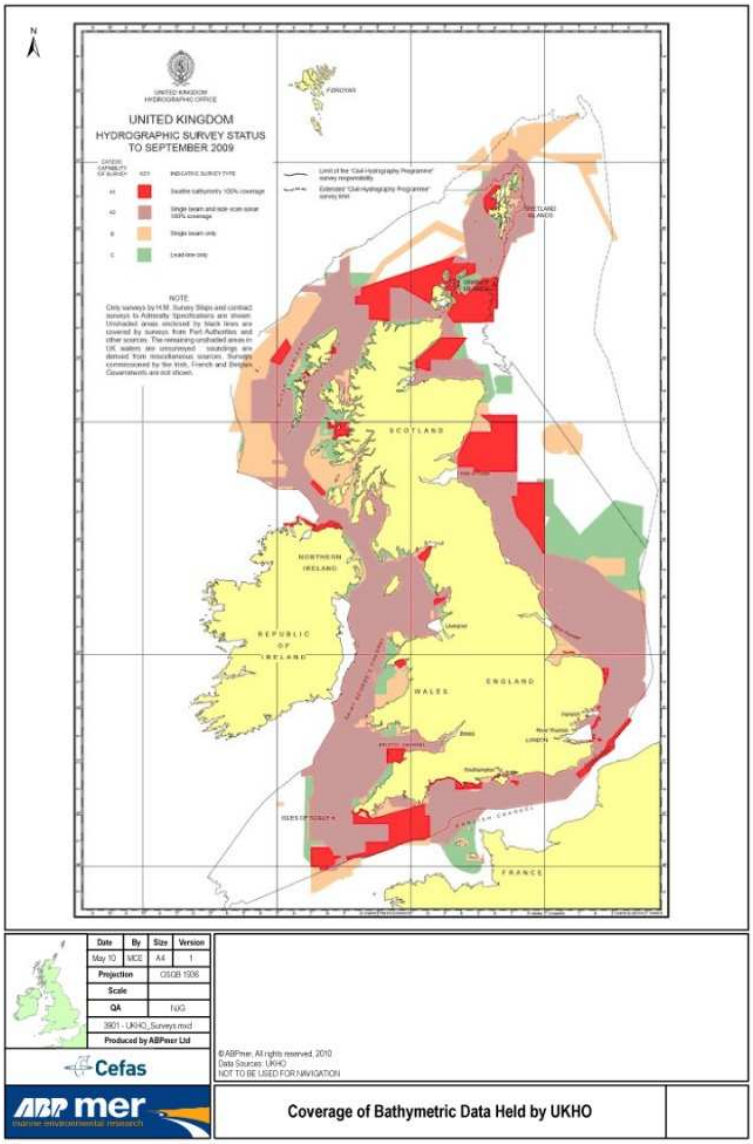
ME5408: Marine Survey Needs to Underpin Defra Policy. Final Report



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EXECUTIVE SUMMARY

Developments in marine policy (e.g. the Marine and Coastal Access Act and Marine Strategy Framework Directive) have caused a step change in the requirements to effectively and efficiently manage the marine environment. These requirements include the development of a network of "ecologicaly linked Marine Conservation Zones" and the target to achieve "Good Environmental Status" by 2020. There is no doubt that there are considerable long term challenges ahead in meeting and maintaining these objectives. The challenges are all the greater because of the difficulties in obtaining sufficient information from the marine environment. Large databases of spatially referenced information, including human activities and biotic and abiotic features, already exist. However, it is not currently clear to what extent Defra's policy requirements are met by these data and future proposed surveys.

One area that has been repeatedly identified as a weak point in our present knowledge is in the distribution of marine seabed habitats. There is a basic lack of information regarding the shape and makeup of the seabed. With the development of high-resolution, complete-coverage sonar mapping (e.g. multi-beam echosounder) and its adoption by national mapping agencies, such information is becoming available, but not at an adequate pace. The availability of detailed seabed maps helps to make decision-making transparent, and aids stakeholder engagement by allowing policy-makers, managers, regulators and the general public to understand the context within which human activities occur and the environmental impact these activities may have. There is a widely agreed set of methods now used internationally for marine habitat mapping and these are starting to be applied at a national scale in other countries including countries neighbouring the UK such as Norway and Ireland.

This report identifies key legislation that requires scientific information about the marine environment in order to manage, protect and monitor ecosystems. The scope of the legislation is broad (relating to ecological status through environmental impacts to individual species), but this report is chiefly concerned with marine benthic habitats and the related survey needs of relevance to Defra.

Key Findings

Key policy frameworks driving current and future benthic data requirements are the Marine & Coastal Access Act, Marine Strategy Framework Directive (MSFD) and the Strategic Environmental Assessment (SEA) Directive. None of the environmental legislation is prescriptive about mapping methodologies so the habitat data requirements must be met in a scientifically justifiable way.

The seabed habitat data currently available is too sparse, patchy and variable in quality to make sound decisions in relation to key planning and management processes required under the above frameworks at a regional and national scale.

Key gaps in data were considered to be:

- Habitat distribution data is incomplete
- Benthic species distributions for UK Biodiversity Action Plan (BAP) and Marine Conservation Zone (MCZ) features are incomplete
- Quality and resolution of predictive habitat maps are often inadequate for effective management planning
- Information about the condition of features is site-based rather than covering extensive areas of marine landscape

- Methods for assessment of habitat quality and status (e.g. MSFD) need further development

Key recommendations highlighted in the report include the following:

i. Improved use of existing data:

- Data sharing and Intellectual property: It is recommended that the Pan Government MoU for data sharing is expanded to include the EA and other strategic partners.
- Data from Industry and The Crown Estate should be made widely available using robust data security protocols.
- Arrangements for data management should be in place before data collection takes place, following the "data clause" recommendations of MEDIN.
- Existing multibeam from MCA and other organisations (e.g. the MAREMAP project) have taken the initiative to interpret these datasets. This process should be the basis of a more systematic and coordinated approach to interpretation of multibeam data into seabed maps.
- Analogue side scan collected by UKHO could be further processed to generate maps at resolutions appropriate for management purposes.
- Seabed-type records held by BGS can provide useful additional information on the location of rock substrates.
- JNCC's UKSeaMap 2010: It is recommended that the upcoming UKSeaMap 2010 is used in management processes. Further development of this product at this time is not detailed here as the product is yet to be released.

ii. Better use of existing survey effort:

There is little spare capacity within existing government funded marine research for a significant national-scale survey programme.

- Bodies such as UKMMAS and the Marine Science Coordination Committee should therefore actively encourage multidisciplinary and multi-agency integration of marine surveys.
- Lessons learned from such activities should be disseminated to demonstrate to the whole community that this approach provides efficiencies and can increase the utility of the data that is collected.
- Sufficient QA processes must be in place to ensure that habitat characterisation data are fit-for-purpose for the specific needs of different agencies (i.e. it is unlikely that broadscale characterisation of a particular area would provide adequate information for archaeological purposes or detailed habitat mapping for MCZ designation).

iii. Coordinated future survey strategy

- Existing processes in UKMMAS, MSCC and MEDIN should be used to ensure there is no duplication or confusion in future data collection and commissioning. It is recommended that CHAS (Civil Hydrography Annual Seminar) and the ability to use MCA contractors through the Civil Hydrography Programme are used by commissioning agencies (including Defra) to deliver more joined up, economic, policy driven surveys. Better utilisation of UKDMOS and Eurofleets should be considered to ensure that future surveys do not coincide with other existing or planned surveys. It is also envisaged that MAREMAP could provide a detailed overview of current data holding for geology, archaeology and heritage.

Towards a rationalisation of future surveys
Existing survey programmes have little scope for providing significant additional spatial coverage. There are efficiencies to be gained by "piggy-backing" additional sensors onto existing cruises but not to constitute additional survey effort of the scale needed. To encourage a fully coordinated future survey strategy and address the key data gaps, any future survey work should be complimentary to the Biodiversity Monitoring and Surveillance Programme (led by JNCC in partnership with the nature conservation bodies). Prioritisation of work in each survey programme should be informed by the supporting legislation. There is likely to be a significant increase in data required to support site validation of MCZs as well as supporting the assessment and monitoring component of the MSFD.

Habitat Survey
The data needs to deliver the objectives of the Marine and Coastal Access Act and MSFD indicate that a significant level of knowledge of seabed habitats and their condition is required at broad spatial scales.

With the development of high-resolution, complete-coverage sonar mapping (e.g. multi-beam echosounder) and its adoption by national mapping agencies, habitat data are slowly becoming available. The availability of detailed seabed maps helps to make decision-making transparent, and aids stakeholder engagement by allowing policy-makers, managers, regulators and the general public to understand the context within which human activities occur and the environmental impact these activities may have. There is a widely agreed set of methods now used internationally for marine habitat mapping and these are starting to be applied at a national scale in other countries including countries neighbouring the UK such as Norway and Ireland.

The MCA recently estimated that there would be capacity in the commercial survey market to survey the UKCS within a 7 year period. This would cover areas not previously surveyed using multibeam. The cost of such a programme would be £30 million a year resulting in a total cost of £210 million with resultant economic benefits likely to be several multiples of that figure.

Additional funding would be required for geological interpretation, biological ground-truthing and habitat suitability modelling/mapping and heritage/historic environment interpretation. The cost and source of funding for the additional work could either be part of a dedicated programme funded along with the baseline acoustic data collection or a separate task funded and run through existing programmes.

Proposed sequence of activities to generate seabed maps

1. Interpret existing multibeam using existing groundtruth data.
   ESTIMATE: £400k

2. Determine the extent/quality of existing UKHO side scan data.
   ESTIMATE: £10k

3. Determine the availability of "raw" singlebeam data available to use freely for non commercial purposes.
   ESTIMATE: £0-1k

4. Test usefulness of working up singlebeam and side scan data using different qualities of side scan data to test what data quality is necessary to prepare a map of acceptable quality.
   ESTIMATE: £40k

5. Work up singlebeam and side scan data where data was of high enough quality to prepare maps. This will need to be prioritised in light of MPA requirements, priorities of the Marine Biodiversity Monitoring and Surveillance Programme, marine planning areas, and MSFD assessments.
   ESTIMATE: £100k-£2m depending on amount of suitable data

6. Prioritise areas for new multibeam survey based on data gaps and associated risk related to MCZ proposals, marine planning areas and MSFD assessments.

   Priority locations for habitat and species mapping can be determined based on the following criteria:

   Habitat
   - the quality of existing habitat maps for the area;
   - the scope for processing existing multibeam or singlebeam and side scan data to create acceptable habitat maps (including any necessary requirement for ground-truthing);
   - adopting a risk-based approach in MSFD assessments, for example by prioritising areas subject to high levels of human pressure, targeting areas of conservation importance or where there is a high level of uncertainty (for example where there are strong gradients or high natural variability in abiotic factors).
   - regional sequence of marine plans;
   - the timetable for MPA site validation and condition monitoring;

   Benthic species
   - the density of existing biological survey data for the area, including UKBAP species were practicable;
   - the scope for processing additional existing survey data (Note: much of this has been done for project MB102 on mobile species mapping) and the scope for further work is considered limited);
   - synergies with proposed areas for habitat mapping involving additional biological survey for ground-truthing;
   - the timetable for MPA site validation and condition monitoring;
   - adopting a risk-based approach, for example by prioritising areas subject to high levels of human pressure, targeting areas of conservation importance or where there is a high level of uncertainty (for example where there are strong gradients or high natural variability in abiotic factors).

7. Prioritise feature condition monitoring based on locations of MPAs and areas of high human pressure (linked to marine biodiversity monitoring programme)

8. Integrate any additional MSFD requirements as they emerge.

9. Define cross-departmental (Defra, DfT, DECC and non-departmental (e.g. Crown Estate)) common interests in a coordinated national survey strategy to gain efficiencies, stimulate economic activity and provide a basis for environmental management.

In the above sequence of activities it is likely that Defra will need to involve a number of organisations including UKMMAS/HBDSEG, MAREMAP partners, MEDIN and the Statutory conservation agencies.

Note: Maps that are included in his report are reproduced from the relevant agencies websites. The keys have been reformatted to provide a consistent layout for the report.

1 INTRODUCTION

The effective and efficient management of the marine environment and its' sustainable use are greatly facilitated by accurate maps. Maps also help to make decision-making transparent and aid stakeholder engagement by allowing policy makers, managers, regulators and the general public to understand the spatial relationship between human activities and biological/geological features of our seas. Large databases of spatially referenced information, including human activities and biotic and abiotic features, already exist but to date only 10% of the seabed on the UK Continental Shelf (UKCS) are accurately mapped. However, it is not currently clear to what extent Defra's short to long term policy requirements are met by these data and future proposed surveys.

Recent developments in marine survey technology have provided the capability to map the seabed at scales relevant to marine habitats. This has led to a number of national seabed mapping programmes including the Mareano programme in Norway and Infomar in Ireland. In a cost/benefit analysis for the Irish Government (PriceWaterhouseCoopers 2008) the cost of a high-intensity survey to complete the multibeam mapping of the Irish EEZ was € 70 million with the economic benefits calculated as € 440 million. The MCA recently estimated that there would be capacity in the survey market to survey the remaining UKCS that has not been surveyed using multibeam within 7 years. This estimate was based on a level of survey which would not distort the market (i.e. increase demand to such a level as to make the project more expensive). The cost of such a programme would be £30 million a year resulting in a total cost of £ 210 million. With several economic assessments putting the economic and ecological value of the marine environment in the tens of billions per year this would provide significant returns both economically, in meeting legislative requirements and in allowing informed decisions on environmental management. However, a more detailed analysis of actual costs and benefits may prove to be a requirement for the business case of any future mapping to ensure an objective case is made from the outset. As an example mitigating against the UK's liability under the Civil Liability Convention; ensuring that the UK has charts based on the best possible survey data, and so demonstrating due diligence against ships grounding (or the liability for not having charted the potential hazards) would seem like a significant incentive to ensure funding for the Civil Hydrography Programme (CHP) was commensurate with the benefits it brings. Specifically it is possible that the cost for cleaning-up a single marine pollution event would exceed the cost of surveying all UK waters.

This project relies on the outputs of a series of existing reports and highlights some relevant key existing activities (e.g. UKDMOS) to ensure the recommendations do duplicate activities already planned for the future.

Since the initiation of this project the Marine Science Co-ordination Committee (MSCC) has identified the high-level goals and research priorities (Defra 2010). These goals have been taken account of when addressing the question of Defra's future survey needs. Based on the MSCC goals and the drivers identified in this report there are two practical ways to improve the amount of relevant information obtained using existing capacity.

1. Coordinating activities to reduce overlap and
2. Carrying out the existing activities more efficiently.

Discussions across government undertaken for this report (including the DfT, DECC, MOD, English Heritage, etc.) highlighted the frequent overlap in locations of interest

and similar data requirements. Therefore future discussions should make the most of survey capacity while ensuring organisational priorities are met.

The aim of this 6 month long project (Nov 09 - May 2010) has been to highlight Defra's information needs against specific policy frameworks, and then to deliver an assessment of Defra's benthic species/habitats data needs, gaps in the current and future knowledge base and recommend a harmonised and rationalised approach for the collation of future survey data.

The geographical scope of this project is the territorial waters of England and UK Offshore waters adjacent to England, Wales and Northern Ireland (refer to the UK Continental Shelf Act 1964 for jurisdiction for seabed and the UK Exclusive Fisheries Zone for the water column). The findings are however equally relevant to the territorial waters of Scotland, Wales and Northern Ireland, and offshore waters adjacent to Scotland.

2 APPROACH / METHOD

The objectives of this project were achieved through the following key project stages:

1) Interviewing Defra directors/deputy directors to ascertain key policy drivers for the next 10 years.
2) Through expert opinion the data/survey requirements were translated from the policy priorities and then agreed through a meeting with key Defra staff. Data requirements in relation to benthic species/habitats were highlighted.
3) Using a register of current and future planned marine surveys to highlight gaps and propose a rationalisation of survey with regards to timing, area etc. Consultations were also held with DfT, DECC, Crown Estate, MCA, BODC (who manage UKDMOS), UKMMAS, MEDIN, English Heritage and other key agencies.
4) Analysis of key policies to identify future survey requirements.

The main output of the project is this report summarising data needs and gaps. This study will provide recommendations to rationalise future surveys suggesting potential combinations of activities to realise efficiencies and synergies.

The approach has built on existing research and has utilised existing institutions and processes to ensure previous related activities are not duplicated.

3 DEFRA'S POLICY PRIORITIES

To support the identification of policy priorities, a series of interviews were held with Defra policy staff. The priorities identified are listed below (Table 1).

Policy Priorities	Responses
Marine & Coastal Access Act	9
MSFD	8
MCZs, HSMPAs	1
Climate Change Act	1
EC Birds Directive	1
EC Habitats Directive	1
EC Water Framework Directive	1
EC Common Fisheries Policy	1
UNCLOS	2
MARPOL	1
Marine Minerals	2

Table 1 Summary of responses by legislative driver

A detailed review of policy needs and priorities is presented in Annex 1.

Few of the policy frameworks considered explicitly require mapping of the seabed or its associated habitats. The most explicit commitments relates to the OSPAR agreement, Bergen Declaration and MSFD to map the distribution of priority habitats. Further guidance on the requirements for monitoring under the MSFD will be provided at European level as the Directive is implemented.

However, mapping is implicit for many of the frameworks when the texts are considered in detail (Table 2) although there is no indication of how much mapping should be undertaken. For example, to deliver the objectives of the MCAA and MSFD it is indicated that a significant level of knowledge of seabed habitats and their condition is required at broad spatial scales.

	Explicit mapping requirements		**Implicit mapping requirements**	
	B	**H**	**B**	**H**
International Drivers				
SOLAS Convention	✓			
OSPAR Convention		✓		
Convention on Biological Diversity			✓	✓
UN Law of the Sea (UNCLOS)			✓	
MARPOL (Civil Liability Convention)			✓	
RAMSAR			✓	✓
European Drivers				

	Explicit mapping requirements		Implicit mapping requirements	
	B	**H**	**B**	**H**
Habitats Directive				✓
Marine Strategy Framework Directive		✓	✓	✓
Water Framework Directive			✓	✓
Strategic Environmental Assessment Directive		✓		
EIA Directive		✓		
Common Fisheries Policy				✓
National Drivers				
Marine and Coastal Access Act			✓	✓
UK Marine Monitoring and Assessment Strategy			✓	✓

B = Bathymetric mapping; H = Habitat mapping

Table 2 Explicit and implicit mapping requirements of selected legislation and policies

4 DATA GAP ANALYSIS

4.1 Introduction

A number of initiatives have sought to make use of seabed survey information to make broad scale spatial assessments of feature distribution or condition in response to existing and new policy drivers:

- Charting Progress (2005)
- Charting Progress 2 (2010)
- Biophysical data layers project (project number MB102)
- UK Fourth National Report to the Convention on Biological Diversity 2009
- Marine Species Protection: A Review of Risk and Considerations for Improvement (Defra, 2006)

These assessments provide useful information on the limitations of existing data (Table 3).

Source	**Key quotes related to Seabed Survey**
Charting Progress (2005)	The full distribution of BAP marine priority habitats is unknown and the status of nine of these habitats is also unknown (December 2004); The UK needs to establish an appropriate surveillance programme to meet its international and national commitments to assess the status of benthic communities in UK seas. The lack of a basic habitat map of UK waters hinders the assessment of the current ecosystem state and the effects of impacts at a wider scale. Such a map would provide a fundamental spatial planning tool
Charting Progress 2 (2010)	Spatial and temporal inadequacies prevent us from properly appreciating the extent of natural variability. There is a general need to improve our understanding of the relationship between large scale physiographic processes and resulting small scale variability in the distribution and condition of species and habitats. The lack of adequate maps of seabed character (geology, substrate and bedforms) and their associated habitats was widely acknowledged as the greatest hindrance to reliable assessment of ecological status. Existing maps lacked the necessary resolution and/or coverage. We need better data on where habitats and species occur through focused monitoring programmes to fill identified gaps. Current habitat maps cover only 10% of the UK continental shelf and we are forced to rely on modelling for the rest. For future assessments we will need to improve the accuracy, resolution and scope of these

Source	Key quotes related to Seabed Survey
	habitat maps by undertaking more surveys and making the existing data more widely available
Biophysical data layers project	Spatial coverage of data on geological/geomorphological features and ecological features was identified as the most common data gap. Much of the information was qualitative (presence/absence) rather than quantitative. Limitations in the spatial resolution and accuracy of physical data used to support the MESH-EUNIS model habitat predictions were also identified.
UK Fourth National Report to the Convention on Biological Diversity 2009	At the moment there are no national surveillance programmes capable of reporting on the status and trends of UK marine habitats
Marine Species Protection: A Review of Risk and Considerations for Improvement (2006)	Detailed evidence was limited for some biotopes or species which restricted the definition of their national/international importance; levels of decline; threats, damage; and sensitivity. This was particularly the case for offshore soft sediment habitats, together with those species which are sampled infrequently, and therefore their true distribution is not clearly defined.

Table 3 Limitations of existing data

It is also instructive to compare the quality of data available for the seabed with equivalent information on land (Figure 1 and Table 4).

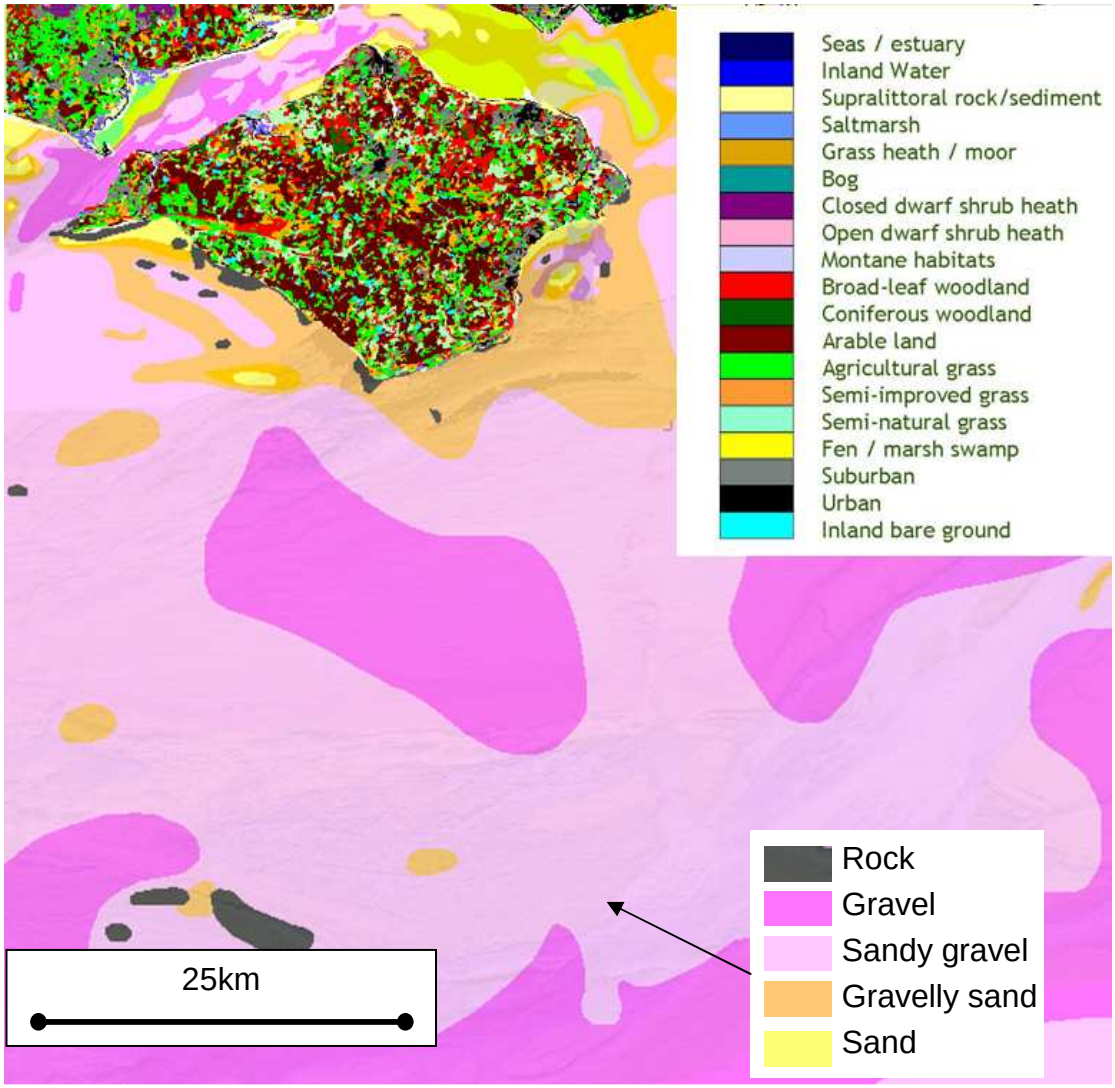

Figure 1 Comparison of most detailed national "substrate" scale maps for land and seabed

	Coverage of high resolution images	Coverage of high resolution topography	Ground-truthing
Land	100% + historical	100%+historical	600 km^2 repeated
Marine	<0.0001%	<10%	0.07 km^2

Table 4 Comparison of terrestrial and marine datasets and coverage

The sampling density for seabed sediments is equivalent to one 0.1 m^2 sample for every 30 km^2 of seabed and even less for biological samples. This will not provide an accurate representation of the distribution of seabed sediments or biota.

A recent report identifying the strategic capabilities on which Defra depend on in delivering the evidence base for its work identified, *inter alia*, the following as a significant area for future development (Arthur D Little Ltd, 2009):

- improved habitat mapping and information on species and habitat vulnerability;

- new monitoring programmes and expansion of existing programmes to support the achievement, evaluation and maintenance of Good Environmental Status under MSFD;
- improved monitoring of Biodiversity Action Plan species.

4.2 Defining the Key Gaps

Based on the indicative requirements for seabed survey identified in section 3 (and Annex 1), the description of existing and proposed survey activity and the experiences of using the existing information described above, Table 5 identifies five key gaps. The gaps are described qualitatively because the policy drivers are not explicit about the extent or quality of information that is required.

Gap	**Drivers**	**Why is the information needed?**
Habitat distribution data is incomplete – requirement for better broad scale information on habitat distributions. (Suitably detailed habitat maps exist for only around 10% of UKCS). It is important to note that this includes intertidal data also.[1]	MCAA – marine planning and MCZ Habitats Directive MSFD UK BAP	To support management of MPAs and to underpin the delivery of the ecosystem-based approach for marine planning; to support assessments of wider ecosystem against GES descriptors
Species distributions for UKBAP and MCZ features are incomplete – requirement for better broad scale information on species distributions	MCAA – MCZ Habitats Directive MSFD UK BAP	To support identification and designation of MPAs and ongoing management; to support assessments of wider ecosystem against GES descriptors
Quality and resolution of predictive habitat maps – the quality and resolution of physical data underpinning the MESH-EUNIS habitat model (being updated in UKSeaMap and EUSeaMap) results in a coarse scale model, for which confidence is low in some areas. The quality and spatial resolution of existing seabed sediment data is a particular limitation of the model	MCAA – marine planning; MSFD	To support management decisions in the absence of comprehensive observational data;
Gaps relating to the condition of features (habitats and species) – there is a general lack of information on the condition of features – most broad scale data is qualitative rather than quantitative	UK BAP MCAA – marine planning; MCZ Habitats Directive MSFD	To support ongoing management of MPAs; to inform preparation and review of marine plans; to support assessments of wider ecosystem against GES descriptors

[1] Natural England recently put an addendum into a current project (MB102) to produce an intertidal Eunis level 3 habitat map as UKSeaMap does not include this information. However the draft outputs indicate that a lot more work is needed to get a comprehensive product.

Gap	Drivers	Why is the information needed?
Assessment of sea floor integrity – there are possible gaps in monitoring in relation to this, and possibly other, descriptors depending on how the assessment criteria are defined	MSFD	To support assessments of wider ecosystem against GES descriptors
Gaps relating to the condition of features – there is a general lack of information on the condition of features – most broad scale data is qualitative rather than quantitative	UK BAP MCAA – marine planning; MCZ Habitats Directive MSFD	To support ongoing management of MPAs; to inform preparation and review of marine plans; to support monitoring against GES descriptors
Assessment of sea floor integrity – there are possible gaps in monitoring in relation to this, and possibly other, descriptors depending on how the assessment criteria are defined	MSFD	To support monitoring against GES descriptors

Table 5 Summary of data gaps

Socio-economic and historical data: It is also worthwhile mentioning that socio-economic information will also be required for marine planning purposes as defined in the MCAA, and is referenced in Defra's High Level Marine Objectives and the UK Marine Science Strategy. In this regard when considering data gaps, historic environmental data should also be highlighted. These data should also include data on submerged palaeo-environments and individual sites and assets of historic, archaeological, architectural or artistic interest, whether or not they are afforded statutory protection by heritage protection legislation.

5 PRIORITISATION OF REQUIREMENTS FOR SEABED SURVEY

5.1 Introduction

Given the qualitative nature of the description of the gap in section 4, it is particularly important that the needs for new seabed survey can be prioritised and targeted. This requires prioritisation both within and between key work areas.

5.2 Habitat Mapping

The development of validated broad-scale habitat maps is a key requirement necessary to respond to many of the key drivers. Such information will be particularly important in providing a baseline understanding of MPAs and for longer-term site condition monitoring, improving knowledge of the distribution of priority BAP habitats and underpinning an ecosystem-based approach to marine planning. It will be essential to meet the assessment, monitoring and management requirements of the MSFD.

We suggest that the priority locations for habitat mapping can be determined based on the following criteria:

- the quality of any existing habitat maps for the area;
- the scope for processing existing physical data (multibeam or singlebeam and side scan data) to create acceptable habitat maps (including any necessary requirement for ground-truthing);
- adopting a risk-based approach for MSFD implementation, for example by prioritising areas subject to high levels of human pressure, targeting areas of conservation importance or where there is a high level of uncertainty (for example where there are strong gradients or high natural variability in abiotic factors).
- the sequence for the preparation of marine plans;
- the timetable for MPA site condition monitoring;

Note: We note that a risk based approach is already being adopted by the Marine Biodiversity Monitoring and Surveillance Programme.

5.3 Benthic Species Mapping

Additional species mapping is required to adequately describe the distribution of priority BAP species and species of conservation importance. Such information will be important in providing a baseline understanding of MPAs and for longer-term site condition monitoring, improving knowledge of the distribution of priority BAP species and in supporting monitoring requirements under MSFD.

Information on species distributions can often be acquired as part of other survey programmes, particularly where ground-truthing surveys are being undertaken for the purposes of habitat mapping. Surveys can be targeted based on specific habitats within which particular species occur.

We suggest that the priority locations for species mapping can be determined based on the following criteria:

- the density of existing biological survey data for the area;
- the scope for processing additional existing survey data (much of this has been done for Defra project MB102 and the scope is considered limited);
- synergies with proposed areas for habitat mapping involving additional biological survey for ground-truthing;
- the timetable for MPA site condition monitoring;
- adopting a risk-based approach, for example by prioritising areas subject to high levels of human pressure, targeting areas of conservation importance or where there is a high level of uncertainty (for example where there are strong gradients or high natural variability in abiotic factors).

Note: We note that a risk based approach is already being adopted by the Marine Biodiversity Monitoring and Surveillance Programme (under the auspices of the JNCC and NE).

5.4 Habitat Modelling

There is considerable scope for improving the spatial resolution and quality of the model which underpin UKSeaMap 2010 and EUSeaMap, particularly through the improvement in input data layers (e.g. seabed substratum) and improving our understanding of the relationship of the biological communities to the physical environmental characteristics. Some constraints associated with light, energy and bathymetry data layers used in the existing (2010) model are described in Frost & Swift (2010), with the full picture to be described in the UKSeaMap final report in autumn 2010. However, a limitation of these types of models is that they can only predict broad-scale habitat types (typically EUNIS level 3 or 4) defined on the basis of their physical characteristics and cannot reliably predict the distribution of detailed biotopes (EUNIS level 5 or 6 classes). This limits the use of model outputs as a management tool, particularly at a local scale, but is less of an issue for regional/national applications which often require habitat data with even less detail (e.g. EUNIS level 2).

5.5 Feature Condition

More broad-scale information on the condition of habitats and species is required to support the assessment of GES for the MSFD and to provide a baseline understanding of MPAs and for longer-term site condition monitoring, improving knowledge of the condition of priority BAP features.

We suggest that the priorities for feature condition monitoring can be determined based on the following criteria:

- adopting a risk-based approach, for example by prioritising areas subject to high levels of human pressure or targeting areas of conservation importance;
- any specific requirements emerging from MSFD implementation linked to MSFD reporting cycles;
- synergies with proposed areas for habitat mapping involving additional biological survey for ground-truthing;
- the timetable for MPA site condition monitoring.

Note: We note that a risk based approach is already being adopted by the Marine Biodiversity Monitoring and Surveillance Programme (under the auspices of the JNCC and NE).

5.6 Specific MSFD Requirements

It is likely that MSFD implementation will identify specific additional monitoring requirements in relation to MSFD descriptors or associated elements[2]. In particular, additional information may be required to support assessments in relation to seabed habitats (Descriptor 1 on biodiversity) and to sea floor integrity (Descriptor 6). It is likely that such information could be collected with other physico-chemical or biological data. The requirement for such information is likely to be targeted towards areas subject to high levels of human pressure and reference areas. Any additional requirements will need to be accommodated within survey programmes at the point they are identified to meet MSFD reporting cycles.

[2] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:164:0019:0040:EN:pdf

6 DELIVERING PRIORITY REQUIREMENTS

In relation to the key gaps as identified in section 4, this section describes delivery of benthic habitat data.
The key approaches are:

- Improved use of existing data.
- Better utilisation of existing survey effort

For a detailed presentation of key agencies, data providers and data products please refer to Annex 2. For an assessment of issues with existing products please refer to Annex 3.

6.1 Seabed habitats: Improved use of existing data

In order to be able to map the distribution of sediments and seabed structure between known data-points (grab samples or photographs) it is possible to use geophysical techniques such as multibeam or side scan sonar to capture the variability between stations.

UKHO data – singlebeam.
As described in section 4 the existing coverage of habitat maps amounts to approximately 10% of the UKCS (using various data sources at various resolutions). Although multibeam data has been recorded for approximately 10% of the UKCS this has not all been interpreted for habitat purposes. The UKHO has a collection of digital singlebeam surveys of variable resolution (also available as a commercial product through SeaZone Solutions Ltd). Where these data are of sufficient quality and the most significant habitat variables can be represented using a gridded depth surface (such as differentiating between rocky reef and sand waves) it could be used to identify broad-scale physiographic zones. However there are areas that the bathymetry, as recorded by the singlebeam data, is not a sufficient descriptor of the habitats (e.g. where the features are too fine scale such as low-relief rocky reef, gas pockmarks, coral mounds or tube-worm reefs, or where changes in seabed sediments occur with little or no topographic expression). In such cases the data would not be suitable to use for habitat mapping. These data are currently being used in UKSeaMap2010, as this work has not yet been published. The extent and density of the source data is not known.

UKHO data – side scan.
In addition to the singlebeam data the UKHO also holds complete coverage side scan sonar surveys on the UKCS. It was the use of these records that allowed the BGS to produce much more detailed seabed sediment maps in the Irish Sea than exist for the rest of the UK (e.g. compare (BGS 1990) Anglesey Seabed Sediments with (BGS 1986) Haig Fras Seabed Sediments). These extensive side scan records have not been fully utilised and could provide a very useful resource for habitat mapping. The task of identifying the quality and extent of the coverage of the data would need to be undertaken first. For example (Kubicki and Diesing 2006) were able to show analogue side scan records from the 1970s could be geo-referenced

and used as a significant source of information at appropriate map scales (

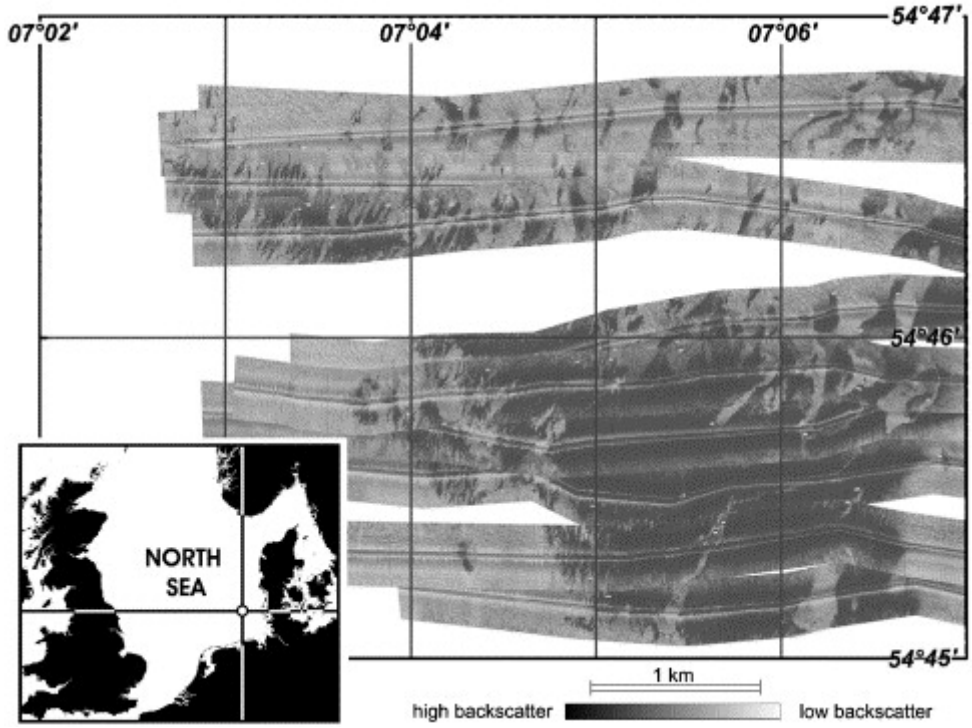

Figure 2). Is should be noted that the UKHO has transferred its legacy side scan records up until 2002 to the BGS.

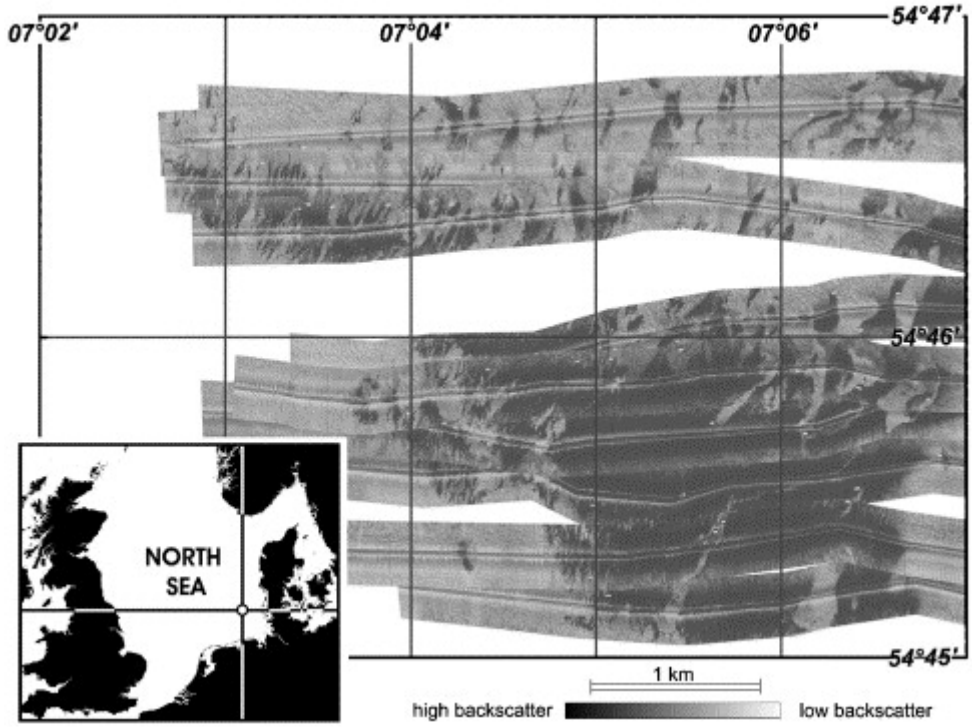

Figure 2 Mosaic image of scanned and georeferenced analogue side scan sonar records from the 1970s can be used to assist in habitat mapping from (Kubicki and Diesing 2006)

UKHO – Digital seabed type

Another potentially useful source of information is the record of seabed types kept by the UKHO. Whist these are of extremely variable quality (some collected with tallow on the bottom of a lead line (McConnell 1982)) and cannot be used for quantitative descriptions of sediment type (i.e. Folk Classification) they can provide useful additional information on the location of rock substrates. These seabed descriptions already exist in digital format although there may be scope for rating the quality of samples based on age or position or it may be useful to re-classify them into different groups.

MCA data – multibeam and samples

The MCA has collected the vast majority of the multibeam data that exists in UK waters and already make it available to government agencies via the Pan-Governmental MoU. They are also now making sediment samples collected during these surveys available to the BGS for further analysis and archiving. The multibeam data has already proven extremely useful in habitat mapping undertaken for JNCC in the SAC process (Solan Bank pSAC). However, there is no programme in place to use these data to systematically create or update habitat maps. It would seem reasonable that such high quality freely available datasets should by default be further interpreted into habitat maps.

UKSeaMap 2010 – substrate data

The BGS is currently updating their DigSBS 250 product (and feeding this into the aggregated product supplied for UKSeaMap 2010, with 5 substrate classes), with a focus on “hard substrates”. The updated aggregated product will be used in UKSeaMap 2010. There are undoubtedly significant changes with the increase in area of hard substrate of 900% (more than the previously mapped rock areas and excluding Scottish waters). The new maps are not based on a new programme of data collection and so the improvements rely on re-interpreting old data and incorporating new information wherever it can be obtained. A key gap remains in the inshore coverage of SBS250 (the so-called ‘white ribbon’) from the intertidal zone out to about 3nm.

6.2 Data sharing and Intellectual property

Current EU policy requires data to be made available and the INSPIRE Directive(2007/2/EC) sets out intellectual property requirements and obliges EU Member States to adopt measures for the sharing of data sets and services between its public authorities. The EC pilot initiative EMODnet is currently developing common datasets for a variety of marine parameters (hydrography, chemistry, biology, geology, and habitats) at a European scale and making these freely accessible via web portals. At the moment there are licences required for government bodies to use each others’ data (Such as BGS maps and UKHO bathymetry data) that hinder use of the data and so research. There would seem to be no policy reason why all such data should not be made freely available in the future.

It is highly recommended that the Pan Government MoU is expanded to include the EA initially and then to include other strategic partners in the upcoming months. Consideration of issues and inclusion of Crown Estate (industry) data with robust data security protocols is also recommended. Currently this agreement sets out the mechanism and standards for sharing data in the future. SEPA and Marine Scotland are currently in the process of considering entering into this agreement too. It is also worthy of note that the UKHO is making multibeam data freely available through the DAC and BGS is aiming to make significant data holdings available as well.

This agreement in the context of INSPIRE should enable the free and transparent transmission of data between agencies.

Improvements to data sharing also require some pragmatic issues to be addressed. If data are to be shared for re-use they must be visible and available. Thus they must be searchable online, and lodged within a secure, long term, data archive with appropriate online access facilities. Arrangements (including funding resource) should be made for this in advance of data collection. MEDIN has developed a "data clause" providing guidance. If these issues are left until after data collection they are too often dealt with inadequately, if at all.

6.3 Better utilisation of existing survey effort

A recurrent theme throughout both reviews of the legislation and the gaps was the issue of representative habitat maps. A key difficulty with achieving this on a national scale is the lack of baseline environmental data. The sampling density for seabed sediments is equivalent to one 0.1 m^2 sample for every 30 km^2 of seabed and even less for biological samples. This will not provide an accurate representation of the distribution of seabed sediments or biota. In order to map the distribution of sediments and seabed structure between known data-points (grab samples or photographs/videos) it is possible to use geophysical techniques such as multibeam or side scan sonar to capture the variability between stations.

The Marine Science Co-ordination Committee (MSCC) has already identified the high–level goals and research priorities (Defra 2010) and we will not replicate that work here. However, based on those goals and drivers already identified there are two practical ways to improve the amount of relevant information obtained using existing facilities. Firstly, coordinate activities to reduce overlap and secondly to carry out the existing activities more efficiently.

There are a significant number of organisations involved in seabed survey programmes. While there is a good degree of co-ordination within disciplines (e.g. MCA co-ordination of bathymetric surveys; UKMMAS co-ordination of biological surveys) there is not effective co-ordination between disciplines focused on developing habitat maps.

There is also the more general point that organisations within UKMMAS can make further improvements to efficiency of survey programmes both within and between organisations, although this is often difficult to achieve.

Reducing overlap

The goal of reducing overlap is achieved by better communication between organisations coupled with the ability to share data. A good example of this is the Pan Governmental MoU on the sharing of multibeam data. The MCA liaises with other government agencies who commission or have the capability to carry-out multibeam surveys to ensure that:

- Surveys are carried out to appropriate standards
    - This can include marginal funding to "upgrade" the survey to meet hydrographic requirements
- Surveys are not carried out in the same place
    - There is a Civil Hydrography Annual Seminar where the survey plans of various organisations are presented in advance.
- Surveys adjacent or close to each other have a common boundary
- Potential areas of common interest are surveyed in the most efficient manner

- It is possible for a MCA hydrographic survey to be extended at cost price to include areas that are not a hydrographic priority.

Each organisation within the MoU makes its survey data available to the others and should be aware of future surveys conducted by the others. At present the Environment Agency is not part of the MoU and as they collect seabed data their inclusion would be valuable.

Efficiencies through integration

In addition to making sure that surveys do not overlap spatially it is possible to maximise the data collection on existing surveys. Based on the Defra commissioned project to look at this issue (Cefas 2010) were able to identify a number of ways to make best use of ship time and relate the data collected to drivers under the MSFD. Table 6 provides an overview of data types collected during the demonstration cruise (Cefas 2010) and the potential relevancy to the GES descriptors as currently developed by the ICES/JRC task groups. The key goals of the demonstration cruise and report was to:

- Maximise efficiencies by testing and assessing novel and efficient approaches to meet Defra monitoring requirements.
- Provide enhanced ability to meet MSFD targets to observe structure and function changes through high quality synchronous science.
- Improve UK's ability for adaptive management of ecosystems
- Maximise value for money by prioritising and planning monitoring activities with other agencies to meet Defra monitoring requirements.
- Develop programmes that maximise concurrent (as opposed to consecutive) monitoring of ecosystem components to allow cost-effective and comprehensive assessment of the ecosystem.

Details of the equipment and which GES descriptors they are best suited to providing assessment information for is provided in
Table . Whilst the above project was specifically looking at the MSFD many of the policy needs meet multiple drivers.

Equipment	Data Type	GES descriptors link[3]
CTD rosette	Oxygen Profile	1, 5
	Suspended solids	1, 5, 7
	Chlorophyll	1, 5
	Nutrients	1, 5
	Salinity	1, 7
	Temperature	1, 7
Beam trawl	Fish Community	1, 3, 4, 10
	Epibenthos	1, 4,
Core / grab	Infaunal Biomass	1
	Infauna species Sediment oxygen profiles and penetration depth (OPD) Sediment porosity Sediment nutrients (adsorbed ammonium) Sediment chlorophyll Sediment Particle Size Analysis (PSA)	1, 4, 5, 6

SPI Camera	Sediment aRPD – oxygenation depth Prism penetration depth Sediment type (high level)	5,6, 8
	Anthropogenic impacts / bioturbation	
Multibeam	Bathymetry and Backscatter	1, 6, 7
Multi-frequency sonar	Fish/Plankton abundance	1, 3, 4
Species Observer	Cetaceans and Seabirds	1, 4,
Drop-down video and still imagery	Abundance and diversity of Epifauna, location and extent of Annex I habitat, evidence of anthropogenic effects	1, 4, 6, 10

Note: Key to GES Descriptors: 1. Biodiversity; 2. Invasive spp.; 3. Commercial fish; 4. Food webs; 5. Eutrophication; 6. Sea floor integrity; 7. Hydrography; 8. Contaminant pollution; 9. Contaminants in seafood; 10. Litter; 11. Energy.

Table 6 Equipment utilised in survey and relevancy to GES descriptors

There are a number of research organisations with vessels that might be able to carry out such integrated survey programmes. That is collecting information for multiple purposes at the same time. A collation of the main organisations with their own survey capability and potential opportunities are presented below.

Summary of key survey providers[4]

Organisation	Drivers	Forward planning	Relevance to Defra
MCA	Hydrography	up to three years	Ability and remit to coordinate and manage government survey activity in existing structure.
NERC	Scientific research (global)	Up to 18 months	Potential for “piggybacking” UK monitoring work on science cruises.
MOD	National security	Up to 4 years	Potential for “piggybacking” UK monitoring work on surveys is limited.
MOD	National security	Up to 12 months	Potential for “piggybacking” UK monitoring work on surveys
Cefas	Monitoring/Research	Up to 12 months	Potential for “piggybacking” UK monitoring/survey work on surveys
BGS	Earth science	Up to 12 months	Potential for “piggybacking” UK monitoring /survey work on surveys. Inshore only.
Marine Scotland	Monitoring/Research	Up to 12 months	Potential for “piggybacking” UK monitoring /survey work on surveys.
AFBNI	Monitoring/Research	Up to 12 months	Have flexibility to adjust programme but details are uncertain as they will be letting a new ship management contract.

[4] This table is not intended to be comprehensive as there are multiple other providers as mentioned in this section (e.g. conservation agencies inshore capacity)

Table 7 Summary of key governmental survey providers

A consultation of UKDMOS provides a list of 34 organisations who are or who have in the past provided information on UK run environmental monitoring programmes.

Future integrated surveys:
Examples of future survey work include:

- JNCC/Cefas/Royal Navy survey – testing proof of concept for integrated approach. (2010).
- Cefas/JNCC surveys – additional monitoring to include data collection for JNCC during the annual Cefas CSEMP monitoring cruise programme. (2010).
- Multi-agency cruise to meet monitoring requirements for multiple MSFD GES descriptors. Cefas lead programme (sea time in 2013).

Existing NERC work planned relevant to Defra needs
Whilst the majority of cruises take place outside UK waters but there information useful to UK legislation may still be collected during passage through UK (UKOTs and Crown Dependencies) and it may be possible to maximise the usefulness of cruises in UK waters for no or minimal extra funding. See below:

James Clarke Ross PAP deployment cruise, research summary:
Deploy the Porcupine Abyssal Plain (PAP) observatory mooring at 49 deg N 16.5 deg W.

As part of the cruise plan it was commented that “If more ship time could be programmed and if additional funds could be found to support this and further science, this time could be used in a most productive manner.” More detail was sought from the science lead Richard Lampitt (telephone conversation on 29/01/10). There is definitely scope for “piggybacking” equipment and personnel onto the above cruise but normally there is a full complement of scientists on cruises organised by Dr Lampitt. However for other surveys additional data could be collected without additional personnel such as underway acoustics, including multibeam and underway water-sampling.

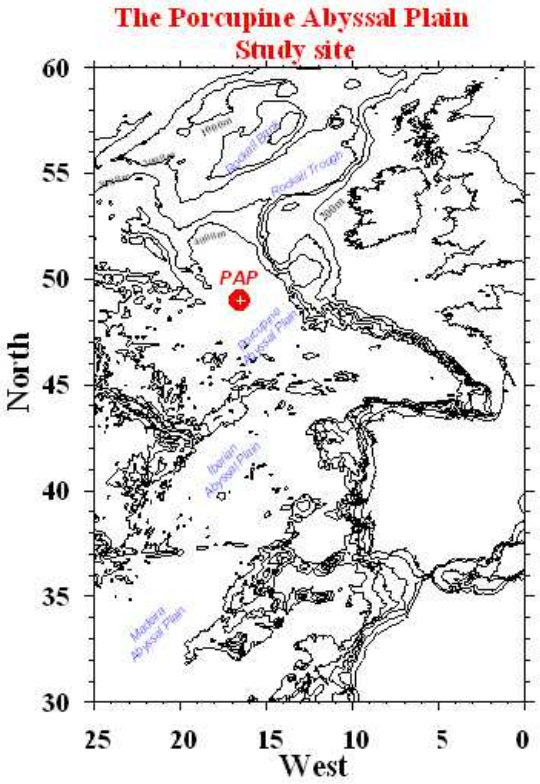

Figure 3 Location of upcoming (June 2010) NERC cruise with potential for additional data gathering.

There are numerous studies showing that such underway acoustics can be used for monitoring not only fish stocks but diurnal and interannual trends in plankton (Chereskin and Tarling 2007), communities affecting ecosystems, marine management and sensitive to climate change (Kloser, Ryan et al. 2009) as well as variations in oceanographic conditions (Ostrowski, da Silva et al. 2009). Dr Lampitt also mentioned the ferry box scheme as well as the ship barter scheme which will have work being carried out in UK waters.

Co-ordination and management of future surveys

UKMMAS/HBDSEG should be involved in identifying future survey work. Importantly constituent members include the JNCC and NE who own and manage the BSMP. The Marine Management Organisation and devolved administrations should also also have an input when identifying survey priorities.
Data access should be through existing structures. Maps/data should be delivered through MEDIN DACs.

Co-ordination to avoid duplication/gaps should be facilitated by tools already developed through UKDMOS[5] and CHAS. Changes could be made to include future one-off surveys and increase scope of the capture of different types of cruises. It would also be highly favourable to ensure that such information is made available t to supra-national co-ordination efforts (e.g. to Eurofleets[6]). At present requests by foreign nations to conduct survey or research activities in UK waters are handled by the Foreign and Commonwealth Office (FCO). There is a process in place to consult with various authorities (e.g. MCA and the former MFA) on whether there are any issues arising from the proposed work. However, it would be possible to request the

[5] http://www.ukdmos.org/content/content.asp?menu=05000000
[6] http://www.eurofleets.eu/np4/sustainable_use

information collected during these cruises if it were thought to be of value and this could be incorporated into the above process.

7 DISCUSSION

The Marine Science Co-ordination Committee (MSCC) is conducting a cross government needs and capability assessment and therefore this report does not intend to duplicate or pre-judge outputs from this process. Similarly, other activities to focus on needs for status assessment are also in existence (e.g. the Biodiversity Monitoring and Surveillance Programme), and again this report does not intend to pre-judge these conclusions.

This section will consider the key findings of the project and highlight the economics of future survey work, both the costs and benefits.

7.1 Policy frameworks and data gaps

The key drivers were considered to be the MSFD, the MCAA and the SEA Directive. Key gaps in data were considered to be:

- Habitat distribution data is incomplete
- Species distributions for UKBAP and MCZ features are incomplete
- Quality and resolution of predictive habitat maps
- Gaps relating to the condition of features
- Assessment of sea floor integrity

7.2 Quick wins

There are a number of categories of quick wins that are identified in terms of making best use of survey capability to meet Defra's needs:

i. **Improved use of existing data**
   - Identify sources of useful information
   - Sharing between organisations
   - Interpretation of existing data into habitat maps
   - Making data accessible
     - discoverable e.g. placing it on a web portable
     - available – free to use

ii. **Better utilisation of existing survey effort**
   - Assessment of existing work to identify overlaps
   - Coordinate location of survey work (avoid overlaps)
   - Collection on useful underway data
     - Using existing systems (e.g. acoustics)
     - Installing new equipment (e.g. ferrybox water samplers)
   - Piggyback new work onto existing cruises

iii. **Coordinated future survey strategy**
   - Identification of Defra priorities for evidence based decision making
   - Manage survey activity to achieve those aims
   - Determine data gaps
   - Commision new survey work to fill gaps not met under coordinated survey efforts using available capability

Some of the above categories would require significant extra work to develop a strategy for coordinating all relevant UK survey activity. However much useful work has already been carried out and projects looking at how to make maximum use of existing survey activity have shown promising results. For example:

Examples of future survey work include:

- JNCC/Cefas/Royal Navy survey – testing proof of concept for integrated approach. (2010).
- Cefas/JNCC surveys – additional monitoring to include data collection for JNCC during the annual Cefas CSEMP monitoring cruise programme. (2010).
- Multi-agency cruise to meet monitoring requirements for multiple MSFD GES descriptors. Cefas lead programme (sea time in 2013).

Previous work has shown that intelligent, collaborative planning can facilitate multiple survey interests. For example some surveys calibrate the geophysical instruments on known wrecks. Sight of this data by English Heritage has proven to be very useful for collating historical data.

The MSCC is conducting a cross government needs and capability assessment and will also ensure that strategic integration will take place in an efficient manner. For the purposes of this project, it is worthy of note that initial discussions across government (including the DfT, DECC, MOD, English Heritage, etc.) highlighted the frequent overlap in locational interest or data requirements. Therefore future discussions should make the most of survey capacity while ensuring organisational priorities are understood.

7.3 Economic benefits of improved data

Hussain, Winrow-Giffin et al. (2010) calculate that the benefits of an MCZ network equate to between £10.2 billion and £23.5 billion. Whilst (Beaumont, Austen et al. 2008) looked at the total ecosystem services provided by the marine environment (i.e. how much it would cost to replace those services) and came up with a figure in excess of £14 billion per annum. A report commissioned by the Crown Estate (Pugh 2008) put the value of marine associated economic activity at £46 billion or ~6 % of GDP in 2005. When compared to the above economic benefits (not to mention the cost of infractions for non-compliance) the returns on investing in marine research are vast.

Indeed the Irish Government continue to fund the INFOMAR (INtegrated Mapping FOr the Sustainable Development of Ireland's MArine Resource) programme on the basis that there is a four-fold return to the wider economy on monies put into the programme. In a cost/benefit analysis for the Irish Government performed by (PriceWaterhouseCoopers 2008) the cost of a high-intensity survey to complete the multibeam mapping of Irish EEZ was put at € 70 million with the economic benefits calculated as € 440 million. The analysis was conservative in that it did not include ecosystem services, or other environmental benefits. They made modest assumptions for the benefit of the survey on:

- Commercial/ Resource Benefits;
- Knowledge Economy;
- Legislative requirements and obligations; and
- Environmental Benefits (not quantified).

The economic benefits are likely to have been underestimated and the findings (based on geographic and sectoral similarities) would apply if a similar programme were to be adopted in the UK. Support for this view is provided by an as yet unpublished report by Anatec UK Ltd for the Maritime and Coastguard Agency who performed a cost-benefit analysis of the existing Civil Hydrography Programme. The findings were that the present cost of the programme, ~£5 million, produces economic benefits of ~£70 million annually. Consistent with the findings of the

(PriceWaterhouseCoopers 2008) report, maximum economic benefits are found to be obtained by “frontloading” the funding of an expanded programme so that the majority of the work occurs early-on. Considering the significance of the marine environment socially, economically and ecologically, and the relatively exacting requirements of the various legislation presented in Section 3. The idea of putting significant investment into baseline surveys in UK waters therefore seems entirely warranted.

The MCA were asked to provide an opinion on UK survey capability and estimated that there would be capacity in the survey market to survey the areas of the UKCS not previously surveyed within 7 years. This estimate was based on a level of survey which would not distort the market (i.e. increase demand to such a level as to make the project more expensive). The cost of such a programme would be £ 30 million a year resulting in a total cost of £ 210 million. This is for the delivered hydrographic specification data but would not include updates for mobile sediments. In addition to this would be the cost of interpreting the data for other purposes (e.g. geology, habitats, MCZs) and collecting ground-truthing information to support these interpretations. There would undoubtedly be significant opportunities to carry out such ground-truthing as part of the overall survey strategy as well as a refocusing of much existing research to incorporate information provided by the survey programme.

It should be noted that the Crown Estate have commissioned ABPMer and Eftec to provide a valuation for the marine estate and the activities that occur within it (Crown-Estate 2010) “Valuing the Marine Estate and UK Seas: An Ecosystem Services Framework“. In the report they recognise:

- “*Good spatial data exists in relation to provisioning services based on the distribution of human use activities and their economic value.*
- *For spatialising regulating and supporting services provided by the sea-bed, it is recommended that the marine landscapes in UKSeaMAP should be used as a starting point.*

Over time, information on the distribution of habitats and the nature and extent of services they provide will improve.”

The final point implies that the existing seabed data needs improvement and assumes that by some means it will. As has already been pointed out there is no systematic programme to map habitats in the UKCS.

8 CONCLUSIONS AND RECOMMENDATIONS

This section provides a summary of recommendations derived from this report. In summary

8.1 Quick wins

The following is a list of recommended quick wins that could be implemented within short timescales.

i. Improved use of existing data:

- Data sharing and Intellectual property: It is recommended that the Pan Government MoU for data sharing is expanded to include the EA and other strategic partners.
- Data from Industry and The Crown Estate should be made widely available using robust data security protocols.
- Arrangements for data management should be in place before data collection takes place, following the "data clause" recommendations of MEDIN.
- Existing multibeam from MCA and other organisations (e.g. the MAREMAP project) have taken the initiative to interpret these datasets. This process should be the basis of a more systematic and coordinated approach to interpretation of multibeam data into seabed maps.
- Analogue side scan collected by UKHO could be further processed to generate maps at resolutions appropriate for management purposes.
- Seabed-type records held by BGS can provide useful additional information on the location of rock substrates.
- JNCC's UKSeaMap 2010: It is recommended that the upcoming UKSeaMap 2010 is used in management processes. Further development of this product at this time is not detailed here as the product is yet to be released.

ii. Better use of existing survey effort:

There is little spare capacity within existing government funded marine research for a significant national-scale survey programme.

- Bodies such as UKMMAS and the Marine Science Coordination Committee should therefore actively encourage multidisciplinary and multi-agency integration of marine surveys.
- Lessons learned from such activities should be disseminated to demonstrate to the whole community that this approach provides efficiencies and can increase the utility of the data that is collected.
- Sufficient QA processes must be in place to ensure that habitat characterisation data are fit-for-purpose for the specific needs of different agencies (i.e. it is unlikely that broadscale characterisation of a particular area would provide adequate information for archaeological purposes or detailed habitat mapping for MCZ designation).

iii. Coordinated future survey strategy

- Existing processes in UKMMAS, MSCC and MEDIN should be used to ensure there is no duplication or confusion in future data collection and commissioning. It is recommended that CHAS (Civil Hydrography Annual Seminar) and the ability to use MCA contractors through the

Civil Hydrography Programme are used by commissioning agencies (including Defra) to deliver more joined up, economic, policy driven surveys. Better utilisation of UKDMOS[7] and Eurofleets should be considered to ensure that future surveys do not coincide with other existing or planned surveys. It is also envisaged that MAREMAP could provide a detailed overview of current data holding for geology, archaeology and heritage.

8.2 Towards a rationalisation of providing future data to underpin policy requirements.

Concurrently, and in keeping with Quick Win number iii and the key data gaps (as identified in section 5), it is recommended that a complimentary and prioritised survey programme is implemented. It should be complimentary to the Biodiversity Monitoring and Surveillance Programme (under the auspices of the JNCC and NE) and other major survey programmes (e.g. for UKMMAS monitoring)..

Costs

As already mentioned a complete multibeam assessment of the UKCS would take 7years and approximately £210 million. This is for the delivered hydrographic specification data but would not include updates for mobile sediments. A proportion of this (~£35 million will take place as part of the Civil Hydrography Programme so the additional costs beyond what would already be funded across government are not known. Additional to this would be geological interpretation, biological ground-truthing, habitat suitability modelling/mapping and heritage interpretation. The cost and source of funding for the additional work could either be part of a dedicated programme associated funded along with the data collection or a separate task funded and run through existing. It would be preferable to run acoustic and ground-truthing programmes together to ensure maximum synergy between them and optimal interpretation of the data.

Proposed sequence of activities to generate seabed maps

1. Interpret existing multibeam using existing groundtruth data.
   ESTIMATE: £400k

2. Determine the extent/quality of existing UKHO side scan data.
   ESTIMATE: £10k

3. Determine the availability of “raw” singlebeam data available to use freely for non commercial purposes.
   ESTIMATE: £0-1k

4. Test usefulness of working up singlebeam and side scan data using different qualities of side scan data to test what data quality is necessary to prepare a map of acceptable quality.
   ESTIMATE: £40k

5. Work up singlebeam and side scan data where data was of high enough quality to prepare maps. This will need to be prioritised in light of MPA requirements,

[7] http://www.ukdmos.org/content/content.asp?menu=05000000

priorities of the Marine Biodiversity Monitoring and Surveillance Programme, marine planning areas, and MSFD assessments.
ESTIMATE: £100k-£2m depending on amount of suitable data

6. Prioritise areas for new multibeam survey based on data gaps and associated risk related to MCZ proposals, marine planning areas and MSFD assessments.

   Priority locations for habitat and species mapping can be determined based on the following criteria:

   Habitat
   - the quality of existing habitat maps for the area;
   - the scope for processing existing multibeam or singlebeam and side scan data to create acceptable habitat maps (including any necessary requirement for ground-truthing);
   - adopting a risk-based approach in MSFD assessments, for example by prioritising areas subject to high levels of human pressure, targeting areas of conservation importance or where there is a high level of uncertainty (for example where there are strong gradients or high natural variability in abiotic factors).
   - regional sequence of marine plans;
   - the timetable for MPA site validation and condition monitoring;

   Benthic species
   - the density of existing biological survey data for the area, including UKBAP species were practicable;
   - the scope for processing additional existing survey data (Note: much of this has been done for project MB102 on mobile species mapping) and the scope for further work is considered limited);
   - synergies with proposed areas for habitat mapping involving additional biological survey for ground-truthing;
   - the timetable for MPA site validation and condition monitoring;
   - adopting a risk-based approach, for example by prioritising areas subject to high levels of human pressure, targeting areas of conservation importance or where there is a high level of uncertainty (for example where there are strong gradients or high natural variability in abiotic factors).

7. Prioritise feature condition monitoring based on locations of MPAs and areas of high human pressure (linked to marine biodiversity monitoring programme)

8. Integrate any additional MSFD requirements as they emerge.

9. Define cross-departmental (Defra, DfT, DECC and non-departmental (e.g. Crown Estate)) common interests in a coordinated national survey strategy to gain efficiencies, stimulate economic activity and provide a basis for environmental management.

In the above sequence of activities it is likely that Defra will need to involve a number of organisations including UKMMAS/HBDSEG, MAREMAP partners, MEDIN and the Statutory conservation agencies.

9 Annex 1: POLICY REVIEW

9.1 Introduction

A review of existing policy drivers has been undertaken to identify explicit or implicit requirements for seabed mapping. This was supplemented by a survey of Defra policy staff to obtain their views on policy priorities.

In an initial review the following policy drivers were identified as being potentially relevant:

- International Conventions
  - Safety of Life at Sea (SOLAS) Convention
  - MARPOL Convention
  - UNCLOS (UN Convention on the Law of the Sea)
  - Convention on Biological Diversity
  - OSPAR Convention
  - Ramsar Convention
- European Directives
  - EC Birds Directive (79/409/EEC)
  - EC Habitats Directive (92/43/EC)
  - EU Marine Strategy Framework Directive (2008/56/EC)
  - EU Water Framework Directive (2000/60/EC)
  - EC Strategic Environmental Assessment Directive (2001/42/EC)
  - EC Environmental Impact Assessment Directive (97/11/EC)
  - EC Common Fisheries Policy
- National Legislation
  - Marine and Coastal Access Act 2009

Based on the review, while there are few, if any, explicit or prescriptive requirements for seabed survey (although the MSFD explicitly requires maps of protected habitats), many of the drivers include implicit requirements for seabed survey. The main drivers are summarised below.

SOLAS Convention
The SOLAS Convention Chapter V Regulation 9 requires that contracting governments ensure that hydrographic surveying is carried out, as far as possible, adequate to the requirements of safe navigation. This provision is a primary driver of the UK Civil Hydrography Programme (CHP) overseen by the Maritime & Coastguard Agency (MCA). This programme provides the most comprehensive dataset (100% coverage multibeam bathymetry and backscatter, made available free of cost to government agencies) for mapping physical habitats but only has a remit to survey for SOLAS purposes.

MARPOL
The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and updated by amendments through the years. It aims to regulate pollution from oil, chemicals, harmful substances carried in packaged form, garbage, sewage, and atmospheric emissions. It is considered the benchmark text for marine pollution prevention.
The MCA are the executive agency of the Department for Transport responsible for implementing the Government's maritime safety policy. As such the MCA has regulatory authority over those activities that fall under the MARPOL Convention

73/78, including monitoring tankers that have to report under the PSSA, machinery space discharge, sewage discharges and garbage at sea.

The MCA are also the UK national competent authority for oil spill response and planning for all ships (including tankers), ports, harbours and coastal terminals but have transferred their oil spill planning regulatory function for offshore oil and gas installations to DECC, on an agency basis. The Secretary of State's Representative (SOSREP) has the power of intervention for large scale oil spill incidents from ships (including offshore platforms).

OSPAR Convention
The OSPAR Commission recommendation 2003/3 seeks to establish the OSPAR Network of Marine Protected Areas (MPAs) and to ensure that by 2010 it is an ecologically coherent network of well-managed marine protected areas.

OSPAR Recommendation 2003/1 encourages the implementation and reporting of The Joint Assessment and Monitoring Programme which seeks to monitor:

- the quality of the marine environment and each of its compartments, that is, water, sediments and biota;
- activities or natural and anthropogenic inputs which may affect the quality of the marine environment;
- the effects of such activities and inputs.

In 2003, the Biodiversity Committee agreed to a programme to map the distribution of habitats listed for protection. Assessments of the wider status of listed habitats (for the Quality Status Report 2010) have been hampered by the lack of comprehensive mapping data for these habitats.

North Sea Bergen Declaration
This declaration aims to conserve, restore and protect the species and habitats of the North Sea to ensure the sustainable use, conservation and protection of marine biological diversity and its ecosystems. It calls for mapping of the North Sea and improvements in the classification of habitats

Convention on Biological Diversity
The UK Biodiversity Action Plan (UKBAP) is the UK Government's response to the CBD which was signed at the Rio de Janeiro Summit in 1992. The Convention calls for the development and enforcement of national strategies and associated action plans to identify, conserve and protect existing biological diversity, and to enhance it wherever possible. The UKBAP sets out to describes the biological resources of the UK and develop plans for conservation of these resources.

EC Habitats Directive
The Directive provides for the establishment of a network of protected areas for specific features of European importance. Development of the network requires an adequate knowledge of the distribution and condition of relevant species and habitats (features) in UK waters. Under the Directive, competent authorities are required to regularly assess the condition of features for which sites have been designated (Article 11) and to report to the European Commission on the conservation status of relevant habitats and species (Article 17). To date the distribution and extent of certain Annex I marine habitats within UK waters is not yet fully known, hampering an assessment of their status and management.

EU Marine Strategy Framework Directive

The MSFD requires Member States to establish and implement coordinated monitoring programmes for the ongoing assessment of the environmental status of their marine waters (Article 11) in relation to the 11 descriptors of Good Environmental Status (GES) (Box 1) on the basis of the indicative elements identified in Annex III and Annex V.

Annex III refers to particular characteristics of elements including 'topography and bathymetry of the seabed', 'the predominant seabed and water column habitat type(s)', 'identification and mapping of special habitat types' and 'a description of the biological communities associated with the predominant seabed and water column habitats'. Specifications and methods for monitoring and assessment are to be developed and agreed in accordance with procedures laid down in the Directive.

Mapping of marine habitats is required either explicitly or implicitly for the Initial Assessment in 2012 and subsequent 6-yearly assessments. Knowledge of the relationship between the distribution of habitats and the pressures from human activities is expected to form a key part of the assessment of Descriptors 1 and 6.

BOX 1 Descriptors of Good Environmental Status under the MSFD:

1: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
2: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
3: Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
4: All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.
5: Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
6: Sea floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
7: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
8: Concentrations of contaminants are at levels not giving rise to pollution effects.
9: Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
10: Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

EU Water Framework Directive

The WFD establishes a framework for the protection and improvement of inland waters, groundwaters, estuaries and coastal waters out to 1nm from the baseline for territorial waters with the headline objective of achieving Good Ecological Status for all waters by 2015. The Directive includes specific requirements for the monitoring of

certain ecological components (phytoplankton, macroalgae, angiosperms, invertebrates and fish). It also requires a knowledge of the hydrological and morphological characteristics of relevant waters, for example, depth variation, quantity, structure and substrate of the bed and structure of the intertidal zone (Annex V).

EC Strategic Environmental Assessment Directive
The SEA Directive requires environmental assessment of the effects of certain plans and programmes to be undertaken to inform option selection and prior to adoption. Such assessments include a requirement for baseline information to be collected or collated, against which likely significant effects of alternative options can be assessed.

Common Fisheries Policy
In accordance with Regulation 2371/2002, the objective of the CFP is to provide for the sustainable exploitation of living aquatic resources and of aquaculture in the context of sustainable development, taking account of the environmental, economic and social aspects in a balanced manner. This broad framework includes consideration of physical impacts to the sea-bed which are acknowledged to be high (e.g. ICES, 2008).

Marine & Coastal Access Act 2009
The MCAA introduces a new framework for the management of UK seas. The principal components of this framework of relevance include:

- A system of Marine Planning – a statutory system of marine planning covering all waters within the UKCS to deliver an ecosystem-based approach to the management of human activities in the sea. Plan preparation will include a Sustainability Appraisal incorporating the requirements of the SEA Directive. The preparation of such plans and completion of the Sustainability Appraisal will require adequate knowledge of the physical geography of the seabed and the distribution and quality of seabed habitats and species.
- Establishment of an ecologically coherent network of marine protected areas – the establishment of the network requires adequate information on the distribution and condition of relevant features and also allows for consideration of socio-economic interests. Once established, periodic monitoring of sites within the network will be required to support site condition assessment and ongoing management to achieve site conservation objectives.

Provisions in the Act to strengthen the environmental responsibilities of Inshore Fisheries and Conservation Authorities (IFCAs) and to strengthen wider fisheries management powers may also create specific additional requirements for seabed survey information.

UK Marine Monitoring and Assessment Strategy (UKMMAS)
UKMMAS provides a coordinated and integrated approach to marine monitoring in the UK. It seeks to ensure that the UK has adequate evidence in support of the UK Government's vision for "clean, healthy, safe, productive and biologically diverse seas" (Safeguarding our Seas (2002)). UKMMAS provides a mechanism for identifying evidence gaps to meet existing and future drivers and prioritising survey and monitoring effort amongst UKMMAS partners. One of the key gaps identified by UKMMAS is the need for high resolution mapping of seafloor topography and benthic communities.

High Level Marine Objectives and the 'UK Marine Science Strategy'
The UK High Level Marine Objectives and the UK Marine Science Strategy were also highlighted during the consultation phase of this project. Both these documents make specific reference to information needs in relation to the historic environment and the requirement for relevant data to support decision making.

Summary: It is of note that few of the drivers explicitly require mapping of the seabed or its associated habitats but such requirements are implicit in many of the drivers (Table 8). Furthermore, none of the drivers indicate how much mapping should be undertaken, for example, the most explicit commitments relates to an OSPAR agreement, Bergen Declaration and MSFD to a programme to map the distribution of priority habitats. Nevertheless, the implicit mapping requirements, for example to deliver the objectives of the MCAA and MSFD indicate that a significant level of knowledge of seabed habitats and their condition is required at broad spatial scales. Further guidance on the requirements for monitoring under the MSFD will be provided at European level as the Directive is implemented.

	Explicit mapping requirements		**Implicit mapping requirements**	
	B	**H**	**B**	**H**
International Drivers				
SOLAS Convention	✓			
OSPAR Convention		✓		
Convention on Biological Diversity			✓	✓
UN Law of the Sea (UNCLOS)			✓	
MARPOL (Civil Liability Convention)			✓	
RAMSAR			✓	✓
European Drivers				
Habitats Directive				✓
Marine Strategy Framework Directive		✓	✓	✓
Water Framework Directive			✓	✓
Strategic Environmental Assessment Directive		✓		
EIA Directive		✓		
Common Fisheries Policy				✓
National Drivers				
Marine and Coastal Access Act			✓	✓
UK Marine Monitoring and Assessment Strategy			✓	✓

B = Bathymetric mapping; H = Habitat mapping

Table 8 Explicit and implicit mapping requirements of selected legislation and policies

9.2 Defra Policy Priorities

To support the identification of policy priorities, a series of interviews were held with Defra policy staff. The priorities identified are listed below: (Table 9).

Policy Priorities	Responses
Marine & Coastal Access Act	9
MSFD	8
MCZs, HSMPAs	1
Climate Change Act	1
EC Birds Directive	1
EC Habitats Directive	1
EC Water Framework Directive	1
EC Common Fisheries Policy	1
UNCLOS	2
MARPOL	1
Marine Minerals	2

Table 9 Summary of responses by legislative driver

9.3 Towards a High Level Description of Defra's Requirements

3.3.1 Introduction
Over recent decades, there has been an important shift in thinking about ecosystems, neatly summarised in Table 10 below.

FROM	TO
• Individual species	• Ecosystems
• Small spatial scale	• Multiple scales
• Short-term perspective	• Long-term perspective
• Humans outside system	• Humans integral
• Management divorced from research	• Adaptive management
• Managing commodities	• Sustain production potential for goods and services

Table 10 Ecosystem thinking (after Lubchenko, 1994)

The ecosystem-based approach to the management of human activities in the marine area which is now embedded in UK policy through commitments under the World Summit on Sustainable Development (2002); the 5th North Sea Conference; Safeguarding our Seas 2002 and now the Marine & Coastal Access Act 2009. Of particular note is that the ecosystem-based approach requires management focus at broad regional spatial scales.

While existing policy drivers are not specific about the requirements for seabed survey, it is nevertheless possible to describe in general terms Defra's priority requirements. These are indicated in the sections below for the key drivers under the MCAA and MSFD.

Requirements for Marine Planning
Implementation of marine planning will require the preparation of marine plans covering broad geographic areas. A Defra consultation on marine plan areas (Defra, 2009) suggested that up to 12 marine plan areas might be established for English territorial and offshore waters. Plan development is expected to occur sequentially over at least a decade with plan production prioritised based on need.

For each marine plan area it will be necessary to have sufficient understanding of the physical geography and the distribution of habitats and species to inform plan preparation. These information requirements would also presumably require (where appropriate) data in relation to the historic environment. Application of the ecosystem-based approach will also require that there is sufficient understanding of the pressures and impacts of human activities on the natural environment and how this affects the condition of relevant features (in particular in relation to the achievement of Good Environmental Status under MSFD). This information will support decisions on the acceptability of existing impacts and the scope and opportunities for further development within the plan area.

While it is not possible to be prescriptive about the level of detail that is required, existing information on habitat and species distributions is patchy and incomplete. These requirements will be prioritised based on an assessment of environmental risk and the order of plan preparation.

Requirements for Marine Protected Areas
The completion of the network of Natura 2000 sites and the identification of Marine Conservation Zones are being taken forward using existing, often limited, information on the distribution of habitats, species and socio-economic interests. Once designated, there will be a requirement to undertake monitoring at these sites both to define a baseline and for periodic assessment to support management requirements for the achievement of site based conservation objectives. Given that the final network as a minimum needs to cover 15-30% of the subtidal seabed (based on the adequacy criterion in the draft Ecological Network Guidance (JNCC and Natural England, 2010)), it is likely to be necessary to establish a significant programme of mapping. It will be possible to prioritise the survey requirements (for example based on level of existing knowledge, extent of human pressure.

Requirements for MSFD
The seabed survey requirements of MSFD are likely to be broadly similar to those for marine planning, although the monitoring requirements in relation to individual GES descriptors may give rise to specific survey needs. In particular the GES descriptors make reference to the quality and occurrence of habitats and the distribution and abundance of species, the structure of marine food webs and sea floor integrity. There is also a requirement to provide maps of special types (listed habitats) and specific areas.

MSFD operates at similarly broad scales to marine planning and will require information on the distribution of biological features and their condition in response to human pressures and impacts to support the development of marine strategies and management measures. Prioritisation of requirements can take account of environmental risk and uncertainty and the distribution and intensity of human pressures but again the limited amount and patchiness of existing seabed topographic, substrate and habitat information makes informed and consistent decision making challenging.

Future considerations
While it will be possible to seek to prioritise requirements in relation to individual policy drivers, good coordination across the different drivers will be necessary to ensure that any requirements for new surveys are delivered efficiently. This might usefully build on existing co-ordination arrangements within UKMMAS to ensure that any new surveys make best use of existing information and maximise benefit for all the relevant drivers.

10 Annex 2: DESCRIPTION OF EXISTING SURVEYS AND INFORMATION

Data collection
The simultaneous collection of data (acoustic and ground truthed data) to be used to create habitat maps is being more widely adopted as the standard method for environmental surveys at all scales. For example the co-ordinated approach to data gathering as demonstrated in the DORset Integrated Seabed study (Doris) conducted by The Dorset Wildlife Trust, the Maritime and Coastguard Agency and Channel Coastal Observatory. However disparate surveys of the sea bed have been carried out for decades using a number of technologies including:

- Bathymetric surveys:
  - Multibeam (or swathe)
  - Singlebeam with Side Scan
  - Singlebeam
  - Soundings (lead line)
- Prospecting surveys for aggregate and hydrocarbon resources
- Site investigation surveys for seabed construction/infrastructure
- Sea bed sediment surveys
- Sea bed biological surveys

These techniques generate useful information on the seabed and details of their coverage both in terms of any parameters measured co-incidentally and a number of organisations manage information about their spatial coverage:

- BODC (for UKDMOS)
- MCA
- MEDIN
- BGS
- CCO (and related programmes)
- JNCC (for NBN Gateway and MESH)

Survey Programmes
Many of the main organisations carry out survey programmes gathering the relevant surveys, as detailed above, on either a regular basis (e.g. annual or five yearly) or as needed to meet their own commitments and obligations. Such organisations and their associated programmes are given in the following sections.

10.1 The Maritime and Coastguard Agency

Currently the MCA is the only UK organisation with a statutory remit (under SOLAS (Chapter V, Regulation 9)) to map the seabed. The MCA has responsibility for collecting bathymetric information that allows charts for safe navigation to be produced by the UKHO, having taken over the Civil Hydrography Programme from the MOD in 2006. Their responsibility is for all UK waters although only areas that

have been identified as presenting a hazard to shipping are prioritised for survey. There is currently approximately 10 years of high priority work already identified in addition to routine resurvey of areas with mobile seabed (hydrographic surveying activities within Port Authority limits are not covered, see below).

For the survey to meet the SOLAS requirements the MCA require that the survey provides 100% bathymetric coverage. These surveys are to be conducted to “Order 1” standard as defined by the International Hydrographic Organization (IHO) publication “Standards for Hydrographic Surveys, Special Publication S44”. Grab-samples are typically taken at 5km intervals to ground-truth multi-beam backscatter observations and a magnetometer is often required to augment wreck detection.

The locations for new survey areas are planned up to 3 years in advance based on areas identified as priorities based on navigational requirements (Figure 4).

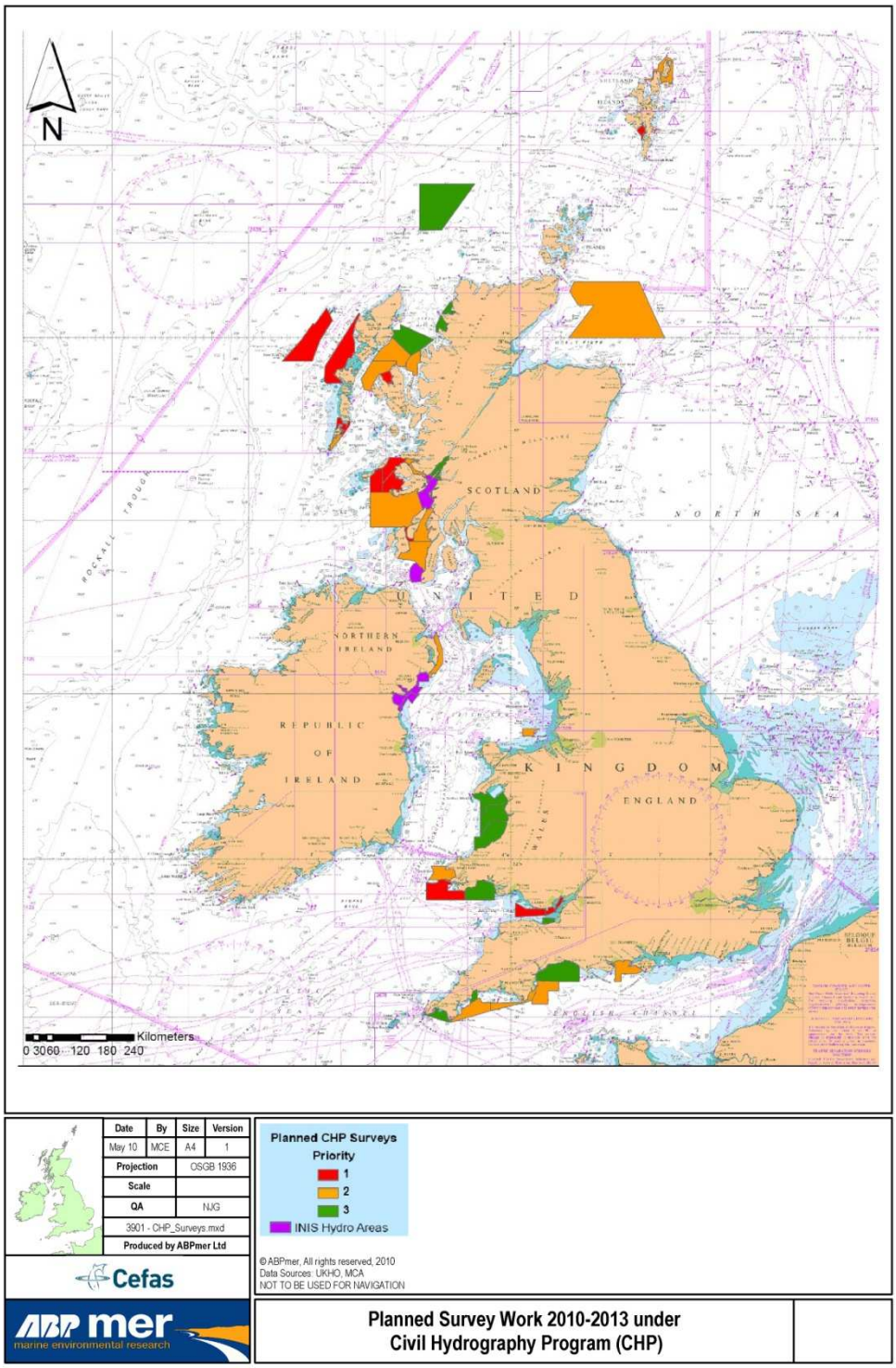

Figure 4 Planned survey work 2010-2013 under CHP

All future MCA survey work is of relevance to Defra as it provides high quality data describing the marine landscape. It provides 100% coverage and in addition to detailed topographic information the multibeam data also describes the physical properties of the seabed substrata. The data collected by the MCA is available to other government departments via the Pan Governmental MoU on data sharing and samples routinely collected during the surveys are now being sent to the BGS for

more detailed sedimentological analysis and archiving. It would therefore seem that the MCA is a key player in any future expanded survey programme as they have the remit to map the seabed, have experience in commissioning large survey programmes, managing the data and sharing it across government.

10.2 Port and Harbour Authority programmes

Routine surveys of the approaches to all UK ports are carried out by the port and harbour authorities. The survey frequency depends on the individual port and harbour obligations to navigation and conservancy issues, the former having a short term regular/ repeat programme while the latter may be on a rolling schedule. These surveys concentrate mainly on the collection of bathymetric data using a combination of multi-beam and singlebeam equipment depending on port size and dynamics of the port/harbour area. These data are not publicly accessible but there is no reason why such information could not be shared as they are not of commercial value and would be cheaper to pay any costs of reproduction than re-collecting.

10.3 Ministry of Defence (MOD)

The Royal Navy has a fleet of four advanced survey vessels with a global remit to patrol and survey, maintaining sovereign presence with defence diplomacy.

The hydrographic survey vessels primarily provide survey support for the MOD which includes data that updates UKHO navigational charts both abroad and within the UK. The vessels vary widely in size from HMS Scott (at 131 m LOA it is the sixth largest in the Navy) to the HMS Gleaner (16 m LOA) which is the smallest commissioned vessel in the Royal Navy.

The Ministry of Defence works closely with one of its agencies, the UK Hydrographic Office (UKHO), in the planning of survey work around the United Kingdom.

Wherever possible, MOD data in UK Waters are released for use in UKHO's commercially available charts. The data are also made available by UKHO under licence to third parties. Any request to the UKHO for data in specific areas is dealt with by the Seabed Data Centre and will include all MOD data wherever release is possible. This is expected to be made available for download from the UKHO's Bathymetric Data Archive Centre (DAC) during 2011.

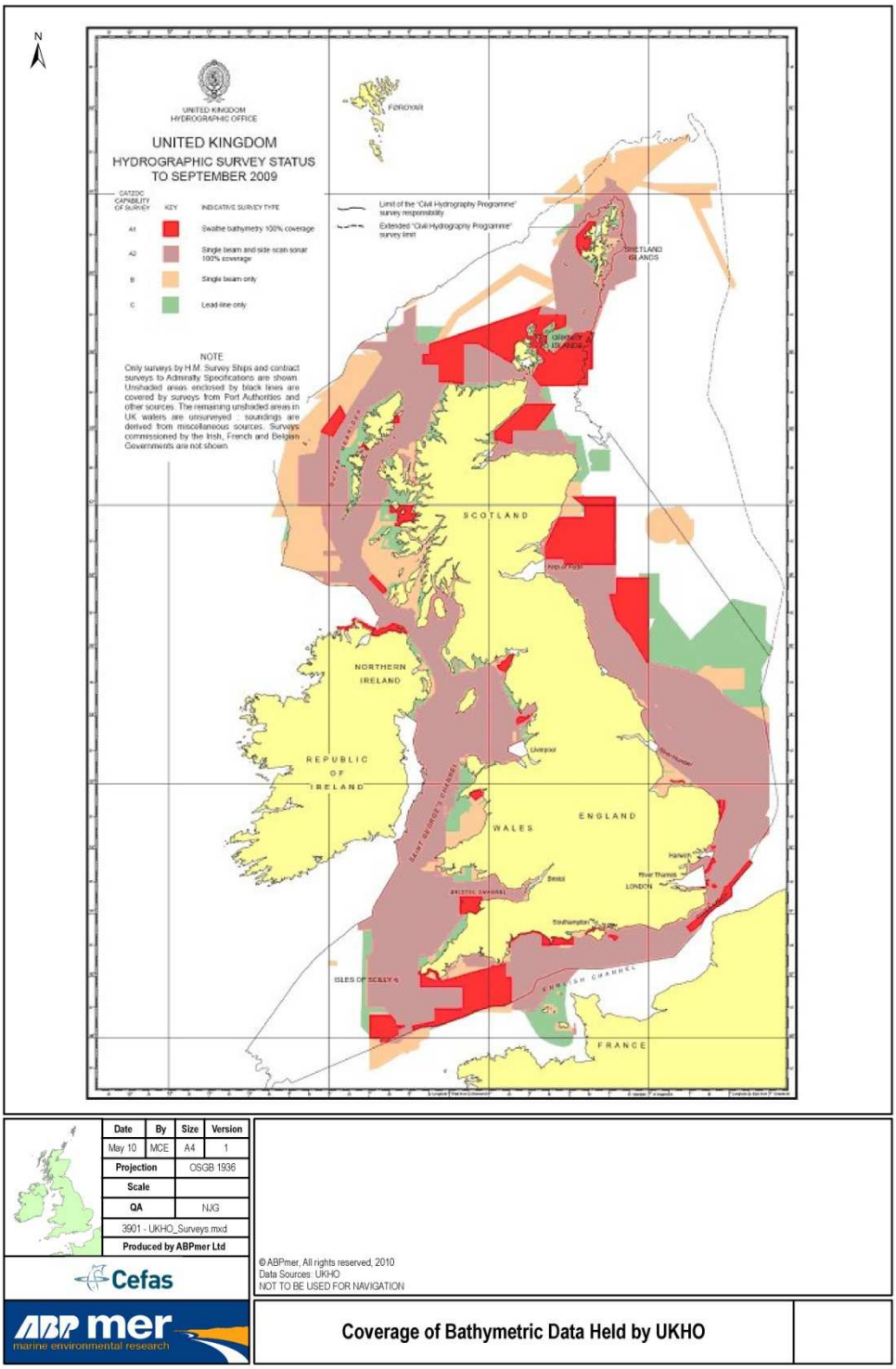

Figure 5 Coverage of bathymetric data held by UKHO

Figure 5 shows the coverage of all surveys held in the UKHO to Sep 2009. A great deal of the data in area 'A2' was collected by the Royal Navy but is only singlebeam, there is however 100% side scan coverage for the A2 region. The map does not show data density and the singlebeam data density varies from more than 120 m to tens of metres (typically higher density in shallower waters). There is another survey

not yet on the chart (Approaches to Plymouth - available around July 2010) that is now completed and will be submitted to the UKHO.

The MOD occasionally has extra requirements beyond a simple bathymetric survey, so resurveys areas recently completed by other organisations. Most of the MODs survey work occurs outside UK waters so currently there is limited scope for the MOD contributing more to such work.

For the year 2010-2011, a major survey was identified of interest for environmental/management purposes. This took place in Cardigan Bay, and JNCC staff and CCW staff were on board to augment the survey to include towed video footage. The survey was also added to the Civil Hydrography Programme Survey Plans to ensure no overlap and no gaps.

10.4 NERC Research

The NERC scientific survey programme uses eight ships of different nationalities, for about 35 surveys annually, all supported by 60 staff using £25m of equipment operated from Southampton. Each survey is focused on meeting different and separate research objectives. The surveys are mostly outside UK waters.

Projects are submitted to NERC outlining the survey requirements, and are then assessed according to scientific merit and graded. The top proposals are then scheduled. The plans are approved for around a year in advance but the approval system is not continuous so that only 6 months of survey activity may be known until the NERC council approve another 12 months worth of work. Once approved the survey plan is made public on the NOC website [http://www.noc.soton.ac.uk/nmf/mfp/mfp.php].

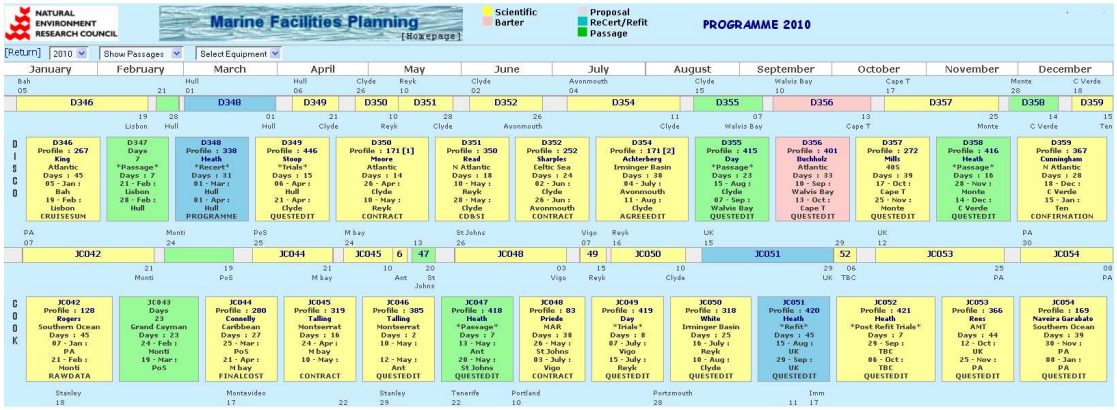

Figure 6 Schedule for NERC vessels James Cook and Discovery for 2010

It is unlikely that the approval system will consider a period of longer than 12 months, meaning that it will not be possible to collate survey plans up to 2020. There are, however some routine surveys that occur in UK water and these could be included as part of a longer term monitoring/survey strategy.

10.5 British Geological Survey

The British Geological Survey (BGS) is the nation's principal supplier of geological expertise and information for decision making for governmental, commercial and individual users. The BGS is part of the Natural Environment Research Council (see

above), but operates its survey programme independently of the NERC research programmes.

Relevant Programmes
BGS's marine geoscience theme provides integrated geological research across the entire United Kingdom designated area. Current research focuses on:

- detailed seabed mapping
- reconnaissance surveys
- basin analysis on the Atlantic Margin

The marine and geological mapping team focuses on developing new series of very detailed seabed geology maps based on multibeam and side scan data that will allow a detailed understanding of the seabed environment. These new data will underpin the assessment of our marine resources and provide an important part of the framework for marine planning. BGS are working closely with other marine organisations, including the UKHO, MCA, JNCC and CEFAS in a Seabed Mapping Working Group, which reports to HBDSEG.

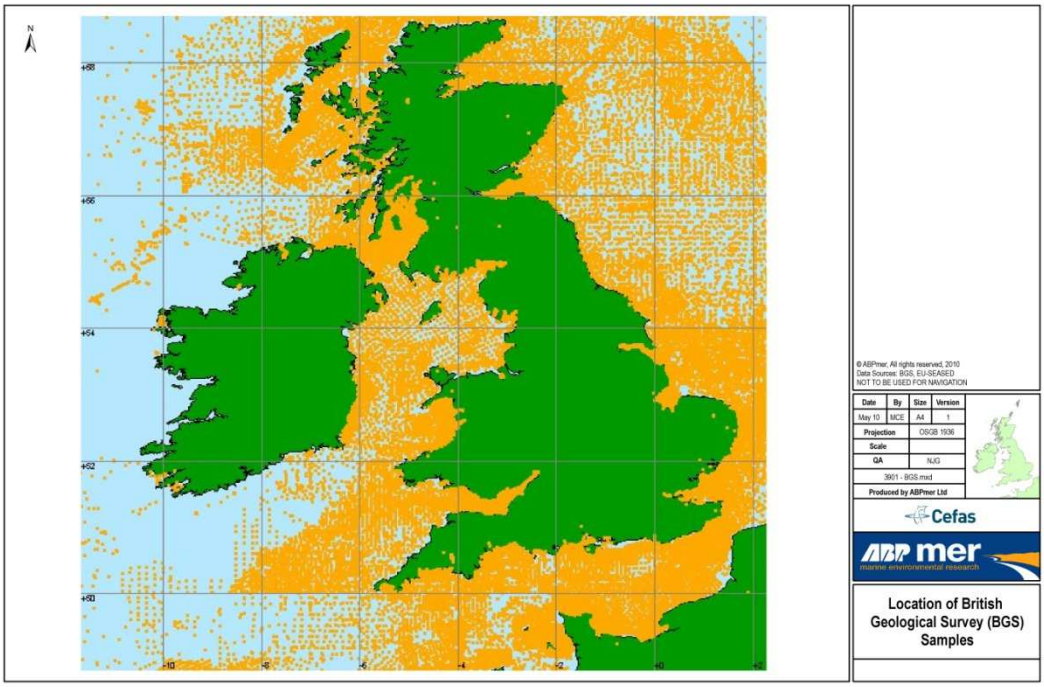

Figure 7 Location of BGS seabed samples

Historic environment
A better understanding of the geology leads to an improved understanding of benthic and pelagic species. However the links between geology and the historic environment should also be considered as the 'historic environment' includes not just shipwrecks and aircraft wreckage but also areas of the seabed that once valuable palaeo-environments. There are intrinsic links between geology and geomorphology and theses 'submerged prehistoric landscapes' where our human ancestors once lived. Therefore these data are highly relevant to agencies such as English Heritage.

10.6 Cefas

Operating as an executive agency of the Department for Environment, Food and Rural Affairs (Defra), it works alongside government and other agencies, both in the UK and internationally, to play a vital role in securing healthy marine and freshwater environments for everyone's well-being, health and prosperity. For more about Cefas' work see http://www.cefas.co.uk/.

Cefas chairs the UK group responsible for co-ordinating a national programme of marine monitoring (CSSEMP) under the auspices of UKMMAS. This programme aims to detect long-term trends in the chemical, physical and biological quality of the marine environment. It advises on setting up and implementing monitoring schemes and their associated activities to measure and assess environmental quality and change.

Relevant Programmes

CEFAS has a strong and active research and monitoring programme which supports strategic requirements and the development and application of innovative methods and technologies. It applies the understanding and knowledge from these programmes to establish systems and formulate advice for effective environmental monitoring and fisheries management.

Monitoring Capability

Cefas has a research vessel (RV Endeavour) with proven capacity to deliver fit for purpose monitoring of the sea floor. Cefas also has the capability to provide a variety of acoustic imaging and data analysis approaches to provide maps of the sea floor for different management requirements.

10.7 Marine Scotland

Marine Scotland: Science (formerly Fisheries Research Services) was established as a division of Marine Scotland on April 1 2009. Its' purpose is to provide expert scientific and technical advice on marine and freshwater fisheries, aquaculture, and the protection of the aquatic environment and its wildlife. This advice informs the policies and regulatory activities of the Scottish Government.

The Aquatic Environment Programme is one of its key scientific programmes. It aims to protect the quality of the Scottish aquatic environment, aquaculture and fisheries, by conducting monitoring and research in support of the provision of scientific advice and the enforcement of environmental legislation.

Sea-going investigations are conducted aboard the research vessels FRV Scotia (68m) and FRV Alba na Mara (27m), and from chartered commercial vessels.

10.8 AFBI

The Agri-Food and Biosciences Institute (AFBI), is a leading provider of scientific research and services to government, non-governmental and commercial organisations.

The major programmes include fisheries stock assessment, marine environmental management, coastal zone management and sea bed mapping. AFBI operates the R.V. Corystes (52m) and undertakes a programme covering a wide range of fisheries and marine environmental research. AFBI also maintains a coastal observatory with

12 moorings providing environmental data via the internet. AFBI has the capacity to conduct multi beam surveys and other sea bed imaging studies and has undertaken extensive seabed surveys in Northern Ireland waters.

10.9 Statutory Nature Conservation Bodies

Joint Nature Conservation Committee

The Joint Nature Conservation Committee (JNCC) is the statutory adviser to the UK government and devolved administrations on UK and international nature conservation. It is responsible for advising on marine nature conservation in offshore waters around the UK, and for working with the country conservation bodies to ensure there is a sound evidence base across the marine environment as a whole, and that international obligations are met in a consistent manner. This includes contributing to the establishment of Marine Protected Areas. See www.jncc.gov.uk/page-3 for more about the marine aspects of its work.

JNCC has an important role in co-ordinating and directing surveillance in the UK, for example, through the Marine Surveillance and Monitoring Programme, coordination of aspects of the UK Marine Monitoring and Assessment Strategy (it currently chairs HBDSEG), and through the framing of common standards for monitoring protected sites. The JNCC have no “in house” survey capacity and rely on contracting such operational capability. There has been a recent partnership agreement between JNCC and Cefas to use the RV Cefas Endeavour for monitoring and MPA work.

JNCC maintains a UK seabed habitat mapping data resource, both through the collation and standardisation of available data (detailed maps) and the modelling of habitats at UK and European scales (see MESH, UKSeaMap and EUSeaMap later). JNCC prepares these maps harmonised to the European EUNIS classification and disseminates them freely via webGIS portals for the benefit of all organisations needing such data.

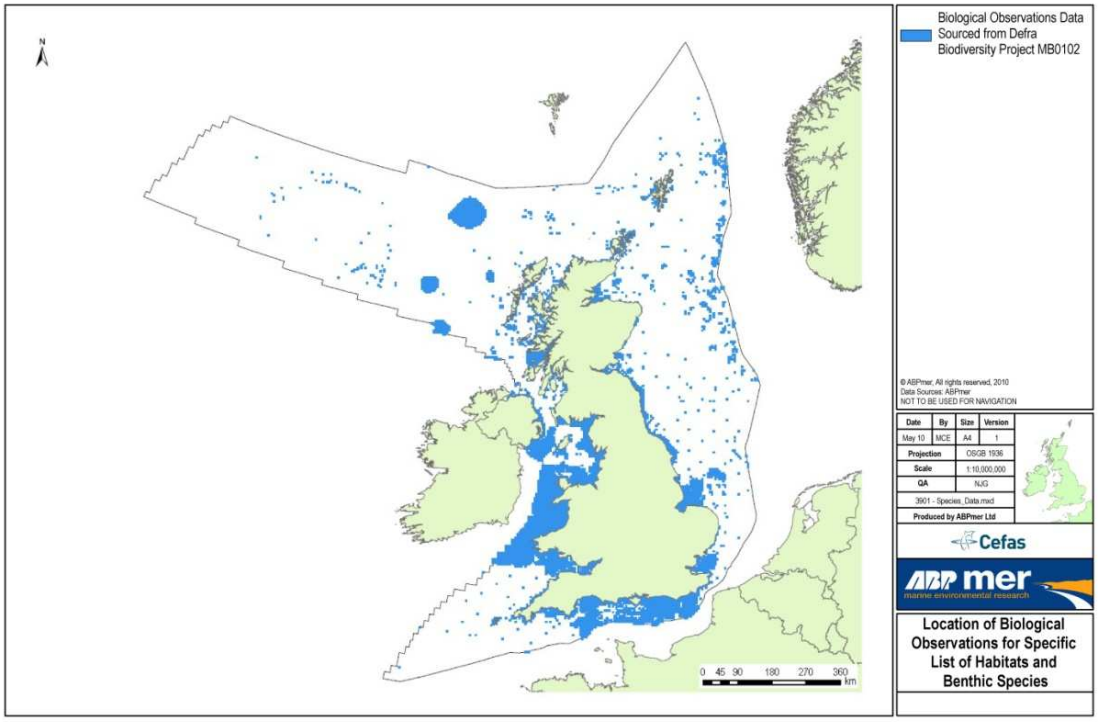

Figure 8 Biological observations for specific lists of habitats and benthic species

Natural England

Natural England (NE) is responsible for advising Government and industry on marine conservation and seascape issues in England's territorial waters (from the coast to 12 nautical miles offshore). The main focus of Natural England's evidence programme is to support delivery of an ecologically coherent network of Marine Protected Areas (MPAs), promote sustainable use in key sectors, and contribute to understanding and management of the wider environment.

NE is implementing Marine Conservation Zones in inshore waters introduced through the Marine and Coastal Access Act. Combining these new zones with existing designated areas, such as Natura 2000 Sites (SACs, SPAs) and the marine components of SSSIs and Ramsar sites, will provide an ecologically coherent network of Marine Protected Areas.

NE is currently progressing 6 draft SACs and 2 potential SPAs in the inshore zone, more information on these sites can be found on the New Marine Natura 2000 sites - Special Areas of Conservation and Special Protection Areas webpages.

Around the UK Scottish Natural Heritage , Countryside Council for Wales and Northern Ireland Environment Agency have a similar role to NE.

10.10Inshore Fisheries and Conservation Authorities (IFCA's)

The Sea Fisheries Committees (SFC's) in England have statutory responsibility for the management of inshore fisheries and aspects of the marine environment in the 0-6nm zone. In 2011 the Sea Fisheries Committees will be replaced by Inshore Fisheries and Conservation Authorities (IFCA's). IFCA will have new duties to

manage and protect inshore areas and will be required to take an evidence based approach to the introduction of management measures (byelaws) for the protection the fisheries and the marine environment[8] Sea Fisheries Committees have assets (patrol vessels) and capabilities to collect data (currently singlebeam / sonar / olex / video etc.) and have collaborated with other agencies, such as CEFAS, Natural England and BGS on projects to map marine habitats and species and have also made contributions to projects such as the Regional Environmental Characterisations. It is envisaged that such collaboration will increase into the future when IFCAs are formed and the IFCA's themselves will require further habitat and species data at a resolution commensurate with their regulatory function.

10.11 Department of Energy and Climate Change (DECC)

Strategic Environmental Assessment (SEA) is the process of appraisal through which environmental protection and sustainable development may be considered, and factored into national and local decisions regarding Government (and other) plans and programmes – such as oil and gas licensing rounds and other offshore energy developments. The process aims to help inform Ministerial decisions through consideration of the environmental implications of the proposed action. The Department of Energy and Climate Change (DECC), as the principal regulator of the offshore oil and gas industry, has used SEAs as a means of striking a balance between promoting economic development of the UK's offshore energy resources and effective environmental protection. Although the European Strategic Environmental Assessment Directive (Directive 2001/42/EC) was not incorporated into UK law until 2004, some SEAs were carried out prior to this date.
The Department of Trade and Industry (now DECC) began a sequence of sectoral SEAs of the implications of further licensing of the UK Continental Shelf (UKCS) for oil and gas exploration and production in 1999. For this purpose the UKCS was subdivided into 8 areas, see Figure 9.

[8] see http://www.defra.gov.uk/foodfarm/fisheries/documents/fisheries/ifca-vision.pdf

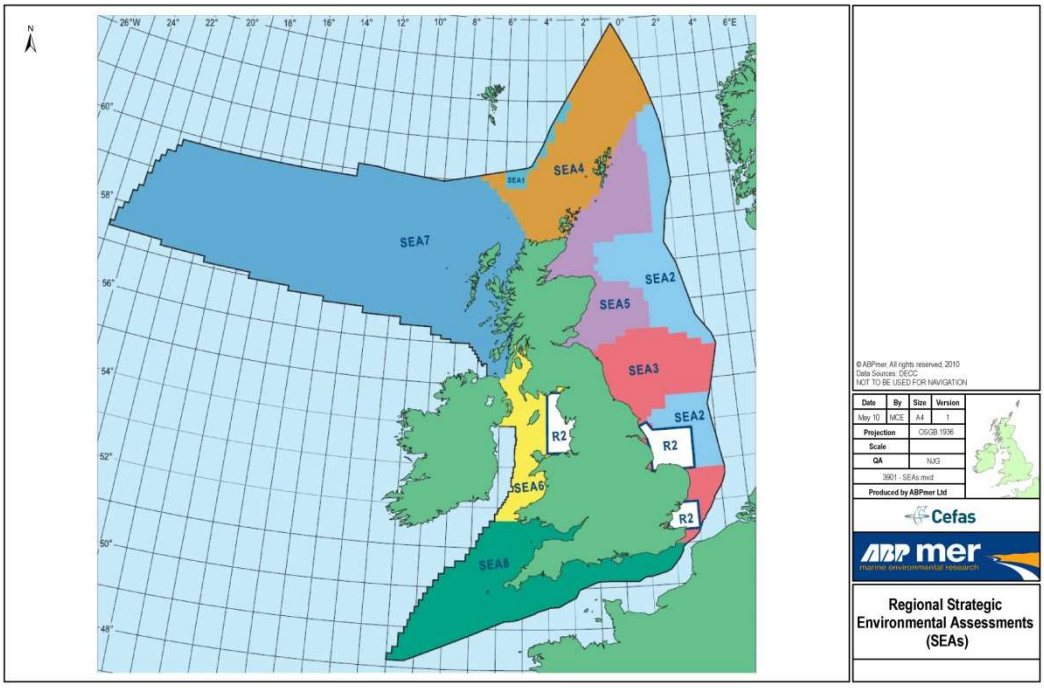

Figure 9 SEA areas

The SEAs consider the whole of the marine environment despite the fact that some areas may not attract much attention from the offshore energy industries. For example, parts of the Western Approaches (SEA 8) are not considered particularly suitable for oil & gas exploration, but were studied as part of the overall SEA process. The SEAs also consider inshore areas, bays and inlets even though they were not currently offered for licensing. The areas indicated continue up to the high water mark in order to consider the marine environment as a whole. Whilst new seabed information was collected as part of the SEA process this was not systematic and varied in nature and extent for each of the SEAs. In terms of adequacy for meeting the legislative drivers the most through recent assessment was by the (Scottish-Executive 2007) and specifically deals with knowledge gaps and highlights many gaps in spatially referenced data.

These difficulties in meeting the requirements of this SEA process using existing data are likely to be equally applicable to other marine SEAs. Indeed the state of baseline knowledge is so poor as to warrant significant work to meet the requirements of the SEA process alone. Other agencies and government departments might co-fund any Defra survey work that would better support the SEA process (e.g. DECC, Crown Estate).

10.12Industry

Marine ALSF

Over the past few years the Marine ALSF has commissioned a series of regional surveys to develop understanding of Britain's submerged habitats and heritage, known as the Regional Environmental Characterisation Projects (RECs). The aim of this programme was to acquire data of the highest quality and detail possible to enable broadscale characterisation of the seabed habitats, their biological communities and potential historic environment assets within the regions.

The RECs have been conducted in the following areas; see Figure 10:

- South Coast
- Outer Thames
- East Coast
- Humber

The South Coast and Thames surveys were undertaken in 2007 (geophysical and biological survey data and survey operations report are available at www.marinealsf.org.uk). The final report for the Outer Thames survey is now available from this website, and all seabed data are available from the WebGIS - http://www.thamesrecgis.org.uk/. The south coast data are currently being interpreted for production of final reports and seabed maps. Whilst the East Coast and the Humber surveys were completed in June 2009 with the geophysical and biological survey data are now available (1 October 2009) at www.marinealsf.org.uk. Both projects are due to produce final reports and seabed maps February 2011.

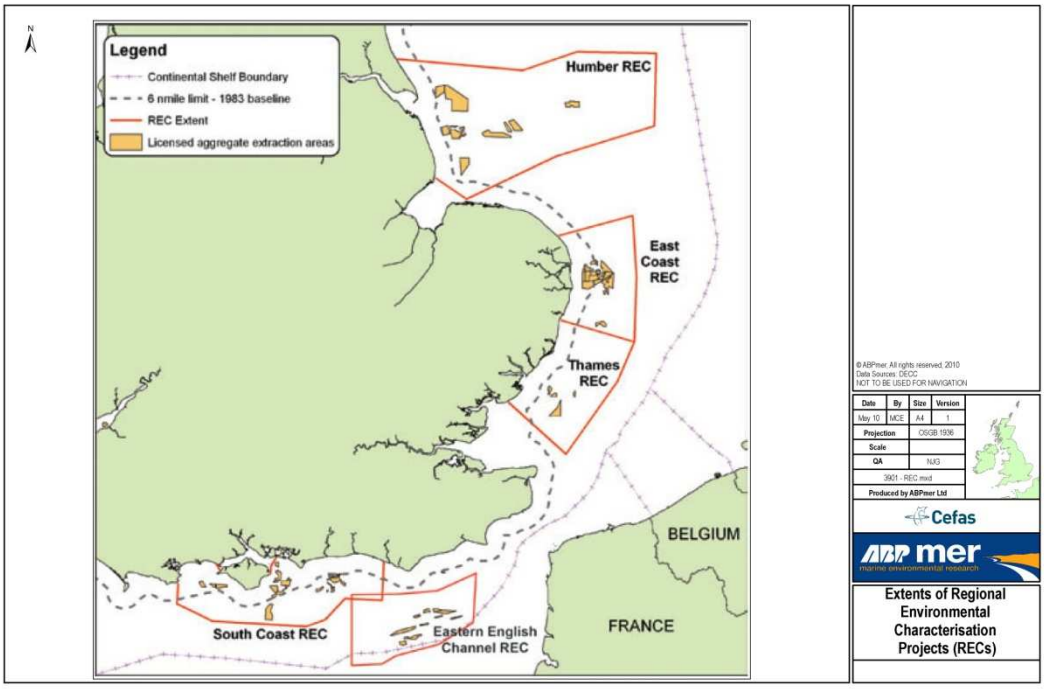

Figure 10 REC project areas

The future of the REC programme is unclear, and two areas that were identified (Outer Thames and Humber) have yet to be commissioned. The Irish Sea will possibly be undertaken within the next 10 years as there are small aggregate production areas with high resource. The Bristol Channel area is less likely to be assessed especially with the uncertainties associated with the potential Severn Tidal Power scheme. Further studies may however be carried out on the existing REC regions to refine the understanding in these areas.

The current MALSF programme ends in March 2011 and it is unclear whether funding will continue.

Aggregate Licenses

All licences are due for renewal by 2013. This will involve the collection of data to meet the REA requirements and then the site specific EIA baseline data (benthic, sediment, habitats, historic environment etc) followed by monitoring. Post 2013 all production areas will then require statutory monitoring programmes to be set up. These will be along the lines of the East English Channel monitoring programme. http://www.eastchannel.info/downloads/chapter04.pdf. It is anticipated that in the next 10 years there will be a number of new applications and prospecting licences in various stages of development. The Crown Estate has issued a series of maps which show the extent of production, application and future option areas in English and Welsh waters, see Figure 11. The future options are widespread covering the territorial waters of England and Wales. They will be categorised as high, medium and low priority assessed both by proximity of the reserves to the landing ports and quality of material.

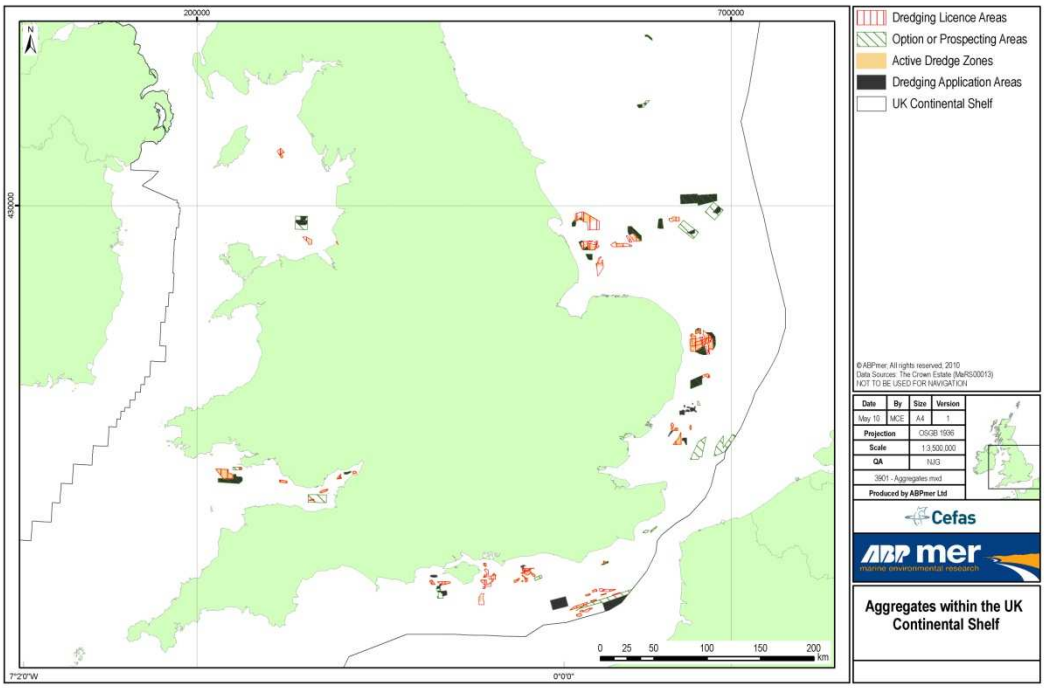

Figure 11 Aggregate production, application and future option areas in English and Welsh waters

Offshore Wind Farms

Round 1

In December 2000 The Crown Estate announced the first round of UK offshore wind farm development and in April 2001, eighteen companies pre-qualified for site development options. Round 1 was intended to act as a 'demonstration' round providing prospective developers with an environment in which they could gain technological, economic and environmental experience. The Round 1 locations were put forward by potential developers on the basis of a range of relevant factors including water depth, wind resource and grid connection. As a result, all the proposed Round 1 wind farm sites are in water depths of less than 20m, and no further than 12km offshore. See Figure 12.

Round 2
Round 1 and 2 offshore wind farm operators have been offered the opportunity to apply for area extensions. This offer is open for any Round 1 and 2 project which is operational or under construction, consented and awaiting construction, or currently awaiting determination of statutory consents.

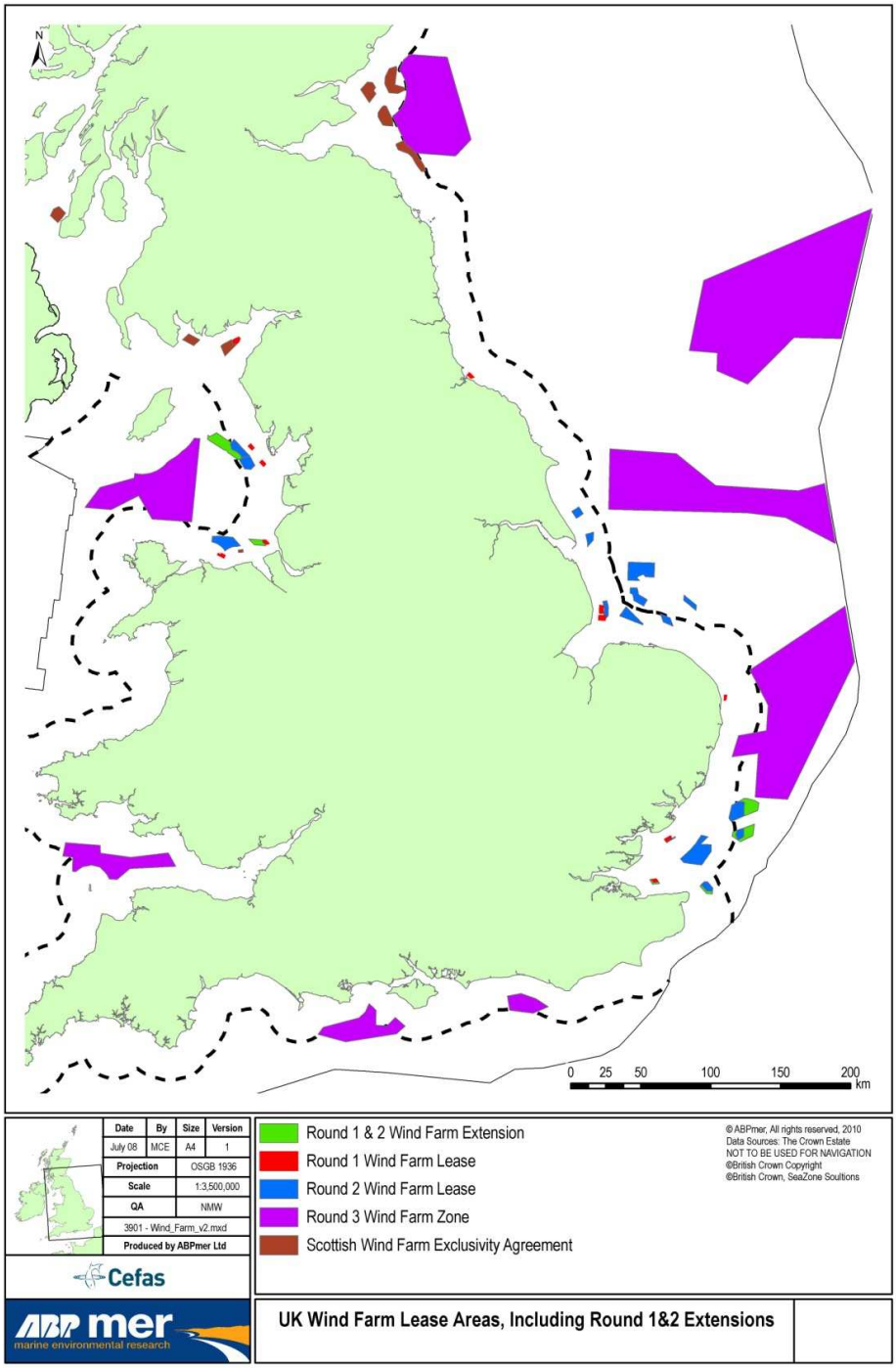

Figure 12 UK Wind Farm Lease Areas

The purpose of offering site area extensions is to take advantage of the possible accelerated delivery of project extensions, in order that construction can be

underway before development starts on Round 3 projects. The Crown Estate made the following awards of extension projects in May 2010:

- Greater Gabbard - extension name Galloper Wind Farm
- Kentish Flats - extension name Kentish Flats
- Thanet - extension name Thanet 2
- Burbo Bank - extension name Burbo Bank Extension
- Walney - extension name Walney Extension

Round 3
The recent release of the Round 3 sites will require developers to fully assess their areas which will involve the full suite of geophysical, environmental, bathymetry and geotechincal surveys. The timings of these will depend on the individual developer's plans for implementation and as yet data gathering exercises are beginning at some sites with differing priorities for the type of data being collected at each site, these assessments are also being/have been carried out at Round 1 and 2 and their extensions. It has recently also been announced that all bathymetric data collected under Round 3 will be to IHO S44 Order 1 as detailed on MCA website. This will ensure that all datasets can be input into the Civil Hydrography programme and used for navigation.

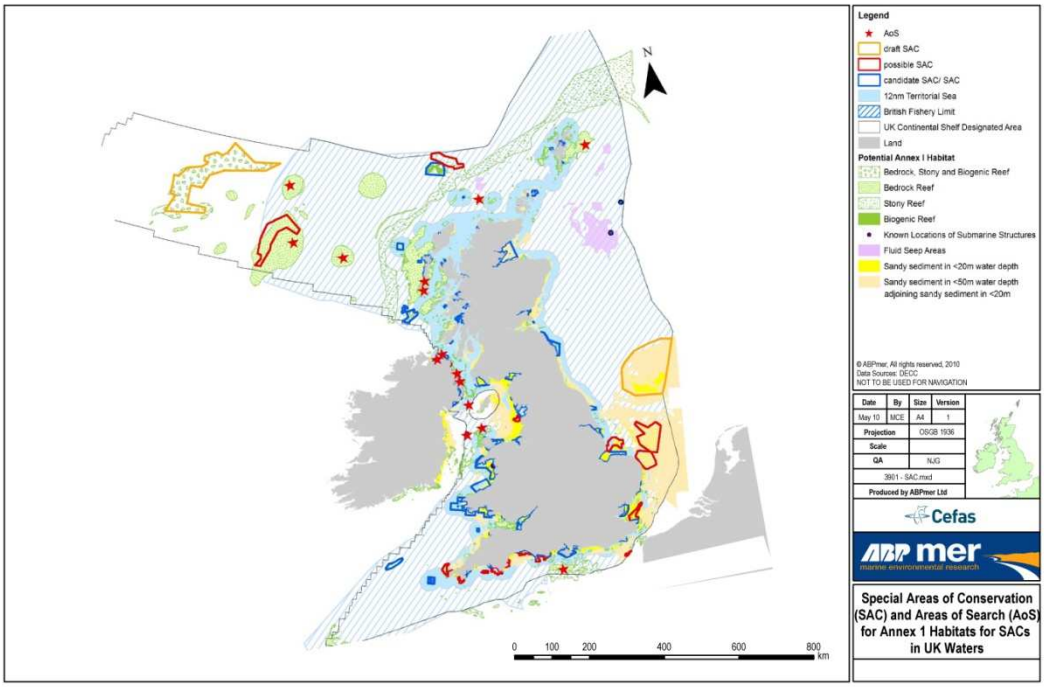

Figure 13 Special Areas of Conservation

Oil and Gas

Periodic Licensing Rounds for Oil and Gas exploration are issued by DECC for unlicensed blocks within the 8 Strategic Environment Assessments (SEAs) Areas. The SEA provides an indication of which areas within each SEA area may require further studies due to their proximity to internationally designated sites (see Figure 13). All other sites can proceed with their exploration, the amount of which will depend on location and proximity to existing fields, wells, etc. These studies will

include some bathymetric survey, seismic and geotechnical data collection and collation.

For blocks which have been awarded a licence but are identified as being either within or adjacent to an Area of Search, proposed, possible or candidate SAC or candidate SPA, further environmental studies will be required to comply with the Habitats Regulations. The work would be expected to include detailed bathymetry, environmental (e.g. benthos) and geophysical surveys. The data collected under the general exploration surveys will be both limited in extent and in the parameters measured. For operators requiring to carry out a full Environment Impact Assessment and/or Appropriate Assessment the area of study will be more extensive both in survey area and data types gathered.

Periodically DECC issue a License Round during which the assessment as described above is required. The 26th Seaward Licensing Round is currently (Jan- March 2010) for unlicensed blocks within all 8 SEA areas. See Figure14.

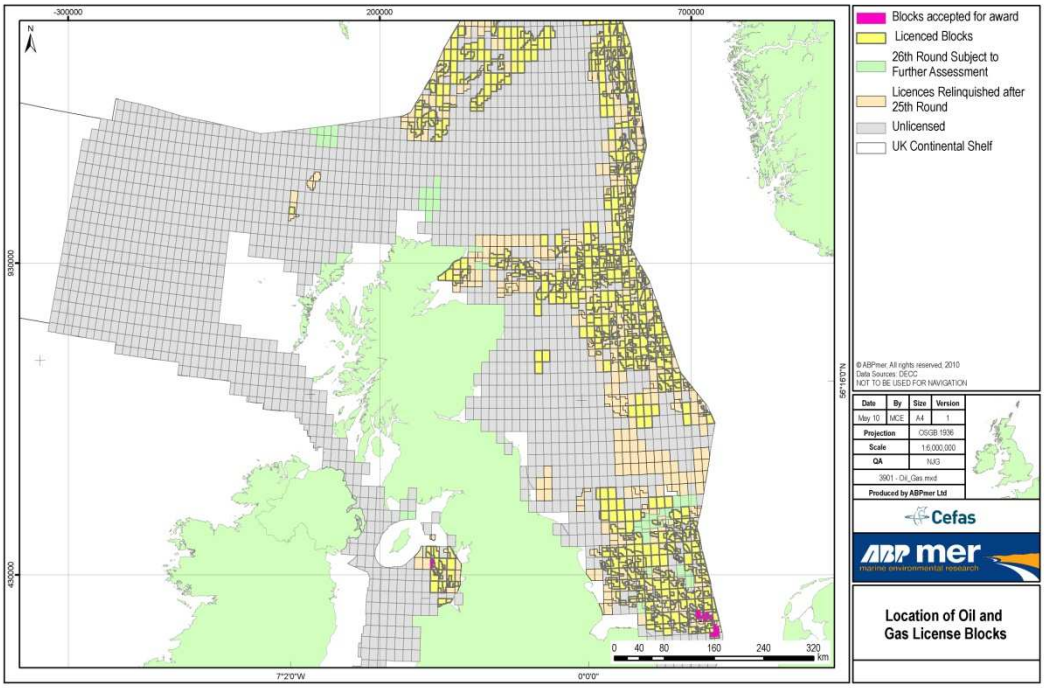

Figure 14 Location of oil and gas license blocks

With experience, it has become increasingly clear that the forecasting of installation removal dates is unreliable due to field closure dates frequently changing. In 2009, COP predictions for 73 fields were changed by 5 years or more - 51 fields were extended and 22 fields shortened. Decommissioning can take up to three years to complete and requires survey work before and after removal. An EIA is required and the surveys are expected to be very specific, as far as area of coverage is concerned, and will at a minimum require bathymetry and benthic surveys to be undertaken. The length of monitoring will be site specific as will the type of data required.

10.13 UK survey activity and coordination

UKDMOS is a web-based application showing UK marine monitoring programmes and was set up to improve coordination across UK agencies. Over 30 organisations are currently carrying out marine monitoring in the UK. Previously information on these monitoring programmes was not readily available. Charting Progress (Anon, 2005) highlighted the need for improved coordination of monitoring and other reports have described environmental monitoring in the UK to be 'large and fragmented' (ERFF 2006). In a response to this, the UKMMAS initiated and funded the UK Directory of Marine Observing Systems (UKDMOS - www.ukdmos.org).

The UKDMOS website provides access to a searchable database of marine monitoring programmes conducted by the UK which provides information to coordinate marine monitoring across different organisations. The database at the core of the application holds 260 monitoring programmes conducted by government organisations, universities, government agencies, and commercial organisations that operate globally.

UKDMOS was implemented to satisfy the needs of the UKMMAS but contains information applicable to the whole marine monitoring community to identify where coordination could be more efficient and therefore save resources such as ship time.

In particular UKDMOS allows:

- interested parties gaining a better understanding of marine monitoring carried out by the UK,
- identification of where sampling can be better coordinated between organisations leading to a more efficient use of resources such as ship time,
- ability to evaluate if current monitoring is sufficient to provide data to meet the scientific objectives.

The technical build of the application has relied heavily on outputs from the EU-funded SeaDataNet project (www.seadatanet.org/) which is in the process of providing a technical update to the existing European monitoring application (www.edios.org). Once the update has been implemented the UK's programmes will be able to be searched alongside other European countries monitoring programmes. UKDMOS forms part of the marine monitoring component of the UK - Environmental Observation Framework (EOF) which is being taken forward by the Environmental Research Funders Forum that aims to maximise the coherence and effectiveness of UK environmental research funding. Maintenance of the UKDMOS database content is completed by the Marine Environmental Data and Information Network (MEDIN). It is envisaged that metadata in UKDMOS will also be available through the MEDIN portal in the future allowing searches to be made on data provided via monitoring programmes and 'one off' studies together.

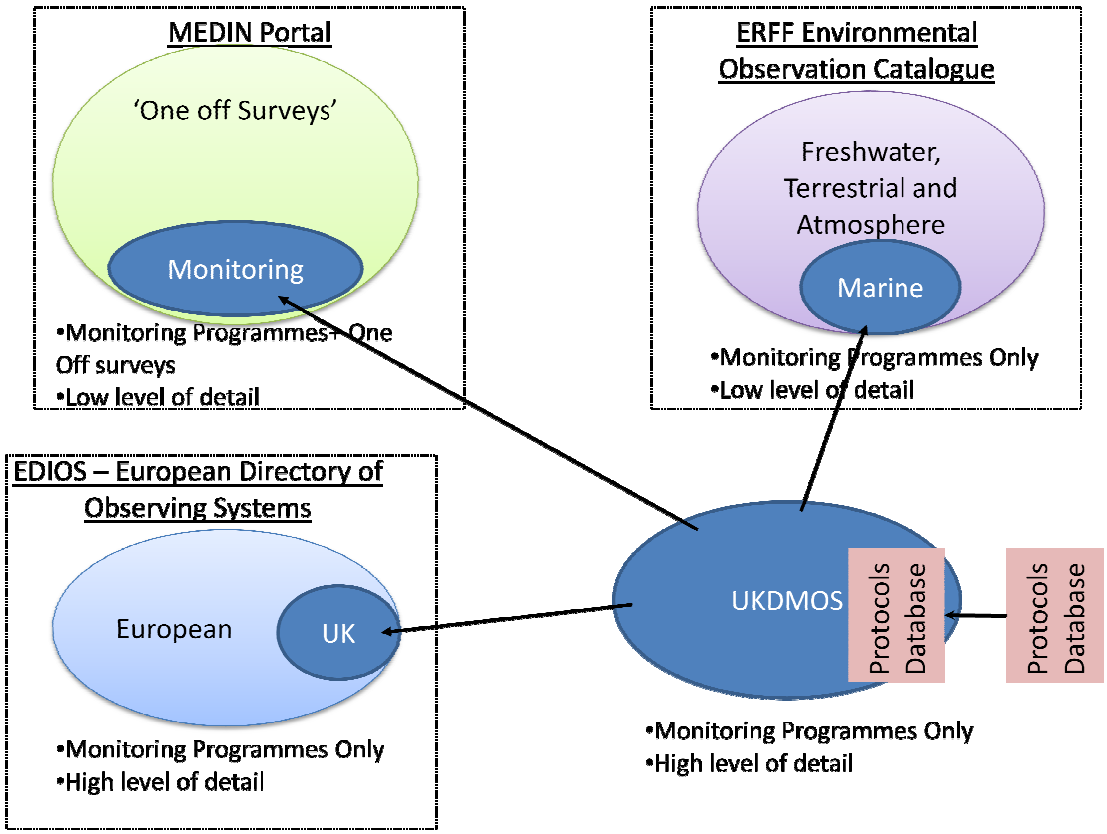

Figure 15 Diagram showing scope of UKDMOS and its relationship to other databases

Although all routine monitoring work should be in UKDMOS there are significant "one off Surveys "(i.e. not part of the regular marine monitoring activities) which are of relevance to Defra survey needs highlighted in the following sections.

Environment Research Funders Forum (ERFF)
ERFF was established in 2003 to provide a forum for all UK public funders of environmental research and to facilitate the sharing of plans, priorities and outputs. It is now part of Living With Environmental Change (LWEC). It does not coordinate activities but facilitates better links (including data sharing) between its members. As can be seen from (Figure) above, the work of UKDMOS is an integral part of the ERFF and constitutes the marine part of its Environmental Observation Catalogue.

10.14Derived Products from relevant surveys

The main derived products from seabed survey activities comprise:

- Habitat maps
- Sea bed bathymetry maps
- Seabed sediment maps
- Biological observations (samples, videos)

Habitat Maps and Methods
There are two approaches to defining what a representative habitat is and where it exists (see (McLoughlin, Morris et al. 2010). There is a broad-scale/top-down approach which models habitat location based on known environmental limits to species distribution and environmental preferences. This top down approach does

not produce a habitat map (defined as showing the spatial extent of areas where there *is* a disproportionate use of available conditions and resources by flora and fauna which respond in space and time to beneficial or detrimental conditions) but rather a "habitat potential" map. That is the distribution of areas which may be suitable rather than areas that are actually being utilised. This is a valid approach but it is dependent on:

- having a good understanding of species environmental preferences
- having sufficiently detailed spatial and temporal data on the significant environmental variables that would allow modelling of the possible/likely species distribution.

The production of such a habitat potential map is further complicated by "feedback" by which species interactions cause changes due to predation, recruitment, altering the environmental conditions and ecological succession. Even without the difficulty of modelling such community dynamics the current state of knowledge of both the environmental preferences and the environmental conditions is at best patchy.

Modelled habitat maps

Mapping European Seabed Habitats (MESH):
The MESH Project ran from 2004-2008 and was made up of a consortium of twelve partners from five European countries led by the UK's Joint Nature Conservation Committee (JNCC), with financial support from the EC's INTERREG IIIB NWE Programme. The MESH partnership included scientific and technical habitat mapping skills, expertise in data collation and its management, and proven practical experience in the use of seabed habitat maps for environmental management within national regulatory frameworks.

The MESH project set out to establish a framework for mapping marine habitats by developing internationally agreed protocols and guidelines for seabed habitat mapping (The MESH Guide – www.searchmesh.net/mappingguide) and generating the first compiled marine habitat map for north-west Europe (http://www.searchmesh.net/default.aspx?page=1921). The project covered the entire marine areas of Ireland, the UK, Netherlands, Belgium and France from the Belgian border to southern Loire on the Atlantic Coast; this area reflects the geographical scope of the INTERREG IIIB financial instrument and does not imply any desire to exclude other EU countries from the process or products.

MESH set out to achieve this goal by:

- compiling, standardising and quality testing the available seabed habitat mapping information to provide the first seabed habitat maps for north-west Europe;
- developing habitat modelling techniques to predict the distribution of habitats for areas with no existing information;
- producing a set of internationally agreed and practically tested protocols and standards for habitat mapping to support future mapping programmes;
- disseminating the key results via a project website that includes a state of the art web-mapping system, providing ready access to the project information for a wide range of end-users; and
- building a network of stakeholders with an interest in seabed mapping to better understand their end needs, to encourage the supply of relevant data and to encourage the improved use of the mapping information in policy development and environmental management.

The MESH webGIS comprises detailed 'local' habitat maps (about 10% of UK waters) and broad-scale modelled maps for the whole study area (all presented to standard EUNIS classification).

Building on the work of UKSeaMap (Connor et al. 2006), JNCC produced predictive maps of seabed habitat types using the European habitat classification scheme, EUNIS. This work was undertaken as part of the MESH project and was completed in January 2008. The aim of the work was to deliver a consistent map predicting seabed types across north-west Europe.

UKSeaMap 2010:
This project will produce a new seabed habitat map for the UK marine area. It builds on the previous work of the Irish Sea Pilot, UKSeaMap 2006 and MESH. Newly available data products and improved techniques are being used to prepare the input data layers. An enhanced predictive approach is being developed to produce an updated version of UKSeaMap (www.jncc.gov.uk/UKSeaMap). Key aims of UKSeaMap 2010:

- Produce a new seabed habitat map using improved input physical data layers to predict EUNIS habitat types in the UK marine area

Create improved confidence layer based on reliability of input data
A final report on UKSeaMap 2010 will be published in autumn 2010. This work is also being developed at the European scale under the EUSeaMap project, led by JNCC. Methods and data used are well-aligned between these two projects.

HABMAP:
The HABMAP approach used in the southern Irish Sea will be examined by the JNCC (within UKSeaMap) to see if it could be used at a UK scale. The HABMAP approach involved using biological data to create rules for the environmental conditions required for a biotope to exist. The rules were used to predict the coverage of seabed habitats and biotopes

Bottom-up species/biotope distribution mapping
The second approach to defining seabed habitats and their distribution is to take a bottom-up approach. This uses localised data to define and map the distribution of biological communities and then interprets these in conjunction with acoustic survey data (e.g. from multibeam or side scan sonar) to define the extent of each habitat type across the area surveyed.

The data requirements for this approach are more onerous than the "top-down" approach in that in order to capture the true distribution of species would require an incredible amount of sampling effort. Work by (Rogers, Somerfield et al. 2008) would suggest that for macrofauna some hundreds of thousands of samples may be required to adequately characterise the UK EEZ. Certainly an order of magnitude larger than we currently have.

Surveyed Habitat Maps:
The existing bottom-up habitat maps tend to much smaller in spatial scale and provide more specific information on the nature of the seabed and its communities. These detailed maps are needed for local planning and management (e.g. for EIAs, MPAs, industry licensing). Examples of such mapping approaches include:

- Mapping carried out for SACs, initially inshore but more recently offshore CCW intertidal maps
- NE intertidal maps
- JNCC MNCR area summary maps

- REC maps
- Industry, Oil and gas, aggregates, windfarms, wet renewable all need habitat maps
- Mapping for Sea Fisheries Committees

Recognising the usefulness of existing broadscale multibeam maps collected by the MCA the MAREMAP project (headed by BGS and NOC) are interpreting these data to produce detailed sea-bed and geological information necessary to underpin the future development of the marine environment in an integrated and systematic manner.

Seazone bathymetry:
Seazone offers a range of data products, e.g. hydro-spatial, charted raster (scanned and geocoded admiralty navigation charts), and most relevant, digital survey bathymetry charts.

SeaZone Digital Survey Bathymetry provides survey data that has been collected digitally, or captured from paper survey sheets, often known as "fair sheets' and quality controlled at the United Kingdom Hydrographic Office and other leading institutions. Where there are gaps in Digital Survey Bathymetry coverage, SeaZone can include Digital Charted Bathymetry (sourced from Admiralty Charts) to infill.

Gebco:
The General Bathymetric Chart of the Oceans (GEBCO) consists of an international group of experts who work on the development of a range of bathymetric data sets and data products, including gridded bathymetric data sets, the GEBCO Digital Atlas, the GEBCO world map and the GEBCO Gazetteer of Undersea Feature Names. The data is provided at a resolution of 800m and the source data is of variable density.

Bathymetry data from commercial fishing vessels:
Many commercial fishing vessels have high specification electronic equipment including corrected GPS, echosounders and plotting software. These systems can and are used for collecting high resolution seabed information including seabed texture information (backscatter). A number of these software packages (e.g. Sodena, MaxSea and Olex) allow data to be logged. The Olex system goes a step further in collating all shared information into a common database. This information is being used by BGS to assist in regional mapping for the UKSeaMap 2010 project (see Figure).

Seabed sediment maps
BGS maps and sample data:
The BGS 1:250,000 Seabed Sediment map series (distributed digitally as SBS250) provides the most comprehensive coverage and is the only source of systematically mapped data available of the distribution of sediments for the UK continental shelf area. Because of the importance of seabed type to habitat mapping, and its broad coverage, there are few habitat mapping studies that do not use this product in some way. SACs, UKSeaMap, Irish Sea Pilot Project, MESH and many others rely heavily on the classes and features as mapped. However the maps were not created for the purposes of habitat mapping (Pantin 1991) but rather as part investigations into seabed process and economic resources (aggregates and hydrocarbons) in line with other work carried out at the Institute of Geological Sciences[9] (IGS). The funding and hence frame of reference for much of the sample collection and mapping programme

[9] the former name for BGS

was from the Department of Energy who played a major role in supporting the development the UK's oil resources (Stevenson 2001). The vast majority of the +20,000 samples used were collected before the DoE funding ceased in the late 1980's.

As a result of this work the UK was the first country in the world to have a complete series of geological maps for its continental shelf. BGS are updating and improving the quality of SBS250 on the basis of more recently collected higher quality data, but significant proportion of the area mapped still relies upon sparsely sampled point.

11 Annex 3: Issues with current derived products: Ecologically coherent network of Marine Protected Areas

One of the requirements of some of the legislation that we have looked at is the creation of a network of marine protected areas. However it should be noted that the policy frameworks discussed in this report also require activities to meet a broader range of environmental objectives.

Representivity – the foundation for identifying a network of MPAs

The most fundamental information required as a prerequisite to effectively identify a network of MCZs is 'representivity'. The logic is that by identifying representative habitats and then managing them effectively it will contribute to maintaining or promoting recovery to a healthy marine ecosystem. Representivity requires that we have an adequate understanding of the physical environmental conditions that contribute to the creation of a habitat (the other contribution being from the biota). As a result we are able to map out the spatial distribution of the habitats, asses any impacts and take appropriate management actions.

Issues with adequacy of existing habitat maps

The situation regarding mapping species distribution has been commented on in the (Defra 2006) "Marine Species Protection: A review of risk and considerations for Improvement" report. The authors conclude that "detailed evidence was limited for some biotopes or species which restricted the definition of their national/international importance; levels of decline; threats; damage, and sensitivity. This was particularly the case for offshore soft sediment habitats, together with those species which are sampled infrequently, and therefore their true distribution is not clearly defined. The paucity of such data highlights the problems inherent in affording species-specific statutory protection in much of the marine environment. In many cases, more effort is therefore required to collate existing data and carry out further research in order to provide a more robust case for such a level of protection."

And again they reinforce the lack of habitat information "There are limitations with respect to the availability of data for many species and habitats in the marine environment, particularly in offshore areas."

The options for approach to marine environmental protection are summarised as:

> "i. The 'Habitat Approach', whereby the habitat function is protected either through a specific area-based protection mechanism or across the wider seas. This approach concentrates on the maintenance of physical and chemical parameters by way of the management/control of certain damaging activities in an area
> ii. The 'Species Approach', whereby individual species are afforded protection achieved either through species-specific protection or through sectoral controls. This approach addresses 'extractive' activities that are either deliberately targeting the key species, or are removing/damaging it as a by-product of the activity."

The approach therefore taken under the MCAA and demonstrated in UKSeaMap is one of using abiotic proxies to predict or characterise a habitat. There are some drawbacks to this approach however it should be noted that broadscale modelling is necessary to provide policy/managers with at least some coarse maps whilst

acknowledging that they are limited in quality (often significantly by the input data layers). With only 10% coverage of seabed and potentially many years/decades to improve the broadscale models provide an essential short-term solution.

"These results[assessment of accuracy of habitat map] have implications for the widespread use of abiotic surrogates in marine habitat mapping to plan for, or assess, representation in marine protected areas. Little confidence can be placed in marine habitat classifications based solely or largely on abiotic surrogates without calibration by rigorous biological surveys at the appropriate scale. Therefore, it is questionable whether marine protected areas designed on this basis can have measurable benefits for conservation" (Stevens and Connolly 2004)

"These results indicate that using broad-scale surrogate measures (rocky shore, sandy beach) for biodiversity (habitats, microhabitats and species) are likely to result in poor representation of fine-scale habitats and microhabitats, and therefore intertidal assemblages in marine reserves." (Banks and Skilleter 2007).

"Where abiotic surrogates are used to represent biodiversity distributions, false homogeneity may result where sites with similar or identical abiotic conditions support different biological distributions, but where those differences remain undetected." (Williams, Bax et al. 2009).

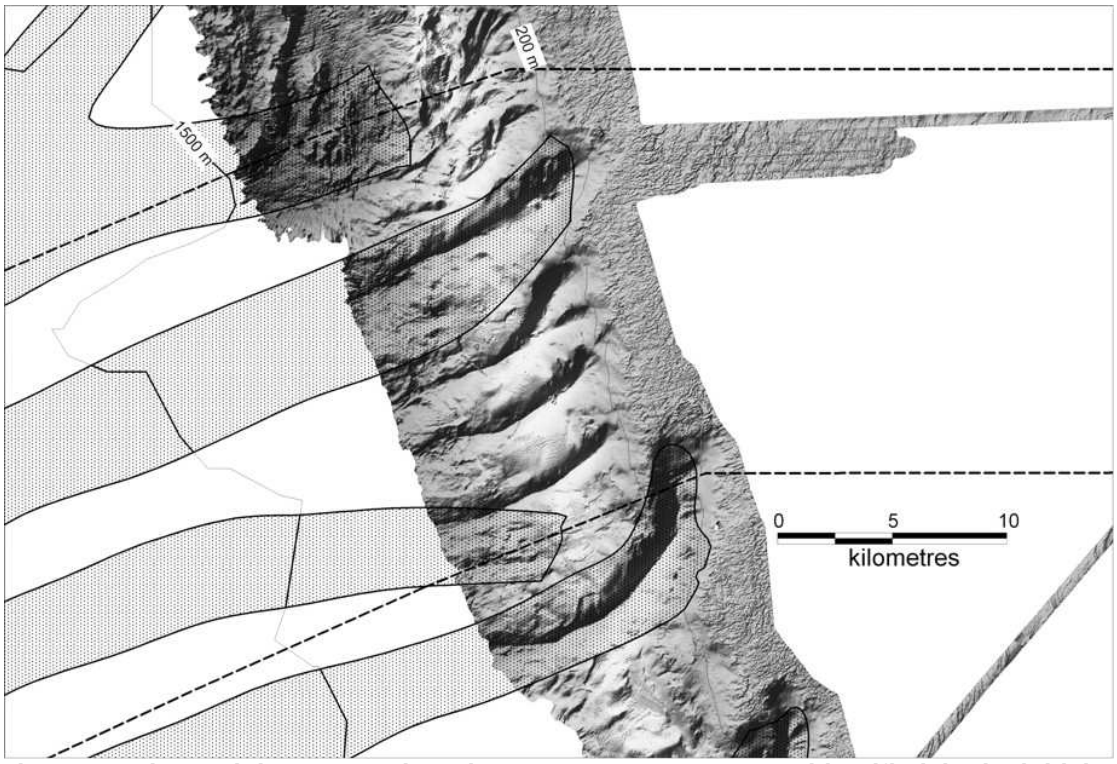

Figure 16 Mismatch between submarine canyons reserve areas identified in the initial mapping (shaded polygons), overlaid on more recently collected MBES bathymetry (from(Williams, Bax et al. 2009))

Unsurprisingly the accuracy of habitat maps is related to how well the derived physical parameters characterise the habitat so, for example, if the information on light-penetration (photic zone) is wrong the predictions of the location of species that require light will also be wrong (See Figures 16 and 18 for examples of where inadequate bathymetric/baseline data led to the incorrect designation of limits for the features they were supposed to cover).

BGS maps.
In relation to the 1:250,000 Seabed Sediment map series, new mapping techniques, survey technology (not least accurate positioning and the use of GIS) and a change of emphasis from resource extraction to ecosystem management means that when judged against the policy needs of habitat mapping that these maps are considered inadequate (e.g. (Coggan, Diesing et al. 2009) and (Scottish-Executive 2007)).

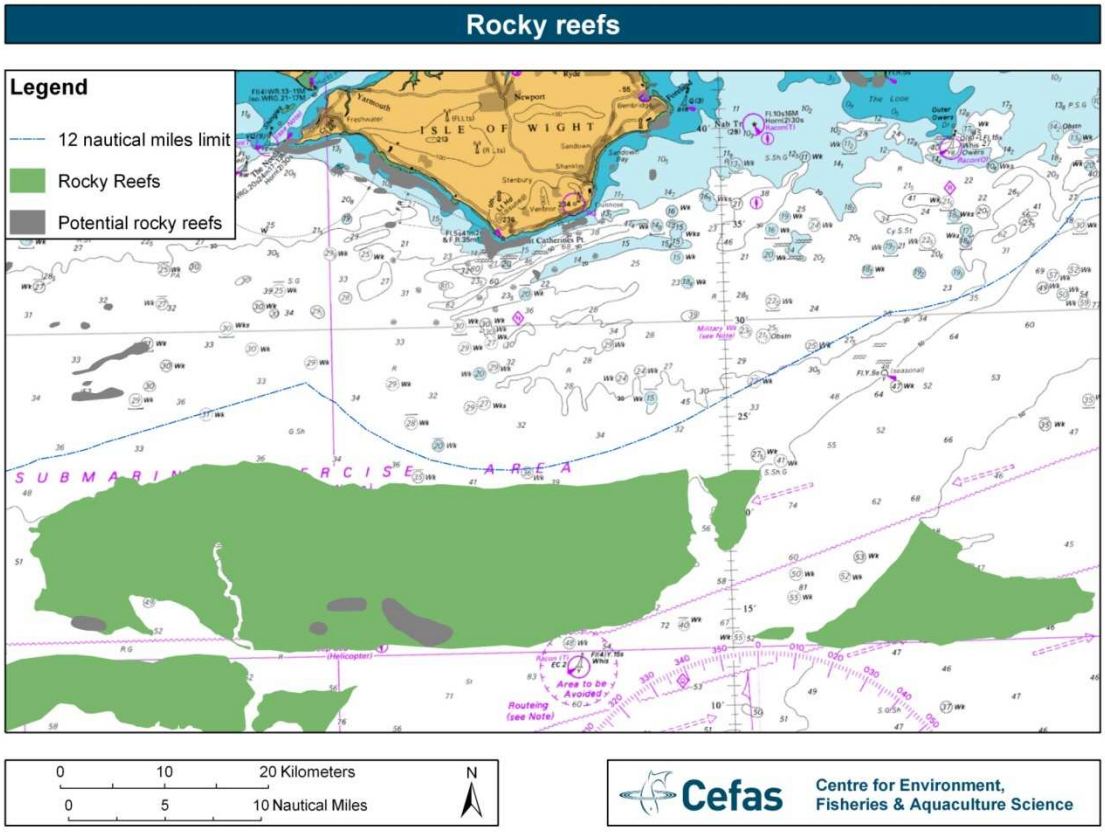

Figure 17 Map showing the discrepancy between the extent of rocky reef as taken from the BGS map (grey polygons) and the actual extent of rocky reef mapped using detailed seabed bathymetry data (combined multibean and digital singlebeam) modified from (Coggan, Diesing et al. 2009))

Even where the BGS sediment maps are comparatively detailed (Irish Sea) the data that they were based on may now be more that 30 years old. (Robinson, Ramsay et al. in press) found in work undertaken as part of the HABMAP (HABitat MAPping for conservation and management of the southern Irish Sea) project, that:

- *"for biotopes at level 3 in the classification hierarchy, the most frequent discrepancy between the physical attributes of the validation points and those tagged to the polygons in which they were plotted occurred between the bathymetry, sediment and bedform parameters.*
- *For biotopes at level 4, the most frequent discrepancies occurred in the sediment and bedform parameters,*
- *The accuracy of predicted habitat maps is dependant on both the quality and quantity of the input data.*
- *The collection of systematic, large-scale physical datasets is required in order for modelling studies such as this to be more successful.*

- *Biotope data is lacking for large areas of the southern Irish Sea, which limits the ability of any modelling study to predict biotope distributions, especially in deeper offshore regions.*
- *Ongoing refinement of the Marine Habitat Classification (especially for offshore waters) is needed to address some of the issues highlighted both here and in other studies."*

The BGS is currently updating the sediment maps with a focus on "hard substrates" which will be used in UKSeaMap 2010. There are undoubtedly significant changes with the increase in area of hard substrate of 900% (compared to the previously mapped rock areas and excluding Scottish waters). The new maps are not based on a new programme of data collection and so the improvements rely on re-interpreting old data and incorporating new information on a piecemeal basis.

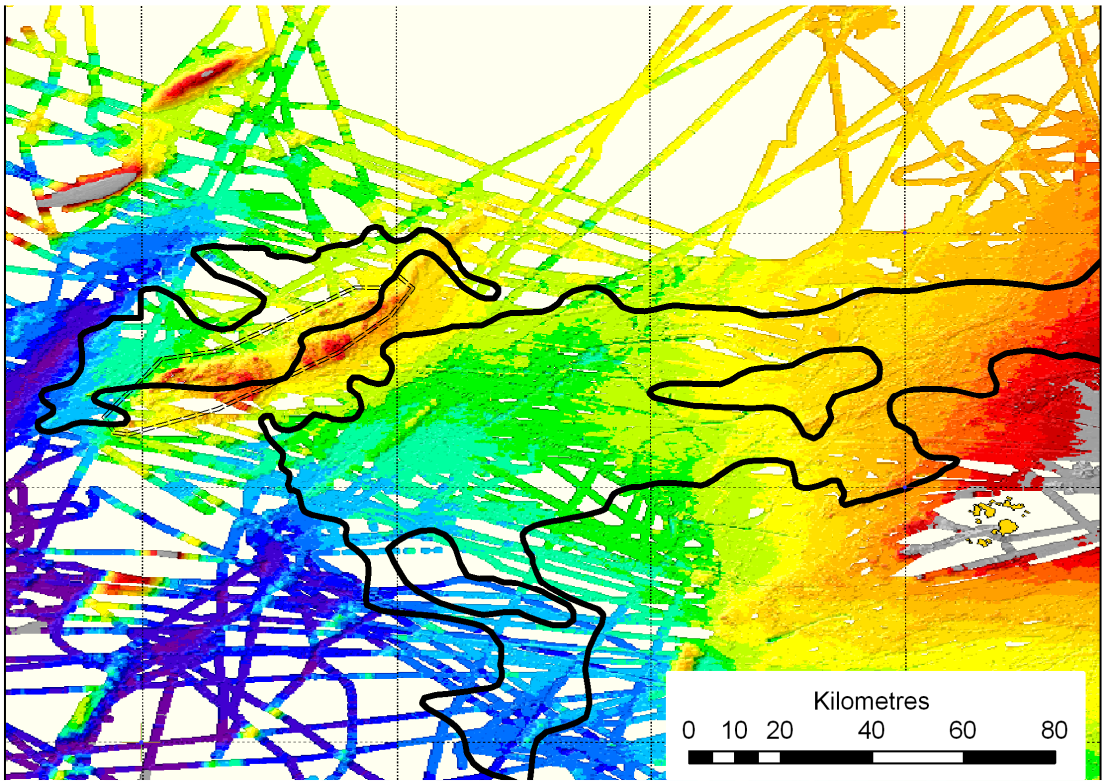

Figure 18 Map of draft hard substrates interpretation (in thick black outline) showing poor correlation to geomorphology (spectrum coloured depth surface) and SAC boundary over Haig Fras.

It would seem therefore that the maximum amount of useful information has been extracted from these data and that for further improvements new data at a scale and resolution appropriate for habitat mapping will be needed data (i.e. not full coverage) from 20 or more years ago.

12 References

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