Marine Habitat Committee **ICES CM 2001/E:07**

REPORT OF THE

WORKING GROUP ON MARINE HABITAT MAPPING

Galway, Ireland
3–6 April 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

Section **Page**

1 OPENING

The Working Group on Marine Habitat Mapping (WGMHM) was convened in Galway, Ireland from 3–6 April 2001. The participants to the meeting were welcomed by Anthony Grehan (Host) on behalf of the Martin Ryan Institute of the National University of Ireland, Galway and the sponsor of the meeting, the Marine Institute in Galway, Ireland.

Eric Jagtman (Chair) opened the meeting. He announced that the Study Group had been re-established as the Working Group on Marine Habitat Mapping (WGMHM) at the ICES 2000 Council Meeting in Bruges, Belgium (CM 2000/E:08).

The meeting was attended by 19 participants, who were asked to introduce themselves. A full list of participants is given in Annex 2.

A provisional agenda for the meeting was discussed, which led to certain amendments. The agenda as it was adopted for the meeting is included in the report as Annex 1.

Eric Jagtman concluded by recalling the first SGMHM meeting in Oban, Scotland, in 1999. He noted the progress made since then and expressed the hope that WGMHM would continue to make a positive contribution in the future.

2 MAIN OBJECTIVES OF THE MEETING AS DEFINED BY THE TERMS OF REFERENCE

The Terms of Reference for the meeting (included in the report as Annex 5) were introduced by Eric Jagtman. He pointed out that during last year three important meetings had taken place:

The OSPAR/ICES/EEA Workshop on Marine Habitat Classification held in Southampton (United Kingdom) in September 2000, the workshop on Deep-Sea Survey Technologies held in Bergen (Norway) in January 2001 and the Theme Session on Classification and Mapping of Marine Habitats held during the Annual Science Conference in Bruges (Belgium) in September 2000. The results of these meetings will be presented at the meeting.

A short discussion followed when Eric Jagtman informed the meeting that the intended second ARC meeting to be organised by Rebecca Allee (NOAA) did not go ahead. The present state of the United States of America (USA) habitat classification work was unclear because no USA delegate was present. Paul Boudreau informed the meeting that Rebecca Allee had moved from her former position and that it may be necessary to establish new contacts with regard to advancing habitat classification in the USA. Thomas Noji and Gary Greene were suggested as initial contacts. Paul Boudreau stated that he would pursue contacts within the Gulf of Maine work.

Dorian Moss asked whether EUNIS should be applied to the entire ICES area. Eric Jagtman in reply stated that feedback from the USA was needed before any such decision could be made.

David Connor expressed the opinion that the main focus of the WGMHM is on habitat mapping rather than classification which can be used as an implementation tool. There is a need to focus on the end-use of the mapping effort supported by habitat classification to understand how best the USA contribution can be integrated.

3 PROGRESS IN HABITAT CLASSIFICATION

3.1 Introduction on the outcome of the Second OSPAR/ICES/EEA Workshop on Habitat Classification and Biogeographic Regions (Southampton)

TOR A: to review the results of the Second OSPAR/ICES/EEA Workshop on Habitat Classification

David Connor reported on the joint OSPAR/ICES/EEA Workshop on Marine Habitat Classification held in Southampton from 18–22 September 2000 (see OSPAR-BDC 00/6/Info.1-E). Key areas covered were:

- Development of the EUNIS Classification particularly at Levels 4 and 5
- How best to deal with biogeographical variations
- Development of a complementary marine landscape/habitat complex classification scheme.

- The main outcomes were:
- Rocky habitats were further checked and refined but the proposed classification requires more OSPAR wide detail at Level 4
- Sediment habitats were further developed, especially for offshore. Biogenic structures moved to Level 3.
- Deep Sea - a major revision of the classification structure was proposed.
- Pelagic Realm - a major revision of the classification structure took place, the new proposals will be discussed at the WGMHM-meeting (Section 3.2 and 3.5 of the report).
- Biogeography - recommend Level 4 to describe functional habitat and Level 5 to show biogeographic variation.
- The results of the workshop were contained in a summary record which was presented to:
- The ICES Marine Habitat Committee at the Annual Science Conference in September 2000.
- EEA. This was followed up by a document written by Cynthia Davies and Dorian Moss explaining how proposals made in Southampton could be implemented in the EUNIS classification (Section 3.3 of this report)
- The OSPAR Biodiversity Committee (BDC) in November 2000.

The OSPAR Biodiversity Committee were advised that the classification needs to move to an operational level, and asked to adopt the classification for use in OSPAR activities (e.g., EcoQO's, threatened habitat work). Three suggested areas for future work were proposed, with varying degrees of cost. OSPAR chose to carry out:

- A review of literature describing marine habitats from different geographic areas to improve the OSPAR wide classification. Most Contracting Parties had signed up to undertake this work over the coming year.
- Habitat mapping work should be further considered.

The UK are advancing the classification development through a top down - bottom up approach coupling the existing MNCR BioMar Classification with the OSPAR-wide review of the literature. The UK classification is being further refined through detailed analysis of survey data. This information will eventually be collated to feed into the EUNIS classification.

The UK DETR in an ongoing Review of Marine Nature Conservation will develop a UK wide marine landscape classification.

A short discussion followed when Brendan Ball asked whether the top down approach met the bottom up approach seamlessly. David Connor replied that there was a significant gap that had been plugged by developing Level 4 biotope complexes. Dorian Moss stated that there was a need to generalise at the lower levels to facilitate integration with top down approach. Brendan Ball informed the meeting that the ICES Benthic Ecology Working Group had found that it was relatively easy to use Level 1 to 3 of EUNIS but the information was so general that the exercise was of little practical value. Craig Brown said that detailed survey work facilitated biotope description at Level 5 but it was still difficult at times to fit the biotopes into the higher levels of the EUNIS framework, particularly when complexes where encountered. Paul Boudreau commented that the scale of this problem needed to be assessed.

Dick de Jong stated that it is important to look at processes; he felt that too much attention is paid to sediment composition alone. David Connor said that the Classification system will be used in different ways and illustrated his point with the example of kelp forest classification. Broadscale acoustic mapping distinguishes physical differences in kelp density between sites but does not account for differences in wave exposure which has a profound effect on the associated biological communities.

3.2 Progress made in the EUNIS classification of pelagic habitats

TOR E: prepare a strategy plan for how to deal with pelagic habitats, taking into account the outcome of the Southampton workshop

Yolanda Sagarminaga reported on the progress made in the EUNIS classification of pelagic habitats.

The presentation is included in Annex 3. Major revision of the pelagic habitats classification was proposed in the 2nd OSPAR/ICES/EEA workshop on habitat classification held in Southampton in September 2000. A recommendation was made on the need for achieving a satisfactory theoretical classification of pelagic habitats up to Level 4 and encourage actions to map the habitats described and test them with existing data on pelagic marine resources. Mapping, to test the classification, will be carried out with data from the Bay of Biscay as part of a Ph.D. project undertaken by Yolanda Sagarminaga.

Some questions arose regarding how to deal with different pelagic events such as zooplankton migration, ecosystems associated with ephemeral algae, floating objects, migratory species and seasonal variation. The inclusion of these cases into the classification needs to examine real data to check the validity of the theoretical classification proposed.

Regarding the mapping difficulties expected in a system as dynamic as the pelagic, it was said that as long as communities are related to conditions defining their habitats, the dynamics of these habitats would not affect the actual distribution of their associated communities. This would mean that there is no need for the inclusion of extra units in the classification system, as long as the existing units will sufficiently express the dynamics of the system.

Discussion was raised how the proposed pelagic habitat classification could be tested with real data and how to proceed in this work. Suggestions were made to bring this to the attention of the ICES Biological Oceanography Committee, asking this Committee to include a remit in the terms of reference of one of its working groups. Other suggestions recommended a literature review, as was decided in the OSPAR Biodiversity Committee for marine benthic habitats. This review calls upon national authorities to provide sampling data from marine benthic monitoring to support further testing of the revised EUNIS classification. The working group, in view of part e) of its Terms of Reference (prepare a strategy plan how to deal with pelagic habitats) decided to spend an extra session on the discussion of pelagic habitats on basis of a second revision of the proposed pelagic habitat structure (Section 3.5 of the report).

3.3 Suggested implementation of proposals made at Southampton, September 2000

TOR D: collate comments to the EUNIS classification system

Dorian Moss presented the EUNIS habitat classification and progress since the Southampton OSPAR/ICES/EEA workshop. The presentation is included as Annex 6 of the report. Dorian reminded the working group of the aims of the classification, its origins, and how the different interest groups (including ICES) fit into its development. He outlined the principles of EUNIS and its future plans. Suggested implementation of proposals made at Southampton, September 2000 had been prepared by Cynthia Davies and himself and circulated in advance of the meeting. They had synthesised the proposals with the pre-existing units in the classification outside the scope of OSPAR/ICES (i.e., Mediterranean and Baltic) and omitted from discussion in Southampton. Attention was drawn to comments showing where further work was required, particularly to combine elements from different classifications in a single coherent EUNIS system. He summarised the relatively minor changes to the benthic habitats in A1 to A4, and the proposals for complete revision of the deep-sea bed habitats (now A5 and A6), pelagic habitats (A7) and the new A8, Ice-associated marine habitats. The proposals for A7 represented a further update on those presented earlier in the day by Yolanda Sagarminaga.

In discussion the points raised included:

- the need to ensure compatibility with the needs of the Water Framework Directive (this is an EU, not an ICES issue);
- the EUNIS website MRW.wallonie.be/dgrne/sibw/EUNIS/home.html which is available to all, but does not include the proposals currently under discussion: the possibility to show these new proposals would be followed up by Dorian Moss and Cynthia Davies;
- USA initiatives appear to be temporarily suspended in relation to this Working Group, but Paul Boudreau reported that the cross-border Gulf of Maine group is using EUNIS;

- mechanisms, (e.g., a further OSPAR/ICES/EEA workshop), to take EUNIS forward and resolve the questions which had been flagged for further attention. This could be combined with follow-up of the results of the OSPAR literature review. The pelagic classification should be developed further at the present meeting;
- future work on EUNIS also needs to involve the Mediterranean and Baltic experts, who may not always be involved with the Conventions.

3.4 Theme Session on Classification and Mapping of Marine Habitats, Bruges Annual Science Conference 2000

TOR A: review the results of the Theme Session on Classification and Mapping of Marine Habitats

Dick de Jong reported on the theme session on marine habitat classification and mapping at the 2000 ICES Annual Science Conference, Bruges. 15 papers had been presented in two sessions, which had been attended by c. 75 and c. 50 delegates respectively. The abstracts are available, and a CD-ROM containing all the papers is due for publication by ICES for sale before or at the next Annual Science Conference. General common points that emerged were the importance of habitat classification and mapping at an international level, and the needs for standardisation, co-operation. Acceptance of EUNIS to Level 4 was meeting some of these aims but agreement was needed on goals and appropriate level of detail. It was illustrated that the relationships between habitat maps, habitat classification and mapping programmes are driven by external goals and technology. All these elements then feed into a habitat database.

3.5 Discussion on the revision of the pelagic habitat units in EUNIS

TOR E: prepare a strategy plan how to deal with pelagic habitats, taking into account the outcomes of the Southampton workshop.

Yolanda Sagarminaga overviewed the preliminary pelagic classification as revised at the Southampton workshop.

During that workshop there was not sufficient expertise present on the neuston and bentho-pelagic interface to further consider this aspect of the classification, so major emphasis was put on the water column *sensu stricto.*

A problem arose with the definition of “vertical mixing” of the water column. A clear definition, on which the WGMHM can agree, seems to be extremely important.

The EUNIS level 4 units within the pelagic habitat turned out to be geographically defined (these units should have a ecological rather than a geographical meaning).

Criteria for short, medium and long residence time were discussed. It was suggested to define “short” as < 1 day, “medium” as 1 to 14 days and “long” as longer than 14 days, based on phytoplankton turnover rates.

Criteria for “freshwater influence” were discussed. Discussion identified fully marine conditions with salinity ranging from 30 PSU up to about 35 PSU. With such a definition, it might be difficult to classify appropriately some North Sea coastal waters using EUNIS. Regional differences have to be taken into account. It was suggested to define freshwater influences in relation to the regional marine conditions. Problems arise when trying to classify the Baltic Sea. Furthermore, temporal effects are important.

Since at this moment the EUNIS level 4 units are too regional and non-exhaustive, the units and unit levels will be reconsidered. Through mapping of the habitats at a local scale (cf. Test cases) the consistency of the (new) level 4 units will/can be checked.

It was argued that the “stratification” questions should be changed to queries about the gradients present in the system. Furthermore, a gradient is present or absent. The use of the term “weak stratification/gradient” will lead to confusion and should thus be avoided.

In addition to gradients in salinity, other environmental gradients (e.g., temperature and oxygen) are biologically/ecologically relevant and have thus to be taken into account within the classification system.

The bentho-pelagic component is difficult to position within the pelagic EUNIS compartment. Hyperbenthic assemblages are related to the bottom (e.g., food resources, diurnal vertical migrations). It was decided to define the

bentho-pelagic compartment as complexes within the EUNIS classification. Experts (e.g., SMB of Ghent University, Belgium) within this field will be contacted and asked for comments.

A revised version of the pelagic part of the EUNIS classification, taking into account the above-mentioned remarks, was discussed on Thursday. The outcome of the discussion led to a newly revised structure for pelagic habitats within the EUNIS system. This new proposal is included in the report as Annex 4. Cynthia Davies recorded comments. There was not full agreement on the revision. Participants were requested to submit comments to Cynthia Davies by May 1st. Two outstanding problems are:

1) A7.5 and A7.B raised questions whether conditions with no gradient in deeper water are biologically the same as fully mixed high-energy systems. Under the current proposals these units, A7.5 and A7.B, follow the same path as stratified waters, thus contradicting the criteria in a35. Options discussed to solve the issue were:
   - deleting the units if they duplicate A7.2 and A7.3
   - retaining the units, but clarifying the distinctions and
   - revising the criteria in a35.
2) A7.2 with regard to its ability to classify estuaries properly.

Cynthia Davies and Dorian Moss were advised to forward the proposal to a group of experts outside the working group for further review. Potential reviewers named were: Juan Brown, CEFAS at Lowestoft, Bill Turrel, Aberdeen (recommended by Matthew Service) plus names recommended earlier from the Southampton workshop.

3.6 Discussion how to proceed

TOR A: The Working Group will prepare material for a discussion on the various classification systems, their advantages and disadvantages, to be dealt with by ACME;

The workshop was unable to discuss the proposed US Classification as there had been no update. The Chair then asked the participants to discuss why there was a need for the classification and mapping and were there demonstrated or projected uses of the classification and habitat mapping. In addition, were there advantages and disadvantages to these systems?

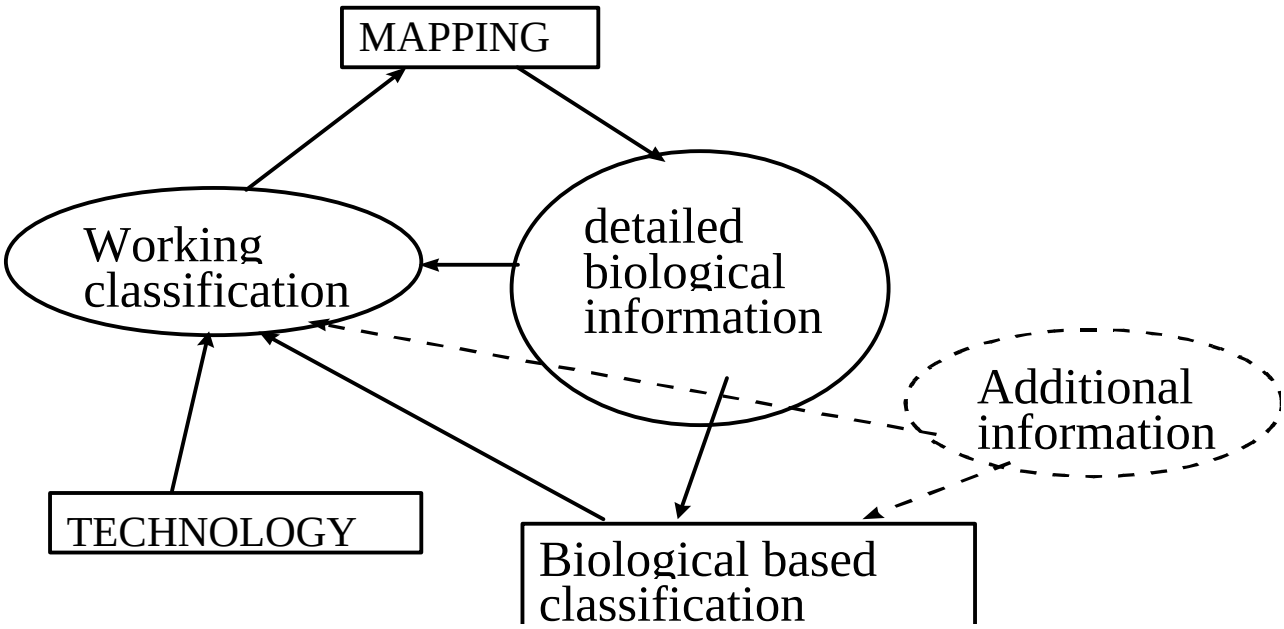
The following examples are potential and/or known uses of habitat mapping:

1) Fishery related issues, e.g., essential fish habitats
2) Biodiversity issues/ biological resource management, e.g., SAC management
3) Determining conservation value based on spatial extent and distribution of habitats and species
4) Risk assessment.
5) Spatial modelling for management and or decision support systems and to give a greater understanding of the ecosystem.
6) Conflict resolution.
7) EIS / contaminant/ pollution monitoring
8) Long term monitoring programmes.
9) Stratified design of monitoring programmes.
10) Geohazard identification.
11) Excellent communication tool for education/ increasing public awareness / informing policy makers and stakeholders.
12) Resource valuation, items 1–11 resulting in greater integrated management.

It was recognised that there needed to be data standards, greater collaboration between countries undertaking mapping projects, and that the mapping of marine habitats would be of high value for ICES.

The group recommended that ICES support the recommendations of the Bergen workshop and that the results be presented to the ICES Annual Science Conference. The participants requested that the recommendation be forwarded to the Advisory Committee on the Ecosystems (ACE) for endorsement The workshop also proposed that the Bergen recommendations were further developed and suggested that a concerted action for funding might be one way forward.

It was felt that it was difficult to relate acoustic data to the EUNIS classification. Was there a need for a separate, intermediate, working, classification that would relate all the possible habitats types that would relate to acoustic signals to generate an unsupervised classification? This was discussed using the following diagram:



The mapping of very large areas of seabed would probably only have very limited ground truthing. Ground truthing was needed to produce a more refined predictive habitat map based on a standard classification such as EUNIS. This led to a discussion on data interpretation using different techniques.

The following were recognised:

- A wide range of survey techniques is used for collecting data - remote sensing (e.g., aerial / seabed) and sampling (ROV, grab, core, trawl etc.). Each technique needs standards for data collection, storage and interpretation.
- The interpretation of each technique will give rise to a series of classes which needs to be consistently derived by different workers.
- There is a need for a consistent means of integrating these data and/or correlating the classes derived from the different sampling techniques (e.g., acoustic and benthic sample data).
- There is a need to integrate data from different techniques to produce interpreted maps, e.g., of habitats.
- Full integration should lead to a robust habitat classification enabling the use of remote and sample data to be matched to a single classification system.
- Large scale integration of data from different projects and across countries will require:
    - Common data formats
    - Common data interpretation
    - Sharing of data
    - Co-operative programmes between organisations / countries
    - Research

3.7 Proposals for future work

Paul Boudreau presented a table (next page) of existing resources and required future work using the issues raised from the presentations and discussions beforehand. This outlook was accepted with the provision of intermediate stepping stones to achieve these ends. By examining the relationship between acoustic signal classes and biological classes, substrate/habitat models may be developed which will facilitate extrapolation of ground truth/biological data over large areas linked to acoustic information. In addition problems between differing sampling techniques, whether acoustical or biological and difficulties in classification, need to be further tested by application to existing datasets.

We have:	Future work:
Maps and data. Problems in data access, quality and visualisation.	Standardising and unifying maps from existing data for the whole OSPAR/ICES area
New technologies. Acoustic technologies are still under development and applying them to habitat mapping still requires testing.	Classification from local biology to ensure habitat definitions are representative and applicable when tested with existing data.
Localised biological data. Lots of biological data is available, but over very small spatial areas and there are problems in quality and taxonomic changes.	Making best use of the developing technologies and linking relationships between broad-scale acoustic classes to biological classes

Standards for acceptable sampling efforts for biological ground truthing are not currently available.

TOR E: The Working Group will prepare material for a discussion on the various classification systems, their advantages and disadvantages, to be dealt with by ACME

The group to date has only considered the development of a single classification system (EUNIS) over its 2-year rapid development. The group acknowledges that whilst it is not finished it has achieved a good consensus on the structure to EUNIS level 4 and much of level 5. Whilst further development is important the perceived shortfalls in the system are in the Baltic and Mediterranean, where the group is lacking in specific knowledge to resolve these issues and in the more detailed aspects for the northeast Atlantic. There had been some input by few representatives from these countries at previous meetings, however, they were not represented at this meeting to attempt to resolve the difficulties.

The WGMHM therefore proposes a shift of emphasis toward the development of habitat maps. These maps will then be used to further test and develop the EUNIS system.

4 PROGRESS IN HABITAT MAPPING

4.1 The ICES Workshop on deep-seabed survey technologies (WKDSST)

TOR C: Review the outcome of the ICES workshop on deep-water survey technologies and the development of standards for marine habitat mapping.

A review of the WGMHM Bergen workshop was given by Anthony Grehan. The presentation is included in the report as Annex 7. The workshop was set up (1) to initiate collaboration between institutes, (2) to discuss survey technologies, strategies, data formats and mapping products (3) covering a broad range of environments by addressing four objectives: i) compile and review information on survey technology, (2) identify and compile information from existing mapping data sets, (3) consider harmonization and standardization and (4) consider collaboration between ICES countries. During the first and second day 23 lectures were presented. During the whole workshop, three working groups each dealt with three group tasks. The group tasks were: (1) strategies for collecting field data and technologies for habitat mapping, (2) formats for marine data and data base requirements, and (3) large-scale marine habitat mapping and co-operation needs. The results from these working groups were discussed in a plenary session and resulted in the identification of general recommendations.

Proposal of a Concerted Action, to the EU, on deep-sea mapping was considered during the Bergen workshop. A follow-up meeting to advance such a proposal will be organised in association with the Geology of Marine Habitat special session (31/05/2001 and 01/06/2001).

An ad hoc steering group was formed to promote collaboration in future work for deep-water habitat mapping. Specific areas of interest are the development of acoustic thematic mapping and ground truthing protocols.

In the Halifax meeting it is proposed that geographical and depth ranges with a range of habitats from coastal to the deep sea will be presented as case studies. At present there is a joint Canadian & US initiative to begin mapping of scallop habitats in the Gulf of Maine.

Within the Irish Seabed Mapping project already 20% of the area has been mapped. Special attention was put on offshore waters. Mapping of the inshore waters will be available through several local mapping initiatives. Similar projects are running in other ICES countries: Norway, Belgium (main attention on sandbank areas), Spain, France, and Northern Ireland.

4.2 Habitat maps for the North Sea

TOR B: report on progress made in the joint WGMHM/WGEXT/BEWG plans on habitat mapping projects (habitat map of the North Sea, Wadden Sea, deep sea map, OSPAR area map to level 3 of the EUNIS classification system)

4.2.1 Habitat Map of Southern North Sea and Wadden Sea

This item was introduced by Dick de Jong. The full presentation is included in this report as Annex 9. The development of a habitat map for the North Sea and Wadden Sea was proposed from the Oban meeting. It was acknowledged that Kirsten Jerosch carried out most of the study. The goals of the study were to develop a habitat map to a EUNIS Level 3 classification, to identify for future studies problems associated with data collection, fitting data to the classification scheme and assessing data availability. People were very co-operative in providing data via database access. However, certain problems did present themselves:

- Metadata was insufficient and inadequate
- Different classification systems were used
- Different base levels were used in bathymetric maps
- No GIS or digital copies of some maps were available
- Definitions were ambiguous, e.g., mud?
- Comprehensiveness of data was insufficient from some areas, e.g., Danish Wadden Sea data
- Many maps were presented pre-classified and therefore could not be used in new classification system

A CEFAS data set was assessed using two classification mechanisms IndVal and TWINSPAN. IndVal identifies indicator species and assemblages and develops clusters according to these. TWINSPAN clusters as well as clusters incorporating depth and sediment composition were input into the model. Both agreed reasonably well with the EUNIS classification of the CEFAS data set. Recommendations of the results to date are:

a) Ensure metadata are accurate and consistent among datasets

b) Retain raw data so as to avoid passing on just pre-classified data

c) Develop a common data format

Craig Brown questioned how the output from the two classification systems agreed with the analysis carried out originally on the CEFAS data by Hubert Rees (CEFAS)? Dick de Jong answered by saying that the project has not progressed to the level of producing maps yet, this will be in subsequent reports. A report outlining the data collection methods, etc., has been prepared.

David Connor described the work as a valuable exercise that highlighted practical (logistical) problems associated with large-scale studies. He quiered the availability of other data sets that might be comprehensive similar to the CEFAS data? He cited the British Geological Survey data that are being reanalysed in light of the Habitats Directive. Dick de Jong commented that it would be nice to have the data except that it was prohibitively expensive to acquire.

Eric Jagtman wondered whether a goal was to develop a EUNIS classification map with all of the pooled data sets? Dick de Jong stated that the data fit EUNIS Level 3 & 4 well and demonstrated with Dutch continental shelf assemblages.

It was pointed out that handling data in this way was a good stepping-stone towards developing Ecological Quality Objectives. Various resolutions of data were apparent, e.g., Biological data was scattered, and sediment data was more regular and bathymetric data was well defined. How is the resolution of the habitat maps defined? Dick de Jong answered that it would be a problem in rocky habitats. However, for the Dutch systems they tended to be homogenous systems that were relatively easy to classify. More complex areas would present significant problems.

4.2.2 Habitat Map for the Central North Sea

This item was introduced by James Massey. His presentation is included in Annex 10. The goal of this study was to map the biological communities of the North Sea and make data available for multiple users in a user-defined format. The reasons for developing the map were because there were no tools for Environmental Risk Assessment and for offshore industries requiring EIA's. Some project constraints were that there were no provisions for collecting new data and only existing data was evaluated. The area studied was the central North Sea because 150–200 data sets were identified from metadata sources. None of these realised any data. A GIS database was developed using ArcView. Problems identified with long-term data sets were, *inter alia*, name changes of species, formatting differences. The database could distinguish various faunal groups and assemblages with various confidence limits depending upon the quality and quantity of the data.

The data could be used for evaluation of sites over time, if the amount, detail and consistency of information was sufficient.

The session concluded with a series of comments relating to the status of other classification systems, e.g., BioMar, Marlin and how information on each could be garnered. Dorian Moss pointed out that the BioMar classification can be viewed on four websites – JNCC (www.jncc.gov.uk/mermaid), *MarlIN* (www.marlin.ac.uk), EUNIS habitats and the National Biodiversity Network (NBN). In the short to medium time frame the aim will be to focus on the NBN gateway at www.searchnbn.net as the first point of entry to all biodiversity information of interest to the UK.

4.2.3 High resolution techniques for mapping sea bed biotopes in the UK

Craig Brown introduced a three-year research project that was started in 1998 and was funded by MAFF. The presentation is included in the report as Annex 11.

The aim of the project was to map assemblages on coarse sediment substrates which would be suitable for sand and gravel extraction.

The techniques used were Sidescan sonar to give 100% cover of the study sites and the AGDS RoxAnn and QTC. Ground truthing was by a mini Hammon Grab with a camera attached, 2 metre beam trawl, and underwater video. There were 4 study sites on the south coast of England. Biological data was analysed using multivariate statistics and characterising species were determined using PRIMER.

The results demonstrated that assemblages of species found may depend on gear as the characterising species for assemblages determined using a Hammon Grab were different from those using a beam trawl.

In determining the biotopes all the data, e.g., data from grab samples beam trawl, sediment characteristics sidescan sonar etc. were used. This resulted in 12 assemblages being identified. These assemblages had not yet been related to the EUNIS Classification. This was the next step but it appeared that they would fit into the category of mixed sediments.

It was demonstrated that biotope description is biased by the sampling gear, the gear deployed and the number of samples. The positional accuracy will determine the resolution of biotope distribution. This will be particularly relevant in long term monitoring with repeat sampling.

4.2.4 Building a Benthic monitoring network - Pilot Study in Brittany (Avant Project sommaire de REseau BENThique - REBENT

This item was introduced by Brigitte Guillaumont. The aims of the project are (1) Determine the contribution of existing networks (2) To service the increasing demand for benthic data when the current knowledge is very heterogeneous (3) support the management of SAC sites designated under the Habitat Directive along the Brittany coast.

The objectives are to create an inventory and analysis of existing data, tools, networks, etc.

The project will determine existing data, reference maps, develop a monitoring strategy, examine available tools and methods etc. The costs involved, planning and human organisation needed to carry the tasks, have to be examined. Twenty research centres are involved with IFREMER as the co-ordinator and encompasses a wide range of data that will be entered into as GIS system. The priorities are the tidal zone, photic zone 0 to 20–30 m and deep coastal waters 20–30 m to the territorial sea limit.

Examples of different types of data available were shown including some substrate and habitats maps of the coast of Brittany. A strategy will have to be developed as to how the data gaps will be filled. There will be two approaches (1) to produce basic maps and then (2) to produce more accurate and detailed maps. The project will try to map using the EUNIS classification but mapping may have to be at different levels, e.g., Levels 4 or 5.

4.3 Habitat mapping and classification in Canada

Paul Boudreau presented a summary of Canadian benthic mapping and classification activities. He drew attention to:

- a major funding proposal for Canadian seabed mapping, which had been delayed by Canadian elections, but that he hoped was to receive funding soon;
- Brian Todd's (NRCan) activities on multibeam mapping;
- mapping work in the proposed marine protected area (The Gully) off Nova Scotia;
- a special session of the Geological Association of Canada on "The Geology of Marine Habitat" is to be held in St. John's Newfoundland in May 2001;
- the Marine Invertebrate Diversity Initiative (MIDI) website, that includes the EUNIS classification;
- the CoastGIS international conference in Halifax, Nova Scotia in May 2001.

4.4 Deep-sea maps

The development of a large grid scale map for the OSPAR area as well as the development of maps for the deep-sea are subject to funding. No progress could be reported for these issues.

4.5 Discussion how to proceed

TOR F: prepare a proposal for the development of a GIS database for habitats with cost estimates included and potential sources of data to be submitted.

There was general agreement amongst WGMHM participants that there is a need to co-ordinate and compile a catalogue/database of existing data sets which are of use in habitat mapping activities. There was a suggestion that metadata should be collated by ICES to allow greater integration and distribution of data sets which would facilitate the production of broad-scale habitat maps. It was commented that ICES is already attempting to 'stream-line' their existing databases.

Following this discussion the question was raised as to whether or not there was already an umbrella group which could take the lead in setting up an international metadata base/GIS. At a national level it was felt that national oceanographic data centres were not updating their databases frequently enough, and that not all relevant data were stored in such centres. Following this discussion 2 options were proposed:

1) That National Oceanographic Data Centres should be encouraged to take on this role.
2) That an ICES data centre is set up where maps produced at a national level using standards set up by WGMHM can be made available.

No agreement was reached amongst the group as to the best way forward.

There was agreement that the role of setting standards for data formats, metadata, etc., should not fall to WGMHM. This is a huge and costly process and other organisations are better placed to do this (e.g., International Hydrographic

Organisation). WGMHM should, however, be establishing guidelines for the production of habitat maps (e.g., EUNIS Level 3 habitat maps).

4.6 Proposals for future work

WGMHM propose to:

- Continue with the North Sea Habitat map, extending it to cover the whole of the North Sea.

Objectives:

- To advance habitat mapping to support EcoQO's (OSPAR/BDC), and the requirements of relevant ICES Working Groups, for the North Sea
- The map will support all points on the list of uses of habitat maps (Section 3.6).

A proposal outline was drafted by James Massey, Dick de Jong and Anthony Grehan (See Annex 8). The Working Group decided that a group consisting of David Connor, Eric Jagtman and James Massey will draft a more detailed proposal. This proposal could then be used to apply for an EU Concerted Action application, to provide funds for a co-ordinator and specific tasks necessary for significant advancement; such as data acquisition, providing a website forum for data exchange and identifying and involving significant parties to clarify problems in metadata standards and specific expert mapping issues. Further the proposal could be submitted for comment to the EU and to assess support. It was also proposed to submit the proposal for comment at the ACE in August, OSPAR in November and the North Sea Conference.

A non-exhaustive list of relevant data sets were identifed as required for the production of habitat mapping was also compiled by the group:

BENTHIC DATA:

BATHYMETRY
- Admiralty charts
- multibeam data
- direct observations

SUBSTRATA (sediment grain size/rock)
- side scan sonar
- AGDS data (QTC/RoxAnn)
- grabs
- direct observations (divers/beach sweeps)
- remote sensing
- Aerial photography
- Video

EXPOSURE
- current meters
- modelling
- indication from biology
- fetch

BIOLOGY
- grabs
- trawls

- acoustics (QTC/RoxAnn/side scan sonar)
- video
- divers/beach survey

PELAGIC DATA:

MIXING/GRADIENTS/SALINITY
- CTD
- modelling
- satellite imagery
- meteorological data
- mooring

RESIDENCE TIME
- tide tables

Whilst all the above data can be used in habitat maps, it was noted that maps can be produced without data from all of the categories.

4.7 Recommended future work

Taking into account the discussions at Bergen and during the WGMHM meeting in Galway the following general issues with respect to recommended future work include:

- Development of thematic deep-water maps.
- Continuation and expansion of the North Sea mapping pilot studies. (Annex 8)
- Development of mapping technologies and standards.

Further development and refinement of the EUNIS classification system should in the immediate future be undertaken by EEA and OSPAR, but should be informed by its practical application in habitat mapping undertaken by ICES.

5 DEVELOPMENT OF ECOLOGICAL QUALITY OBJECTIVES FOR MARINE HABITATS

Hein-Rune Skjoldal stated that in preparation for the North Sea Ministers Conference Ecological Quality Objectives for *inter alia* habitats in the North Sea are being developed. There is a need to develop ecosystem-based approaches to management in the North Sea. There are a number of different possible approaches to this task. An introduction to a workplan to develop EcoQO's was presented. In setting quality objectives the following criteria might be used:

- representativeness - example of typical habitat
- coverage or abundance, e.g., small natural range - rare, vulnerable
- threatened and/or declining

Tasks foreseen were:

1) to make an inventory of distribution of habitats derived using
   - Low resolution North Sea map EUNIS Level 3 and 4
   - Higher resolution maps - EUNIS Level 5
   - A network of national data centres/holders
   - Marine Protected Areas (MPA) - compilation of information

2) to identify habitat quality

   - "functional habitats" (e.g., spawning grounds, nursery areas, wintering areas, etc.)

3) to identify threats

   - threatened and/or declining habitats.

Comments made at the meeting:

Criteria for "threatened and/or declining habitats have been developed by OSPAR but their application is still under discussion.

The North Sea Ministerial Conference may provide an opportunity to inform Governments of the importance of marine habitat mapping to underpin sustainable management of marine resources and make a commitment that this work is furthered.

Habitat mapping will include both the intertidal and the sublittoral. The focus and priority will be on areas most in use in the North Sea which will give priority to the near shore zone.

Broadscale mapping will not identify habitats that have a rare or small-scale distribution.

The Ministerial conference is scheduled for around 20th March, 2002. A summary report is due in autumn 2001. There will be a stakeholder meeting scheduled for October 2001. The report will synthesise the proposals for EcoQO's 1–10:

1) Reference points for commercial fish species
2) Threatened and declining species
3) Sea mammals
4) Sea birds
5) Fish communities
6) Benthic communities
7) Plankton communities
8) Habitats
9) Nutrient budgets and production
10) Oxygen consumption
11) The Advisory Committee on Ecosystems will review all of the proposals in August 2001

6 RECOMMENDATIONS

In order to proceed the work of the WGMHM we recommend:

- To endorse the Bergen workshop recommendations and support follow-up initiatives.
- To continue with the high resolution mapping, by extending cover to the whole of the North Sea and possibly the Irish Sea. (Annex 8).
- To review existing coarse grid map systems currently in use to inform selection of WGMHM standard for low resolution synoptic mapping at the ICES regional scale.
- To produce low resolution, broad-scale coarse grid maps of habitat for the whole ICES area to a mapping standard to be set by the WGMHM. Production of these synoptic maps will require either provision of low resolution data or completed maps from various participating countries. Within this map local/regional mapping initiatives could be represented.
- National status reports on mapping and classification will be requested for input.

- WGMHM will explore the setting up of a data exchange platform to service the above initiatives. This should result in the establishment of an ICES habitat mapping metadatabase containing standardized and verified metadata. This should provide information on: difficulties in coupling mapping projects, common problems in classification, data handling and quality issues, development of common goals, and potential overlap with existing projects, and intercalibration of classification, mapping, and development of potential quality checks.
- To facilitate further refinement of the EUNIS pelagic classification. To this end the WGMHM had put forward a list of names of experts to be consulted. This list includes experts on bentho-pelagic, pelagic and neuston habitats.

6.1 Proposed Terms of reference for WGMHM for 2002

ICES C.Res. 2001/

The Working Group on Marine Habitat Mapping (Chair: E. Jagtman, Netherlands) will meet from date-date in venue to review developments in marine habitat classification and habitat mapping, in particular to:

a) to collate and review national status reports on marine habitat mapping;

b) to discuss progress in the development of high resolution habitat maps, with a focus on the North Sea and possibly the Irish Sea;

c) to discuss progress in the production of low resolution, broad-scale coarse grid maps of habitats for the whole ICES area;

d) to discuss progress in the setting up of a data exchange platform to service the above initiatives and to develop standards or best practices for data handling with regard to habitat maps.

References

Foster-Smith *et al.*, 1996. Mapping survey of the littoral and sublittoral biotopes of the Berwickshire coast Scottish Natural Heritage Research, Survey and Monitoring report. No. 60.

ANNEX 1: AGENDA

Working Group on Marine Habitat Mapping (WGMHM) in Galway, Ireland

3 APRIL 2001, TUESDAY

10.00 Opening (Forster Court Hotel, Galway) by Anthony Grehan (Host)

1) Arrangements for the meeting (working hours, lunch, venue etc.)

2) Participants to introduce themselves

3) Further announcements:

- Article received by Geoff Meaden: Gaining flexibility for marine habitat modelling and mapping
- Invitation by Malcolm Thomson to participate in a future workshop on the SUMARE-project to develop the use of autonomous underwater vehicles for mapping sebad resources (maerl banks and sand banks) (www.mumm.ac.be/SUMARE/)
- Theme session in 2002 on integration of (acoustic) survey technologies and marine biological data
- Development of Ecological Quality Objectives for OSPAR; role of ICES

4) **List of documents distributed**
(also available from: www.ices.dk/reports/mhc/2001/wgmhm/meeting_documents)

- cres00.doc: terms of reference for WGMHM in 2001
- mhc00.doc: Draft report from the meeting of the Marine Habitat Committee at ASC 2000 in Bruges
- wkshop.pdf: Complete Summary Record of the OSPAR/ICES/EEA Workshop on Marine Habitat Classification held in Southampton from 18–22 September 2000
- osparbdc.pdf: Proposal by UK to OSPAR Biodiversity Committee regarding progress and future work on habitat classification and mapping
- full arc report.doc: summary record of ARC workshop on marine and estuarine ecosystem and habitat classification
- proposals feb01v3.doc: EUNIS HABITAT CLASSIFICATION. Suggested implementation of proposals made at Southampton, September 2000 (Cynthia Davies and Dorian Moss)
- report on theme session.doc: summary record of ASC theme session in marine habitat classification and mapping (Bruges, 2000)
- agenda for the 2001 wgmhm.doc: agenda for wgmhm meeting in Galway, Ireland
- report on Workshop on Deep-Seabed Survey technologies (version 3; 15 february 2001)

5) Adoption of the Agenda

6) Rapporteurs for the meeting

7) Introduction of Terms of Reference (Eric Jagtman; Chair)

8) Progress in habitat classification

Review the outcome of the Second OSPAR/ICES/EEA Workshop on Habitat Classification and Biogeographic Regions (Southampton):

- Introduction of work done in Southampton; David Connor
- Progress in classification of pelagic habitats; Yolanda Sagarminaga
- Suggested implementation of proposals made at Southampton, September 2000

Further progress in habitat classification:

- Introduction on Canadian developments by Paul Boudreau

Review of other reports brought to the working group:

- Theme Session on Classification and Mapping of Marine Habitats, Bruges Annual Science Conference 2000 (Dick de Jong)

4 APRIL 2001, WEDNESDAY

Start of discussion, with the aim to

- prepare a strategy plan how to deal with pelagic habitats, taking into account the outcomes of the Southampton workshop.
- prepare material for a discussion on the various classification systems, their advantages and disadvantages to be dealt with in ACME ('how to move forward?');
- collate comments to the EUNIS classification system to be handed over to the EEA;
- invite comments from WGEXT and WGECO;
- make proposals for future joint activities (workplan for WGMHM).

5 APRIL 2001, THURSDAY

Progress in habitat mapping

Review the outcome of the ICES workshop on deep-water survey technologies and the development of standards for marine habitat mapping:

- Presentation by Anthony Grehan on behalf of Tomas Noji (IMR; Norway).

Habitat maps of the North Sea or Wadden Sea:

- presentation by James Massey (North Sea map)
- presentation by Dick de Jong (North Sea map)
- presentation by Craig Brown

Deep sea maps

- Progress in developing deep sea maps

OSPAR area map

- Progress in developing OSPAR coarse grid map (information by David Connor)

Preparation of guidelines for habitat mapping and data-handling

Discussion on the development of a GIS database for habitats, with cost estimates included

- (CANCELLED) Presentation by Geoff Meaden, Gaining flexibility for Marine Habitat Modelling ands Mapping (Canterbury Christ Church University College). *Paper will be distributed among WGMHM-members for discussion during the meeting.*

- Time allowing: Discussion of results on the development of Ecological Quality Objectives for habitats in the North Sea (OSPAR project, contracted by IMR and RIKZ). Hein-Rune Skjoldal from IMR will be present on Thursday to introduce this subject.
- Next years meeting: date and venue, including discussion on future work (draft workplan)

6 APRIL 2001, FRIDAY

Presentation of draft workshop report (summary record)

Adoption of Report

13.00 Closing of the meeting

ANNEX 2: LIST OF PARTICIPANTS

WORKING GROUP ON MARINE HABITAT MAPPING

3–6 April 2001

Name	Address	Telephone no.	Fax no.	E-mail
Brendan Ball	Ireland			
Paul Boudreau	Canada			
Colin Brown	Ireland			
Craig Brown	England			
David Connor	England			
Cynthia Davies	England			
Steven Degraer	Belgium			
Anthony Grehan	Ireland			
Brigitte Guillaumont	France			
Eric Jagtman (Chair)	Netherlands			
Dick de Jong	Netherlands			
James Massey	England			
Dorian Moss	England			
Frances O'Beirn	Ireland			
Yolanda Sagarminaga	Spain			
Matt Service	England			
Liz Sides	Ireland			
Hein-Rune Skjoldal	Norway			
Laurence Vigin	Belgium			

ANNEX 3: STATE OF PROGRESS ON PELAGIC HABITAT CLASSIFICATION

In the framework of joint OSPAR/ICES/EEA habitat classification workshops

Yolanda Sagarminaga (Spain)

Galway, 3–6 April 2001

At the 1st meeting of the ICES Study Group on Marine Habitat Mapping (SGMHM) held in Oban, Scotland, from 6–10 September 1999, in conjunction with a joint OSPAR/ICES/EEA Workshop on habitat classification (OSPAR/ICES/EEA, 1999), the pelagic zone was not discussed officially, but informal contact with workshop participants resulted in a proposed classification for pelagic habitats (A7).

During the SGMHM 2nd meeting held in The Hague (The Netherlands) from 10–13 April 2000, it was pointed out that within the EUNIS habitat classification the pelagic zone had not been as developed as other marine zones, and a recommendation was made for further development of this item during the Second OSPAR /ICES/EEA Workshop on Marine Habitat Classification to be held at the Southampton Oceanographic Institute (UK) from 18–22 September 2000.

In Southampton, four parallel sub-groups on deep-sea, sediment, rock and pelagic habitats, were set up to further discuss the current EUNIS classification during the duration of the workshop. Each sub-group produced a report of their work.

The constituted sub-group for pelagic habitats was composed by Dr Sabine Christiansen (WWF), Paul Boudreau (Canada), and Dr Thomas Noji (Norway), and Yolanda Sagarminaga (Spain).

The proposals made by this group were the following:

1) The EUNIS classification system for pelagic habitats was substantially revised. The main reasons for this were:

q) Important habitat complexes, e.g., bentho-pelagic zones were lost at lower levels. Besides this, a problem noted with the current structure of EUNIS was that where at level 2 in the benthic section had already been divided into several units, the pelagic section had only one.

Thus, the sub-group proposed to divide level 2 based on media/interface.

Media Interface

Air/water	→	Neuston
Ice/water	→	Ice associated habitats
Water column	→	Pelagic habitats
Water/Seabed	→	Bentho-pelagic habitats
Seabed	→	Benthic habitats

q) Preliminary classifications on ice-associated habitats and Neuston were proposed, but it was recognised that more development and expertise are needed, which applies as well to the bentho-pelagial zone.

NEUSTON → Permanent/Temporal Neuston layer

ICE ASS. HAB. → Brine Channel → 1st Year/Multiyear

Under-Ice Habitats - 1st Year/Multiyear

Fresh-water Ice habitats

q) The current EUNIS version of the pelagic habitat classification relied largely upon geographical boundaries and references (enclosed, not enclosed, etc.) which did not express the fundamental tools for classifying habitats in the pelagic realm. The sub-group believes that it is important to base early decision making steps in the classification key on ecologically relevant physical processes.

Due to the 3d aspect of the classification of pelagic habitats, use of processes in key decision making steps is much more relevant than referencing to fixed geographical features or points.

The use of process-related criteria facilitates modelling of pelagic habitats in the future.

The revised version more clearly reflects the sub-groups belief that it is more important to characterize the water column rather than a water mass.

q) It is essential to develop a pelagic classification system that can be easily linked to the benthic system of classification.

q) Criteria adopted for a pelagic classification regarded:

- Extent of Vertical mixing as a disaggregator between shallow and deep waters.
- Residence Time (Long/short/Medium)
- Gradients (Horizontal and vertical)
- Temporal resolution (Persistent/Seasonal/ephemeral)
- Fresh water influence
- Light influence
- Bathymetry

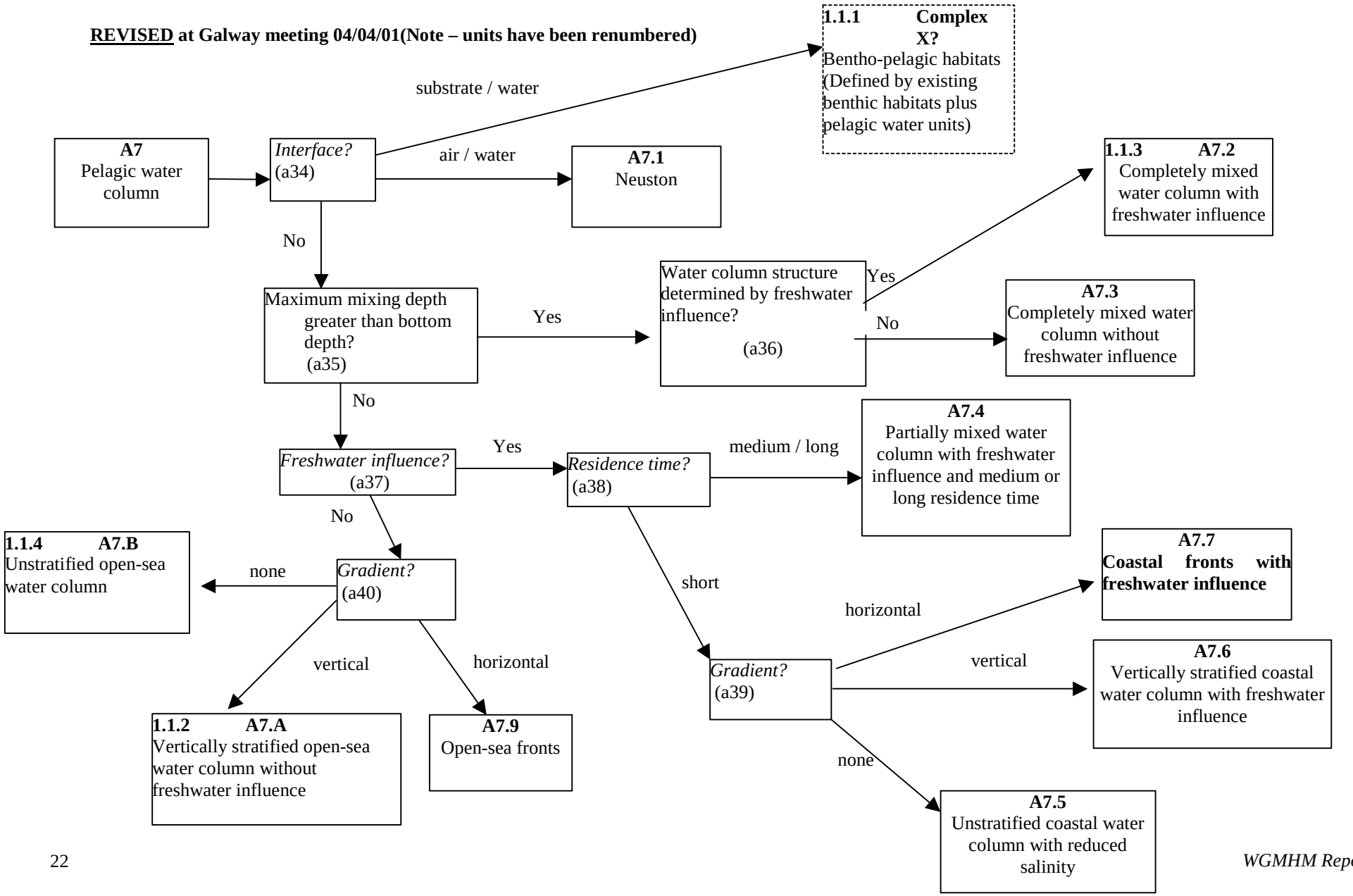
The scheme developed in Southampton is shown in Figure 2.The proposal for including these criteria and habitats into the EUNIS scheme was sent by Cynthia Davies to the co-workers of the group and showed the scheme presented in Figure 3.

q) The criteria applied need to be reviewed and defined by additional experts. For example residence time is used only in a relative sense in this version. More development of residence times in relation to biological development (e.g., Generation time of Key species) is suggested.

In The Hague it was suggested that when The Study Group on Marine Habitat Mapping [SGMHM] (Chair: E. Jagtman, Netherlands) would meet in 3–6 April 2001 at the Martin Ryan Institute of the National University of Ireland in Galway, Ireland it would be necessary to review developments in marine habitat classification and habitat mapping, and concerning the pelagic habitats in particular, to prepare a strategy plan how to deal with pelagic habitats, taking into account the outcomes of the Southampton workshop.

ANNEX 4: DRAFT EUNIS HABITAT CLASSIFICATION: CRITERIA FOR PELAGIC HABITATS (A7) TO LEVEL 3

(number) refers to explanatory notes to the key



Explanatory notes to the key: Level 3 (Habitat type A7)

a34) Is the habitat developed at the interface between the *substrate / water*; *air / water;* or in the main water column (path = *No*)? Note that where the habitat is developed at the interface between the substrate and water it is best described as Complex X… - a combination of units from A1–6 and A7.

a35) Is the water column subject to complete mixing (Path = *Yes*) due to its relatively shallow nature, or is the depth of the water body greater than the depth of mixing (Path = *No*)?

a36) Is the water column influenced by freshwater i.e., is the salinity reduced relative to the adjacent fully marine seawater (Path = *Yes*)? These units are usually found in relatively shallow, coastal situations. (NB: need to have a better definition of freshwater influence as this will vary according t the geographic region).

Note: Level 4 units in A7.2 and A7.3 are separated according to the residence time – short, medium or long. Short residence time is defined as changing diurnally, medium residence time is greater than daily and up to about 14 days (based on the tiem required for the phytoplankton population to double) and long residence time lasting longer than 14 days. (NB: More information/better standard definition required.)

a37) Water columns which are deeper than the maximum mixing depth and which have reduced salinity relative to adjacent fully marine waters are separated (Path = *Yes*). These units are usually found in deeper coastal water situations. (NB: Need to have a better definition of freshwater influence as this will vary according to the geographic region).

a38) Partially mixed reduced salinity waters with a *short* residence time are separated from those with *medium or long* residence times.

a39) Reduced salinity habitats characterised by the type and degree of gradient are distinguished: those with pronounced *vertical* stratification (e.g., caused by atmospheric temperature, river discharge influence or ice-melt); *horizontal* gradients giving rise to fronts; and those with very weak gradients or *none*.

Note: Units with vertical stratification are separated at level 4 by the cause and degree of persistence of the gradient — e.g., seasonal temperature gradients or persistent salinity gradients etc. Units with horizontal stratification are separated at level 4 by the degree of persistence of the stratification

a40) Full salinity habitats characterised by the degree and direction of gradient are distinguished: those with pronounced *vertical* stratification (e.g., caused by atmospheric tenperature); *horizontal* gradients giving rise to fronts; and those with very weak gradients or *none*.

Note: Units with horizontal stratification are separated at level 4 by the degree of persistence of the stratification — ephemeral such as eddies, gyres and upwellings; seasonal upwellings or persistent water mass interfaces. Note: The pelagic classification at level 4 and below should be based on multiple sampling events because of the strong temporal nature of the pelagic classification

A7 Pelagic water column

A7.1 Neuston

A7.11 Temporary neuston layer

A7.12 Permanent neuston layer

A7.2 Completely mixed water column with freshwater influence *(Alternative title: Completely mixed water column with reduced salinity)*

A7.21 Completely mixed water column influenced by freshwater with short residence time

A7.22 Completely mixed water column influenced by freshwater with medium residence time

A7.23 Completely mixed water column influenced by freshwater with long residence time

A7.3 Completely mixed water column without freshwater influence *(Alternative title: Completely mixed water column with full salinity)*

A7.31 Completely mixed water column not influenced by freshwater with short residence time

A7.32 Completely mixed water column not influenced by freshwater with medium residence time

A7.33 Completely mixed water column not influenced by freshwater with long residence time

A7.4 Partially mixed water column with freshwater influence and medium or long residence time (Alternative title: Partially mixed water column with reduced salinity and medium or long residence time)

A7.41 Partially mixed water column with freshwater influence and medium residence time

A7.41 Partially mixed water column with freshwater influence and long residence time

A7.5 Unstratified coastal water column with reduced salinity

A7.6 Vertically stratified coastal water column with freshwater influence *(Alternative – 'with reduced salinity')*

A7.61 Coastal water with ephemeral thermal stratification

A7.62 Coastal water with seasonal thermal stratification

A7.63 Coastal water with permanent thermal stratification

A7.64 Coastal water with ephemeral halocline

A7.65 Coastal water with seasonal halocline

A7.66 Coastal water with permanent halocline

A7.67 Coastal water with ephemeral oxygen stratification

A7.68 Coastal water with seasonal oxygen stratification

A7.69 Coastal water with permanent oxygen stratification

A7.7 Coastal fronts with freshwater influence *(Alternative – 'with reduced salinity')*

A7.71 Ephemeral coastal water front

A7.72 Seasonal coastal water front

A7.73 Persistent coastal water front

A7.8 Open-sea fronts

A7.81 Ephemeral open-sea fronts

A7.81 Seasonal open-sea fronts

A7.81 Permanent open-sea fronts

A7.9 Vertically stratified open-sea water column without freshwater influence

A7.91 Open-sea water with ephemeral thermal stratification

A7.92 Open-sea water with seasonal thermal stratification

A7.93 Open-sea water with permanent thermal stratification

A7.94 Open-sea water with ephemeral halocline *(is this required?)*

A7.95 Open-sea water with seasonal halocline *(is this required?)*

A7.96 Open-sea water with permanent halocline *(is this required?)*

A7.97 Open-sea water with ephemeral oxygen stratification

A7.98 Open-sea water with seasonal oxygen stratification

A7.99 Open-sea water with permanent oxygen stratification

A7.A Unstratified open-sea water column

A7.A1 Open-sea euphotic zone (epipelagic)

A7.A2 Open-sea mesopelagic zone

A7.A3 Open-sea bathypelagic zone

A7.A4 Open-sea abyssopelagic zone

ANNEX 5: TERMS OF REFERENCE FOR 2001

2:E:08 The Study Group on Marine Habitat Mapping [SGMHM] will be re-established as the Working Group on Marine Habitat Mapping [WGMHM] (Chair: E. Jagtman, Netherlands) and will meet in Galway, Ireland from 3–6 April 2001 to:

a) review the results of the Second OSPAR/ICES/EEA Workshop on Habitat Classification and Biogeographic Regions (Southampton), the Second Aquatic Restoration and Conservation (ARC) Workshop on Habitat Classification, the Theme Session on Classification and Mapping of Marine Habitats, for consideration in the WGMHM Workplan, and will prepare material for a discussion on the various classification systems, their advantages and disadvantages, to be dealt with by ACME;

b) report on progress made in the joint WGMHM/WGEXT/BEWG plans on habitat mapping projects (habitat map of the North Sea, Wadden Sea, deep sea map, OSPAR area map to level 3 of the EUNIS classification system);

c) review the outcome of the ICES workshop on Deep-Water Survey Technologies and the development of standards for marine habitat mapping and initiate the preparations of guidelines for habitat mapping and data handling;

d) collate comments to the EUNIS classification system, including comments from BEWG, WGECO, and WGEXT, to be handed over to the EEA after review by ACME;

e) prepare a strategy plan for how to deal with pelagic habitats, taking into account the outcome of the Southampton workshop;

f) prepare a proposal for the development of a GIS database for habitats with cost estimates included and potential sources of data to be submitted.

WGMHM will report by 20 April 2001 for the attention of the Marine Habitat Committee and ACME.

ANNEX 6: PROPOSED ADAPTATIONS IN THE EUNIS CLASSIFICATION

Presentation by Dorian Moss

EUNIS HABITAT CLASSIFICATION

CYNTHIA DAVIES & DORIAN MOSS

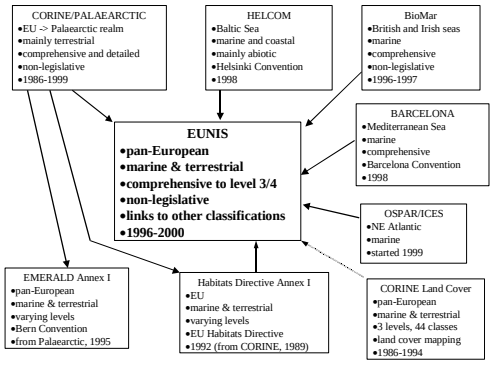
EUROPEAN ENVIRONMENT AGENCY

CENTRE FOR ECOLOGY AND HYDROLOGY
MONKS WOOD, UK

Aims of the classification:

- provide a common language
- enable mapping of units at a regional level
- comprehensive and applicable at different levels of complexity
- allow aggregation, evaluation and monitoring of habitat units
- provide a common framework: new information and links to other classifications

Relationships between classifications



Principles of the classification (1)

- Classification is hierarchical
- Units at a given hierarchical level to be of similar importance
- Clear criteria for each division
- Logical sequence of units
- Use clearly defined non-technical language

Principles of the classification (2)

- Ecologically distinct habitat types supporting different plant and animal communities should be separated
- Habitats from different locations differing on the basis of geographical range only should not be separated
- Habitat units and habitat complexes are separated

Future plans

Stability at level 3 to allow proper feedback and field testing

- Fill in parameter frame with data from e.g BioMar and Physis databases
- Collate feedback from the website publication, ICES working groups etc.
- Incorporate relevant comments
- Explore how to link national systems to the EUNIS classification

POINTS TO REMEMBER

- Hierarchical structure and criteria
- Avoidance of duplication of biotopes
- Level 4 groupings of functional groups
- Level 5 groupings of detailed geographical variants
- Adequate geographical coverage
- Missing level 3 units?
- Expansion of level 3/4 titles to allow variants to be grouped together
- Defined parameters

Habitat classification website: developed at
http://mrw.wallonie.be/dgrne/sibw/EUNIS/home.html

Contents of the website
- More information on the EUNIS Habitat classification
- Main entries of the list of habitat types
- Key for identification
  - Criteria for identification of habitats (box by box and page by page mode)
  - Gallery of criteria diagrams
- Habitat search tool
- Glossary of terms
- Download
  - Key
  - List of habitat types
  - EUNIS links with Habitats Directive Annex I
  - EUNIS links with Bern Convention habitats
  - EUNIS links with the Palaearctic habitat classification
  - EUNIS links with CORINE Land Cover

Using the web site

ANNEX 7: REPORT OF WORKSHOP ON DEEP-SEA SURVEY TECHNOLOGIES

Workshop on Deep-Seabed Survey Technologies (WKDSST)

Thomas T. Noji, Chair

Arne Hassel, rapporteur

31 January–2 February 2001 in Bergen, Norway.

Terms of Reference

Background

- Growing interest in maritime countries to conduct marine habitat mapping surveys.
- Advances in acoustic as well as database technology (GIS) enabling the rapid collection, archiving and presentation of survey and other data
- At the first SGMHM meeting in Oban, Scotland from 6–10 September 1999, three joint OSPAR/ICES proposals were supported to advance developments in the production of high-quality habitat maps:

  ”To carry out cooperative comparison of deep-sea survey technologies and to explore the possible development of standards in this field”

Scope of the workshop

- need to initiate collaboration between institutes conducting or planning marine habitat investigations
- to discuss survey technologies and strategies, data formats and mapping products for deep-water habitats.
- cover a range of environments from shelf depths to the deep sea.

Objectives of the Workshop

- Compile and review information on deep-sea survey technology to map the seabed and benthic habitats;
- Identify and compile information on existing data sets from mapping of the sea bed and benthic habitats;
- Consider harmonization or standardization of survey technology, data processing, interpretation and map products (GIS) for future applications;
- Consider collaboration and possible joint projects between ICES countries on marine habitat mapping field activities.

Briefing Presentations

Series of briefing presentations about current or planned deep-water mapping activities which included discussion of:

- Regional/habitat specific mapping efforts
- Emerging mapping technologies
- habitat characterisation schemes
- data visualisation, databasing and GIS

Working Group Tasks

Participants split into 3 groups to each work on the following tasks:

Day-1 tasks (1a) Assess and recommend, if possible, strategies for collecting field data for marine habitat mapping; (1b) compare and recommend, if possible, technologies used for marine habitat mapping

Day-2 tasks: (2a) Assess and recommend, if possible, formats for marine data; (2b) assess database types and requirements with respect to ease of data exchange as well as research and management applications

Day-3 tasks: (3a) Identify large-scale marine habitat mapping needs; (3b) discuss proposals for cooperation and joint projects

Day 1 Plenary Comments and Recommendations

General Principals

Working Definition of Habitat: ”Set of physical, chemical and biological conditions on the sea floor and in the water column in which flora and fauna exist”

- A particular habitat is affected by oceanographic conditions:
    - geological
    - physical
    - chemical
    - biological
      e.g., seabed morphology, sediment texture, water mass dynamics, nutrient supply, fauna, etc. Note that habitat encompasses both spatial and temporal variables.

It was noted that this working definition is in accordance with terms used in the report on Habitat Classification by the European Topic Centre on Nature Conservation (ETC/NC) nature information system (EUNIS).

Recommendations:

1a. Strategies

It is crucial to ”mine” existing scientific data before designing and executing new field surveys.

Purposes of the survey for present and future uses should be considered when planning and conducting field surveys.

Water depth and substrate should be considered with regard to the technologies suitable for the survey.

Cost vs. funding availability should be considered with regard to the selection of technologies used for the survey.

There is a need to identify the scale of the habitat of interest, i.e., small region (tens of meters) up to large regions (e.g., continental shelf).

Even if the area of interest is relatively small, it is essential to assess this within the larger regional setting.

1b. Technologies

Acoustic Survey Design

- Collect and archive data, i.e., do not discard any data which are not immediately used, as they may be instrumental for future purposes.
- There is a need to define the attributes that can be mapped by each technique.
- Choose the highest resolution appropriate to the definition of the surficial sea floor substrates, size of area and depth.
- Multibeam echo-sounding (ME) and ME backscatter data should usually be the first choice as a tool for describing the sea floor for all except small-scale surveys. Small-scale surveys are best conducted with high-resolution tools.

Ground truthing

- Various methods can be used depending upon study objective.

- Remote sensing data must be ground-truthed
- Photographic technology (still camera / video) is useful for medium-scale transects and fine-scale discrete sites. Affected by turbidity - alternatives include ”acoustic” photography and laser line scanning and laser stripping.
- Coring and grab sampling is useful at discrete sites.

Acoustic Backscatter Groundtruthing and Calibratio

Calibration:

- understanding the acoustic parameters of survey system;
- frequency, gain level, etc. of transmitted/received signal;
- acoustic footprint, beam angle, water column structure.

Groundtruthing:

- Interpretation with reference to sample, video, and other types of data;
- Use high frequency acoustic systems;

Backscatter dominated by surface texture and roughness of seafloor

- Photographic data good for groundtruthing;
- Low frequency systems - penetrate sub-seafloor as backscatter will have component of subsurface input - substrate sampling will give better groundtruth.

Other considerations

- The Wentworth scale is still valid for definitions in particle size.
- Groundtruthing should always be bottom georeferenced.
- Accuracy of navigation is extremely important.
- The development of new technologies and their application should be encouraged if the technologies are proven to be robust
- Non-destructive methods (e.g., photography) should be used if possible, particularly where long-term monitoring is intended.

2a. Data formats

a) It is important to establish the type of data:
   Spatial data, e.g., point, line, area;
   Non-spatial data, e.g., rates, derived data products, etc.;
   Raster or vector types.

b) Raw data should always be stored in their native format.

c) Raw data should always be stored in the original resolution.

General recommendations

- refer to established international standards and data formats.
- for aerial remote sensing.
- for routine oceanography measurements.
- IHO standards are being developed for multibeam bathymetric data gathered during large-scale surveys. Multibeam data quality control procedures should be employed and documented.

- Backscatter data, and other derived mapping parameters, may be transferred and stored image format (e.g., GEOTIFF).
- No standards exist to our knowledge for small-scale remote sensing (e.g., photography, video records). A proper record of supporting data (e.g., georeferencing, image scaling) should be ensured. Still photos can be made more accessible if they are available on commonly used data storage media, e.g., CD-ROM.
- When raw data must be reformatted, if possible, it should be done according to international standards. Some current formats may be acceptable under ISO (International Organization for Standardization). Commonly used formats include ASCII, CSV, DXF, VPF (vector product format) and GEOTIFF (for images).
- Data formats should be in accordance with end-user needs.
- It is vital that corresponding metadata are accessible.
- If possible, geological core samples as well as seabed fauna should be archived in repositories.
- Data originating from publicly funded research should be made publicly available.

2b. Meta-data

a) Meta-data must comply with international standards. Some current standards are published by the U.S. Federal Geographic Data Committee (FGDC; FGDC-STD-001–1998), and these are in the process of "harmonization" with ISO standards.

b) When possible, use of meta-data authoring tools should be used rather than "free form" written documentation

c) Meta-data should be recorded as data are recorded and not afterward.

d) The data dictionary within the meta-data must be available, since it is critical for the documentation of codes used for data attributes.

e) There must be a clear audit trail (gear, procedures, etc.) for all analysis and interpretation of data e.g., to permit future re-interpretation of the data. There is often a need for clarification of interpreted data due to "value" added beyond the original raw data.

f) "Common denominators" from established meta-databases should be identified and should eventually be part of a recommendation by ICES for ICES standards. A number of organizations (ROSCOP/EDMED, EU initiatives, U.S.G.S.) have defined standards. The GCMD for earth sciences is a large international library for meta-databases (Global Change Master Directory at http://gcmd.gsfc.nasa.gov).

g) Geodetic information should be fully documented to permit e.g., re-projection to other systems. The documentation should include complete description of the datum and offsets applied.

3. Large-scale habitat mapping needs and future collaboration

3a. Possible themes for concerted-action projects:

- production of new thematic maps;
- identify metadata sources relevant for habitat mapping;
- habitat mapping in relation to fisheries-related issues such as "essential fish habitats";
- habitat mapping in relation to biodiversity issues and marine protected areas;
- habitat mapping in relation to other relevant issues;
- long-term monitoring programs for marine habitats;
- technological development of marine habitat mapping tools.

3b. Possible joint field surveys

Oceanographic sites of interest, which could be a focal point for **field surveys** related to habitat mapping were considered. Two regions were presented by researchers, who seek collaboration. These were:

1) Mapping of the deep-sea benthos in the Azores - Seamount biology, marine resources, hydrothermal vents; contact person Ricardo Santos;

2) Mapping at mid-Atlantic Ridge as part of Census of Life investigations - contact person Jan Helge Fosså or Odd Aksel Bergstad (odd.aksel.bergstad@iMrno) also at IMR.

It was noted that there may be a need for a reference site for the above 2 sites, as the sites under (a) and (b) are characterized by rapid changes and extremes in bathymetry.

Concerted Action Initiative Steering Group

Objectives

- New thematic maps useful for management in:
    - fisheries
    - biodiversity
- Standardisation through creation of a glossary of terms
- Provide management performance measures for MPA's etc.
- Technological development, standards, quality control, etc.
- Identify existing meta-data sources relevant to habitat mapping

Follow-up meeting

- Linked to *Geology of Marine Habitat* special session being held in St. John's, Newfoundland at end of May.
- Follow up meeting on Thursday, May 31 and Friday, June1, 2001.
- Hosted by the Geological Survey of Canada, Bedford Institute of Oceanography, in Dartmouth, Nova Scotia, Canada.

Workshop Conclusions

- Large-scale marine habitat mapping of the sea floor has become a reality
- Integration in GIS databases of geological, chemical and biological data facilitates access to and visualization of information about marine habitats.
- Integrating information on human activities in multi-layered products will prove particularly important as tools for environmental managers and other end-users.
- The production of detailed maps and the implementation of long-term monitoring of marine habitats are and shall become increasingly important for the management and protection of marine resources including biodiversity.

ANNEX 8: PROPOSAL FOR HABITAT MAPPING PILOT STUDY IN THE NORTH SEA

General Objective

Through a pilot study in the North Sea, advance habitat mapping to support sustainable development in the marine environment.

Specific Objectives

1) Identify relevant existing data sets and assess their availability, cost and quality
2) Develop methods for standardisation of existing data
3) Produce guidelines for new data surveys to fill gaps
4) Agree comparable standards for map production
5) Co-ordinate joint thematic mapping ventures to service user defined requirements.
6) To investigate the linking of intertidal and subtidal maps that deal with different scales

Rationale

The WGMHM, as part of its terms of reference, has undertaken to advance habitat mapping and classification within the ICES area. Building on existing mapping efforts by group participants in part of the North Sea, this proposal will extend the area of operation to the entire North Sea. This will involve collaboration between several group participants and will act as a pilot study for broad scale, collaborative mapping efforts which can in the future be applied to the whole of the ICES area. This proposal will attempt to create a generic GIS framework capable of resolving the various data handling issues which will arise during map production.

ANNEX 9: MARINE HABITAT MAPPING OF THE SOUTHERN NORTH SEA AND THE INTERNATIONAL WADDEN SEA

D J de Jong & K Jerosch (Rijkswaterstaat-RIKZ, P.O.box 8039, 4330 EA Middelburg, The Netherlands. Email: D.J.dJong@RIKZ.RWS.MinVenW.NL)

At the first SGMHM meeting, held in cooperation with the OSPAR/EEA habitat classification workshop in Oban, Scotland from 6–10 September 1999, SGMHM agreed on the support of three ICES/OSPAR proposals to advance developments in the production of high-quality habitat maps. One proposal was to produce a detailed habitat map of the Southern North Sea and the international Wadden Sea using existing data, to test data access, data compatibility and cooperation between Contracting parties.

Miss K Jerosch (Germany) and Mr D J de Jong (NL) carried out the work. The work is still continuing so this is an interim report.

Aims of the project

Aims of the project are: 1) to make habitat maps (EUNIS level 3 or 4) of the Southern North Sea (up to the Dogger bank) and the international Wadden Sea, and 2) to find out what kind of problems there are in making such maps with concern to availability and collection of data and fit of data of different sources.

Results

Generally people were very cooperative and access was given to several databases, but for some areas hardly any data could be collected in a period of six months. Many problems had to be overcome with the data collected. Many data were only available as raw data and (to) often the metadata were incomplete or even absent. This caused many problems in combining data from different sources as different methods of data collection and analyses were used. E.g. for bathymetrical maps different base levels were used. Also different projections, sometimes without notification which projection, were used and some maps were only available in an already classified way which generally did not fit with the EUNIS classification; see table.

EUNIS classification name	% mud	Map German Wadden Sea	Folk classification
Mixed sediment	0		
Gravel	0		
Sand	0–10	0–5/5–10	0–10
Muddy sand	10–30	11–20	10–50
Sandy mud	30–80	21–50	50–90
Mud	80–100	>50	90–100

The available map data are combined when possible. In the case no acceptable map could be composed available ‘paper maps’ were digitised (e.g., bathymetric map of the Southern North Sea; see below).

For the North Sea a sample set from CEFAS (UK), containing data on macrozoobenthos, sediment composition and depth, is used for further analyses with respect to a biotic classification in relation with abiotic parameters. This classification was carried out in two ways. With TWINSPAN a clustering to 14 clusters was carried out. These TWINSPAN clusters (based on the macrozoobenthos) as well as 6 possible own defined groups of clusters (defined with respect to sediment or depth) were tested with IndVal (see below). This is a technique that tests a proposed classification for indicator species in each cluster. From these tests it turned out that both the TWINSPAN clustering as well as one of the own defined clusters (with respect to sediment composition) gave a positive result with one or more indicator species for each cluster.

A report is made (still a draft) in which these results are described. This will become available soon.

To be continued

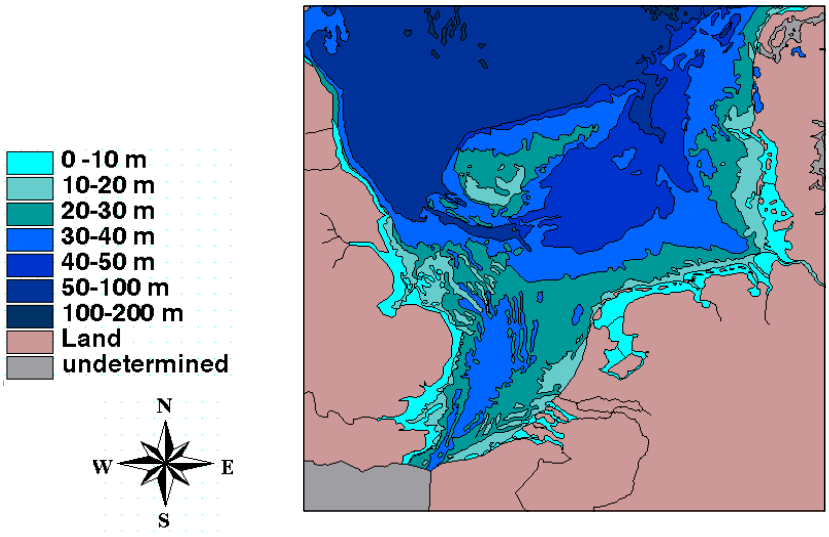
In a second part of the project the clustering results will be worked out into a habitat map for the Southern North Sea. Next, a similar procedure will be carried out for the International Wadden Sea. This will be described in a second report, to be come available around September 2001.

Conclusions/recommendations

Although the project is not finished yet, some major conclusions and recommendations can be made already. 1) It is difficult to get a good overview of all institutes that might have useful data for the preparation of habitat maps and available data; it is important that an overview will be made on this subject. Metadata are often incomplete or even absent. This must be improved as it turned out to be very difficult to retrace metadata that are absent. Many (especially map) data is stored in a preclassified way, which hampers adaptation to new classifications. Data storage should be done without classification and the original data should be stored as well.

IndVal

IndVal (Indicator Value) is a method to distinguish indicator species characterizing groups of samples ('clusters') that are defined by the user. It looks for species that are characteristic for a group of samples, viz. species that are present in a group and in all samples of that group. More information can be found on the website: mrw.wallonie.be/dgrne/sibw/outils/indval/home.html.



Bathymetric map of the southern North Sea; digitized from ICONA Atlas of the North Sea

ANNEX 10: HABITAT MAP FOR THE CENTRAL NORTH SEA

James Massey, Glasgow Marine Technology Centre "*Mapping biological information in the North Sea"*

There are no current tools for quantitative environmental risk assessment using biological information to answer 'what if?' scenarios. New projects requiring environmental information are continually collected at great cost. The projects aim is to provide biological information for the offshore industry to allow effective site-specific environmental risk assessment. The project has no provisions for collecting new data; therefore existing data sources have been evaluated.

In the first year environmental consultancies, agencies and oil and gas companies were contacted and areas lacking in information were identified. It was perceived that little biological data available or used in the whole offshore process. Information that was required was collected for each new project as required. However, there is increasing legislative pressure for environmental risk assessment as the emphasis for proving there is little or no impact moves to producer. In addition, it was felt that there was no database of previous surveys or information collected. Although the numbers of web-accessed datasets appears to be increasing, no actual data can be accessed from these sources effectively. This means that there is also no comparative information for EIA[1] evaluation.

The project aims:

- provide a biological resource.
- allow multi level use.
- use existing datasets.
- provide a GIS[2] system.
- use biological communities.
- use biological evaluation to allow risk assessment.

Data has been collected form a variety of sources, including the ICES[3] '86 survey of the North Sea, and UkBenthos a database of environmental survey reports compiled by Heriot-Watt University for UKOOA[4]. These datasets have been used to create a GIS database, whilst maintaining the integrity of each individual dataset. This information is used to interpret biological information for the study area.

The Biotope classification is coded according to the JNCC[5] biotope classification system (BioMar). This can be entered into the EUNIS[6] classification scheme which is currently under development.

In addition to the biotope classification, the availability of species data means that areas where rare or red listed species have been found will be highlighted

Biological information can be provided from these data sources directly and areas can be assessed using spacial interpolation techniques, especially if detailed seabed data could be provided in the same spatial format, and areas lacking data can be quickly identified.

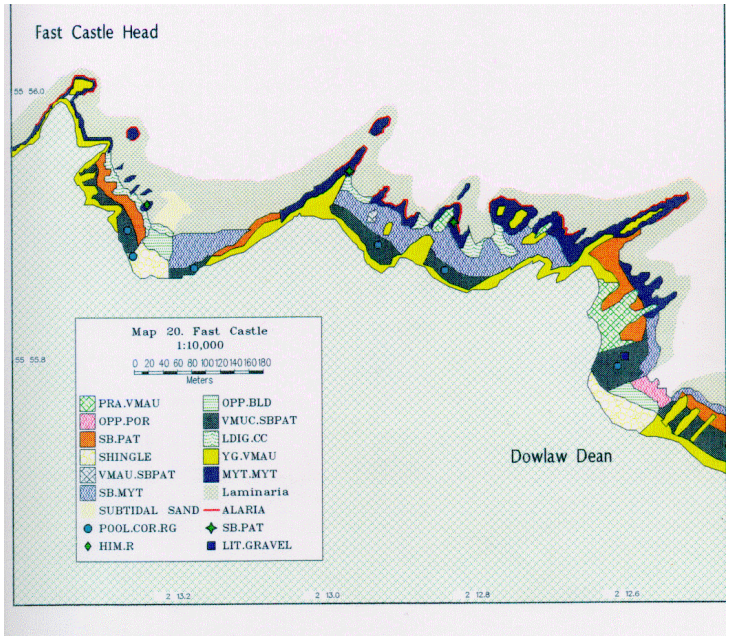
This species information can be classified into biotopes and links to the Marine Life Information Network (MarLIN). This web-based database will provide a sensitivity information for the biotope to allow risk based management.

The project is currently carrying out a study of a coastal habitat using the MarLIN information to assess sensitivity to impact in order to complete the risk assessment. It is hoped that as the classification system for the sublittoral and pelagic habitats in the EUNIS system is complete that this can be applied to the study area.

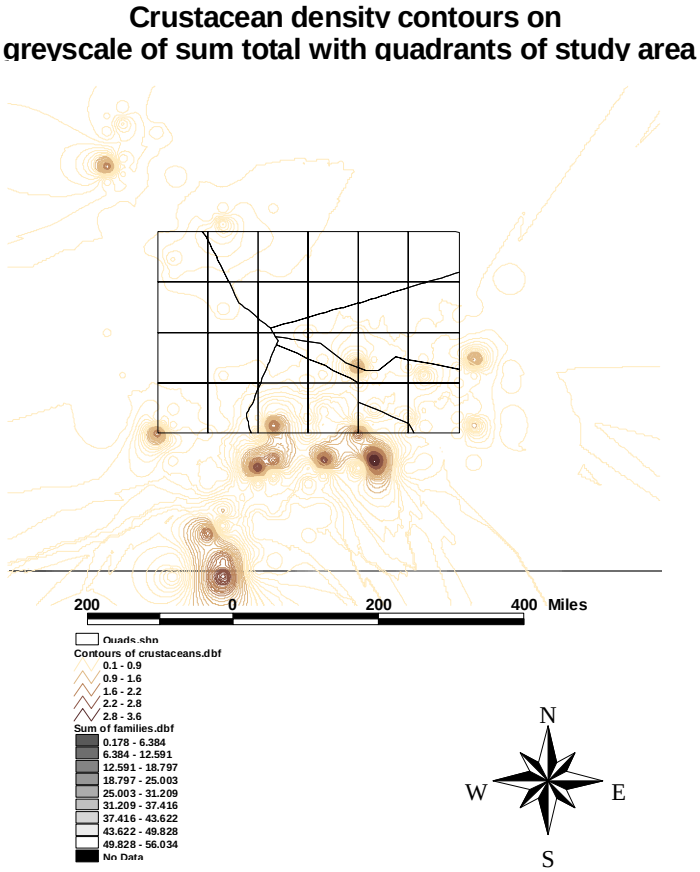
---

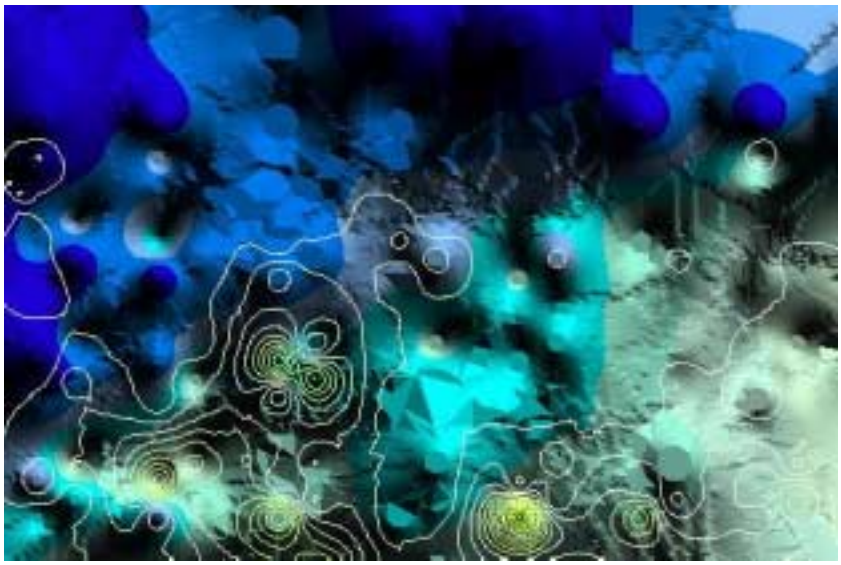
[1] EIA Environmental Impact Assessment
[2] GIS Geographical Information System.
[3] ICES International Convention for the Exploration of the Seas
[4] UKOOA United Kingdom Offshore Operators Association
[5] JNCC Joint Nature Conservation Committee
[6] EUNIS European Union Nature Identification System

The Study Area



A coastal Biotope map produced as part of the MNCR survey programme





ANNEX 11: HIGH-RESOLUTION MAPPING OF SEABED BIOTOPES IN UK COASTAL WATERS

Presentation by Craig J. Brown *et al.* CEFAS, UK

An overview of progress in the habitat mapping project was given "Mapping of gravel biotopes and an examination of the factors controlling the distribution, type and diversity of their biological communities (project A0908)". A summary of the project aims and details of the presentation are provided below.

Date project commenced: April 1998

Duration of project: 3 years

Organisation(s) undertaking research project: The Centre for Environment, Fisheries and Aquaculture Science

Collaboration with: SeaMap, University of Newcastle upon Tyne & British Geological Survey.

Funding bodies: MAFF

INTRODUCTION

Much of the seabed surface around the England and Wales coastline is comprised of coarse material. Where these deposits are present in sufficient quantity, are of the right consistency, and are accessible to commercial dredgers, they may be exploited as a source of aggregate for the construction industry, to supplement land-based sources and as a source of material for beach nourishment. It is likely that the demand for marine-won aggregate will further increase in the near future (especially to meet coastal defence needs), and construction companies are already prospecting on a much wider geographical scale for new sources of material. In timely anticipation of this increased demand for marine aggregate, this project was established to evaluate the utility of seabed mapping techniques for surveying habitats and also to evaluate the fundamental role of superficial coarse deposits in the coastal marine ecosystem.

Recent advances in acoustic technologies are offering new insights and opportunities to explore and map seabed habitats. Benthic studies have traditionally used grabs and/or dredges to quantify the invertebrate fauna of the sea floor. The data generated from such techniques provides single, geographically separated points of data across the area of seabed under investigation. In order to produce biotope maps (physical habitats and their associated biological assemblages) from such sources of data it is necessary to interpolate between these data points. However, interpolation has the potential to overlook discrete seabed features and/or biological assemblages, which may lie between sample stations. For this reason the use of acoustic techniques to assist in mapping the geographical distribution of biotopes can be seen to have many potential advantages, including the prospect of 100% coverage of the seabed as resources allow or priorities dictate.

The production of high-resolution biotope maps of the seabed will assist in future site-specific environmental assessments of potential aggregate dredging areas, and would be of value during any subsequent environmental monitoring activities. The issue of extraction licences by the Crown Estate is subject to a favourable Government View, with MAFF being an influential contributor. The development and then evaluation of the utility of mapping techniques is considered essential to ensure that the best scientific advice is available to underpin the fisheries and marine environment concerns that are MAFF's policy remit.

Research aims

Establish the utility of seabed mapping techniques for surveying habitats to provide an essential underpinning to future site-specific environmental assessments of potential dredging areas.

Fill fundamental gaps in knowledge by elucidating the major factors that operate over various scales (Km2 to m2) and are responsible for determining the character of the gravel biotope. Such factors include substrate composition and bathymetry coupled with dynamic features of the water column. This will provide a greater understanding of the sources of ecological variation and supplement knowledge regarding the functional significance of the gravel biotope to fisheries and as an environmental resource.

A major challenge for the work was to sample at relevant scales. This was achieved by deployment of state-of-the-art seabed mapping tools, closely linked with physical and biological sampling, to derive descriptions of the nature and extent of the habitat.

Objectives

The main objective of this work was to assess the utility of seabed mapping techniques for surveying habitats and examine the environmental influences affecting gravel biotope communities.

There were seven scientific objectives:

Objective 1: To characterise the seabed in an area of the eastern English Channel using various physical and geophysical techniques.

Objective 2: To incorporate biological, sedimentological and hydrographic information along with existing environmental and fisheries data into a geographic information system, in order to evaluate the functional role and importance of the gravel biotope relative to other substrate types, and for use in licensing procedures for the area surveyed.

Objective 3: To determine the causes of biological variation and of observed patchiness and to devise appropriate sampling strategies to allow for this variation. This work will take particular account of dynamic aspects of the environment within which the benthic communities have developed.

Objective 4: To establish the utility of seabed mapping techniques for surveying habitats.

Objective 5: To examine broad-scale fishery-independent beam trawl survey data from the eastern English Channel. Describe the range of assemblages sampled using dominance of commercially important fish and macro-epibenthic invertebrate by catch, and where possible explain the ecological rationale for observed patterns in species affinities.

Objective 6: To evaluate the susceptibility of gravel biotope benthic communities to anthropogenic disturbances in contrasting areas, particularly by dredging. This will involve the testing of established and novel methods for describing and quantifying biological status and sensitivity.

Objective7: To report on the significance of the findings for the management of aggregate extraction activities.

Summary of the project

A range of acoustic techniques were evaluated in the first year of the project, and sidescan sonar was selected as the main acoustic mapping system for use in subsequent surveys. In addition, two acoustic ground discrimination systems (AGDS), *RoxAnn* and *QTC-View*, were also chosen for use alongside the sidescan sonar system. Four sites were selected in the eastern English Channel to develop the mapping techniques (Figure 1). The main site for study was offshore from Shoreham (28km x 12km in area). The site was selected as it offered a range of sediment types which were relatively homogeneous in their distribution, and would therefore offer an environment in which the relationship between acoustic output, physical habitat type and biological assemblage structure could be investigated. The other three sites, at Hastings, the eastern Isle of Wight and Dungeness (all 12km x 4km in area) were chosen to offer a wider range of substrata of varying degrees of spatial complexity (sediment patchiness) over which the techniques developed at Shoreham could be tested.

Each site was intensively surveyed using a digital sidescan sonar system. A mosaic of the sidescan sonar data was produced to provide 100% spatial coverage maps at each location. This was then divided into acoustically distinct regions which, following ground-truthing using underwater video, were found to relate to discrete habitat types. Each region was sampled using a suite of physical sampling and visual techniques. The main sampling tools were a $0.1m^2$ Hammon Grab fitted with a video camera and light (all sites) and a heavy duty 2 m beam trawl (Shoreham and Hastings) which were used to characterise the benthic communities and sediment characteristics within each region. Relationships between acoustic regions, physical habitat characteristics and assemblages were then investigated using a range of univariate and multivariate techniques. Results from these analyses were used to identify discrete biotopes (physical habitats and associated communities) at each site, and to establish which factors were responsible for the distribution, type and diversity of communities within each region.

In most acoustic regions, particularly where there was a high degree of sediment homogeneity within discrete habitat boundaries, statistically distinct assemblages were identified. The situation was less clear where the seabed consisted of a complex arrangement of sediment types, such as to the east of the Isle of Wight. Nonetheless, discrete assemblages were still detected, although it was more difficult to ascertain natural boundaries between neighbouring habitats/assemblages. Sediment properties (granulometry) and seabed morphology appeared to be the main factors

controlling the distribution of communities at each site. Hydrographic factors (tidal velocities, suspended loads, water temperatures etc.) were also considered, but at the scale of the individual sites these factors appeared to have less influence on assemblage structure.

At each site, data derived from the analysis of the acoustic, biological, sedimentological and visual data sets were used to identify and define biotopes. Discrete biotopes often existed within the boundaries of acoustically distinct regions. This was not always the case, however, and the physical habitat and biological assemblages were sometimes similar over a number of acoustic regions, and were therefore classed as one type of biotope in these situations. 12 biotopes were identified and described from the study sites at Shoreham, Hastings and the Isle of Wight.

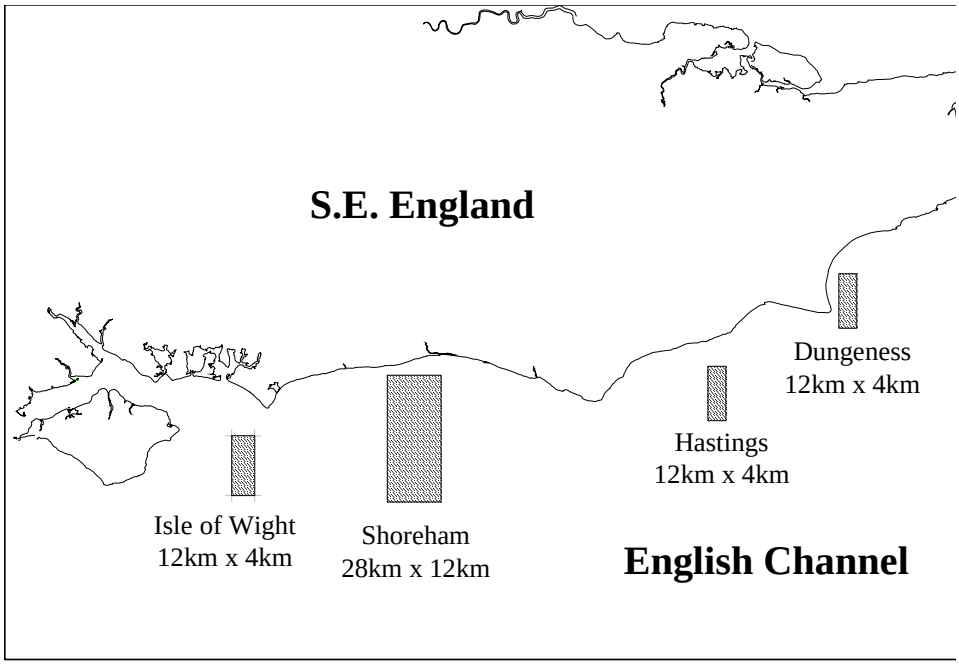
Work has started on the development of a Geographic Information System (GIS) to hold and manipulate a wide range of data types collected during seabed mapping surveys (acoustic, biological, geological, hydrographical etc.). The system is designed to act as a data repository, and will ultimately be capable of carrying out detailed geographical queries to examine the relationship between the various data layers. This will be of particular importance when comparing the factors controlling the distribution of biotopes over larger geographical/biogeographical regions. Despite progress in the development of such a system, additional work is required before the system is capable of carrying out all the functions which are required to allow comprehensive assessment of the relationships between the various data types/layers.

The AGDS data was analysed in collaboration with the SeaMap Group, University of Newcastle upon Tyne. A number of image analysis methods were used to process the data collected at the site off Hastings. Habitat maps from these analyses were produced, and results were compared to the habitat maps derived from the sidescan sonar data. There was general agreement between the two types of system, although this was very dependent on the post-processing methods applied to the AGDS data sets. The swathe coverage of the sidescan sonar system proved, unsurprisingly, more accurate at identifying habitats than the single beam AGDS systems.

A number of project reports will be available by the end of April 2001, and the work will also be presented in St. Johns, May 2001 (Brown *et al.* & James *et al.*). Peer-reviewed publications are also in progress

Funding has just been issued by MAFF to continue this work for a further 4 years under a new project entitled ‘Role of seabed mapping techniques in environmental monitoring and management’.

Figure 1. Location of the four survey sites, eastern English Channel.



ANNEX 12: GLOSSARY OF ABBREVIATIONS USED IN THIS REPORT

ACE	Advisory Committee on Ecosystems (ICES)
ACME	Advisory Committee on the Marine Environment (ICES)
AGDS	Acoustic Ground Discrimination Systems
ARC	Aquatic Restoration & Conservation (USA)
BDC	Biodiversity Committee (OSPAR)
BioMar	An EC Life-funded project (1992–97)
BGS	British Geological Survey (UK)
CEFAS	Centre of Environment, Fisheries and Aquaculture Science (UK)
CTD	Conductivity, Temperature, Depth
DETR	Department of Environment, Transport and the Regions (UK)
EPA	Environmental Protected Area
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EUNIS	European Nature Information System (EEA)
EIS	Environmental Impact Statement
EcoQO	Ecological Quality Objectives
GIS	Geographical Information System
ICES	International Council for the Exploration of the Sea
IndVal	Indicator Value
JNCC	Joint Nature Conservation Committee (UK)
MNCR	Marine Nature Conservation Review (a JNCC project)
MPA	Marine Protected Area
MAFF	Ministry of Agriculture, Fisheries and Food (UK)
MarLIN	Marine Life Information Network (UK)
MIDI	Marine Invertebrate Diversity Initiative (Canada)
NOAA	National Oceanic and Atmospheric Administration (USA)

NRCan	Natural Resources Canada
OSPAR	Oslo and Paris Convention
PRIMER	Plymouth Routines In Multivariate Ecological Research (an analytical programme)
QTC	Questor Tangent Corporation
REBENT	REseau BENTHicque (France)
ROV	Remote Operated Vehicle
SAC	Special Area of Conservation (EC Habitats Directive)
SGMHM	Study Group for Marine Habitat Mapping (ICES)
SMB	Marine Biology Section (Ghent University, Belgium)
UKOOA	United Kingdom Offshore Oil Operators Association
WGMHM	Working Group on Marine Habitat Mapping (ICES)
WKDSST	Workshop Deep Sea Survey Technologies (ICES)
WWF	World Wildlife Fund for Nature