Accessing and developing the required biophysical datasets and data layers for Marine Protected Areas network planning and wider marine spatial planning purposes

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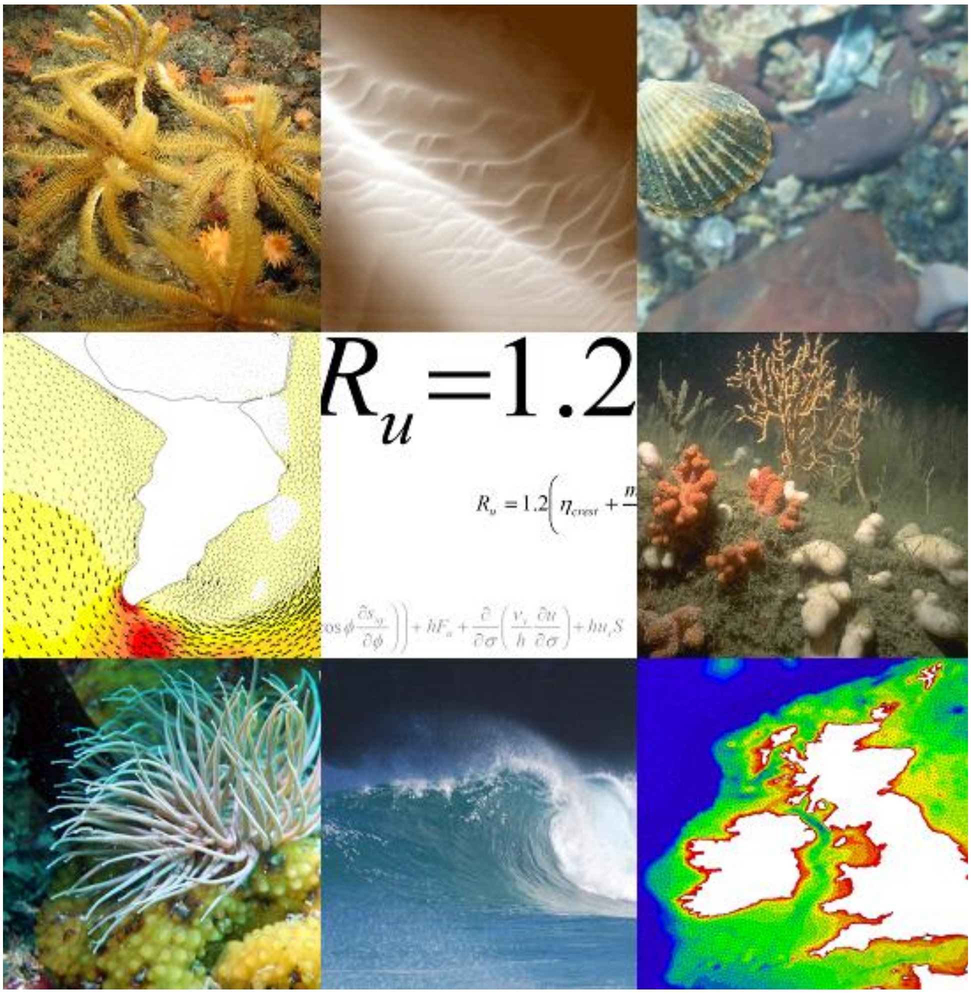

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Executive Summary

The UK is committed to the establishment of a network of marine protected areas (MPAs) to help conserve marine ecosystems and marine biodiversity. MPAs can be a valuable tool to protect species and habitats and can also be used to aid implementation of the ecosystem approach to management, which aims to maintain the 'goods and services' produced by the healthy functioning of the marine ecosystem that are relied on by humans.

A consortium[1] led by ABPmer have been commissioned (Contract Reference: MB0102) to develop a series of biophysical data layers to aid the selection of Marine Conservation Zones (MCZs) in England and Wales under the Marine and Coastal Access Act 2009 and the Nature Conservation MPAs in Scotland under the Marine (Scotland) Act 2010. In Welsh inshore waters the MCZ Project Wales will designate a small number of highly protected MCZs with the site selection being managed by Welsh Government (WG). Such data layers would also be of use in taking forward marine planning in UK waters. The overall aim of the project is to ensure that the best available information is used for the selection of MPAs in UK waters, and that these data layers can be easily accessed and utilised by those who would have responsibility for selecting sites.

The Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 allow for the designation of MCZs and nature conservation MPAs for marine geological features, species and habitats. To deliver this requirement, the project has been divided into a number of discrete tasks, which were designed to cover a number of aspects to provide assistance to those tasked with making recommendations on where the new designations might be located. To do this the project has had five elements covering:

1. The improvement of the existing predictive modelling of the seabed and its habitats;
2. The production of comprehensive maps for threatened species and habitats;
3. The production of secondary information to help support the site selection processes, e.g. benthic productivity, biodiversity, knowledge of invasive species locations and the amount of energy reaching the seabed;
4. In addition to help the planners with their selection process a number of sensitivity tables have been produced which provide background information on the pressures to which the features to be protected are sensitive; and
5. The information gathered within the mapping element of the study has been used to provide the contextual background to the webGIS which was developed to allow a wider range of stakeholders to input their own information into the site selection process.

In order to make the data available to the contributing bodies and non-commercial organisations, all resulting datasets have been given their own metadata and have

[1] ABPmer, MarLIN, Cefas, EMU Limited, Proudman Oceanographic Laboratory (POL), Bangor University and exeGesIs.

been lodged in SPIRE[2] and deposited within their applicable MEDIN Data Archiving Centre[3] see Appendix A.

Although the project has provided a large number of data layers which have a UK wide coverage and has provided improvements to UKSeaMap, it must be remembered that as with all data collection activities they also have a number of limitations. For this study these include:

- Lack of data in the layers does not necessarily mean that the species/habitat is not present as the area may not have been surveyed. This results from the fact that many of the datasets used have been collected for very discrete reasons e.g. monitoring compliance and as such have limited spatial coverage but are often temporally rich (many years of sampling the same locations), this may lead to skewing of the underlying data and hence the derived data layer;
- Data included in the layers have been sourced from national data gathering organisations, for example Joint Nature Conservation Committee (JNCC), Countryside Council for Wales (CCW), Natural England (NE), Environment Agency (local offices) and Cefas, and do not include many industry or private data collections. It was the intention that these data were collated by the Regional MCZ Project teams, as described above;
- The inclusion of some known datasets has not been possible due to the resource commitment required to provide them and the general lack of engagement in the process encountered from certain national organisations. Such difficulties were encountered with the Environment Agency and the British Geological Survey (BGS);
- To safeguard the true location of the species/habitat as requested by the data supplier some datasets have been gridded and subsequently mapped at scales of 1, 5 and 10 km. Therefore, although the maps indicate the presence of a feature or species within the general area, they may be less helpful in some of the decision making processes. The information as to which layers contain such data is provided in the associated metadata record;
- Data coverage is coarse in some examples, for mobile species distributions the International Council for the Exploration of the Sea (ICES) rectangles (divisions of UK sea areas as used by the fishing industry) were used which means that not all of the Scottish waters are mapped. These divisions were used as they are in many cases the only way in which fish species are recorded and therefore it was not possible to reduce the grid sizes beyond those used in the recording e.g. smaller than quarter rectangles;
- Some tasks have been mapped using data derived from model outputs. This has been necessary because there is insufficient data coverage to provide a complete layer of the United Kingdom Continental Shelf (UKCS), this is particularly true of task 2E outputs where the models used have been calibrated using measured points. The confidence of these underlying models then becomes even more important to consider;

[2] Shared Spatial Information Services (SPIRE). The SPIRE project is driving forward the corporate use of GI through the improvement in quality and accessibility of GI, leading its wider use within Defra, its Executive Agencies and Non-Departmental Public Bodies.
[3] Marine Environmental Data and Information Network (MEDIN) are establishing a network of marine data archive centres (DACs) to provide secure long-term storage for marine data. This network will provide the capability to upload and retrieve data.

- Some data layers have use limitations as detailed in the accompanying metadata and reports, and should be used accordingly. Thus although the data layers can be used for the purpose of this project, they may not be available to all national projects, thus limiting the usage and confidence if incomplete layers are used in the future;
- The age of some datasets also reduces confidence, for example, in relation to historic isolated species records. For this study, such records have been included with appropriate reference in the metadata; and
- Surveying and recording techniques and methodologies used vary between organisations and are commonly linked to the reporting requirements of the information collected, meaning that the collation of these to one layer can lead to a mismatch of data consistency.

This has been one of the largest, coordinated UK marine contracts and during the execution of the project a number of lessons have been learnt for studies of a similar size and nature undertaken in the future, these include:

- Regular contact is maintained between the client and lead contractor with arrangements for cover and delegation of decision-making during periods of leave;
- Buy-in is obtained from the governmental bodies and their representatives to fully engage in the whole process to ensure that the data layers provided are as comprehensive as possible;
- Promotion of feedback in a timely manner; and
- Ensure there is sufficient understanding amongst users of the spatial coverage, quality and limitations of the requested outputs.

In addition the study has also highlighted some suggestions for consideration both for the longevity of the data layers produced under this contract and for the management of such studies in the future, including:

- Provide a mechanism for the data layers to be updated in the future;
- Provision of sufficient resources to extract information in the future from different organisations;
- Ensure lines of communication are well established, more frequent face to face meetings and /or regular phone calls between key client and contractor members.

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1. Introduction

1.1 Biophysical Data Layers Project

1.1 The UK is committed to the establishment of a network of marine protected areas (MPAs) to help conserve marine ecosystems and marine biodiversity. MPAs can be a valuable tool to protect species and habitats and can also be used to aid implementation of the ecosystem approach to management, which aims to maintain the ‘goods and services’ produced by the healthy functioning of the marine ecosystem that are relied on by humans.

1.2 As a signatory of the OSPAR Convention the UK is committed to establishing an ecologically coherent network of well-managed MPAs. The UK is already in the process of completing a network consisting of Special Areas of Conservation (SACs) and Special Areas of Protection (SPAs), collectively known as Natura 2000 sites to fulfil its obligations under the EC Habitats Directive (92/43/EEC) and EC Birds Directive. Through provisions in the Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010, Marine Conservation Zones (MCZs) and nature conservation MPAs may be designated in UK waters[4]. These sites are intended to help to protect areas where habitats and species are threatened, and to also protect areas of representative habitats.

1.3 The MCZ Project was established by the Joint Nature Conservation Committee (JNCC) and Natural England to identify MCZs in English territorial waters and offshore waters adjacent to England, Wales and Northern Ireland. Four Regional MCZ Projects have been established to lead this process, Finding Sanctuary, Net Gain, Irish Sea Conservation Zones and Balanced Seas. The Regional MCZ Projects recommended MCZs to JNCC and Natural England in August 2011. A formal public consultation led by Defra is expected in 2012, further details can be found at https://www.gov.uk/marine-protected-areas#marine-conservation-zones-mczs.

1.4 The Scottish MPA Project is seeking to designate MPAs for the following purposes within Scottish territorial waters (inside 12 nautical miles):

- Nature Conservation MPAs for the conservation of nationally important marine wildlife, habitats, geology and undersea landforms.
- Demonstration/Research MPAs to demonstrate or research sustainable methods of marine management or exploitation.
- Historic MPAs for features of historic/cultural importance such as shipwrecks and submerged landscapes.

[4] MCZs will exist alongside European marine sites (SACs and SPAs), to form a marine protected areas network. Existing Marine Nature Reserves at Lundy and Skomer will be converted into MCZs. MCZs will protect areas covering the habitats and species which exist in our seas. They will be both large enough, and close enough together, to support functioning communities of marine wildlife. They will be used to protect areas that are important to conserve the diversity of rare, threatened and representative habitats and species.

- The UK Marine and Coastal Access Act includes equivalent provisions for Scottish Ministers to designate MPAs for the conservation of nationally important marine wildlife, habitats, geology and undersea landforms in offshore waters (outside 12 nautical miles) adjacent to Scotland, see http://www.scotland.gov.uk/Topics/marine/marine-environment/mpanetwork and http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/national-designations/marine-protected-areas-(mpa)/

1.5 In Wales the Marine Conservation Zones Project Wales has been established with the Wales Coastal and Maritime Partnership to take the MCZ process forward in Welsh inshore waters up to 12 nautical miles from shore. Their plan is to identify sites for creation by 2012, http://jncc.defra.gov.uk/page-4164.

1.6 The UK Marine and Coastal Access Act (2009) extends in part to Northern Ireland, where the Northern Ireland Marine Bill will contain provisions for marine planning and marine nature conservation within Northern Ireland's territorial waters (within the 12 nautical mile limit). The Northern Ireland Marine Bill which, subject to Executive approval, should be introduced to the Northern Ireland Assembly in 2011 as detailed in: http://www.doeni.gov.uk/index/protect_the_environment/natural_environment/marine_and_coast/marine_policy/northern_ireland_marine_bill.htm

1.7 Selection of MPAs should be based on the best available information from a wide range of sources including biological, physical and oceanographic characteristics and socio-economic data such as the location of current activities. To ensure such data are easily available to those who would have responsibility for selecting sites Defra and its partners[5], (who along with representatvies from MEDIN and the Marine Management Organisation formed the Project Steering Group (PSG)), commissioned a consortium lead by ABPmer Ltd and partners to take forward a package of work. New Geographical Information System (GIS) data layers developed included:

- Geological and geomorphological features;
- Habitats and species of conservation importance;
- Seabed energy;
- Marine diversity layer;
- Benthic productivity; and
- Residual current flow.

1.8 In addition to the development of data layers, there has been a need to ensure such information can be easily accessed through a webGIS given the participatory nature of the MCZ process.

1.9 This report provides a high level overview of all the tasks undertaken and offers a brief description of the outputs for each task with recommendations on

[5] Joint Nature Conservation Committee (JNCC), Countryside Council for Wales (CCW), Natural England (NE), Scottish Government (SG), Department of Environment Northern Ireland (DOENI) and Isle of Man Government.

how to use any resulting data layers. This report also provides a reference to the location of each task report and where the data layers can be found, see Section 3 and Appendix A for further information.

1.2 Aims and Objectives

1.10 We as a nation want to protect and conserve important habitats and species found in the UK's marine environment and have a duty to do so. One way to do this is through the identification, designation and management of areas considered important to protect. Such sites are often termed 'Marine Protected Areas' (MPAs). The UK Government has made a commitment to deliver such a network of marine protected areas, so in order to ensure that we are protecting the right areas, and that the network is coherent, the selection of sites needs to be based on the best available evidence. This has required the collation of a variety of data including the location of rare/threatened habitats and species; features of geological and geomorphological importance; and biodiversity and productivity areas.

1.11 It is important to ensure the best data are accessed and made available for the MPA planning processes in the UK. In order to achieve this, there was a need to collate a range of data (e.g. biological, physical and socio-economic) from a range of organisations. These data needed to be easily interpreted, accessed and used by those responsible for the identification of MPAs.

1.12 The objectives of the research undertaken in this study have related to the collation and improvement of data layers on biological and physical aspects of the marine environment. They have included providing data to improve current habitat maps; identifying the current distribution of species and habitats of conservation importance; reviewing approaches which will have allowed marine biodiversity hotspots and important areas for benthic productivity (e.g. nutrient cycling) to be identified; and areas where important geological features are found. The data layers have also needed to be easily accessed. The project was also required to carry out a review of existing Geographical Information Systems (GIS), and make recommendations on how best to achieve this.

1.3 Format of the Report

1.13 The report comprises four main sections:

- Section 1 delivers an introduction to the MB0102 project, this section;
- Section 2 discusses how the project was divided into a range of tasks to improve existing data layers and develop new data layers;
- Section 3 looks at the data standards employed within this project and how the final data layers have been disseminated for use; and
- Section 4 provides the considerations including lessons learnt.

2. Adopted Approach

2.1 The study has included a wide range of different tasks which were designed to provide information to inform existing habitat maps such as UKSeaMap, whilst others collated data from a number of government organisations and their agencies. The broad nature of the study required the project team to draw on a wide range of different skills and expertise. The following sections detail the tasks undertaken.

2.1 Task 1 Improving Existing Habitat Maps

2.2 This suite of tasks had the following objectives to further develop benthic (the collection of organisms living on or within the sea bed) habitat maps through:

a. Biotope[6] tagging prioritised benthic sample datasets in accordance with the Marine Habitat Classification for Britain and Ireland (Connor 2004);
b. Translating benthic habitat maps to the European Union Nature Information System (EUNIS) 2007 classification scheme; and
c. Assessing confidence in the Mapping European Seabed Habitats (MESH) EUNIS model, by investigating ‘errors’ in the underlying data models and generating a ‘confidence layer’.

2.1.1 Task 1A - Biotope tagging of benthic sample datasets

Aims and Objectives

2.3 This task aimed to assign a biotope description to each dataset provided under the two phases of the work, which then enabled the description to be translated into an appropriate level in the Marine Habitat Classification for Britain and Ireland (version 04.05). These descriptions were then to be converted into a EUNIS code where the minimum was to be the biotope complex code EUNIS Level 4. This was because EUNIS Levels 2 and 3, Broad habitat codes and Habitat complex codes do not include biological information. If possible higher levels were to be achieved however where a biotope complex code could not be identified due to lack of information then the appropriate Broad habitat code or Habitat complex code was to be chosen. The corresponding habitat type from the EUNIS 2007 habitat classification scheme was also to be provided for each Marine Habitat Classification biotope tag. This task was carried out by Emu Ltd.

Methodologies

2.4 In Phase 1 three data types were supplied to Emu Ltd for analysis to assist in the determination of biotopes, these were grab sample data, videos and still images. These were from surveys gathered by the research vessels covering areas including North West Irish Sea, Outer Bristol Channel, Isle of Mann, Central and Eastern English Channel, Anglesey and West Hebrides. The

[6] An area that is uniform in environmental conditions and in its distribution of animal and plant life

different datasets were analysed according to their type and included the following:

- Primary analysis;
- Data to be tagged;
- Data to have biotopes checked;
- Data needing ENUIS translation;
- Data to be entered into Marine Recorder; and
- Data to be revised within Marine Recorder.

2.5 The data gathered was entered into the Marine Recorder database which is the main database used by the conservation agencies to hold marine monitoring habitat data for Special Areas of Conservation.

2.6 Phase 2 consisted of other identified datasets including data from Northern Ireland, CCW and the Environment Agency covering areas such as the Dee Estuary, Skomer Island, Menai Strait, Irish Sea and Lough Foyle. Similar data analyses were conducted on these data but have yet to be completed and so have not been reported.

Outputs

2.7 The outputs of this task have all been entered into the Marine Recorder and are therefore available as information through that resource. The datasets were also supplied as Excel spreadsheets. Reports for both Phase 1 (Thomas *et al.*, 2009) and Phase 2 (Thomas *et al.*, 2010) were produced.

Issues

2.8 The consideration of biotopes was based on the comparative table available on the JNCC website, however this was not up to date and in addition their descriptions contained species information which was not replicated in the species lists, which made the identification difficult. It was also hard to divide the sedimentary biotopes into infralittoral and circlittorial by description.

2.9 It was identified that the data source of the information forming the biotope is important i.e. whether the source was a grab sample or taken from video footage. For this project a primary biotope has been provided per site, whereas it is known that other projects, such as the Eastern Channel two biotopes have, in places, been attributed to one location.

2.10 This project has specifically had difficulty in identifying the field of view for stills images from the metadata provided with the original datasets and the fact that the data needed to be entered into the Marine Recorder as a point. Similarly depth data were not always available for the video data.

2.11 Reworking of data was required for a number of stills datasets where inconsistencies became apparent between different staff and their interpretation of the sediment descriptions and certainty of species identification.

2.1.2 Task 1B - Translation of habitat maps

Aims and Objectives

2.12 This task was divided into two phases of work. The first phase focussed on translating a series of habitat maps from their previous habitat classification to their appropriate EUNIS 2007 type and processing them to the Mapping European Seabed Habitats (MESH) data exchange format. The second phase translated a number of sample points that are stored in Marine Recorder from the Marine Nature Conservation Review (MNCR) 97.06 classification to the equivalent MNCR 04.05 biotope code. ABPmer provided a confidence assessment of the habitat maps based on the methodology provided within MESH. This task was carried out by MarLIN and ABPmer.

Methodologies

2.13 Under Phase 1, MarLIN were supplied with shapefiles of habitat data and each distinct original habitat was extracted and put into a Microsoft Access database. The Access database also contained the data specification outlined in the Translated MESH Data Exchange Format (DEF) including detailed translation and validation comments. In some cases where the original habitat type represented a number of EUNIS habitats, and it was not appropriate to create a new interim EUNIS code, a EUNIS level habitat that represented all habitats outlined in the data were selected. Where the mix of habitats was such that only a EUNIS level 1 code was possible the EUNIS code was not assigned.

2.14 In Phase 2 MarLIN were supplied with point data extracted from the Marine Recorder database. Where codes translated directly a translation was made, however where this was not possible then the biotope was determined by referring to the habitat and species information stored in the JNCC marine recorder snapshot and by referring to reports where available. However, full habitat or species information was not available for all sample points along with a lack of salinity, depth or sediment type information.

2.15 The confidence assessment followed the methodology developed within the MESH project where the evaluation process addresses three main questions:

1. How good is the remote sensing?
2. How good is the ground truthing?
3. How good is the data interpretation?

2.16 The confidence assessment could only be undertaken if there was sufficient supporting information to accompany the habitat maps. This includes a documented record of the survey techniques, post processing and analysis as well as any QA steps that have been undertaken. This limited the number of maps for which a confidence assessment could be undertaken.

Outputs

2.17 After the QA process for Phase 1 the data were transferred into the shapefiles and the translated data were added. A report was produced detailing this Phase (Frost and Seeley, 2009a). In Phase 2 the data were transferred to the Marine Recorder database and the translated data were added and a report was produced to document this (Frost *et al.*, 2009b).

Issues

2.18 Under both phases of work it was often found that codes did not always translate directly from their current habitat classification to their appropriate EUNIS code and MESH DEF or to their MNCR 04.05 biotope code. In some cases a translation could not be made.

2.19 The data translations involved a considerable amount of interpretation and as such ten percent of records were Quality Assured (QA) by an experienced marine ecologist.

2.1.3 Task 1C - Assessing confidence of broadscale classification maps

Aims and Objectives

2.20 The MESH EUNIS Model predicts broad scale EUNIS marine habitat types based on a combination of physical parameters. Task 1C set out to produce a repeatable methodology for assessing the spatial confidence of each of the physical data layers that form part of the MESH EUNIS Model and the implications for the associated biological predictions. The physical data layers used to inform these predictions include biological zone (depth, light penetration, and wave disturbance), substrate and energy. Confidence can be described as a statement about how reliable a map user thinks the map is given its purpose. This task was undertaken by ABPmer.

Methodologies

2.21 This task was undertaken in two Phases, in Phase 1 an assessment was carried out on the broad scale physical data underlying the MESH EUNIS Model with regard to its suitability and confidence. The broad scale EUNIS marine habitat types are based on the following physical parameters:

- Biological zone:
    - Depth;
    - Light penetration;
    - Wave disturbance;
- Substrate; and
- Energy.

2.22 The assessment considered each layer in turn and investigated the errors within each under three key headings:

- Errors associated with the raw data measurements;
- Errors in data processing; and
- Natural spatial and temporal variability.

2.23 Methods for potentially assessing all the errors within each layer were also investigated.

2.24 During this Phase a number of recommendations were made as to how the underlying data could be improved and thus increasing the confidence in the modelling that used these data. These included revising the bathymetry layer using a combination of available datasets, namely GEBCO, Scripps and SeaZone; revising the light penetration layer using updated satellite data and the depth data; and the revision of the wave disturbance information by using wave data archives from POL and energy disturbance from Task 2E, see section 2.2.5. These improved layers together with their confidence layers would then provide the biological zone layer through a combination of statistics. At this point it was decided that the improvements to the substrate layer would be undertaken by BGS and that the energy layer would be provided by the outputs of Task 2E (section 2.2.5).

2.25 Phase 2 took forward the recommendations of Phase 1 by creating three new layers with their associated confidence layers which were generated using validation datasets not used in the production of the physical data layers.

Outputs

2.26 Two reports were produced under this Task the first providing the review and recommendations (Frost *et al.*, 2009c), the second from Phase 2 providing the details of the improved data layers and confidence layers (Frost and Swift, 2010).

Issues

2.27 Although the data layers have been improved using more recently available data, the primary data layers of water depths, wave disturbance and light penetration, underlying the output from the study, all possess a certain level of uncertainty which is subsequently transmitted into the corresponding levels of combined uncertainties into the biological zones. The outputs of this process demonstrated the greatest degree of uncertainty is found at the edges of the biological zones and that complex probability (uncertainty) patterns exist in parts of the Channel, the Irish Sea and off the East coast.

2.2 Task 2 - Data Layer Development

2.28 The tasks under this heading were concerned with the production of data layers which would provide datasets of national coverage derived from national bodies, e.g. NE, Environment Agency, JNCC, Cefas, and other government institutions. These data layers were designed to provide background information for a range of differing features, species and physical parameters to assist the national teams and the Regional MCZ Projects in determining the potential locations of the MCZs. The datalayers will also be developed through the Scottish MPA Project to assist in the determination of Nature Conservation MPAs. The aim was therefore to develop new digital GIS data layers and associated databases for the UK marine environment showing the distribution of:

a. Geological and geomorphological features;
b. Conservation priority species, and spawning and nursery grounds for highly mobile conservation priority species ;
c. Listed habitats;
d. Non-native species;
e. Seabed energy layers;
f. Marine biodiversity;
g. Residual current flow;
h. Benthic productivity; and
i. Intertidal habitats.

2.2.1 Task 2A - Geological and geomorphological features

Aims and Objectives

2.29 This task aimed to identify and map geological and geomorphological features that are of interest when considering the designation of MCZs. The specific aims of the task were as follows:

- To identify a suite of geological and geomorphological features located around the UK continental shelf;
- To prepare digital GIS data layers showing the distribution of geological and geomorphological features; and
- To undertake a conservation importance/value assessment to identify possible geological and geomorphological sites for inclusion in Marine Conservation Zones and Marine Protected Areas.

2.30 This task was carried out by ABPmer, supported by Neil Kenyon.

Methodologies

2.31 The first phase of Task 2A was to identify, categorise and map the geological and geomorphological features on the UK seabed by undertaking an extensive desk based literature search whilst developing a detailed feature categorisation system which identified a series of process-based feature units and sub-categories. In total over 70 separate feature categories were established and classified into one of five Geomorphological/Geological ‘process units’ (see Appendix B).

2.32 The categorisation and mapping focussed on the identification of features visible at the seabed as mapping sub-surface features was outside the remit of this task. However, in instances where the literature search inadvertently revealed the documentation of sub-surface features then these have been mapped and a comment included in the GIS attribute table.

2.33 The mapped geological and geomorphological features included in the GIS layers were derived from either previously developed GIS layers, scanned images sourced from hardcopy reports/papers or images 'clipped' from electronic reports.

2.34 The second phase of Task 2A was to develop and implement a conservation importance/value assessment for all of the c. 6500 features identified in Phase 1. The methodology developed by Furze and Roberts (2004) for the Irish Sea Pilot study was reviewed and an adapted version was developed and used to undertake the conservation importance/value assessment. The assessment was undertaken on a feature-by-feature basis and comprised three separate components (a) a feature importance assessment; (b) a feature vulnerability assessment and (c) a confidence assessment of scores. These three components were considered separately and were carried out using a highly automated procedure which combined ArcGIS, Excel and a sequence of 'look-up' tables.

2.35 Following the calculation of the feature importance scores, all of the features were subsequently ranked according to overall score with the highest ranking listed separately.

Outputs

2.36 Phase 1 resulted in 29 GIS data layers being created holding c. 6500 Geomorphological and Geological features whilst Phase 2 produced a conservation assessment for all features detailed in and Excel spreadsheet (Brooks *et al.*, 2009).

Issues

2.37 Whilst this mapping exercise involved the review and digitisation of large amounts of data, the literature search was by no means exhaustive of all archives with large amounts of potentially relevant information being held by oil and gas companies who deem the information commercially sensitive and as such unavailable.

2.38 It is also the case that our understanding of the morphology, distribution and genesis of seabed features in UK waters is incomplete and this is particularly relevant for the deep-water environments found in the north and northwest of the region. However, recent advances in seabed surveying are resulting in the discovery of previously unidentified features and much of this work has only recently been published. It is important the data layers are regularly updated to reflect this anticipated increase in knowledge.

2.2.2 Task 2B - Species data (mobile and non-mobile)

Mobile Species Aims and Objectives

2.39 This task aimed to map the distributions of highly mobile species of conservation interest identified from being either listed on the OSPAR List of Threatened and Declining Species, or highlighted as UK Biodiversity Action Plan (BAP) species. In total 40 marine species were considered to be highly mobile including 22 species of bony fish, 17 species of shark and skate, and one marine reptile (see Appendix C).

2.40 The objectives were to:

a. Map the broad, biogeographical distribution patterns of the species around the UK;
b. Provide evidence-based distribution maps based on the captures of fish from contemporary fishery-independent ground fish survey;
c. For those species that were insufficiently abundant in fishery independent ground fish surveys, to provide evidence-based distribution maps based on other data sources (e.g. commercial landings data and historical records); and
d. Provide digital GIS datasets of the layers in ESRI data format.

2.41 This task was undertaken by Cefas.

Methodologies

2.42 In order to map the distribution of the identified mobile species biogeographical distribution maps, scientific trawl surveys and reported landings data were used. For species that were not sampled effectively by fishery-independent surveys historical accounts, information from rare fish records and data compiled from other sources (e.g. MarLIN, JNCC). The distribution of highly mobile species was aggregated to three spatial resolutions and is discussed below.

2.43 The Quarter International Council for the Exploration of the Sea (ICES) Rectangle data layer contains relative abundance information for 12 of the 40 species by gear type (GOV, PHHT, and 4 m beam trawl). This data has been obtained from a number of fisheries independent research surveys as well as otter and/or beam trawl surveys.

2.44 The Half ICES Rectangle data layer contains all 40 highly mobile species. Data were initially obtained from Aquamaps which provides standardized distribution maps for 9,000 species of fish, marine mammals and invertebrates and subsequently adapted to ensure consistency with standard sources of fish information and other information sources.

2.45 The ICES Rectangle data layer contains data for all 40 highly mobile species. This data layer provides abundance data collated from fisheries independent research surveys along with presence/absence information from fisheries independent research surveys, commercial fisheries data collections and data mining.

2.46 A GIS layer for the biogeographical distribution in the study area was created for all the case study species. These layers show the broad distributions of the species, but do not identify those areas or sites of greatest ecological importance or abundance.

Outputs

2.47 This task produced two reports (Ellis *et al.*, 2009 and Ellis *et al.*, 2010) and three derived data layers of highly mobile species distribution at three different spatial resolutions; quarter ICES rectangle, half ICES rectangle and ICES rectangle.

Issues

2.48 The task identified a number of general issues which related to the collection, quality assurance, collation, access and onward dissemination of data. More specific issues are given below.

2.49 Accurate taxonomic identification is fundamental to proving robust evidence-based information for species of interest, and such issues can compromise the quality of some of the data available for a selected number of the species considered in this task.

2.50 Most recent surveys are conducted on an annual basis, and so do not encompass seasonality in fish distributions. Some fish species may exhibit pronounced seasonal patterns in either distribution or abundance and this may not be reflected in the derived data layers.

2.51 Some of the rarer case-study species are not recorded reliably in commercial catch statistics, either because they are not commercial species or because species-specific landings would not be considered reliable. Extra data on the sites where these species have been recorded have been collated during 'data mining' and the users of these derived layers must remember these layers incorporate data from a range of sources.

Non Mobile Species Aims and Objectives

2.52 This task aimed to map the distribution of key species (see Appendix D) with limited mobility identified from being either listed on the OSPAR List of Threatened and Declining Species, or highlighted as UK Biodiversity Action Plan (BAP) species with the results displayed in GIS layers with associated spatially referenced tables. This task was carried out by MarLIN.

Methodologies

2.53 Data were requested from all major holders of marine biodiversity data for the target species. Additional records for the species were sought through direct contact with authors, specialists, recording schemes, societies and organisations know to have carried out work on target species. At the data gathering stage MarLIN simultaneously requested data for this task along with Habitats (2C) and Non-native Species (2D).

2.54 Where data permissions allowed the records gathered were entered into the Marine Recorder database. The species data were then imported into an ESRI Geodatabase structure and the GIS information was standardised and referenced to geographic coordinate system WGS84. In addition a survey table was produced in Microsoft Access to record the details of each survey and allow further interrogation of the layers. The layers in the Geodatabase can be linked to the table through the SurveyID field.

2.55 A confidence assessment of each layer produced under this task was developed as MarLIN were aware that some data had not been made available to them under the scope of this project and it was necessary to add a measure of confidence to these species layers.

Outputs

2.56 Derived data layers were produced for all the identified species of low mobility in GIS point format and a report was produced alongside these to document the methodology (Seeley *et al.*, 2010a).

Issues

2.57 A number of organisations holding key datasets were very slow to respond to data requests which caused a delay to the task whilst many organisations held large volumes of their data at regional level, often with incomplete cataloguing. Two organisations also refused to contribute data to the project.

2.2.3 Task 2C - Mapping of protected habitats

Aims and Objectives

2.58 The aim of Task 2C was to produce spatially referenced tables and associated GIS layers showing the distribution of priority protected habitats (see Appendix E). This task was undertaken by MarLIN.

Methodologies

2.59 Data were requested from all major holders of marine biodiversity data for the target habitats. Additional records for the habitats were sought through direct contact with authors, specialists, recording schemes, societies and organisations known to have carried out work in these areas.

2.60 Where data permissions allowed the records gathered were entered into the Marine Recorder database. The habitat data were then imported into an ESRI Geodatabase structure and the GIS information was standardised and referenced to geographic coordinate system WGS84. In addition a survey table was produced in Microsoft Access to record the details of each survey and allow further interrogation of the layers. The layers in the Geodatabase can be linked to the table through the SurveyID field.

2.61 The methods used for mapping each habitat differed depending on its definition (see Report No.16 for more detailed information). Only records were there was certainty in the biotopes i.e. the biotope could be determined or was likely to be present (species abundance and habitat indicative) were included in the layer.

Outputs

2.62 Derived data layers were produced for all the identified species of low mobility in GIS point format and a report was produced alongside these to document the methodology (Seeley *et al.*, 2010b).

Issues

2.63 The data gathering issues experienced for the species of limited mobility (2B) applied to Task 2C along with some further issues discussed below.

2.64 Biotope data are missing or patchy in many areas of the UK and it is particularly difficult to access reliable maps of subtidal biotopes. It is therefore recommended that the habitat maps are considered indicative rather than comprehensive until more high quality data becomes available.

2.65 In the next 24 months a number of biotope and habitat mapping projects will be undertaken and it is anticipated that there will be a large volume of up to date and accurate biotope data becoming available and it is recommended that these maps are updated once this data are released.

2.2.4 Task 2D - Mapping of selected non-native species

Aims and Objectives

2.66 The aim of Task 2D was to produce a series of data layers showing the distribution of key non-native species (see Appendix F). This task was carried out by MarLIN.

Methodologies

2.67 Data were requested from all major holders of marine biodiversity data for the target species. Additional records for the species were sought through direct contact with authors, specialists, recording schemes, societies and organisations know to have carried out work on target species. Where data permissions allowed the records gathered were entered into the Marine Recorder database.

2.68 The data were entered into a standard structure and is displayed as ESRI shapefiles. The spatial referencing system was standardised and the distributions clipped to the MCZ project boundaries for England and jurisdiction boundaries for Scotland, Wales and Northern Ireland. The underlying data tables were quality assured to check valid information was entered in each of the attributes. A metadata record was created for each derived data layer to assist in the reuse of the outputs.

2.69 For each layer a confidence assessment was produced. The confidence assessment was based on the volume of data acquired and the information provided by experts and organisations and took account of datasets that were not available or in a suitable format.

Outputs

2.70 The derived data layers were produced for all the identified non-native species in GIS point format along with a report to document the task (Higgs *et al.*, 2010).

Issues

2.71 Much of the polygon data available was too generic to be used for plotting species data even though some biotopes are relevant to species data.

2.72 The data layers must be interpreted using the coordinate precision field. The precision may affect how a record displays, particularly for those at 10 km resolution as they may appear offshore for an intertidal species or intertidal for a sublittoral species.

2.2.5 Task 2E - Seabed energy layers

Aims and Objectives

2.73 The aim of Task 2E was to assist in the development of models in order to improve the energy layer used in the predictive mapping work under MESH and UKSeaMap. In addition to creating a number of individual seabed energy layers the task also developed wave and tidal current induced kinetic energy data layers. This task was undertaken by ABPmer and the Proudman Oceanographic Laboratory.

Methodologies

2.74 A bespoke wave model was constructed using MIKE21SW software to support production of the outputs for this task. The wave model was derived using the ProWAM wave model (maintained by POL) as a base combined with a high resolution model of the coastal regions constructed specifically for this project by ABPmer. In the active wave zone the resolution of the model was required to be in the region of 100 – 300 m.

2.75 The model was then used to develop maps of seabed peak wave-induced kinetic energy and tidal currents induced kinetic energy layers. As a result of producing these layers several other data layers were output at different stages of the model build and these are listed below.

Outputs

2.76 The following data layers were delivered under this task: Wave height, period and direction; wave induced bed sheer stress (from 1 in 5 year wave); maximum tidal current at 10% above the sea bed and associated direction; classified tidal current (according to Marine Recorder classes); tidal maximum bed shear stress; classified tidal maximum bed shear stress (according to EUNIS classes); comparison of Marine Recorder and EUNIS classification systems; combined bed sheer stress (wave and maximum tide); instantaneous wave energy; instantaneous tidal energy; classified instantaneous wave energy (biologically significant thresholds provided by JNCC); classified instantaneous tidal energy (biologically significant thresholds provided by JNCC); confidence evaluation of instantaneous wave energy; and confidence evaluation of instantaneous tidal energy.

2.77 The above are offered as raster layers in WGS84 with the exception of the comparison of Marine Recorder and EUNIS classification systems.

2.78 A report was produced (West *et al.*, 2010) which documents the development of the marine diversity data layers.

Issues

2.79 The approach taken particularly for the wave induced kinetic energy predictions are considered to be robust and repeatable, whereas the approach taken to generate the tidal current energy layers have relied on the review of error quantification given by Holt *et al.,* (2005) rather than being based on field measurements. It is believed that, although the results are sound that they could be improved to provide greater confidence in the uncertainties provided.

2.2.6 Task 2F - Marine biodiversity (pelagic and benthic)

Aims and Objectives

2.80 There was an original requirement to consider a data layer which identified biodiversity (the degree of variation of life forms within a given ecosystem, biome, or an entire planet and is one measure of the health of ecosystems) both for pelagic (relating to or living in or on oceanic waters, the pelagic zone of the ocean begins at the low tide mark and includes the entire oceanic water column) and benthic (relating to the bottom of a sea or lake or to the organisms that live there).

2.81 The aim of this task was to identify and review current approaches available for the development of a marine diversity areas data layer of UK waters. The key aims of this element of the contract were:

- To complete an objective review of the current approaches available for the generation of marine diversity layers, identifying their strengths and weaknesses and any refinements/modifications required; and
- To present the review in a clear report that includes an assessment of the value (and use) of creating a marine diversity data layer for MPA site selection.

2.82 This task was carried out by MarLIN, Plymouth Marine Laboratory and ABPmer.

Methodologies

2.83 The review looked at the rationale for identifying areas of high diversity, these included investigating the methods used to define areas of diversity, by examining first the evolution of the term “biodiversity hotspots”, its definition and then questioning what is a representative measure of diversity. Following on from the review of past approaches the study looked at the identification of high diversity areas which included the issues regarding the units of measurement (metrics) used to show diversity. The review also investigated the ways the current methodologies could be extended to incorporate offshore areas, data-poor environments and the pelagic realm. Finally recommendations were made on the most appropriate methods and data needs for identifying marine biodiversity in UK territorial waters (inshore waters of England, Wales, Northern Ireland, Scotland and UK Offshore waters).

2.84 It was important that the methods developed to identify areas of biodiversity were widely reviewed and agreed by the scientific community in order to add rigor and support to the identification of MPAs, and marine nature conservation in the UK. This was first achieved through a workshop held on the 8th January 2009 in London where methods for identifying marine biodiversity with the data available were critically discussed, and subsequently through individual feedback with selected experts.

2.85 Our knowledge regarding diversity patterns of pelagic organisms is scarce though the role of diversity in mediating and stabilising ecosystem function (through, for example, biomass production and elemental cycling) is becoming increasingly apparent. The review of methodologies for mapping pelagic biodiversity appraised a series of metrics spanning different levels of ecological organisation of the pelagic system. These included:

- Diversity measures for different system components including phytoplankton, zooplankton and fish;
- Satellite earth observation (EO) surrogate measures (thermal fronts, sea surface temperature (SST) and ocean colour); and

- Indicators such as pelagic megafauna (e.g. basking sharks, cetaceans), seabirds and pelagic fish spawning areas.

2.86 EO oceanic fronts were selected for development to represent the pelagic diversity data layer, using the long time-series of EO SST data to map frequently occurring thermal fronts within UK waters. Unlike most terrestrial and benthic systems, the pelagic ecosystem is not restricted by biotope boundaries such as reef edge or change in substrate, and is mobile i.e. constantly changing. This variability is shown at a variety of spatial (area) and temporal (time frame) scales ranging from species fluctuations resulting from short-term changes (including weather) to seasonal cycles, inter-annual and long-term change (such as climate change). As it was important that this data layer captured some of this variability it was decided that front maps would be presented seasonally, with indications of both spatial and temporal variability.

2.87 The benthic biodiversity data collation exercise undertaken for the other biological components of the MB0102 project; Limited Mobility Benthic Species (2B), Habitats (2C), Non-native species (2D) was also utilised to gather the underlying data for the biodiversity layers. After collation, the underlying data tables were quality assured to check valid information was entered in each of the attributes. In addition to the quality criteria applied to the collated datasets, confidence ratings based on the quality and quantity of data used in the final analysis were calculated for each grid cell. Alongside the spatial data, each derived data layer has a metadata record to assist in the discovery and reuse of the outputs.

2.88 The analysis was carried out using the measures identified in the review; species and habitat richness, taxonomic distinctness and biotope distinctness, as these represent the most appropriate (in terms of application to variable datasets) and most comprehensive measures (in terms of covering diversity at different organisational levels). Species richness was calculated separately for each broad sampling method type while for the measure biotope richness, the centre of each polygon was taken. Taxonomic distinctness was conducted on a subset of the species data, with only the most widely distributed species being included. Biotope distinctness was calculated in a similar manner to taxonomic distinctness. All outputs were provided for the offshore, inshore and intertidal areas covering all UK waters.

Outputs

2.89 The output of the first Phase was a report in which recommendations for the benthic and pelagic layers were detailed together with the costs to produce these, Jackson, E.L *et al*., (2009). The resulting deliverables from the pelagic part of the Task included maps of the fronts found seasonally together with a supporting report (Miller *et al*., 2010). The benthic data layers have been described in the Langmead, *et al*., (2010.) report which accompanies the resulting outputs.

Issues

2.90 There are limitations to the approach used, firstly because the ocean fronts are a proxy for enhanced biodiversity and not a direct measure and it is not currently possible to quantify the enhancement or to predict at what times the effect will be greatest. Satellites only observe surface fronts, though strong and persistent surface fronts usually indicate a depth profile through the whole surface layer. Therefore when considering MCZ designation, the major fronts may offer some indication of surface plankton and mobile pelagic species (and possibly seabirds), but not benthic fauna. Fronts should be considered alongside direct measures of biodiversity, for example to assist in assessing the spatial and temporal context of known hotspots.

2.91 Thermal infrared EO data are limited by cloud cover, which may lead to biases in data analysis and despite improvements in the near-coastal detection of fronts there is still a lack of useable SST data within a few kilometres of the coast which prevents observation of small-scale fronts associated with coastal processes, estuaries and intertidal zones.

2.92 The large scale data collation and aggregation exercise for the benthic element of the Task encountered several issues. In particular, the need to harmonize disparate data formats and the negotiation with a variety of data providers to allow the widest possible release of the resulting layers. In addition, the work highlighted the importance of cataloguing and storing datasets with an appropriate level of metadata. However the main limitations of this approach are the large gaps where there are no data available.

2.2.7 Task 2G - Residual current flow

Aims and Objectives

2.93 The aim of this task was to create data layers displaying residual current flows in the offshore, coastal and enclosed tidal water bodies to assist in the formulation of more accurate assessments of larval connectivity to be made. The key objectives of this task were:

- To produce data layers at the finest resolution possible; and
- To present the data layers with a key to identify open, semi-closed and closed systems.

2.94 This task was carried out by ABPmer and Proudman Oceanographic Laboratory (POL).

Methodologies

2.95 There are nominally three types of residual current flow that are considered important in coastal and offshore regions of the UK Continental Shelf area:

- Tidal residual current;
- Density driven currents; and

- Surge residual current.

2.96 The principal source of residual current flow data for offshore and coastal waters was POL using a specially developed Extended Atlantic Margin Model (EAMM). The model was used to obtain annual and seasonal mean residual current flow information. To do this a model simulation was run covering a total of 45 years (1 January 1960 to 31 December 2004).

2.97 During the 45 year run, the residual current speed at each location and depth level was calculated and recorded on each model day, as the mean current speed and direction over a 25 hour period. These values were then grouped and analysed to yield mean residual current flow speed and direction on annual and seasonal timescales along with depth layers corresponding to the total water depth, measured from the surface downwards.

2.98 In an enclosed water body (EWB) the same three residual transport types outlined above may be observed. However, due to the smaller spatial scales and the relatively faster response of these systems to variability, both the spatial and temporal patterns of residual flow will also be smaller in scale.

2.99 The EAMM did not resolve the spatial detail of the EWBs and therefore could not provide a reliable, quantitative measure of residual currents. Data for EWBs was sourced from the UK Estuaries database. Out of the 163 estuaries in the JNCC database, the required data were available for only 50 of the major estuaries.

2.100 For the purpose of the study representative values were chosen to characterise the flushing rate of each estuary. Three flushing parameters were analysed; mean river flushing; maximum river flushing; and tidal flushing. The sum of the points for each estuary was used as the flushing score with possible values ranging from 0-6. Low values in the range correspond to a poorly flushed estuary (a more closed system), whereas higher values correspond to a strongly flushed estuary (a more 'open' system).

Outputs

2.101 A report (Lambkin *et al.*, 2010) and a number of data layers were produced to represent mean residual current flow speed and direction on annual and seasonal timescales, namely:

- Annual (January - December);
- Winter (January - March);
- Spring (April - June);
- Summer (July - September); and
- Autumn (October - December).

2.102 And data layers were produced for each temporal group at the following depths:

- 10% (near surface);

- 25%;
- 50% (mid-water);
- 75%; and
- 90% (near bed).

Issues

2.103 The predictions are restricted to the grid size of the underlying models, thus reducing the capability of resolving the detail close inshore and in estuaries. Improvements could therefore be made if the resolution was increased but this would be hugely expensive and unrealistic.

2.2.8 Task 2H - Benthic productivity

Aims and Objectives

2.104 The aim of this project was to identify and review current approaches available for measuring secondary production by invertebrates and to assess the suitability of these for generating broad-scale benthic productivity maps of UK waters. The key aims of this element of the study were:

- To complete an objective review of the current approaches available for the generation of benthic productivity maps, identifying their strengths and weaknesses and any refinements/modifications required;
- To present the review in a clear report that included an assessment of the value (and use) of creating such a data layer for MPA site selection; and
- To undertake a trial pilot study to compare the performance of two different approaches to estimating benthic productivity.

2.105 This task was carried out by ABPmer.

Methodologies

2.106 In order to fulfil the aims and objectives of this task, a systematic literature review was undertaken, to identify the different methodologies that could be used to assess benthic productivity.

2.107 A one-day workshop was held in January 2009, where experts from research and other institutions were invited to discuss the issues around mapping benthic productivity. Specifically opinions and feedback were sought on the approaches that could be used to construct a productivity data layer and the use of this to deliver management objectives.

2.108 This process identified two approaches as potentially suitable to develop a UK wide seabed production data layer without requiring biological data (which is expensive and time consuming to collect). These were; 1) the Duplisea *et al*., (2002) model modified by Hiddink (2006), referred to in this study as the Duplisea/Hiddink model, that predicts production from environmental variables and other drivers of production and; 2) models parameterised using environmental variables to predict production (so that environmental variables are used as proxy indicators of production).

2.109 To assess the feasibility of these two approaches the pilot study outlined in this report was carried out to test and compare the performance of these approaches. A region of the North Sea seabed that had been previously sampled by Cefas as part of a Defra funded programme (project no.ME3112) was selected as the pilot study area. The earlier sampling programme provided environmental and biological information and estimates of benthic macroinvertebrate production for this area based on empirical modelling using the Brey model developed by Thomas Brey. This model has been judged in peer-reviewed papers to be the most accurate approach available to assess production. The estimates from the Brey model formed a baseline to compare the estimates of the Duplisea/Hiddink approach and underpinned the development of models using proxy indicators of production. These approaches were applied to the same area to determine if the more cost-effective, proxy indicator approach, could be justified rather than the more data intensive models.

2.110 The results from the Duplisea/Hiddink model were not found to correlate with the Brey model. It was therefore not possible to demonstrate that the Duplisea/Hiddink model could be used for data layer development instead of the more direct estimation approach of Brey (2001) that relies on sampling and processing of biological data and published literature values. The pilot study also found that it was not possible to identify robust proxy indicators of soft-sediment benthic production applicable to the UKCS.

Outputs

2.111 Two reports were produced under this Task, the first providing a review and recommendations (Tillin *et al.*, 2009), the second providing the results of a trial pilot study assessing the production of a data layer (Tillin *et al.*, 2010a).

Issues

2.112 The findings from this study concur that no consistent, quantifiable relationships between environmental variables and production rates could be identified at the scale of the UK. However, it is likely that, at a regional or broad habitat type scale (habitats classified on environmental variables, such as depth rather than biological features e.g. EUNIS level 3), models could be developed to quantify patterns in productivity that could be used to assign productivity values to broadscale habitats, although such an approach would require validation.

2.2.9 Task 2I - Intertidal habitats

Aims and Objectives

2.113 Task 2I set out to develop an intertidal habitats data layer for English Territorial Waters. In order to achieve this intertidal habitat maps were transferred from their current habitat classification to the appropriate EUNIS 2007 type in the MESH translated DEF to produce a single intertidal habitat layer containing the broad scale habitat types. A confidence assessment for each habitat data set used in the production of the overall intertidal habitat data layer. This task was undertaken by ABPmer.

Methodologies

2.114 In order to develop an intertidal habitats data layer firstly the intertidal area for English Territorial Waters was defined using the 2009 Ordnance Survey (OS) MasterMap 'Foreshore' layer. The next stage was to translate 12 habitat maps supplied by various data owners from their current habitat classification to their EUNIS level 3 intertidal habitat types. A shapefile according to the MESH Translated Habitat DEF standard was created for each habitat dataset translated.

2.115 Where the energy level for the rock biotopes was contained within the original habitat code this was maintained through the translation process into EUNIS Level 3. If this was not possible then the rock habitats were initially translated to EUNIS Level 2 and then these polygons were further categorised to Level 3 using point data contained within the Marine Recorder Database.

2.116 A confidence assessment was undertaken on each of the respective input databases to this task following the MESH methodology.

Outputs

2.117 One overall intertidal habitats data layer was created along with a report to document the task (Frost, 2010). Where this resulted in overlaps between polygons, the polygon from the dataset with the highest confidence score was considered to have the highest probability of occurrence. The intertidal habitat data layer created covers approximately 86% of the total intertidal area of English Territorial Waters.

Issues

2.118 A series of assumptions have been made throughout the task in order to automate a number of the computational steps required to produce the data layer. This was necessary due to both the nature of the input data and the scale at which the data layer was produced.

2.3 Task 3 - Sensitivity Matrices

Aims and Objectives

2.119 To support the identification and management of MCZ/MPAs, it is helpful to have information on the likely sensitivity of conservation features to environmental pressures associated with human activities. Such information can identify whether particular features are likely to have been affected by historic or ongoing pressures (thus possibly affecting their attractiveness as prospective MCZ/MPAs) and which activities may need to be managed in the future to support achievement of conservation objectives.

2.120 The objectives for this task were:

- To review the current techniques available for the development of sensitivity assessments including assessment of the approach for data layer production and to make recommendations on the most suitable technique to the Project Steering Group.
- To test the sensitivity assessment methodology and scoping the cost of developing a vulnerability data layer.

Methodologies

2.121 A review was undertaken of approaches to sensitivity and vulnerability assessment to identify possible approaches that could be used to support the identification and management of MCZ/MPAs. A stakeholder workshop was held as part of the review process.

2.122 The review recommended that the assessments of sensitivity should be based on the concepts of resistance (tolerance) and resilience (recovery) of species or habitats to human pressures. The review concluded that there was currently insufficient spatial data on the distribution and intensity of pressures associated with human activities across UK seas to facilitate the production of an overall vulnerability layer.

2.123 A second phase of the study therefore concentrated on the formalization of a methodology and production of a sensitivity matrix for 108 MCZ/MPA features against 40 different human pressure categories. For each MCZ/MPA feature, sensitivity (in terms of resistance and recovery) was assessed based on a scale of High/Medium/Low or none against a benchmark 'average' level of pressure using standard assessment criteria. Much of the work to populate the matrix was completed at two stakeholder workshops; other assessments were completed by the project team.

Outputs

2.124 The outputs from the task included:

- A pressures-MCZ features sensitivity matrix (Excel spreadsheet). The matrix also incorporated a confidence assessment based on the availability of information on each pressure-feature interaction;
- A project report (Tillin *et al.*, 2010b) including a clear description of the methodology and advice on how the matrix might be used.

Issues

2.125 A number of issues were encountered during the study:

- The lack of comprehensive information on the distribution and intensity of human pressures prevented the development of a UK wide vulnerability layer;
- The broad-scale habitats and some of the habitat FOCI include a wide range of different biotopes of varying sensitivity. In assessing these biotopes, it was therefore necessary to express sensitivity as a range - sometimes this range was large (e.g. None to High); and
- There was a lack of direct evidence to underpin many of the assessments which were therefore often based on expert judgement.

2.4 Task 4 - Maximising Data Access and Use

Aims and Objectives

2.126 In addition to the development of data layers, a review of GIS platforms was undertaken as it was identified that there was a need to ensure these layers could be easily accessed through a WebGIS by stakeholders given the participatory nature of the MCZ process. Task 4A undertook a review of a selection of existing webGIS portals and applications dealing with marine spatial planning. The review concluded that none of the webGIS interfaces were able to meet all the requirements for MPA planning, instead it recommended that a webGIS framework should be built on a combination of Finding Sanctuary, Marine Map and other functionality from interfaces identified in the report (Jackson C.J., *et al*, 2009). As part of this review, it was also revealed that there was a need to collate data at a regional level, with focus on those activities which were difficult to collect data for at a national level.

2.127 The specific objectives of task 4B were to provide a webGIS interface to cater for a wide range of users and or stakeholders that are being engaged in the MCZ process via the Regional MCZ Projects, including Government Departments; Industry Sectors; Non-Governmental Bodies and the general public. The system was required to:

- Be user-friendly in ease of navigation to cater for the needs of a range of end users with different technical capabilities;
- Allow the relevant datasets being collected at the regional level to be entered, with the correct QA processes in place to ensure quality of the data;
- Have agreed and defined categories which will permit easy interpretation;
- Include help boxes which assist users in guiding themselves through the webGIS to ensure it can be easily used; and
- Allow data to be viewed at a Regional and a National Scale.

2.128 This task was undertaken by ABPmer and exeGesIS.

Methodologies

2.129 The MCZ Project Interactive Map web site has been built by exeGesIS using well established and widely used technologies and can be accessed via www.mczmapping.org. Where possible open source components have been used to speed the development process and ensure that the site has a user friendly, familiar interface.

2.130 The MCZ Project Interactive Map web site includes all the tools which a member of the public would require to explore the 150 marine map layers and associated attributes, as well as record their sites of interest under their chosen role or roles. The web site includes a complete user guide which details the exact functionality along with step by step guidance for each operation.

Outputs

2.131 The web site has produced a marine focussed interface at a national scale, which for the first time enables anyone to explore a wide range of existing data sets as well as contribute their knowledge to the MCZ process.

2.132 As part of task 4B a report (Warken *et al.*, 2012) was produced to document the development and implementation of the webGIS.

Issues

2.133 Due to the sheer number of data layers being displayed on the web site issues were encountered in the display of these. Organisation of multiple map layers, some of which have extensive coverage without obscuring other data was particularly problematic on the website, especially when data layers are logically grouped. Use of transparency or non solid polygon fills can sometimes help to overcome these difficulties, but have their own problems especially in the ordering and length of time that they take to display.

2.134 The implementation of layer re-ordering functionality was neither intuitive to users nor did it work well with the logical grouping of data layers (e.g. Physical, Admin boundaries etc). It was therefore better to get the default map layer order correct from the start rather than expecting users to re-adjust the layer order.

2.135 The website uses a third party map service which provides a low cost method of serving the base maps, but maintenance down time on such sites will inevitably also cause the web site to be out of service.

3. Data Standards and Dissemination

3.1 The main requirement for all the datasets derived under this project was that they should be freely available to the funding bodies and their agencies and they should not be used by private organisations for commercial gain. This meant that they were developed without copyright or licensing issues where at all possible. In order to meet this objective, and promote discovery and reuse all datasets have had metadata (information about the data) associated with them which meet the Marine Environmental Data and Information Network (MEDIN) discovery metadata standard (Standard v2.3.3) which is in turn compliant with UK GEMINI and EU INSPIRE standard. This means that all data layers have a detailed description of how they were constructed and what licensing and use issues they have. The presence of the accompanying metadata also means that the data layers can be found through the MEDIN website portal (http://www.oceannet.org/). In addition a data agreement document has been drawn up by Defra to enable the free exchange of datasets between the contributing partners which details the limitations of each dataset with regard to their copyright, licensing and use restrictions. All datasets have been logged with the most suitable MEDIN Data Archiving Centre (DAC), see Appendix A, which will ensure that they remain available for future use. All datasets will also be made available through Shared Spatial Information Services (SPIRE) an initiative set up within Defra to improve quality and accessibility of Geographic Information leading to its wider use within Defra, its Executive Agencies and Non-Departmental Public Bodies.

3.2 All data layers derived within this project have been delivered to the WGS84 datum[7]. This datum has been adopted as it is the most commonly used within marine navigation. Data are collected in a number of datum depending on the method of survey e.g. by boat using GPS or by foot using transects and have traditionally been recorded in either WGS84 (or UTM version e.g. 30 or 31) or in OSGB36 (the Ordnance Survey datum) respectively. Any datum transformation or re-projection into WGS84 from any other projection will lead to the introduction of minor positional inaccuracies.

3.3 The reports produced for each Task are available on the Defra website: http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16368. A copy of each report is also provided in a DVD at the back of this report.

[7] World Geodetic System of 1984 (WGS84). Provides a common reference for the world using space techniques, enables transit and GPS system measurements.

4. Limitations and Lessons learnt

4.1 The project was established to develop data layers necessary to inform the identification and designation of MCZs and MPAs in UK waters. The need for the underlying data to be robust as possible is borne out by the requirement of this and other national and international drivers that UK governments are seeking to address including INSPIRE Directive[8] and the EU MSFD[9]. The collation of the data layers identified to assist primarily with the MCZ/MPA process has highlighted a number of the difficulties in obtaining nationally collected datasets from public bodies. This has resulted in known data gaps existing in the final products, leading to concerns as to whether some of the outputs are considered to have sufficient information resulting in a reduction in the confidence in the decision making process.

4.2 This project has concentrated on obtaining the national datasets and those collated by national bodies such as Natural England, JNCC, Environment Agency, CCW, SNH, Cefas and DOENI. The objective was to provide coherent universal data layers that could initially be used by the Regional MCZ Projects and national teams (Natural England, JNCC, CCW and SNH) and be supplemented with locally collated data especially with respect to the Regional MCZ Projects. These layers therefore do not include many of the datasets collected by industry, regional non-government bodies or private companies or bodies.

4.3 The collection of marine data is a costly and difficult process due mainly to the costs of ship time, weather constraints and equipment availability. Today many organisations seek to combine survey cruises to obtain the best use of limited resources. These restrictions have lead in the past to organisations targeting their survey effort to cover their individual commitments under various legislative drivers, leading to data coverage limitations as described below.

4.4 MEDIN promotes sharing of, and improved access to, these data. It is an open partnership and its partners represent government departments, research institutions and private companies. Marine data are expensive to collect and always unique in relation to time and geographical position. There are wide benefits to be gained from working together to share and properly manage these data. MEDIN aims to provide:

- Secure long-term management of marine data sets by setting up a network of Data Archive Centres (DACs);

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[8] INSPIRE Directive in May 2007, establishing an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment.

[9] The MSFD is the environmental pillar of Integrated European Maritime Policy and has clear linkages with other Directives and International Conventions. It has been developed to promote sustainable use of the seas and conservation of marine eco systems. It sets out a common framework based on co-operation between Member States to ensure the sustainable use of marine goods and services by current and future generations. Each Member State must achieve or maintain Good Environmental Status in the marine environment by 2020.

- Improved access to authoritative marine data held in this network, through a central discovery metadata portal;
- An agreed set of common standards for metadata, data format and content maintained and supported by partners; and
- Guidelines, contractual clauses and software tools to support standards and best practice data management.

4.5 This initiative however relies on organisations ensuring that data are logged within the various DACs and that their metadata are made available on the MEDIN portal for discovery by others in an attempt to reduce re-survey or enable cost effective survey planning in the future.

4.1 Data Limitations

4.6 Although the project has provided a large number of data layers which have a UK wide coverage and has provided improvements to UKSeaMap it must be remembered that, as with all data collection activities, they also have a number of limitations. For this study these include:

- Lack of data in the layers does not necessarily mean that the species/habitat is not present as the area may not have been surveyed. This results from the fact that many of the datasets used have been collected for very specific and discrete reasons e.g. compliance monitoring and assessment for EC Directives such that they have limited spatial coverage but are often temporally rich (many years of sampling the same locations), this may lead to skewing of the underlying data and hence the derived data layer;
- Data included in the layers have been sourced from national data gathering organisations, for example JNCC, CCW, NE, Environment Agency and Cefas, and do not include many industry or private data collections. It was the intention that these data were collated by the Regional MCZ Project teams, as described above;
- The inclusion of some known datasets has not been possible as they were not made available by some national bodies due to their lack of engagement in the process. These organisations include the Environment Agency, British Geological Survey (BGS) and The Scottish Association for Marine Science (SAMS);
- Some datasets have been gridded to safeguard the true location of the species/habitat as requested by the data supplier. These grids vary between 1, 5 and 10km and so although indicating a presence within a general area may be less helpful in some of the decision making processes. The information concerning which layers contain such data is provided in the associated metadata record;
- Data coverage is coarse in some examples, for mobile species distributions the International Council for the Exploration of the Sea (ICES) rectangles (divisions of UK sea areas as used by the fishing industry) were used which means that not all of the Scottish waters are mapped. These divisions were used as they are in many cases the only way in which fish species are recorded and therefore it was not possible to either reduce the

grid sizes beyond those used in the recording e.g. smaller than quarter rectangles;

- Some tasks have been mapped using data derived from model outputs. This has been necessary because there is insufficient data coverage to provide a complete layer of the UKCS, this is particularly true of task 2E outputs where the models used have been calibrated using measured points. The confidence of these underlying models then becomes even more important to consider;
- Some data layers have use limitations as detailed in the accompanying metadata and reports, and should be used accordingly. Thus although the data layers can be used for the purpose of this project, they may not be available to all national projects, thus limiting the usage and confidence if incomplete layers are used in the future;
- The age of some datasets also reduces confidence, for example, in relation to historic isolated species records. For this study, such records have been included with appropriate reference in the metadata; and
- Surveying and recording techniques and methodologies used vary between organisations and are commonly linked to the reporting requirements of the information meaning that the collation of these to one layer can lead to a mismatch of data consistency.

4.2 Client – Contractor Relationship

4.7 The project was set up by Defra who engaged a number of funding bodies and government agencies to manage and be the receiver of the project products, totalling seven original clients and the Regional MCZ Projects once they were established. The contracting team was formed of seven organisations. The large number of organisations and individuals within them meant that lines of communication needed to be strong and maintained and these were discussed during the project team start up meeting in November 2008 where it was agreed that all correspondence was to be copied to the relevant team members. This became increasingly difficult to control from a management perspective once the sub-contractors communicated directly with the Project Steering Group (PSG) and its representatives.

4.8 The delivery of the products to the tight timeline required data supply to the contractors to be done in a timely manner, similarly once the reports and data layers were available in draft a review process was put in place to check that the outputs met the client's expectations. Due to the busy nature of the reviewing individuals, delays in the provision of the final product release were experienced. These delays in the feedback also meant that continuity within the sub-contactor team was not always possible resulting in an element of re-learning and re-distribution of resources to ensure revised timelines were met.

4.9 To assist with the distribution of draft and final products ABPmer set up a project related web interface to allow the exchange of data layers and reports. This web site was tailored to differentiate between the different groups of reviewer to ensure that datasets did not get released prior to sign off.

4.3 Lessons Learnt

4.10 This has been one of the largest, coordinated UK marine contracts and during the execution of the project a number of lessons have been learnt for studies of a similar size and nature undertaken in the future, these include:

- Regular contact is maintained between the client and lead contractor with arrangements for cover and delegation of decision-making during periods of leave;
- Buy-in is obtained from the governmental bodies and their representatives to fully engage in the whole process to ensure that the data layers provided are as comprehensive as possible;
- Promotion of feedback in a timely manner; and
- Ensure there is sufficient understanding of the spatial coverage, quality and limitations of the requested outputs.

4.4 Future Suggestions

4.11 In addition the study has also highlighted some suggestions for consideration both for the longevity of the data layers produced under this contract and for the management of such studies in future, including:

- Provide a mechanism for the data layers to be updated in the future;
- Provide sufficient resources to extract information in the future from different organisations;
- Ensure lines of communication are well established, more frequent face to face meetings and/or regular phone calls between key client and contractor members.

5. References

Brey, T. 2001. Population dynamics in benthic invertebrates. A virtual handbook. http://www.awi-bremerhaven.de/Benthic/Ecosystem/FoodWeb/Handbook/main.html. Alfred Wegener Institute for Polar and Marine Research, Germany.

Brooks, A.J, Roberts, H., Kenyon, N.H. & Houghton, A. J. (2009) Mapping of Geological and Geomorphological Features. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer Task 2A, Report No. 8.

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northern, K.O. & Reker, J.B. (2004) The Marine Habitat Classification for Britain and Ireland Version 04.05 JNCC, Peterborough ISBN 1 861 07561 8 (internet version) www.jncc.gov.uk/MarineHabitatClassification

Duplisea D.E, Jennings S, Warr K.J, Dinmore T.A (2002) A size-based model of the impacts of bottom trawling on benthic community structure. Canadian Journal of Fisheries & Aquatic Science 59:1785-1795.

Ellis, J.R., Readdy, L. & South, A. (2009) Recommendations for mapping the distributions of highly mobile species. Defra Contract No. MB0102. ABPmer and Centre for Environment, Fisheries and Aquaculture Science (Cefas), Task 2B, Report No. 5

Ellis, J.R., Readdy, L. & South, A. (2010) Distribution of highly mobile species. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and Centre for Environment, Fisheries and Aquaculture Science (Cefas), Task 2B, Report No. 15.

Frost, N. & Seeley, B. (2009a) Translation of Habitat Maps, Phase 1. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and MarLIN, Task 1B, Report No. 7.

Frost, N., Seeley, B. & Lear, D. (2009b) Translation of Habitat Maps, Phase 2. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and MarLIN, Task 1B, Report No. 13.

Frost, N.J., Petrey, D. & Swift, R. (2009c) Assessing the confidence of broad scale classification maps, Phase 1. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer Task 1C, Report No. 1.

Frost, N.J. (2010) Intertidal habitats datalayer. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer, Task 2I, Report No. 24.

Frost, N.J., & Swift, R. (2010) Assessing the confidence of broad scale classification maps, Phase 2. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer Task 1C, Report No. 11.

Furze M.F.A., Roberts M.J. 2004. Assessing the Conservation Value of Geological Sites in the Marine Environment: Numerical Assessment of Candidate Sites. JNCC Contract Number:F90-01-665.

Hiddink J.G (2006) Modelling the state of soft-sediment benthic communities in Welsh coastal waters. CCW Contract Science Report No 773.

Higgs, S., Seeley, B., Lear, D., Adams, L., Bilewitch, J., Wilkes, P. & Evans, J. (2010) Task 2D. Mapping of Non-Native Species. Development of a marine diversity data layer: review of approaches and proposed method. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Marine Life Information Network (MarLIN), subcontracted by ABPmer, Task 2D, Report No. 17.

Holt. T, Allen. J. I, Proctor. R, Gilbert. F (2005): Error quantification of a high resolution coupled hydrodynamic-ecosystem coastal-ocean model: part 1 model overview and assessment of the hydrodynamics. Journal of Marine Systems, 57, 167-188

Jackson, C.J., Belcher, S.C., Russell, R.J., Ray, P.A. & Brown, C.E. (2009) Assessment of Existing webGIS Platforms for communication and dissemination of information for the planning of marine protected areas. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer Task 4, Report No. 3.

Jackson, E.L., Langmead, O., McQuatters-Gollop, A., Miller, P., Fox, C., Hiscock, K., Tyler-Walters, H. & Saunders, J. (2009) Development of a marine diversity data layer: review of approaches and proposed method. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Marine Life Information Network (MarLIN) Plymouth, subcontracted by ABPmer, Task 2F, Report No. 2.

Lambkin, D.O., Wakelin, S., Holt, J. & Bell, C. (2010) Residual current flow datalayer: Description of approach. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and Proudman Oceanographic Laboratory (POL), Task 2G, Report No. 9.

Langmead, O., Jackson, E.L., Griffiths, C., Wilkes, P., Neilly, P., Lear, D., Lickraft, I., Foggo, A. & Tyler-Walters, H. (2010) UK marine benthic diversity layer. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Marine Life Information Network (MarLIN), subcontracted by ABPmer, Task 2F, Report No. 25.

Miller, P., Christodoulou, S. & Picart, S.S. (2010) Oceanic thermal fronts from Earth observation data - a potential surrogate for pelagic diversity. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Plymouth Marine Laboratory (PML), subcontracted by ABPmer, Task 2F, Report No. 20.

Seeley, B., Lear, D., Higgs, S., Neilly, M., Bilewitch, J., Evans, J., Wilkes, P. & Adams, L. (2010a) Mapping of Benthic Species. Development of a marine diversity data layer: review of approaches and proposed method. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Marine Life Information Network (MarLIN), subcontracted by ABPmer, Task 2B, Report No. 14.

Seeley, B., Higgs, S., Lear, D., Evans, J., Neilly, M., Campbell, M. Wilkes, P. & Adams, L. (2010b) Mapping of Protected Habitats. Development of a marine diversity data layer: review of approaches and proposed method. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Marine Life Information Network (MarLIN), subcontracted by ABPmer, Task 2C, Report No. 16.

Thomas, N. & Irving, R. (2009) Biotope Tagging of Benthic Sample Datasets, Phase 1. Development of a marine diversity data layer: review of approaches and proposed method. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Emu Ltd and SeaScope, subcontracted by ABPmer, Task 1A, Report No. 6.

Thomas, N. & Irving, R. (2010) Biotope Tagging of Benthic Sample Datasets, Phase 2. Development of a marine diversity data layer: review of approaches and proposed method. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. Emu Ltd and SeaScope, subcontracted by ABPmer, Task 1A, Report No. 19.

Tillin, H.M., Frost, N.J., & Hull, S.C. (2009) Development of a Benthic Productivity Datalayer: Assessing the Available Approaches. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer Task 2H, Report No. 4.

Tillin, H.M, Bolam, S. & Hidddink, J. (2010a) Benthic Productivity Data Layer Development - North Sea Pilot Study. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and Marine Life Information Network (MarLIN) Task 2H, Report No. 21.

Tillin, H. M., Hull, S.C. & Tyler-Walters, H. (2010b) Development of a Sensitivity Matrix (pressures-MCZ/MPA features). Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and Marine Life Information Network (MarLIN) Task 3, Report No. 22.

West, N. Swift, R. & Bell, C. (2010) Seabed Energy Layers. Development of a marine diversity data layer: review of approaches and proposed method. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and Proudman Oceanographic Laboratory (POL), Task 2E, Report No. 10.

Warken, N.W., Brown, C.E. & Pettitt, T. (2012) MCZ Project Interactive Map report. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer and exeGesIS, Task 4, Report No. 23.

Appendix A. MB0102 Project Output Datasets and Relevant Data Archive Centres (DAC)

Mb0102 task ref.	Derived data layer title	Specific layers included in derived data layer	Dac
1A	Biotope Tagged Benthic Sample Datasets	A number of datasets were biotope tagged and translated to an appropriate level in the Marine Habitat Classification for Britain and Ireland (version 04.05). Data sets are available via an Access Data Base (Marine Recorder Snapshot). Refer to Reports 6 and 19 for further details on the data sets biotagged.	DASSH
1B	Translated Habitat Maps	Refer to Report 7 for details on the habitat maps translated during Phase 1 and Report 13 for this translated as part of the second Phase of activities.	DASSH
1C	Confidence Maps for Broadscale Habitats	Bathymetry data layer (GEBCO 30 second & Seazone 30 m DEM). Light penetration layer (from MODIS 4 km resolution data) & its associated confidence layer based on the 1% light penetration threshold for the boundary between the infralittoral and circalittoral zones. Wave disturbance layer & its associated confidence layer. Biological zones layer and their individual and overall confidence layers for the following zones: infralittoral; circalittoral; deep circalittoral; upper slope; upper bathyal; mid bathyal; lower bathyal; abyssal.	BODC
2A	Geological & Geomorphological Features	Erosional Glacigenic Features, Depositional Glacigenic Features, Erosional Fluvioglacial Features, Depositional Fluvioglacial Features, Periglacial Features, Ice Limit ,Tidal Bank Features, Transverse Bedform Features, Longitudinal Bedform Features, Bedform Field Other, Erosional Scour Features, Ebb Delta, Slide Deposit ,Slide Scar ,Rollover Fold ,Turbidity Flow Features, Palaeo Channel Features, Submerged Peats, Submerged Terrace Features, Buried Dune Field Features, Submerged Cliffline Features, Palaeo Lagoon Features, Submerged Caves, Topographic Features and rock outcrops, Rock Structures, Bioherm Features, Fluid and Gas Seep Structures, Mud Diapir, Sediment Drift	BGS
2B	Species Data Layers - Limited Mobility	*Alkmaria romijni, Amphianthus dohrnii, Anotrichium barbatum, Arachanthus sarsi, Artica islandica, Armandia cirrhosa, Arrhis phyllonyx, Ascophyllum nodosum ecad mackaii, Atrina pectinata, Caecum armoricum, Cruoria cruoriaeformis, Dermocorynus montagnei, Edwardsia ivelli, Edwardsia timida, Eunicella verrucosa, Fucus distichus, Funiculina quadrangularis, Gammarus insensibilis, Gitanopsis bispinosa, Gobius cobitis, Gobius couchi, Haliclystus auricula, Heleobia stagnorum, Hippocampus guttulatus, Hippocampus hippocampus, Leptopsammia pruvoti, Lithothamnion coralloides, Lucernariopsis campanulata, Lucernariopsis cruxmelitensis, Nemastostella vectensis, Ostrea edulis, Pachycerianthus multiplicatus, Pachycordyle navis, Padina pavonica, Palinurus elephas, Paludinella littorina, Phymatolithon calcareum, Pollicipes pollicipes, Swiftia pallida, Tenellia adspersa, Thyasira gouldi, Victorella pavida*	DASSH

Mb0102 task ref.	Derived data layer title	Specific layers included in derived data layer	Dac
	Species Data Layers - Mobile	*Merlangius merlangus, Dipturus batis, Rostroraja alba, Aphanopus carbo, Anguilla anguilla, Ammodytidae, Clupea harengus, Gadus morhua, Merluccius merluccius, Pleuronectes platessa, Scomber scombrus, Solea solea, Trachurus trachurus, Raja clavata, Raja montagui,,Raja undulata, Squalus acanthias, Molva molva, Lophius piscatorius, Micromesistius poutassou, Coryphaenoides rupestris, Hippoglossus hippoglossus, Hoplostethus atlanticus, Molva dypterygia, Reinhardtius hippoglossoi, Centrophorus granulosus, Centrophorus squamosus, Centroscymnus coelolepsis, Dalatias licha, Thunnus thynnus, Isurus oxyrinchus, Galeorhinus galeus, Lamna nasus, Prionace glauca, Cetorhinus maximus, Osmerus eperlanus, Salmo trutta, Leucoraja circularis, Squatina squatina, Dermochelys coriacea, Raja microocellata, Leucoraja naevus, Amblyraja radiata, Raja brachyuran*	DASSH
2C	Habitats Data Layers	Littoral Chalk Communities BGS, Sheltered Muddy Gravels BGS, Subtidal Chalk BGS, Subtidal Mixed Muddy Sediments BGS, Subtidal Sands and Gravels BGS, & Mud Habitats in Deep Water BGS.	BGS
		Subtidal_chalk_modelled_poly_BGS and Littoral_chalk_communities_modelled_BGS	BGS
		All predicted Tideswept channels layers	BODC
		Coral garden, Mud in deep water, and deep sea sponge distribution layers	DASSH
		Blue Mussel Beds, Carbonate Mounds, Carbonate Reefs, Coastal Saltmarsh, Cold water coral reef, Coral garden potential, Deep sea sponge aggregation potential, Estuarine rocky habitats, File shell beds, Fragile sponge anthozoan, Intertidal boulder communities, Intertidal mudflats, Intertidal *mytilus edulis* beds, Maerl beds, *Modiolus modiolus* beds, *Musculus discors* ,*Ostrea eduli*s, Peat clay exposures, *Sabellaria alveolata* reefs, *Sabellaria spinulosa*, Saline lagoons, Sea pens and burrowing megafauna, Seagrass beds, Seamounts, Serpulid reefs	DASSH
2D	Non Native Species	*Asparagopsis armata; Botrylloides violaceus; Crepidula fornicata; Codium fragile; Caprella mutica; Corella eumyota; Crassostrea gigas; Mercenaria mercenaria; Perophora japonica; Ensis (americanus) directus; Eriocheir sinensis; Spartina anglica; Sargassum muticum; Styela clava; and Undaria pinnatifida.*	DASSH
2E	Seabed Energy Layers	Number of derived data layers are contained within this layer: Wave Height (maximum 1 in 5 year significant wave height), with associated Period and Direction; Wave induced bed shear stress (from maximum 1 in 5 year wave conditions); Maximum tidal current speed at 10% above the sea bed and associated direction; Classified tidal current speed (according to classes defined by the Marine Habitat Classification of Britain and Ireland); Tidal current induced bed shear stress (maximum conditions);	BODC

Mb0102 task ref.	Derived data layer title	Specific layers included in derived data layer	Dac
		Combined bed shear stress (due to the combined effects of maximal wave and tidal current effects); Wave-induced water velocity at seabed; Instantaneous kinetic energy at the seabed due to the effects of waves; Instantaneous kinetic energy at the seabed due to the effects of tidal currents; Classified Instantaneous kinetic energy at the seabed due to the effects of waves (biologically significant thresholds provided by JNCC); Classified Instantaneous kinetic energy at the seabed due to the effects of tidal currents (biologically significant thresholds provided by JNCC); Confidence evaluation of instantaneous wave kinetic energy; Confidence evaluation of instantaneous tidal kinetic energy; Period integrated kinetic energy at the seabed due to the effects of waves; Period integrated kinetic energy at the seabed due to the effects of tidal currents; Ratio Period-integrated wave KE: Period-integrated current KE	
2F	Marine Diversity Area - Pelagic (Front Proxy)	The source of data for this frontal analysis was the AVHRR archive acquired by Dundee Satellite Receiving Station, has made several passes per day over the UK continuously since August 1981. The maximum spatial resolution is 1.1 km, sufficient for detection of all scales of fronts relevant to pelagic diversity, including mesoscale and near-coastal fronts. Ten years of data were processed to encompass the inter annual variability, from December 1998 to November 2008	DASSH
	Marine Diversity Area - Benthic	Data layer showing the distribution of benthic biodiversity measured as biotope/ habitat richness and distinctness. Will be provided as a continuous layer of diversity (i.e. will not specifically identify biodiversity hotspots).	DASSH
2G	Residual Current Flow	The principal source of residual current flow data were the Proudman Oceanographic Laboratory (POL), using a specially developed Extended Atlantic Margin Model (EAMM).	BODC
2I	Intertidal	Two versions of single datalayer covering the intertidal area of England comprising of High energy intertidal rock, Moderate energy intertidal rock, Low energy intertidal rock, Intertidal coarse sediment, Intertidal sand and muddy sand, Intertidal mud, Intertidal mixed sediments, Coastal saltmarshes and saline reedbeds, Intertidal sediments dominated by aquatic angiosperms and Intertidal biogenic reefs. One version is clipped to a layer derived from OS Mastermap, and the other is unclipped	DASSH

Appendix B. Task 2A Geomorphological and Geological Feature Categories

Please see to Brooks, A.J, Roberts, H., Kenyon, N.H. & Houghton, A. J. (2009) Mapping of Geological and Geomorphological Features. Report to the Department of Environment, Food and Rural Affairs. Defra Contract No. MB0102. ABPmer Task 2A, Report No. 8.for more detail on references

Geomorphological/ Geological Process Unit Category	**Process Unit Sub-Category**	**Feature Class**	**Feature Class Description**
1: Glacial Process Features			
	1(a) Erosional Glacigenic Features		
		Glaciated Channel/Trough	Feature formed by channelled ice flow causing bedrock erosion. Commonly steep-sided and may be several hundred metres deep and several ten's of kilometres long (Summerfield, 1991).
		Grounded Sea Ice Marks	Features formed when sea ice (ice formed by freezing of the sea-surface) makes contact with the seabed.
		Iceberg Ploughmark Field	Feature formed when the keel of an iceberg makes contact with the seabed. In UK offshore waters, ploughmarks are commonly found at 140-500m water depth with a width of c.20m, depth of c.2m and length of up to 5.5km. Associated with Quaternary (c.2myr - 20kyr ago) glacial episodes (Belderson *et al*., 1973).
		Nunatak	Exposed summit of a mountain which stands above a surrounding ice sheet. Evidenced by 'trimlines' which mark the boundary between frost shattered and glacial scoured rock (Allaby, 2008).
		Roche Moutonnée Field	Asymmetric streamlined glacial feature formed of bedrock. Comprised of a smooth end facing the direction of ice flow and a craggy steeper lee side. May be several hundred metres in length (Summerfield, 1991).
	1 (b) Depositional Glacigenic Features		
		Drumlin Field	Streamlined bedform feature comprised of glacial debris and formed beneath moving ice. Commonly blunted on its up-glacial margin and pointed on its lee side. May be up to 2km in length, 50m in height and 500m in width (Summerfield, 1991).
		Flute Field	Long narrow ridge feature comprised of glacial debris and formed sub-glacially. Aligned parallel to the direction of ice flow. Flutes are commonly up to 10m in height and 1km in length (Summerfield, 1991).
		Ice Rafted Sediment Mounds	Feature comprised of glacial debris which has been transported seaward then deposited by melting icebergs.
		Moraine	Generic term given to feature comprised of unconsolidated glacial debris. May be orientated parallel or transverse to the direction of ice flow. Moraines may form beneath or on-top of moving ice or may form at the ice margin (Summerfield, 1991).
		Prograding Wedge	Stacked glacigenic debris flow deposits lain down in front of large glacial troughs. Located along the continental shelf margin and associated with large-scale sub-marine landslides (Dahlgren *et al*., 2005).
	1 (c) Erosional Fluvio Glacial Features		
		Glacial Lake Outburst-Flood Scour Feature	Erosional feature formed when water dammed by a glacier or a moraine is rapidly released. Catastrophic failure of the containing ice or glacial sediment can release this water over a time-span of minutes to months and flow rates may be extremely high.
		Meltwater Channel	Channel feature cut by glacial meltwater flowing along, under or in front of an ice margin.
		Tunnel Valley	Channel feature cut by glacial meltwater flowing beneath an ice sheet/glacier. May be several hundred metres deep and several kilometres long (Summerfield, 1991).
		Sandur Plain Channel Networks	Channel feature cut into a glacial outwash plain (which forms along the margins of an ice sheet). Channel networks commonly form braided patterns (Allaby, 2008).
		Glacio-marine Channel	Open channel feature 10-15m deep, up to 200m wide and over 15km in length. Found on the

Geomorphological/ Geological Process Unit Category	Process Unit Sub-Category	Feature Class	Feature Class Description
			continental slope and are thought to have formed from cascading currents of dense glacial melt-water flowing down the continental shelf (Kenyon, 1987).
	1 (d) Depositional Fluvio Glacial Features		
		Esker Field	Sinuous ridge feature formed of sand, gravel or boulders. Formed by glacial meltwater flowing either beneath or on top of a glacier or in ice-marginal locations. Feature may be up to 200m high, 3km in width and up to 100km in length (Summerfield, 1991).
		Sandur	Glacial outwash plain formed of sediments deposited by meltwater at the terminus of a glacier. Material is generally very coarse close to the ice but diminishes in size further away (Allaby, 2008).
	1 (e) Periglacial Features		Features formed in areas adjacent to (former) ice sheets. Often associated with the presence of permafrost.
		Periglacial Patterned Ground	Symmetrical arrangement of stones on the surface of soil in periglacial environments. Patterns may be circular, polygonal or striped and these develop as a result of the growth and expansion of ice lenses within soil. Pattern dimensions vary although may measure several 10's of metres (Summerfield, 1991).
		Pingo	Large ice-cored earth mounds which form in permafrost regions as a result of frozen ground being forced upwards by the growth of a sub-surface ice mass. As the ice melts, this mound collapses leaving behind a depression or crater, with a wall of displaced sediment around the rim. This depression may be up to 600m in diameter and the surrounding rim up to 70m high (Summerfield, 1991).
2: Marine Process Features			
	2 (a) Tidal Bank		
		Sand	Significant feature encountered on the continental shelf and in coastal regions. Active banks are found where current velocity exceeds 0.9ms^{-1} and where there is abundant sand. Usually formed from medium or coarse sand and may extend to 80km in length, 3km in width and tens of metres in height (Belderson, 1986; Bearman, 1993; Dyer and Huntley, 1999)
		Gravel	Similar morphology to sand banks although composed of coarser (gravel) material. Presence depends on high current speed and the availability of gravel (Dyer and Huntley, 1999).
		Mud	Bank comprised of silt/clay. Presence depends on low current speed and the availability of sediment.
		Bank (unknown substrate)	(Seabed sediment data lacking)
	2 (b) Transverse Bedform Features		
		Sand Wave Field	Submerged transverse ridges of sand with wave-lengths of c.30-1000m and heights of c.3-18m. Occur where sand is abundant and where current velocities are between c. 0.55ms-1 to c.0.9ms-1. May be symmetric or asymmetric depending on the direction of the net-tidal sand transport (Bearman, 1993).
		Gravel Wave Field	Small-scale mounds or ridges of gravel which are usually asymmetrical and produced by current action on the bed.
		Sediment Wave Field	Generic term given to regular sediment waves identified by seabed surveys in north and northwest UK offshore waters.
	2 (c) Longitudinal Bedform Features		
		Sand Ribbon Field	Low relief, elongate sand strips which may be up to 15km long, 200m wide and 1m high. Indicative of sediment starved environments with strong tidal flows (Kenyon, 1970a).
		Sand Stringers	Linear to slightly curved seabed features measuring up to 130m in width but with no discernable vertical relief (BGS, 1988).
		Gravel Furrow Field	Current-parallel, linear features spaced 25-100m apart, but with an amplitude of less than 0.5m. Individual furrows may measure several kilometres and be more than 10m wide. (Evans *et al.*, 1998). Located where peak current speeds are c.1.5ms^{-1} (Bearman, 1993).

Geomorphological/ Geological Process Unit Category	Process Unit Sub-Category	Feature Class	Feature Class Description
		Longitudinal Bedform Field	Generic term given to areas containing sand streaks, sand ribbons and/or longitudinal sand patches.
	2 (d) Bedform Field (Other)		
		Sharp Edged Sand Patches	Neither transverse nor longitudinal features. 0.75-3m high; flat topped, found in low current areas (c. <0.5ms^{-1}). Sometimes crescentic in plan view (Kenyon, 1970b; Kenyon, pers. comm.).
		Current Bedform Field (unclassified)	Large-scale sediment wave facies identified in north-west UK offshore waters by Due *et al*. (2006) in water depths exceeding 1500m. Better known as contourite mud waves. Initiation of these sediment waves occurs when near-bottom current speed episodically reaches a maximum range of 0.3-0.5 ms^{-1}.
		Gravel Reefs	Gravel bedform features formed from the winnowing of glacial deposits
		Gravel Patches	Gravel bedform features formed from the winnowing of finer material by strong tidal currents
	2 (e) Erosional Scour Features		
		Scour Channel	Large-scale erosional feature formed by the scouring action of deep-water oceanic currents.
		Scour Moat	Feature created by accelerated persistent currents directed around changes of sea-bed slope in deep-water, offshore environments. Usually several kilometres across and over 100m deep and are indicators of energetic and stable long-term environments (Holmes *et al*., 2006).
		Erosional Scour Field	Small-scale erosional features formed by strong oceanic currents flowing in deep offshore environments.
		Tidal Scour Field	Group of small-scale shallow seabed depressions on the continental shelf. Formed by the action of tidal currents.
	2 (f) Ebb Tidal Deltas		Protuberance extending out from shoreline. Formed where rivers enter the sea and supply sediment more rapidly than it can be redistributed by coastal processes (Summerfield, 1991).
3: Mass Movement Features			
	3 (a) Slide Deposit		Large-scale accumulation of sediment in response to gravitational instability along particular shear planes. Many of the slides in UK offshore waters are associated with glacial depocentres and range in age from >2Ma to <10ka. The common association of slides and tectonic features suggests that seismic activity has had a major influence on slide location and distribution (Evans *et al*., 2005).
	3 (b) Slide Scar		Feature which is left on the seabed slope after a sub-marine slide has taken place
	3 (c) Roll-over Fold		Feature formed largely by slumping. Fold is up-dip facing and usually <25m high. Commonly located on prograding wedges (BGS, 1990).
	3 (d) Turbidity Flow Features		Features formed by density-driven flows that carry sediments suspended by the flow turbulence.
		Turbidite Accumulation	Build-up of turbidite deposits. Usually form over a period of hundreds of thousands of years and may extend for several thousand kilometres.
		Continental Slope Canyon	Deep, steep-sided valley feature whose axis slopes seaward at up to 80m/km. Development relates to erosion by turbidity currents (Allaby, 2008).
		Turbidite Channel System	Network of deep-water channels transporting turbidity currents.
4: Features indicating past change in relative sea level			
	4 (a) Palaeochannel		River channel formed at a time when sea-level was lower than present day and the seabed was sub-aerially exposed.
	4 (b) Submerged Peat/ Forest Beds	Holocene	Peat deposits/forests which formed above the former position of high water. Formed during the Holocene period (last 10 000 years) when sea level was lower than present day.

Geomorphological/ Geological Process Unit Category	Process Unit Sub-Category	Feature Class	Feature Class Description
		Pre-Holocene	Peat beds/ forests which formed prior to the Holocene period
	4 (c) Submerged River Terrace		River terraces formed at a time when sea-level was lower than present day and the seabed was sub-aerially exposed.
	4 (d) Buried Dune Field		Wind blown sand dunes formed at a time when sea-level was lower than present day and the seabed was sub-aerially exposed.
	4 (e) Submerged Cliffline		Cliffline representing a former position of the coastline.
	4 (f) Palaeo Lagoon		Lagoon feature which was formed at sea level but has subsequently been submerged.
	4(g) Submerged/partially submerged sea Caves		Submerged and partially submerged caves which are exposed to the sea at high tide. May vary in size, from only a few metres to more extensive systems, which may extend hundreds of metres into the rock (JNCC, 2007).
5: Geological Process Features			
	5 (a) Topographic features and rock outcrops		
		Continental slope	Relatively steeply sloping surface extending from the outer edge of the shelf to the continental rise. Slope angle commonly ranges from 1 to 15^0 (average 4^0) (Allaby, 2008).
		Deep ocean rise	Large-scale undersea topographic feature rising relatively steeply at least several hundred meters from the surrounding deep-ocean floor. Ranges in size from a few kilometres (e.g. seamounts) to many hundreds of kilometres wide.
		Irish Sea Mounds	Group of bedrock outcrops located in the North Channel (which separates Northern Ireland and Scotland). In between the outcropping bedrock areas are large expanses of soft sediments, which are bioturbated by megafauna (Mellor *et al*., 2008)
		Precambrian Rock Outcrop	Rock outcrop of Precambrian age. The Precambrian period spans approximately 4000 Ma, from the time at which the Earth initially formed (c.4540 Ma) to the start of the Cambrian period (542 Ma) (Allaby, 2008).
		Seabed mound or pinnacle	Small-scale undersea topographic feature located on the continental shelf. May be up to several kilometres long and several tens of metres high.
		Deep Ocean Channel	Large geologically controlled channel in which deep-oceanic currents flow. May be several hundreds of kilometres long.
		Ledge	Significant sea-bed protrusions of the coast. Commonly located at headlands and may stretch several kilometres seaward.
	5 (b) Rock Structures		
		Parasitic Cone	Volcanic cone which may rise several ten's of metres above the surrounding seafloor.
		Rock Concretions	Hard masses of sedimentary (and, more rarely, volcanic rock) that form from the preferential precipitation of minerals (cementation) in parts of the rock. Commonly sub-spherical (Allaby, 2008).
	5 (c) Bioherms		Organic reefs comprised of both living and dead marine invertebrates.
		Carbonate Mound	Seabed structure formed from the skeletal remains of cold water coral. Features are commonly located in deep offshore environments, form over many millennia and may be up to 300m high. Development strongly influenced by biological, hydrographical and geological processes and also by climate changes (Roberts *et al*., 2008).
		Lophelia Reef	(Biogenic reef forming species). Biogenic reefs are solid, massive structures which are created by accumulations of organisms and have a geomorphic expression. The reef structure may be composed almost entirely of the reef building organism (along with its tubes or shells) or it may to some degree be composed of sediments, stones and shells bound together by the organisms (Holt *et al*., 1998).
		Maerl Bed	
		Modiolus Bed	
		Sabellaria Reef	
	5 (d) Fluid and Gas Seep Structures		

Geomorphological/ Geological Process Unit Category	Process Unit Sub-Category	Feature Class	Feature Class Description
		Carbonate Cemented Reef	Reef formed by methane-derived carbonate cementing sediments together to form a hard rock. The carbonate cement forms just beneath the seabed as a by-product of the anaerobic oxidation of methane and is closely associated with seabed gas seeps (Judd *et al*., 2007).
		Pockmarks	Shallow seabed depressions, typically several tens of metres across and a few metres deep. Commonly formed in soft, fine-grained seabed sediments by the escape of fluids (gas or water) into the water column (Judd, 2001).
		Cold Seep Structures	An area of the seabed where hydrogen sulphide, methane and other hydrocarbon-rich fluid seepage occurs. (The seeping fluids are the same temperature as the surrounding seawater, but are termed “cold seeps” to distinguish them from hydrothermal vents, where extremely hot water is vented from the seafloor) (Allaby, 2008).
		Darwin Mounds	Coral topped mounds comprised mostly of sand and interpreted as 'sand volcanoes'. Formed when fluidised sand 'de-waters' and the fluid bubbles up through the sand, pushing the sediment up into a cone shape. Individual mounds are up to 75 m in diameter and 5 m high and occur at 1000 m water depth in the northern Rockall Trough, northwest of the UK (Masson *et al*., 2003).
	5 (e) Mud Diapirs		A muddy sediment structure that has intruded into a denser overlying rock causing doming of the seabed (Judd and Hovland, 2007).
	5 (f) Sediment Drift		Large-scale accumulation of sediment formed by deep oceanic bottom-current activity. Commonly covers an area of many thousand square kilometres and forms over a period of several million years.
Geological Conservation Review sites			Sites of national and international geological/ geomorphological importance which have been selected at a Great Britain level through the systematic process of the Geological Conservation Review (GCR) (Ellis *et al*., 1996). This layer contains all GCR sites located at the coast and is predominantly (but not exclusively) comprised of sites from the ‘Coastal Geomorphology block’.

Appendix C. Task 2B Mobile Species

Common name	**Scientific name**
* Gulper shark	*Centrophorus granulosus*
* Leafscale gulper shark	*Centrophorus squamosus*
* Portuguese dogfish	*Centroscymnus coelolepsis*
Kitefin shark	*Dalatias licha*
* Spurdog	*Squalus acanthias*
* Angel shark	*Squatina squatina*
* Basking shark	*Cetorhinus maximus*
Shortfin mako	*Isurus oxyrinchus*
* Porbeagle shark	*Lamna nasus*
Tope shark	*Galeorhinus galeus*
Blue shark	*Prionace glauca*
* Common skate	*Dipturus batis*[10]
Sandy ray	*Leucoraja circularis*
* Thornback ray	*Raja clavata*
* Spotted ray	*Raja montagui*
Undulate ray	*Raja undulata*
* White skate	*Rostroraja alba*
* European eel	*Anguilla anguilla*
Herring	*Clupea harengus*
Smelt	*Osmerus eperlanus*
Brown/Sea trout	*Salmo trutta*
* Cod	*Gadus morhua*
Whiting	*Merlangius merlangus*
Blue whiting	*Micromesistius poutassou*
Blue ling	*Molva dypterygia*
Ling	*Molva molva*
European hake	*Merluccius merluccius*
Roundnose grenadier	*Coryphaenoides rupestris*
Anglerfish	*Lophius piscatorius*
* Orange roughy	*Hoplostethus atlanticus*
Horse mackerel	*Trachurus trachurus*
Sandeels	Ammodytidae[11]
Black scabbardfish	*Aphanopus carbo*
Mackerel	*Scomber scombrus*
* Blue-fin tuna	*Thunnus thynnus*
Atlantic halibut	*Hippoglossus hippoglossus*
Plaice	*Pleuronectes platessa*
Greenland halibut	*Reinhardtius hippoglossoides*
Sole	*Solea solea*
Leatherback turtle	*Dermochelys coriacea*

[10] Since this report was drafted, common skate has been reported to be comprised of two distinct species. As available data cannot be disaggregated between these species, we have retained *Dipturus batis* to refer to the common skate species complex.

[11] Includes five species (Raitt's sandeel *Ammodytes marinus,* sandeel *A. tobianus,* smooth sandeel *Gymnammodytes semisquamatus,* Corbin's sandeel *Hyperoplus immaculatus* and greater sandeel *H. lanceolatus*)

Appendix D. Task 2B Non-Mobile Species

Common name	**Scientific name**
Tentacled lagoon worm	*Alkmaria romijni*
Sea fan anemone	*Amphianthus dohmii*
Bearded red seaweed	*Anotrichium barbatum*
Scarce tube dwelling anemone	*Arachnanthus sarsi*
Ocean quahog	*Arctica islandica*
Lagoon sandworm	*Armandia cirrhosa*
A deep sea shrimp	*Arrhis phyllonyx*
Wig wrack or sea loch egg wrack	*Ascophyllum nodosum ecad mackaii*
Fan mussel	*Atrina fragilis*
De Folin's lagoon snail	*Caecum armoricum*
A red seaweed	*Cruoria cruoriaeformis*
A red seaweed	*Dermocorynus montagnei*
Ivell's sea anemone	*Edwardsia ivelli*
Timid burrowing anemone	*Edwardsia timida*
Pink sea fan	*Eunicella verrucosa*
A brown seaweed	*Fucus distichus*
Tall sea pen	*Funiculina quadrangularis*
Lagoon sand shrimp	*Gammarus insensibilis*
An amphipod shrimp	*Gitanopsis bispinosa*
Giant goby	*Gobius cobitis*
Couch's goby	*Gobius couchi*
A stalked jellyfish	*Haliclystus auricula*
Lagoon Spire Snail	*Heleobia stagnorum*
Long snouted seahorse	*Hippocampus guttulatus*
Short snouted seahorse	*Hippocampus hippocampus*
Sunset cup coral	*Leptopsammia pruvoti*
Coral maerl	*Lithothamnion corallioides*
A stalked jellyfish	*Lucernariopsis campanulata*
A stalked jellyfish	*Lucernariopsis cruxmelitensis*
A gooseneck barnacle	*Mitella pollicipes*
Starlet sea anemone	*Nematostella vectensis*
Native oyster	*Ostrea edulis*
Fireworks anemone	*Pachycerianthus multiplicatus*
Brackish hydroid	*Pachycordyle navis*
Peacock's tail	*Padina pavonica*
Crayfish, crawfish or spiny lobster	*Palinurus elephas*
Sea snail	*Paludinella littorina*
Common maerl	*Phymatolithon calcareum*
Loch Goil sea squirt	*Styela gelatinosa*
Northern sea fan	*Swiftia pallida*
Lagoon sea slug	*Tenellia adspersa*
Northern hatchet shell	*Thyasira gouldi*
Trembling sea mat	*Victorella pavida*

Appendix E. Task 2C Protected Habitats

Priority habitat
Modiolus modiolus beds
Maerl beds
Mud habitats in deep water
Sea-pen and burrowing megafauna communities
Intertidal mudflats
Sheltered muddy gravels
Ostrea edulis beds
Sabellaria spinulosa reefs
Seagrass beds
Littoral chalk communities
Carbonate mounds
Carbonate reefs
Deep-sea sponge aggregations
Blue mussel beds
Intertidal *Mytilus edulis* beds on mixed and sandy sediments
Seamounts
Cold-water coral reefs
Coral Gardens
Lophelia pertusa reefs
Saline lagoons
Serpulid reefs
Subtidal sands and gravels
Tide-swept channels
Intertidal boulder communities
Peat and clay exposures
Fragile sponge & anthozoan communities on subtidal rocky habitats
Estuarine rocky habitats
File shell beds
Coastal saltmarsh
Sabellaria alveolata reefs
Subtidal chalk

Appendix F. Task 2D Non-Native Species

Scientific Name
Asparagopsis armata
Botrylloides violaceus
Crepidula fornicata
Codium fragile subspecies *tomentosoides*
Caprella mutica
Corella eumyota
Crassostrea giga;
Mercenaria mercenaria
Perophora japonica
Ensis (americanus) directus
Eriocheir sinensis
Spartina anglica
Sargassum muticum
Styela clava
Undaria pinnatifida