habitats (e.g. cold-water corals), areas of importance for commercial species, and areas potentially impacted by bottom trawling and other human activities.

The Marine Research Institute is in the process of mapping the seabed using mutlibeam echosounder. The Icelandic EEZ is about 754 000 km^2, and to this date 84 000 km^2 (11%) have been mapped (Figure 21). The selection of areas has been based on various criteria, including the reported presence of cold water coral habitats, the distribution of fishing grounds, areas of potential value for the exploitation of petroleum, and areas of particular geological importance.
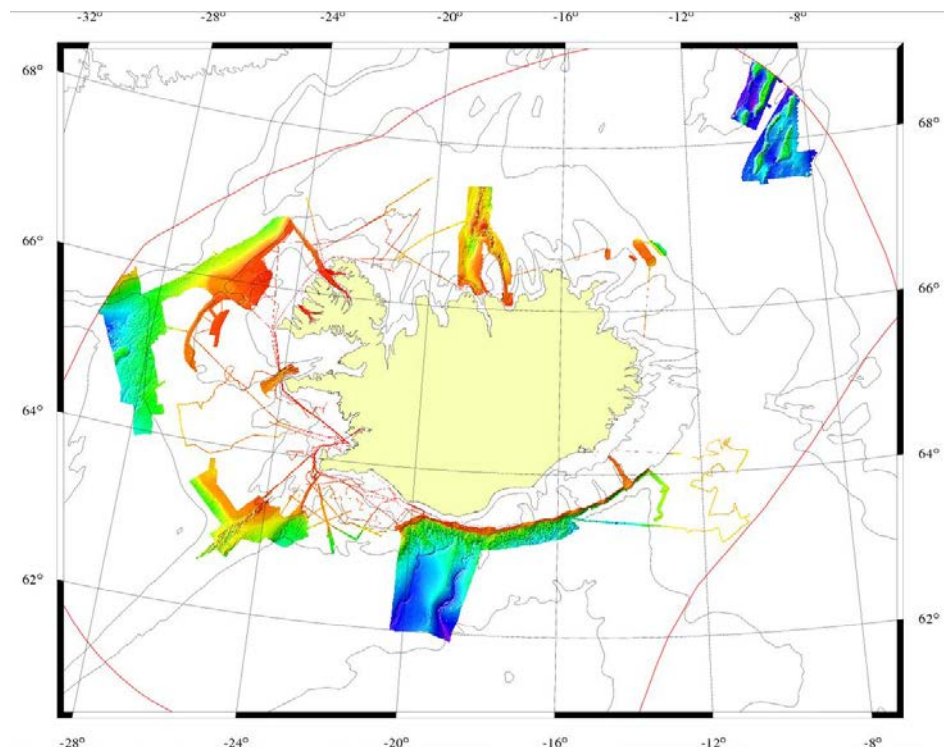
Figure 21. Areas in the Icelandic EEZ mapped with multibeam echosounder.

Biotic datasets available to be used for habitat mapping include the benthic fauna database, mainly based on the BIOICE project (Benthic Invertebrates in Icelandic Waters) carried out between 1992 and 2004. This database contains records from about 1400 samples in nearly 600 stations, collected at depths ranging from 30 to 3000 m depth within the Icelandic EEZ (Figure 22). The main target of the project was to collect data on benthic biota, but information on sediment composition was also collected.
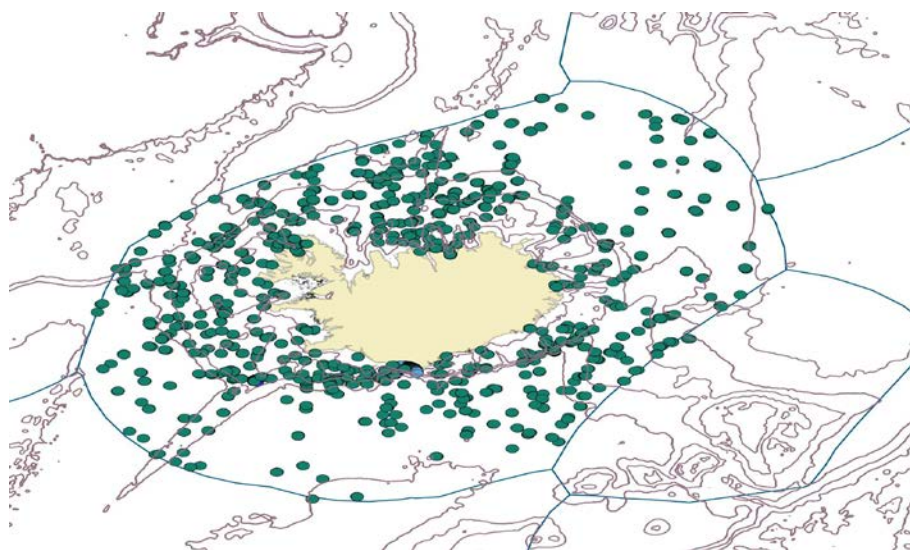
Figure 22. BIOICE sampling stations within the Icelandic EEZ.

Cold water coral areas have been mapped in order to evaluate their extent and conservation status, and to delineate MPAs. At the onset of the MRI mapping project very few registration of *Lophelia pertusa* were available. Potential locations for coldwater coral habitats were identified by assessing knowledge among fishermen, examining bycatch data and existing records (e.g. from the benthic database and sea charts). Areas identified as the main area for cold water coral were mapped with multibeam echosounder and explored with underwater camera systems (i.e. ROV and Campod).
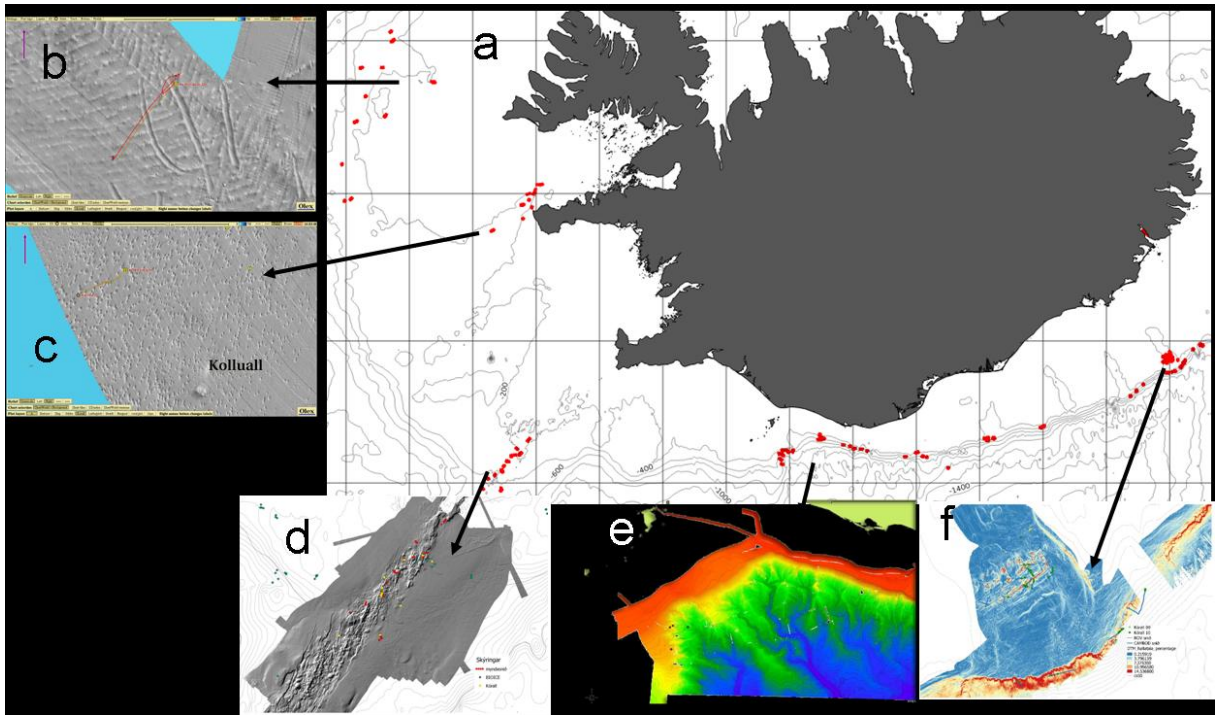
Figure 23. a) Transects collected with underwater camera systems (red lines on the map). Different geomorphological features observed from multibeam echosounder data: b) Iceberg marks, c) pockmark field, d) volcanic ridge, e) canyon system, f) continental shelf and break with high density of coral.

The Icelandic shelf is shaped by glacial effects and volcanic activity. This means that the topography is complex, presumably resulting in many different habitats. Additional sampling effort has therefore target different topographical settings, including pockmark areas, iceberg marks, morain ridges, hydrothermal seepage areas, troughs and ridges. To this data a total of 138 transects that have been taken the south and west of Iceland (Figure 23).

As a part of the CoralFISH project (2009–2012), a concentrated sampling effort has been carried out in Lónsdjúp trough with the objective to describe the interactions between fish and coral habitats. For this project detailed maps were made, including bathymetry, acoustic backscatter, coral distribution and anthropogenic impacts. Biological communities were described and classified. These categories were combined with contributions from other participating partners, resulting in a detailed biota list for cold water corals in European waters.

As a result of the mapping of coral areas, 10 areas were proposed for protection to the Ministry of Fisheries and Agriculture. Five areas were closed to all types of bottom fishing in 2005 and other five were closed in 2011. The total size of the MPA's dedi-

cated to the protection of corals is 480 km^2. These areas have been included in the OSPAR list of MPAs.

The priorities and aims for the Icelandic habitat mapping project in next years is to focus on large scale mapping of marine landscapes using abiotic surrogates, including among others bathymetry and derivates, productivity, temperature, and near bottom current speed derived from the ocean circulation models. A more detailed mapping will also be carried out in areas of specific interest (i.e. VME's, important areas for commercial species or habitats impacted by fishing activities). Working on habitat suitability models for cold water corals will continue.

As a member of the EES, Iceland hast to implement the Water Framework Directive for Icelandic waters. This work is in process.

4.8 National report for Sweden

Ola Hallberg (Swedish Geological Survey)

The Swedish Geological Survey (SGU) is a central government agency responsible for the investigation of the geology of Sweden. Its main task is to prepare and issue geological maps/data and provide geological, geophysical, geochemical and sedimentological data prognoses and information regarding resources such as groundwater, sand and gravel, ores and minerals. SGU grants licenses for prospecting of sand, gravel, or stone within public waters of the Swedish continental shelf at the same time as it must ensure compliance with the legal regulations and conditions for such licenses. In 1985 the Department of Marine Geology was established, but the marine geological mapping activities have been ongoing since the beginning of the 1970s´. In later years there has been an increased focus on environmental issues. The information that SGU is producing is therefore often used for habitat mapping and prediction, especially for benthic flora.

4.8.1 Surveying equipment

SGU have two survey vessels at its disposal. S/V Ocean Surveyor, a 38 meter long catamaran, and R/V Ugglan, a small launch vessel operating from Ocean Surveyor (Figure 24).

Figure 24. The two survey vessels S/V Ocean Surveyor and R/V Ugglan.

Surveying is performed using six channel airgun seismics, sub-bottom profiling, side-scan sonar, and multibeam echosounding (Figure 25). In addition to hydroacoustics, various kinds of sediment samplers are used to facilitate and confirm interpretation.
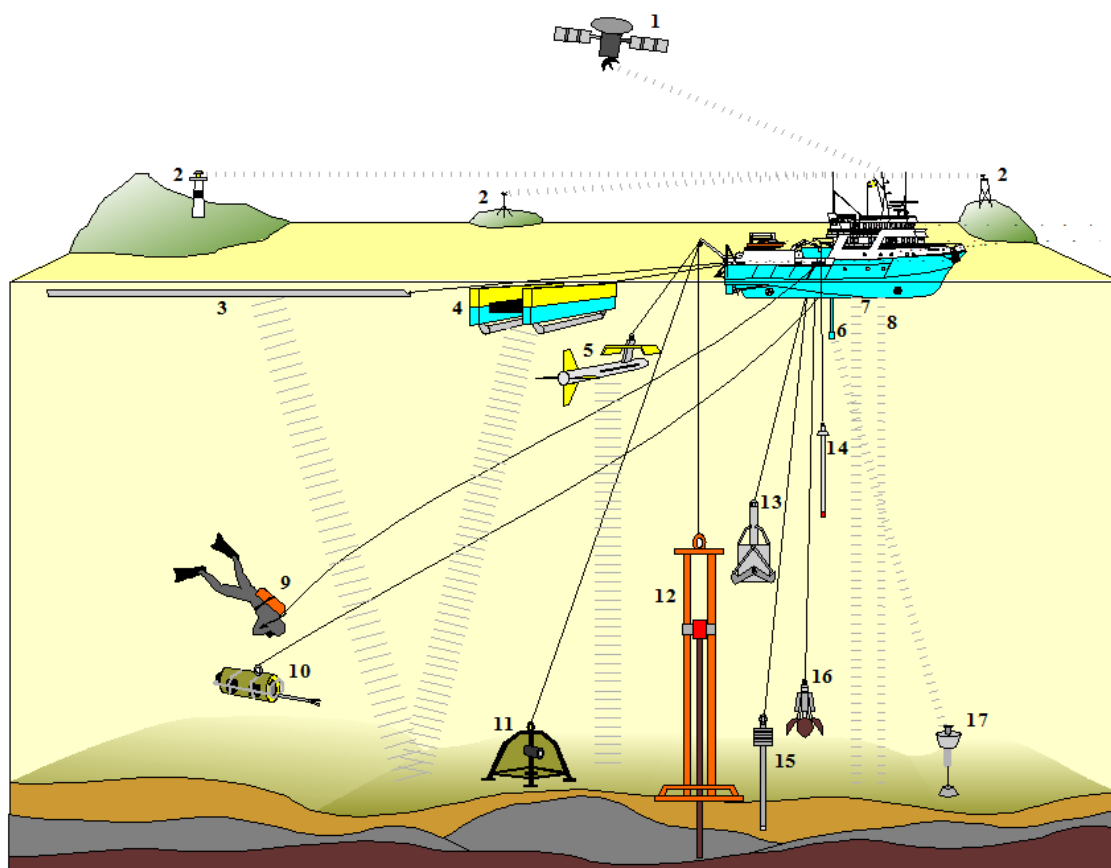
Figure 25. Instrumentation onboard S/V Ocean Surveyor. 1.) GNSS. 2.) Radio positioning. 3.) Hydrophone. 4.) Airgun. 5.) Side scan sonar. 6.) HPR-transducer. 7.) Sub-bottom profiler. 8.) Single beam echosounder. 9.) Diver. 10.) ROV. 11.) Camera. 12.) Vibrocorer.

4.8.2 Geological Mapping Programme

Marine geological maps have produced in two main principal programmes. One broader scaled (1:500 000) and one finer scaled (1:100 000). The finer scaled mapping programme methodology states that full side scan coverage should be achieved. In the broader scaled mapping programme, survey line spacing is 13 kilometers, creating surveyed corridors, in between which the interpretation is interpolated. The field work of the broader scaled programme ended in 2008, when the last part of the Swedish continental shelf area (162 000 km²) was mapped. The field work of the fine scaled mapping programme is ongoing and so far ca 19 500 km² have been completed (Figure 26).
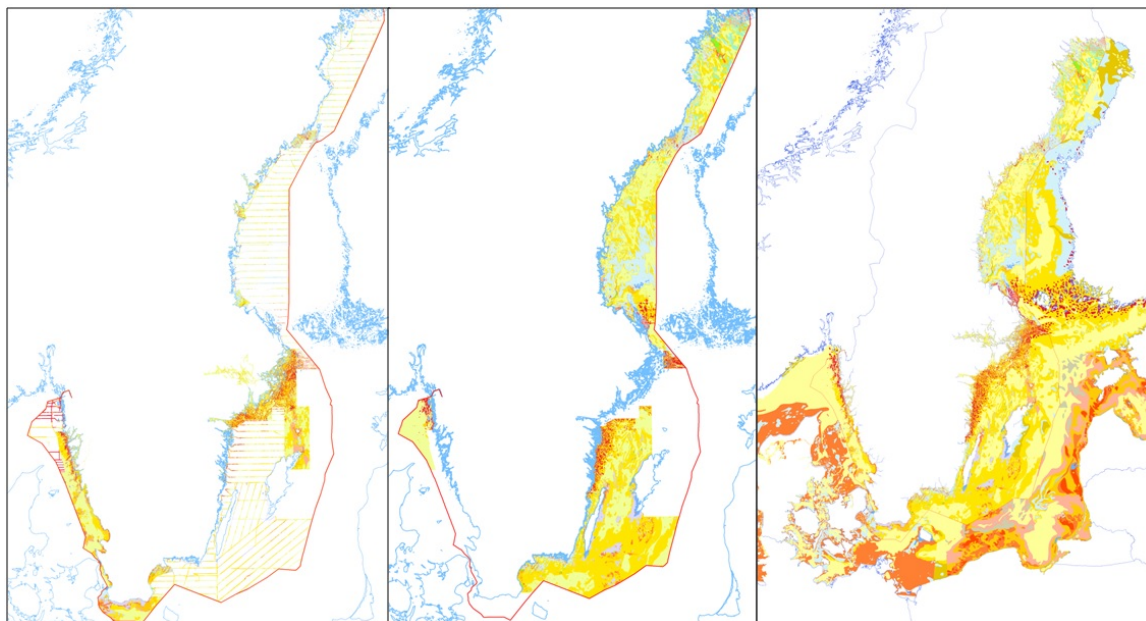
Figure 26. The status of marine geological mapping at SGU. From left to right: 1:100 000 scale map, 19 500 km² of a total of 162 000 km². Next the 1:500 000 scale map, and finally an overview of the Baltic Sea and the Swedish parts of the North Sea in the scale of 1:1 000 000.

4.8.3   Translating Marine Geology Maps to Substrate Maps

The SGU has developed superficial substrate maps from available marine geological information in Swedish sea areas. The maps show nine different classes of substrates, which are based on the EUNIS classification scheme. The classes are defined through Factor analyses on 2 900 visual seabed observations described according to the EUNIS terminology (Figure 27).

Figure 27. Substrate classes derived from factor analyses of 2900 pictures from the seabed.

The seabed observations are quite evenly geographically distributed in Swedish sea areas. A direct translation from the geological nomenclature and marine geological map to the EUNIS classification and superficial substrate map gave best results. The two modelling methods, Generalized Regression Analysis and Spatial Prediction (GRASP) and Classification and regression trees (CART), using the input variables; marine geological map, bathymetry, wave exposure, bottom current and visual observations gave poorer results when validating the produced substrate maps. This may be due to the fact that more errors being introduced by using bathymetry, wave exposure and bottom current data of less good quality and resolution (Figure 28).
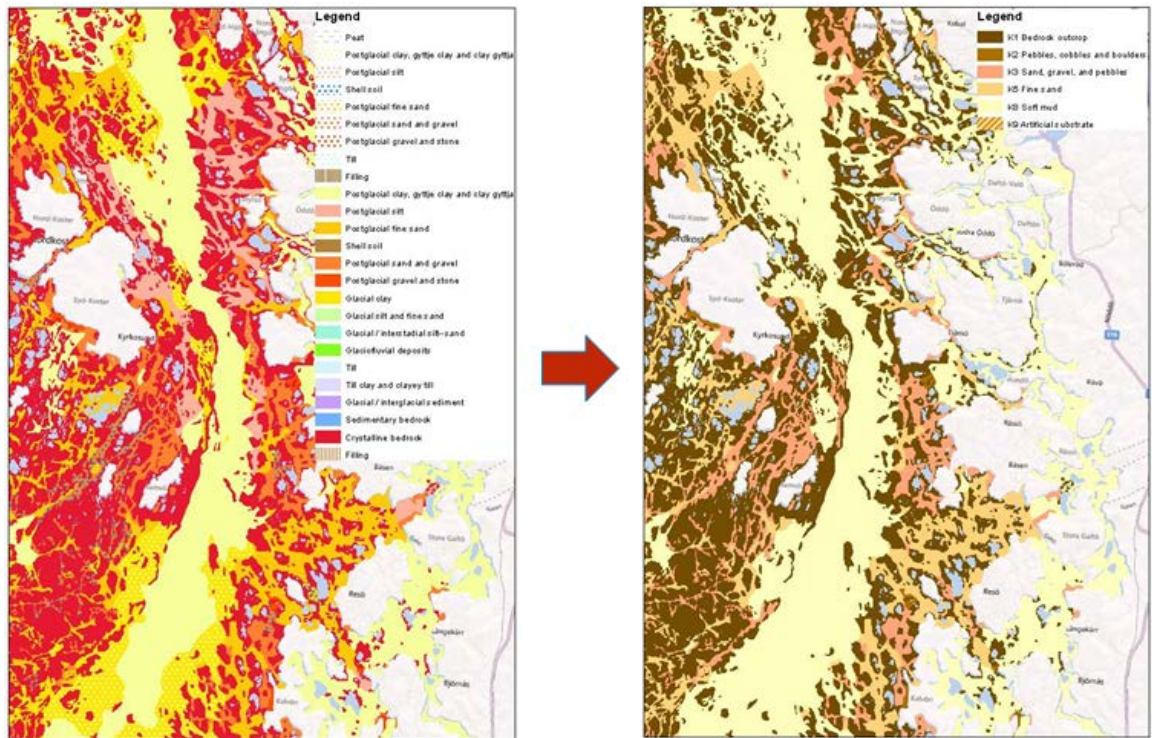
Figure 28. The Koster area on the Swedish west coast. To the left the marine geological map is displayed and on the right, the substrate map derived from the marine geological classification.

In addition, mobility maps have been developed showing the coarsest grain size, according to the EUNIS classification grain size scale, which erode (become mobile) within different areas due to the effect from wind-induced waves. A comparison between the developed mobility maps and estimates of mobility from 415 visual observations shows a significant relationship, although there are indications that the calculated values sometimes are low. This could be due to the lack of bottom current data and that the calculations are based on average wind conditions. In conclusion, the method of using direct translations from geological nomenclature and SGU marine geological maps to EUNIS classification and superficial substrate maps were found to give the best results and are therefore employed here. Substrate maps will continuously be produced in areas SGU surveys in the future. The marine geological maps show the original deposited material and reflect past and present hydrodynamic processes such as bottom currents, wave exposure, sediment-erosion, -transportation and -deposition as well as bathymetry.

4.8.4   Project Skåne strand

Skåne is an area in the most southern part of Sweden. The area is densely populated and is of great economic interest. The shoreline mainly consists of highly erosive materials, such as mud and sand. In some areas, coastal erosion is a major problem (Figure 29). The problem is enhanced by no isostatic uplift in combination with the threat of future sea level rise due to climate change. In order to provide information for actions against erosion and protection of near shore values, SGU is making a seamless land/marine geological map of the shore of Skåne. The map will cover 500 meter of land from the shoreline on land, together with 1000 meters of the seabed (Figure 30).

Data from different sources will be used creating the maps. For the seabed, LIDAR data is used near shore, plus interferometric side scan sonar in the depth zone 3–10 meter, combined with high resolution multibeam data from waters deeper than 10 meters. This will enable a seamless terrain model from land covering all areas of the seabed. The project will also produce detailed mapping of quarternary deposits and morphology, lithostratigraphy, extensive photo documentation, documentation of active erosion and coastal protection, and a classification of beaches for onshore cleanup of oil spills. In addition, SGU will map the abundance of Eelgrass (*Zostera*). The project started in 2012 and will end in 2014.
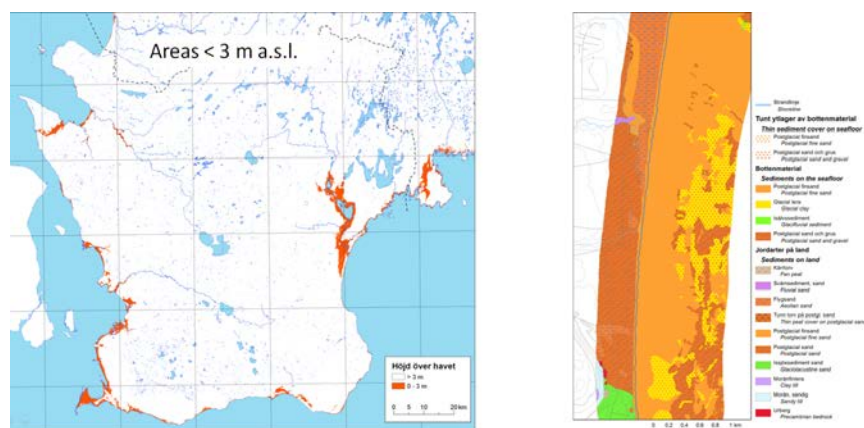
Figur 29. The Skåne area in in most southern parts of Sweden. Areas in red are lower than 3 m a.s.l. and therefore extra sensitive to erosion and sea level rise.

Figur 30. Seamless land/marine geological map, east coast of Skåne.

4.9 National report for the United Kingdom

Helen Ellwood – JNCC

This update covers survey and mapping work carried out in 2013-14, progress of collaborative programmes for data gathering, interpretation and sharing and a summary of developments in habitat classification.

4.9.1 Surveys and map interpretation

In addition to the continuing civil hydrography programme surveys, 2013 and 2014 have seen further benthic surveys for identifying and validating marine protected areas – particularly those designated under the UK Marine Acts. These have been carried out through collaboration between statutory nature conservation bodies and government research bodies. Large amounts of data have been obtained in a short amount of time and the use of object-based image analysis to map and classify habitats based on the survey data has helped produce several habitat maps in a short time in a consistent way, e.g. East of Haig Fras Marine Conservation Zone (JNCC, 2013a). For other sites, e.g. Swallow Sand Marine Conservation Zone (JNCC, 2013b) object-based image analysis was not possible because of a lack of suitable coverage acoustic data (data collected in transit only). Instead, geostatistical analysis of sediment sample data has given a greater understand of the sediment distribution in the sites (Lark, 2014). In Scottish territorial waters a project was undertaken to map particular features in 10 possible Nature Conservation Marine Protected Areas using a variety of recent and historical data, which mostly consistently of point sample and video

data (Envision Mapping Ltd., 2014). For this a mostly manual interpretation approach was required.

4.9.2 Collaborative working

Seabed mapping activities in the UK are co-ordinated through a number of groups and activities from:

a) planning of surveys (Civil Hydrography Annual Seminar);
b) archiving marine information through the Data Archive Centres of the Marine Environmental Data and Information Network (MEDIN);
c) information sharing through a pan-Government Hydrographic Data Sharing Memorandum of Understanding;
d) delivery of sea-bed mapping products and data such as the UK Marine Environmental Mapping Programme (MAREMAP) and the European marine observation and data network (EMODnet).

In addition, the Seabed Mapping Working Group is an over-arching group that aims to:

- ensure that the UK's seabed mapping resource is fit for the requirements of the UK marine monitoring and assessment strategy (UKMMAS), and
- provide a forum for the UK seabed mapping community to agree best-practice and provide seabed mapping advice.

4.9.3 Data compilation

A table summarising the main habitat mapping products that are collated and produced by JNCC in collaboration with the inshore statutory nature conservation bodies can be found on the JNCC website:

http://jncc.defra.gov.uk/seabedhabitatmapdata

Updates to UK-wide datasets in the last 12 months have been:

- full-coverage EUNIS level 3 layer integrating maps from surveys and broad-scale models – polygons – March 2014
- OSPAR threatened and/or declining habitats – points and polygons – Feb 2014
- Habitats Directive Annex I: Submarine structures made by leaking gases – points, line and polygons – June 2013

4.9.4 Habitat classification updates

The current Marine Habitat Classification for Britain and Ireland (Connor *et. al.*, 2004) describes seabed habitats from the intertidal zone down to depths of up to 200m. It has become a priority to develop a deep-sea section for the classification to allow deep-sea survey data to be assigned a biotope. This should help prevent numerous new biotopes being proposed independently for similar data and as such losing cohesion within the classification community.

It is hoped that any proposed deep-sea biotopes in the Marine Biotope Classification for Britain and Ireland will be considered for inclusion in the upcoming revision of EUNIS to ensure classification within the UK is consistent with the approach taken at the European scale.

The approach taken in the development of this classification system takes into account lessons learnt in using the current system, such as:

1) Assemblages may occur across the boundaries of zones and substrata types.

The deep-sea classification hierarchy will display assemblages multiple times where they can be associated with different regions, zones or substrate types. We hope to limit replication by making divisions as biologically relevant as possible.

2) Communities described in biotopes descriptions are often biased towards either epifauna or infauna depending on the methodology used to collect the data.

The deep-sea classification will include separate infaunal and epifaunal habitat types at level 4 and above and allow the user to select one of each for the same area.

The new deep-sea section of the Marine Biotope Classification for Britain and Ireland will be published on the JNCC website by August 2014.

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5   Habitat mapping techniques and modelling

ToR c) – Evaluate recent advances in marine habitat mapping and modelling techniques, including field work methodology, and data analysis and interpretation

5.1   Hydrophysical parameters for biotope modelling

Julian Burgos – MRI & Pål Buhl-Mortensen – IMR

5.1.1   Introduction

Species distribution and habitat selection is mainly controlled by the species' biological processes adapted to certain optimal conditions or ranges of values. However, it is common to perform habitat modelling without including hydrophysical parameters. Interpreted sediment composition and predictors derived from bathymetry and backscatter are then assumed to express the environment in an indirect way, still enabling trustworthy models. Such predictors are easily derived from multibeam echosounder data.

However, it is important to remember that the bathymetry and terrain variables are only proxies for environmental factors that control the distribution of species by influencing their biological processes such as respiration, metabolism, reproduction and growth.

There are several factors that influence the biological processes directly, such as:

Temperature, Salinity, Currents, Wave exposure, Oxygen, Turbidity/Light penetration, Chlorophyll concentration. These are often not included in habitat suitability modelling.

Both the geology and the biology of the seabed are, heavily influenced by the oceanographic conditions and currents which operate near the seabed. Oceanographic properties including, but not limited to, temperature, salinity and light availability are vital to determining which areas are suitable habitat for the various benthic fauna. Water circulation and currents play a crucial role in shaping the distribution of seabed sediments. In high current areas fine material is eroded quickly, leaving coarser sediments sometimes with hard bottoms where filter feeding organisms may find a rich supply of food from the flowing water. In other areas currents play a direct role in shaping the morphology of the seabed inducing mobile bedforms such as sandwaves. In areas with low current we find sedimentation areas where the accumulation of fine material provides a soft sediment habitat often with a rich diversity of burrowing megafauna and infauna.

Depth is often observed to be correlated with a change in habitats, however it is not through any direct effects of water depth but the proxy effect of increasing pressure, reduced light intensity and changing water mass properties (T,S) that accompany changes in depth and have a direct effect on the benthic communities.

When mapping over a limited geographic area (e.g. <10 km), or depth range (e.g. <100 m) outside the coastal zone, the properties of the water column (T, S) may remain relatively unchanged. However over scales of tens of km (megahabitat) variations in the oceanographic properties of the water become quite significant. When we think of this in a biogeographic context this may mean that the same environmental conditions may occur at different depths in mid-Norway and north-Norway, or that

the same topography at these different locations occurs within a completely different environmental setting ('climate'). As a consequence the values of the terrain variables do not hold the same meaning for the benthic fauna at the two locations. Without oceanographic data the only proxies available, which can no more than partially account for bio-geographic variations, are latitude/longitude.

All these oceanographic properties and currents vary over spatial and temporal scales that are constantly changing in the dynamic ocean environment. However, it is generally recognized that average conditions over long time periods (1 or more years) can give a reasonable impression of the prevailing habitat conditions at the seabed. The nature of variation (max, min, std, etc.) is probably as important at the mean.

Hydrodynamic modelling efforts have traditionally focussed on modelling of surface currents, however together with the rise of better resolution bathymetry and increased computing power oceanographic models that more accurately represent bottom currents are now a reality.

5.1.2 On the use of ocean physical models to inform marine habitat mapping

Only a small proportion of the sea bottom can be observed or sampled directly. In most cases, the development of benthic habitat mapping requires the prediction of the distribution of species or habitats to unsampled locations. This prediction can be based on purely statistical models (e.g. krieging), although a generally preferred alternative is to model the relationship between specific benthic species or habitats and environmental covariates, and use these models to predict their spatial distribution.

The geology and the morphology of the seabed are heavily influenced by the oceanographic conditions and currents with operate near the sea bottom. Oceanographic properties including, but not limited to, temperature, salinity and light availability are vital to determining which areas are suitable habitat for the various benthic fauna. Water circulation and currents play a crucial role in shaping the distribution of seabed sediments. In high current areas fine material is eroded quickly, leaving coarser sediments sometimes with hard bottoms where filter feeding organisms may find a rich supply of food from the flowing water. In other areas currents play a direct role in shaping the morphology of the seabed inducing mobile bedforms such as sandwaves. In areas with low current we find sedimentation areas where the accumulation of fine material provides a soft sediment habitat often with a rich diversity of burrowing megafauna and infauna.

It is clear then that oceanographic variables describing the conditions near the bottom can aid in the mapping of marine benthic habitats. Nevertheless, most benthic habitat maps are produced without using oceanographic variables. For example, among the studies reported by Brown *et al.* (2011), only a small portion used oceanographic variables. Most studies rely instead on surrogate variables derived from the terrain analysis of digital elevation models, under the assumption that terrain attributes are associated with near bottom hydrography. This assumption may hold over a limited geographic area (e.g. <10 km), or depth range (e.g. <100 m) outside the coastal zone, where the properties of the water column (T, S) may remain relatively unchanged. However over scales of tens of km (megahabitat) variations in the oceanographic properties of the water become quite significant. As a consequence the values of the terrain variables do not hold the same meaning for the benthic fauna at the two locations. Without oceanographic data the only proxies available, which can no more than partially account for bio-geographic variations, are latitude/longitude.

The low number of studies using oceanographic variables can be explained by the fact that, compared to variables derived from multibeam acoustics (i.e. bathymetry, terrain analysis derivates, and backscatter), in most cases the resolution from oceanographic variables derived from direct measurements is low. Oceanographic parameters are measured directly either by using remote sensors or by compiling *in-situ* measurements. Remote sensors can provide measurements at resolutions similar or higher than of multibeam acoustics, but can be used directly to map habitats only in shallow waters (e.g. tropical coral reefs and seagrass beds, Mumby *et al.* 1997, Chauvad *et al.* 1998). In most cases, near bottom conditions are characterized through direct measurements with bottle samples, ship-deployed Conductivity-Temperature-Depth (CTD) packages, moored and drifting buoys, bottom landers, etc. Variables measured may include temperature, salinity and oxygen concentration. Individual measurements are of limited use, but large numbers of measurements can be interpolated to generate continuous fields (in two or three-dimensions) that can provide inputs for habitat mapping. For example, the World Ocean Atlas 2013 (WOA13, http://www.nodc.noaa.gov/OC5/woa13/) provides statistical fields of observed oceanographic profile data interpolated to 102 standard depth levels on 5°, 1°, and 0.25° grids for the World Ocean. Oceanographic parameters include in situ temperature, salinity, dissolved oxygen, and nutrients. Values are provided as annual, seasonal, and monthly composites. Near bottom conditions can be approximated by extracting the deepest standard depth level available at each location (Buhl-Mortensen *et al.*, submitted). Nevertheless, the highest available resolution is one order of magnitude larger than multibeam data. In addition, their capacity to describe oceanographic features at small spatial or temporal scales is limited, in particular areas of low sampling density. Also, in most cases, in-situ measurements do not quantify physical variables like current speed or near-bottom shear that may have a large influence on benthic habitats.

State-of-the-art ocean physical models like the Regional Oceanic Modelling System (ROMS, Shchepetkin *et al.* 2005) can provide very realistic descriptions of near-bottom oceanographic settings at multiple spatial and temporal scales. In recent years researchers have been using ocean physical models as input for habitat mapping and habitat suitability models. For example, Bryan and Metaxas (2007) used near-bottom tidal velocities derived from an ocean model developed by Hannah *et al.* (2001) for the western coast of Canada, while Davies *et al.* (2008) obtained near-bottom current speeds from the HYCOM model by Bleck *et al.* 2002.

In relatively shallow waters, waves can be an important factor that regulates the distribution of benthic habitats. Different approaches have been used to model wave exposure and energy. The simplified wave exposure model (SWM) developed by Isæus (2004) uses data on fetch (distance to the nearest shore) and wind strength and direction. Output of this model has been used as a predictor of the distribution of *Zostera marina* (Bekkby *et al.* 2008) and of *Laminaria hyperborea* (Bekkby *et al.* 2009).

In their habitat suitability model for the European lobster (*Homarus gammarus*), Galpasoro *et al.* (2009) included the distribution of mean wave flux over the first meter above the sea floor. The distribution of wave energy over the Basque continental shelf was calculated using the coastal hydrodynamic numerical modelling software (SMC) developed by González *et al.* (2007). This model uses on bathymetry, wave data and sea level. Galpasoro *et al.* (2009) modelled representative cases and let waves propagate to the coast. The average wave energy flux over the first meter above the sea floor was estimated using linear wave theory. A similar approach was followed by Borja *et al.* (2006).

At a broader spatial scales, Huang *et al.* (2011) proposed a benthic classification system for benthic habitats. Their level 3 classification is based on sediments characteristics, topographic relief, and percentage exceedance. Percentage exceedance is a variable representing the degree of seabed sheer stress produced at a location by tide and wave energy, and measures the proportion of time that the seabed sher stress exceeds 0.4 Pa, a threshold identified as critical for some benthic species (Haywood *et al.* 2007). Data provided by the GEOMACS model (Hemer, 2006, Porter-Smith *et al.* 2004). Seabed was classified as high, moderate and low sheer strees (% exceedance >50, 15–50 and <15, respectively).

One of the most interesting developments is the high-resolution model developed by Mohn *et al.* (2014) to study the distribution of cold-water corals (namely *Lophelia pertusa*) off Ireland. Because at local scales the distribution of cold-water corals is influenced by a combination of suitable flow conditions and supply of nutrients, oceanographic conditions were modelled at the scale of individual coral mounds and mound clusters (250m). Mohn *et al.* (2014) used a 3-D split-explicit, 3-D split-explicit, free-surface Regional Ocean Modelling System with grid refinement (ROMS-AGRIF) to simulate currents, temperature and salinity. Rengstorf *et al.* (2013) modelled the distribution of L. pertussa in these areas using a Maximum Entropy framework also at the 250m scale, although the oceanographic variables they used were derived from a model with lower resolution (2.5 km). Both studies suggest that high-resolution modelling is a useful approach to map the distribution of very patchy benthic habitats.

Oceanographic variables derived from physical models can be included in analyses that use the process-driven habitat mapping approach proposed by Kostylev and Hannah (2007). This approach is based on the ecological theory that relates species life history traits to the properties of their environment. Kostylev and Hannah (2007) proposed a classification of the sea bottom along two gradients or descriptors, termed disturbance (the intensity of habitat alteration) and scope of growth (the amount of energy available for growth and reproduction). The estimation of the disturbance variable requires an estimation of characteristic bottom stress, which in turn requires data on wave height and period data, and on near-bottom tidal currents. Kostylev and Hannah (2007) used wave climate data from a wave hindcast by Swail and Cox (2000), while near-bottom tidal currents were derived from two 3-D ocean models (Hannah *et al.*, 2001; Han and Loder, 2003). Galparsoro *et al.*, (2013) applied the process-driven benthic sedimentary habitat model developed by Kostylev and Hannah (2007) on the Basque continental shelf.

New applications of ocean models for habitat mappings are in development in Iceland and Norway. In Iceland, the output of the CODE model (Logemann *et al.* 2013), namely near bottom temperature, salinity, current speed and bottom shear, is being used as input for mapping cold-water coral reefs and other benthic habitats. CODE (Cartesian coordinates Ocean model with three-Dimensional adaptive mesh refinement and primitive Equations) is a coupled three-dimensional sea ice/ocean model of the entire North Atlantic and Arctic Ocean, being driven by the GFS atmospheric forecasts. It assimilates satellite and ARGOS-CTD profiles and is operationally used by the University of Iceland mainly for hydrographic forecasts of Icelandic waters (Logemann *et al.* 2013). In Norway, the MAREANO project (ref here) will undertake broad scale oceanographic modelling (c. 800 m or coarser) to produce data on near-bottom temperature, salinity, and near bottom currents.

5.1.3 Oceanographic data including hydrographic modelling in MAREANO

For the Barents Sea, IMR have recently compiled data at 25 km resolution on temperature and salinity measurements (Figure 31). This is an important first step in providing oceanographic information that will support habitat mapping for MAREANO and other projects in this area. However to capture the oceanographic conditions at scales more relevant to regional mapping currently performed by MAREANO finer scale oceanographic information will be required and should include bottom currents and therefore requires modelling in addition to measurements.
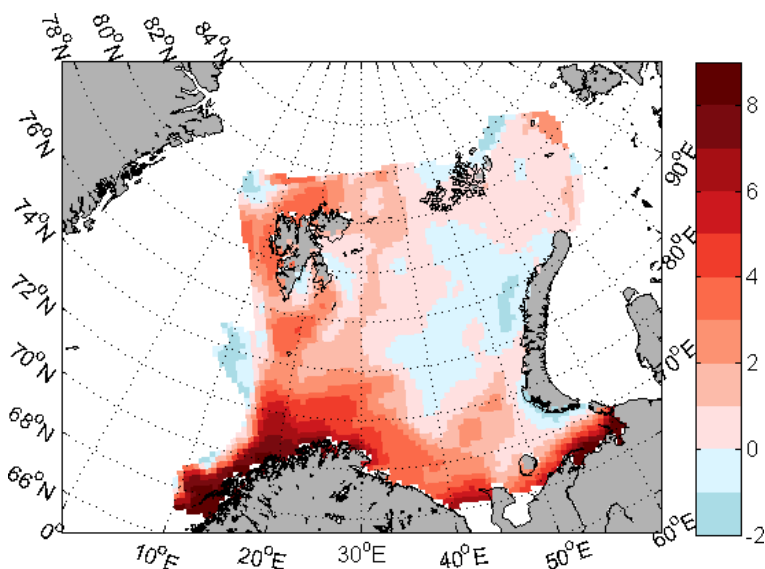
Figure 31. Example of mean bottom temperature from the compiled CTD data for the Barents Sea.

MAREANO will begin in 2014 to make oceanographic data compilation and modelling an integral part of MAREANO:

1) Compile temperature, salinity records from IMR database and any other sources (including Kartverket) for the Norwegian Sea.

2) Undertake broad scale oceanographic modelling (c. 800 m or coarser) to produce data on:

    i.   Near-bottom Temperature (Annual (or longer) Max, Min and Standard deviation)

    ii.   Near-bottom Salinity (Annual (or longer) Max, Min and Standard deviation)

    iii.   Near bottom currents (Annual (or longer) Mean, Max and Standard deviation for speed, Mean and Standard deviation for direction)

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5.2   Cumulative link models (CLMs) for ordinal/categorical response data

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In distribution modelling, the response variable is often binomial (0 or 1), either because we deal with true presences and absences or because we are defining a limit/threshold at which the higher values are defined as presences and the lower as absences. Sometimes we also deal with continuous responses. As part of the Norwegian mapping, densities are often defined into classes, i.e. the responses are ordinal/categorical. In that case, Cumulative Link Models (CLMs, Agresti 2013) are suitable. This method similar to what is called "ordinal regression models", "continuation ratio models" and "proportional odds models" (McCullagh 1980). They are comparable to its linear or curved counterparts (e.g. Generalised Linear Models, GLMs) but using categorical response variables (e.g. density classes) with no assumption of the distance between the classes. CLMs may be applied in R version 2.15.2 (R Core Team 2012; R library: ordinal, Christensen 2012).

5.3   A process–driven sedimentary habitat modelling approach

Ibon Galparsoro – AZTI

The process-driven habitat template is a conceptual model, used to relate species life-history traits to the properties of the environment, transforming maps of the physical environment into a map of benthic habitat types (Kostylev and Hannah, 2007). It is based upon ecological theory that relates species life-history traits to the properties of the environment (Southwood, 1977;Margalef *et al.*, 1979; Huston, 1994; Reynolds, 1999), transforming maps of the physical environment into those of benthic habitat types. This approach is based upon the aggregation of sets of environmental selective factors, on two axes. The 'Disturbance' axis reflects the intensity of habitat alteration or destruction, or the durational stability of habitats, including only natural seabed processes responsible for the selection of species life history traits, on the evolutionary time-scale. The 'Scope for Growth' (SfG) axis describes the amount of energy available for growth and reproduction after adjusting the available food supply by environmental stressors that pose a cost for the physiological functioning of organisms.

This approach was implemented in the Basque continental shelf (Galparsoro *et al.*, 2013) with the aim of mapping the major environmental factors influencing soft-

bottom macrobenthic community structure and the life-history traits of species. Among the 18 environmental variables considered (i.e. Annual mean temperature, Annual maximum temperature, Annual minimum temperature, Annual temperature range, Annual mean chlorophyll concentration, Spring chlorophyll concentration, Mean grain size, Sorting, Gravel content, Sand content, Fine content, Organic Matter content, Redox potential, Depth, Resuspension index, Distance to rock, Salinity, and Oxygen saturation), a combination of water depth, mean grain size, a wave-induced sediment resuspension index and annual bottom maximum temperature, are the most significant factors explaining the variability in the structure of benthic communities in the study area. These variables were classified into those representing the 'Disturbance' and 'Scope for Growth' components of the environment. It was observed that the habitat classes defined in the process-driven model reflected different structural and functional characteristics of the benthos. Moreover, benthic community structure anomalies due to human pressures could also be detected within the model produced. Thus, the final process-driven habitat map can be considered as being highly useful for seafloor integrity and biodiversity assessment, within the European MSFD as well as for conservation, environmental status assessment and managing human activities, especially within the marine spatial planning process.

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6   Habitat mapping relating to management

ToR d) – Review practise about the use of habitat maps, for example Mapping for the MSFD, marine spatial planning, and management of MPAs

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Introduction

Seafloor habitat mapping has become increasingly important to provide basic data on the seabed environment. This data represents fundamental information for the effective characterization, a suitable management and monitoring of the marine environment.

A range of commonly collected seabed parameters are useful for identifying baseline environmental conditions, including seabed physical characteristics, habitat types and biological communities. Baseline conditions are usually not static and useful datasets encompass spatial and temporal variations in environmental characteristics. Variations can be due to natural fluctuations that occur seasonally or over several years. Longer-term trends are also important to identify, such as shifts in benthic species range due to changes in climate.

For an effective and defensible marine environmental planning and management especially baseline data on the spatial distribution of seabed physical and biological characteristic is essential. The collection and synthesis of physical and biological data is necessary to differentiate environmental features that are meaningful to marine organisms – the feature that makes a particular area suitable or preferable for basic life functions such as feeding, reproduction, and avoiding predators. So the first step in being able to sustainably manage the marine environment is to identify key natural assets (areas of high biodiversity; habitat for commercial species; unique physical and biological features), in particular the location of key ecological features and processes.

Baseline data likewise provide foundation information upon which monitoring programs can be developed. Monitoring or repeat surveys are important for detecting change, both natural changes and change due to significant human impacts, as well as changes that may be related to the cumulative impacts of a number of pressures.

Overall, habitat maps can improve the sustainable management of living marine resources since they can help us to:

- understand the distribution and extent of marine species and habitats
- assess the importance of species and habitats in a regional context
- provide evidence-based information to safeguard priority habitats
- assess changes in marine habitats as a result of human activities
- understand interactions and the complexities within survey areas and encourage decision making based on ecosystem relationships, rather than the needs of a single species.

Mapping is highly relevant for management and planning, as information on what is where is of important when planning activities, actions and/or areas to protect. The points below show some aspects of relevance to managers based on the experience from the Norwegian mapping in the coastal zone.

1. Is water flow just water flow?

Often water flow is regarded as one factor and both waves and currents are combined. However, wave exposure and ocean currents (in particular if ocean currents are mainly tidal driven) are different in their mode. Wave exposure is driven by wind conditions and is orbital and stochastic. The wave energy is at its maximum close to the sea surface, declining towards the sea bed. Tidal driven currents are more regular with respect to direction, intensity and frequency as they follow the tidal cycle. Tidal forces are more homogeneous with depth than wave exposure, even though friction at the seabed influences also ocean currents. Results therefore often find that wave and current driven water flow affect the biology differently.

2. The quality and complexity of models

For management, the value of included more predictors and more complicated models, and thereby increasing the predictive ability of a model, has to be weighed against the cost of developing more and more complicated models.

Erikstad *et al.* (2014, Marine Geodesy) shows what even though the resolution of the data is important for identifying terrain and seabed structures, a lower resolution model might be better if the quality of the input data is high. This means that resolution should not be the only focus in the discussion, but also the need for good quality data. A lot of the models used (e.g. on terrain, wave exposure, ocean current) use bathymetry, so the quality and resolution of the bathymetric data is important.

Sundblad *et al.* (2014, ECSS) compared four wave exposure models, ranging from simple to more advanced techniques. Even though the more complex models explained more of the variation than the simple ones, the performance of the models overlapped and even the simplest model preformed satisfactory. This illustrates that the value of developing more complex models must we weighed against the cost of developing them.

3. Is mapping the habitat building species enough?

This discussion used the kelp forests in Norway as an example, but it may apply to other systems and areas. Traditionally, the kelp forests in Norway have been mapped based on the properties of the kelp itself, and the valuation of the kelp forests has mainly been based on kelp density and the size of the kelp forest. This is because the kelp forests (in particular *Laminaria hyperborea*) have been grazed by green sea urchins (*Strongylocentrotus droebachiensis*) and the focus has been on whether or not the kelp forests have returned. However, now we see that even though the kelp forests themselves have returned and grown back to the original height and density, the ecosystem is not restored because the epiphytic algae on the stipe have not returned. We see that the red sea urchin (*Echinus esculentus*) graze on the stipe associated epiphytic algae, which again results in the loss of associated fauna. It is therefore important to identify the associated species within the kelp forest, not only the kelp forest itself, in order to know if the kelp forest is restored and intact or not.

7 The use of habitat maps for monitoring of the environment

ToR e) – Assess the ability to use habitat maps for monitoring of the environment

7.1 Introduction

Trine Bekkby – NIVA/UiO

Habitat maps can for instance be used to design the set of stations to monitor, to find reference conditions, if an areas is no longer intact, or reference areas, e.g. to make sure that the changes observed is caused by actions in that area, not something happening on a larger scale. These three points are discussed in more detail below.

1. Habitat maps for monitoring station design

Monitoring an area often includes separating the effect on an impact, action or pressure from what is caused by natural variation, and also to see if the effect is different along the environmental gradients (e.g. is the effect higher in the shallow and sheltered areas than in the more exposed outer coast?).

2. Habitat maps for finding reference conditions

Some areas are for instance not at its reference conditions, and action are planned to restore the area. If monitoring is taking place as part of this restoration action, the developing models based on old mapping data to find the distribution of the species under natural conditions might help to find where actions should be taken and what should be the aim when it comes to the distribution, density etc. of the species.

3. Habitat maps for finding reference areas

If monitoring is taking place in order to find out if there are changes in the environment due to action, activity or pressure, we need an area to compare with, to separate the changes in the specific area from the changes found at a larger scale. We then need a reference area. The reference area should have the same range of conditions when it comes to the geohydrophysical conditions (such as depth, terrain, wave exposure, current speed etc.). These areas may be identified through modelling and the integration of habitat maps.

7.2 Development of MSFD indicators related to habitat mapping

Helen Ellwood – JNCC

7.2.1 Background

The overarching aim of the Marine Strategy Framework Directive (MSFD, 2008/56/EC) is for Member States to put in place measures to achieve Good Environmental Status (GES) in their marine waters by 2020. The Directive lists 11 qualitative *descriptors* for determining environmental status and Commission Decision of 1 September 2010 (2010/477/EU) gives more details about the *criteria* for assessing the various biodiversity components – one of which is benthic habitats. Under Descriptor 1 (Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions.), the Commission Decision states that "Additional efforts for a coherent classification of marine habitats, supported by adequate mapping, are essential for assessment at habitat level". Under Descriptor 6 (Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected) it states that "The main concern for management purposes is the magnitude of impacts of human activities on seafloor substrates structuring the benthic habitats".

The Criteria and accompanying *indicators* that are most relevant to habitat mapping are:

Criterion 1.4. Habitat distribution

      Indicator 1.4.1. Distributional range

      Indicator 1.4.2. Distributional pattern

Criterion 1.5. Habitat extent

      Indicator 1.5.1. Habitat area

      Indicator 1.5.2. Habitat volume, where relevant

Criterion 6.1. Physical damage, having regard to substrate characteristics

Indicator 6.1.1. Type, abundance, biomass and areal extent of relevant biogenic substrate

Indicator 6.1.2. Extent of the seabed significantly affected by human activities for the different substrate types.

Although, habitat mapping will also form part of the underpinning layers for other criteria and indicators such as those associated with condition (Criterion 1.6). Marine Strategies have been submitted by Member States to the Commission with the list of indicators and targets that are going to be used to assess the Commission Decision Criteria.

7.2.2 Progress

In 2013 the JNCC generated a rationalised list of benthic habitats that represents the minimum number of habitats for which the UK nature conservation agencies require information to complete all the assessments and reports required under different obligations (Robson, 2014). The resultant list contains 76 habitats which can be used as the main reference list of habitats for monitoring, assessment and reporting purposes by UK nature conservation agencies.

Following this, a workshop was held and an approach was developed for the prioritisation of these habitats for extent and distribution indicator development. Three key aspects were identified as part of this exercise: (i) ecological, (ii) evidence gathering and data limitations and (iii) additional considerations.

Ecological aspects:

1) Extent and/or distribution indicators are appropriate in determining GES only when pressures are known and are expected to cause a change in the extent and distribution of a given habitat at the MSFD regional/sub-regional scale;

2) Extent and/or distribution indicators are mainly appropriate for those habitats with widely understood and agreed definitions. For less well-known habitats further information should be collected before evaluating the feasibility to develop extent and distribution indicators;

3) In most cases, *extent* indicators are not appropriate for habitats when seasonal/ natural variability is much greater than any change brought about by a pressure;

4) A *distribution* indicator should be considered for ephemeral and naturally-variable habitats rather than an *extent* indicator, and in particular connectivity and the potential risk of fragmentation of a habitat's distributional range.

Evidence gathering and data limitations:

1) Extent and/or distribution indicators are not appropriate for any habitat that cannot be feasibly mapped with the array of techniques available to us (i.e. acoustic, remote sensing, ground-truthing);

Additional Considerations:

a) We must consider whether we can cost-effectively measure the extent and/or distribution of a habitat at a sub-regional scale; it may be more cost-effective to measure the pressure impacting on the extent/distribution of the habitat (i.e. physical loss);

b) Data availability from different sources, including data from industry, should be taken into account;

c) For *extent* indicators a distinguishable acoustic signature should be technically feasible in order to measure the boundaries of sub-tidal habitats.

Using the five main principles the list of habitats to consider was reduced to 26 for habitats suitable for pursuing indicators under the Habitat extent (1.5) and Habitat distribution (1.4) criteria and an additional 7 that may be suitable for assessing Habitat distribution but not Habitat extent.

In 2014 further research is planned to better understand principle 5 related to evidence gathering and data limitations for the short list of 26 habitats that are possibly appropriate for assessing using the Habitat area (1.5.1) indicator. The work aims to identify the sources and the range of errors associated with detecting change in the extent of selected benthic habitats and provide recommendations on whether and how this error can be minimised.

A key requirement of MSFD is for Member States to work together on the implementation of the Directive. For the North East Atlantic the regional coordination is facilitated by OSPAR and its intersessional coordination groups such as that on the Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM). This group has been tasked with the development of MSFD indicators that will be applicable for the OSPAR region. 'Area of habitat loss' is one of the priority candidate indicators proposed by the ICG-COBAM and is equivalent to the MSFD indicator 'Habitat area'. It has been proposed that habitat mapping showing extent of habitats will be used as one of the underpinning layers for the development of indicators associated with habitat loss therefore the outputs from the work described above will help to guide next steps of development of the COBAM indicator.

7.2.3   Recommendations

The working group agreed that the principles for determining the suitability of indicators related to habitat mapping for benthic habitats are appropriate and stressed the importance of the following in order to improve consistency in habitat mapping:

- Refining the definitions of certain benthic habitats – this work is developing for certain deep-sea OSPAR habitats as a result of a workshop in Bergen in 2011 (Buhl-Mortensen *et al.*, 2013).

- Improving guidelines for certain survey techniques and data processing, including:

  o video analysis – this has developed recently through a workshop in Southampton and

  o acoustic backscatter data acquisition and processing – this may progress thorugh the Working Group on Sonar Backscatter Data Acquisition and Processing and Processing (http://geohab.org/bswg/) which aims to propose:

    ▪ To users: guidelines or best practice approaches for the acquisition and processing of backscatter data from seafloor-mapping sonars;

    ▪ To sonar manufacturers and software developers: recommendations for the improvement and further development of systems and processing tools.

The desire is for backscatter data acquired from differing systems, or processed through differing software tools, to generate consistent values over a same area under the same conditions; and that these data are scientifically meaningful and usable by end-users from various application domains.

References

Buhl-Mortensen, P., Buhl-Mortensen, L., Guillaumont, B. and Skjoldal, H. R. 2013. Deep-water megafauna habitats. Report to the OSPAR Biodiversity Committee from a Workshop on the improvement of the definitions of habitats on the OSPAR List, Bergen: 20-21 October 2011.

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Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

Robson, L. 2014. Monitoring, assessment and reporting of UK benthic habitats: A rationalised list, JNCC Report 499, JNCC, Peterborough. Available online at http://jncc.defra.gov.uk/page-6671.

Annex 1: List of participants

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Annex 2: WGMHM Terms of reference for the 2014 meeting

2013/2/SSGSUE04 The **Working Group on Marine Habitat Mapping** (WGMHM), chaired by Pål Buhl Mortensen, Norway, will meet in San Sebastian, Spain, 19–23 May 2014 to:

a) International programmes:

Report on progress in international mapping programmes (including OSPAR and HELCOM Conventions, Emodnet, EC and EEA initiatives, CHARM, and Mesh-Atlantic projects);

b) National programmes (National Status Reports):

Present and review important results from national habitat mapping during the preceding year, as well as new on-going and planned projects focusing on particular issues of relevance to the rest of the meeting. Provide National Status Report updates in geographic display in the ICES webGIS;

c) Habitat mapping techniques and modelling:

Evaluate recent advances in marine habitat mapping and modelling techniques, including field work methodology, and data analysis and interpretation;

d) Habitat mapping relating to management:

Review practise about the use of habitat maps, for example Mapping for the MSFD, marine spatial planning, and management of MPAs;

e) Assess the ability to use habitat maps for monitoring of the environment.

WGMHM will report by 21 June 2014 (via SSGSUE) for the attention of SCICOM and ACOM.

Supporting Information

Priority	This Group coordinates the review of habitat classification and mapping activities in the ICES area and promotes standardization of approaches and techniques to the extent possible.
Scientific justification	The working group provides an important forum to discuss international and national seabed mapping programmes, along with their relevance to Regional conventions and European directives and more specifically among them the MSFD.
	The MSFD required better knowledge of the seabed, both from a biodiversity but also an integrity point of view. WGMHM examines techniques with a capacity to address these issues, whether for direct mapping or through modelling.
	Habitat suitability modelling is a key emerging technique as it allows addressing large areas of the seabed using field data and environmental parameters or their proxies, limiting the need for survey data. Mapping physical habitats is also a promising approcah.
	The compilation of National status reports remains an important tool to show progress in knowledge of our seabed. This extends to interpreted and modelled maps as well as substrat maps.
	ToR d: This ToR is of paramount importance in view of the many developments and impacts occurring in the coastal, shelf and even deeper zones and because of the MSFD requirements where a link is sought between the ecology and the pressures. However linking science and usages remains a difficult task and hopefully some members will be keen to address this at 2014 meeting.
	ToR e: It is important to understand the larger environmental context (environmental settings of habitat) when monitoring changes in environmental

	indicators. This issue was partly covered during the meeting in 2013 but could be further explored during the 2014 meeting.
Participants	The Group is normally attended by some 15–20 members and guests.
	Representatives from Member Countries with experience in habitat mapping and classification.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	ACOM.
Linkages to other committees or groups	BEWG, WGEXT, WGDEC, WGMPCZM
Linkages to other organizations	OSPAR, HELCOM, EEA

Annex 3: WGMHM 2014 (19–23 May) – Revised Agenda

Monday 19.05.

- 09:30 – Meeting starts at AZTI.
  - o Refining the agenda, and discussing the ToRs briefly.
- 10:00 – ToR A - *Progression in International mapping programs*
  - o the OSPAR mapping programme (Helen Ellwood)
- 11:00 – Coffe break
- 11:30 ToR A (cont.)
  - o MESH-Atlantic and EUSEAMAP2 (Mickael Vasquez)
  - o Please consider additional informative presentations
- 13:00 – Lunch
- 14:00 – ToR A (cont.)
  - o Plenary discussion/break-out groups
- 17:00 – end of day

Tuesday 20.05.

- 09:00 – ToR B - *National programmes (National Status Reports)*
  - o UK (Helen Ellwood),
  - o Germany (Roland Pesch/Claudia Propp),
  - o Iceland (Steinunn Hilma Olafsdottir/Julian Burgos)
- 11:00 – Coffe
- 11:30 – ToR B (cont.)
  - o Spain – (Ibon Galparsoro),
  - o France – (Mickael Vasquez)
  - o Norway - MAREANO (Pål Buhl-Mortensen),
- 13:00 – Lunch
- 14:00 – ToR B (cont.)
  - o Sweden (Ola Hallberg),
  - o Denmark (Kerstin Geitner)
  - o Ireland (Fergal McGrath)
- 16:00 – Plenary discussion/break-out groups
- 17:00 – end of day

Wednesday 21.05.

- 09:00 - ToR B (cont.)
  - o Norway (Trine Bekkby)
- ToR C - *Habitat mapping techniques and modelling*
  - o On the importance of hydrographical parameters for bio-tope modelling (Pål Buhl-Mortensen)
  - o Video annotation and analyses (Pål Buhl-Mortensen)
  - o Process driven habitat mapping (Ibon Galparsoro)
- 11:00 – Coffe
- 11:30 – ToR D - *Habitat mapping relating to management*

- o The use of habitat maps for monitoring and assessing the MSFD 'Habitat extent' criterion (Helen Ellwood)/(also relevant under ToR E)
  - o Techniques and aspects relevant to management (Trine Bekkby)
- 13:00 – Lunch
- 14:00 – ToR E - *Assess the ability to use habitat maps for monitoring of the environment*
  - o Plenary discussion/break-out groups/status of report
- 17:00 – end of day

Thursday 22.05

- 09:00 – Next year's ToR
- 11:00 – Coffe
- 11:30 – Break-out groups/reporting
- 13:00 – Lunch
- 14:00 – Break-out groups/reporting
  - o Discussion
  - o Break-out groups/reporting
- 17:00 – end of day

Friday 23.05

- 09:00 – Finishing report/Discussion
- 11:00 – Coffe
- 11:30 – Election of new chair/Next year's venue
- 13:00 – Lunch
- 14:00 – Finishing report/Discussion
- 16:00 – end of meeting