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Annex 7: 2018 options for monitoring UK offshore benthic habitats

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Foreword

Yessica Griffiths and Dr Karen Webb, JNCC (2024)

This historical paper is part of an archival report series, produced between 2016 and 2018, which collectively presents options for monitoring UK marine biodiversity.

These options for monitoring were evaluated at a series of workshops in 2017 and 2018, by scientific experts from the Healthy and Biologically Diverse Evidence Group (HBDSEG) and policy advisors from the four governments of the UK. The initial set of workshops provided a steer on political ambitions for monitoring specific aspects of marine biodiversity, while a final workshop garnered advice from scientific experts on the proposed monitoring across UK marine biodiversity. In 2019, the combined outcomes of these workshops formed advice for UK Governments on monitoring of UK marine biodiversity. The process for developing this advice is outlined in the summary paper (Webb *et al*. 2024).

Publication of this historical report series provides a publicly available audit of the information underpinning the 2019 advice to UK Governments on proposed marine biodiversity monitoring in UK waters. This information provides a solid foundation for developing updated future advice. At the time of publication (2024), many of the evidence gaps which have been highlighted remain and, in some instances, have increased.

This paper provides a snapshot in time of UK offshore benthic habitat monitoring in 2017 and the collated viewpoints, on proposed monitoring, of HBDSEG and policy representatives in 2018. These viewpoints are historical and do not necessarily reflect viewpoints at the time of publication in 2024. All monitoring options developed and presented in this paper were dependent on the assumption that core UK monitoring programmes would continue at the same level of funding. Since 2017, further Marine Protected Areas (MPAs) have been added to the network. In parallel with decreasing resources, inflation has significantly increased the costs of marine monitoring, particularly those that were vessel based and as a result there has been ongoing, yearly erosion of core monitoring.

Greater understanding of offshore benthic ecosystems is required to provide evidence for tackling the biodiversity loss and climate crisis. Monitoring offshore benthic habitats provides valuable data on the overall ecosystem health and biodiversity, fulfilling legal obligations and informing decisions to ensure sustainable management and conservation of marine resources. These benthic habitats provide a major dietary component for many commercially important fish species which feed on seabed invertebrates. Soft-bottom habitats play an important role in the recycling of energy and nutrients back into the water column, promoting productivity in overlying waters.

It should be noted that some of the legislative drivers which have been referenced in this report have been updated or superseded since 2017. In addition, new legislation and obligations have been introduced since 2017. For clarity, '[2017]' has been included alongside all occurrences of the term 'current' (and its derivatives) and within all table and figure captions and headings, throughout this paper.

Contents

1 Issue

The UK Marine Biodiversity Monitoring R&D Programme (led by Joint Nature Conservation Committee) has been tasked by UK Governments with developing recommendations for an integrated monitoring scheme for all marine biodiversity across all UK waters. We are not currently [2017] fulfilling our nature conservation obligations for monitoring and assessment in a coordinated and cost effective manner, nor are we able to provide robust evidence for marine management purposes.

JNCC and the Country Nature Conservation Bodies (CNCBs) have worked together to agree an approach which prioritises benthic habitats and MPAs for monitoring effort to feed into three monitoring options for policy colleagues to consider (Table 1). Thus far, the approach has been developed and applied in the context of the offshore marine environment to produce a suite of draft monitoring options. In this context, offshore refers to waters beyond 12 nautical miles, within British Fishery Limits and the seabed within the UK Continental Shelf Designated Area, excluding the deep sea (habitats occurring below 200 m water depth), which has been covered in a separate process. It is suggested that with further refinement this approach should also be applied to the inshore marine environment (i.e. territorial waters within 12 nm) so that ultimately a suite of options can be presented which ensures representativity and ecological relevance for those habitats occurring within both the inshore and offshore environment.

An initial discussion has now taken place regarding which option may be preferred for the monitoring of UK offshore benthic marine habitats and their associated biological communities. This preference will need to be considered further once options for inshore benthic habitats are also available. There is no requirement for countries to select the same monitoring options, but where possible, high priority assessment and reporting obligations should be met across the whole network in a strategic manner. Determination of which monitoring option to implement will not be a purely scientific decision, as it will involve consideration of acceptable level of risk of damage to biodiversity if changes are not monitored sufficiently to enable timely management decisions to be made, set against the cost to society of obtaining better evidence for such decision making.

2 Recommendation

A workshop on 7 to 8 March 2017 discussed UK benthic habitats monitoring options so that policy colleagues could understand them. The offshore benthic habitats options proposals were discussed and evaluated and the forward look and implications for producing inshore benthic habitats options was considered. It was not the purpose of the workshop to choose an option but to use criteria to discuss and score the risks and benefits of each. This activity built understanding during the workshop and provided a way of capturing views that can inform further considerations, that will eventually conclude on which option is preferred. The process to be undertaken to decide on a suite of options has been further clarified following discussions which took place in May 2017 at the UK Marine Biodiversity Monitoring Programme Board meeting. This process will be forwarded separately to workshop participants to allow a full understanding of the next steps.

3 Timing

This discussion can be had alongside the consideration of monitoring options for other components of marine biodiversity (e.g. seabirds and cetaceans). Any initial preference on monitoring options for the offshore environment should be reviewed when inshore monitoring options are available, to ensure a certain level of consistency. Once all options are available for all biodiversity components it will be helpful to look across these to ensure there is an

appropriate balance and to consider opportunities for integration. Monitoring options for seabirds and cetaceans will have been presented to Governments in February 2017 with other options (for seals, plankton, and fish) being developed through the UK's Healthy and Biologically Diverse Seas Evidence Group (HBDSEG). Integration of targeted monitoring for benthic habitats with other biodiversity components (e.g. mobile species could possibly yield significant improvements in efficiency and it is therefore recommended that options are eventually considered together).

4 Background

JNCC and the CNCBs have been asked by the Governments of the UK for advice on options for marine biodiversity monitoring for the waters of the UK. This work forms part of the UK Marine Monitoring and Assessment Strategy (UKMMAS) and is being undertaken in partnership with the UK's Healthy and Biologically Diverse Seas Evidence Group (HBDSEG). The advice aims to cost-effectively encompass the UK's significant policy and statutory obligations, such as the:

- High Level Marine Objectives
- Marine and Coastal Access Act, Marine (Scotland) Act, Marine Act (Northern Ireland)
- OSPAR Convention
- EC Habitats Directive
- EC Marine Strategy Framework Directive (MSFD)

For benthic marine habitats, the task of developing monitoring options is extremely complex. This is because of the great diversity of benthic habitats occurring in UK waters, the paucity of data on the range, extent, and condition of the vast majority of these habitat types (especially in the offshore environment) and the underdeveloped nature of suitable state and pressure indicators for monitoring. These factors result in options for benthic habitats having to be developed in a phased manner i.e. deep sea benthic habitats have been considered and presented separately. The development of offshore benthic habitat options was achieved during an inter-agency workshop in December 2016. Options for inshore benthic habitats, which have additional layers of complexity, will seek to align with the offshore benthic options where possible and the proposal is for these to be considered in the coming months.

The monitoring options include the following three types of monitoring that can be applied in various ways to collect evidence on habitats both within MPAs and in the wider marine environment:

- **Sentinel Monitoring of long-term trends (Type 1 monitoring)** – Objective: to measure rate and direction of long-term change.

This type of monitoring provides the context to distinguish directional trends from short-scale variability in space and time by representing variability across space at any one time and documenting changes over time. To achieve this objective efficiently, a long-term commitment to regular and consistent data collection is necessary; this means time-series must be established as their power in identifying trends is far superior to any combination of independent studies.

- **Operational Monitoring of pressure-state relationships (Type 2 monitoring)** – Objective: to measure state and relate observed change to possible causes.

This objective complements monitoring long-term trends and is best suited to explore the likely impacts of pressures on habitats and species and identify emerging problems. It leads to setting of hypotheses about processes underlying observed patterns. It relies on finding relationships between observed changes in biodiversity and observed variability in pressures and environmental factors. It provides inference but it is not proof of cause and effect. The spatial and temporal scale for this type of monitoring activity will require careful consideration of the reality on the ground to ensure inference will be reliable; for example, inference will be poor in situations where the presence of a pressure is consistently correlated to the presence of an environmental driver (e.g., a specific depth stratum).

- **Investigative Monitoring to determine management needs and effectiveness (Type 3 monitoring)** - Objective: to investigate the cause of change.

This monitoring type provides evidence of causality. It complements the above types by testing specific hypothesis through targeted manipulative studies. The design and statistical approach that can be used in these cases gives confidence in identifying cause and effect. It is best suited to test state/pressure relationships and the efficacy of management measures.

Monitoring within and outside of MPAs would be designed around these three types of monitoring. At this stage of the process, a detailed consideration of whether a habitat within or outside of an MPA would be suitable for Type 2 or 3 monitoring has not been possible in the time available. Type 1 monitoring would be assumed for all high priority and representative offshore habitats, MPAs and wider environment areas. Any Type 2 or 3 monitoring designs that are required within these MPAs or wider environment CP2 regions would ideally be nested within the Type 1 monitoring design for optimal efficiency. Undertaking Type 2 and/or 3 monitoring in the offshore environment is therefore not predicted to equate to additional costs at this stage of the options development process. However, it should be noted that in designing and implementing actual surveys to deliver evidence for adaptive risk management of human activities in specific circumstances, additional sampling may be required, and industry could make a valuable contribution to this sampling effort.

Table 1: Benthic marine habitat monitoring options (options agreed and endorsed by the inter-agency Chief Scientist Group (CSG) in August 2016) with the types of monitoring activities that each option would include [table created in 2017].

Monitoring type	**Option 1:** Vessels of opportunity and existing data and data products	**Option 2:** Monitoring a representative subset of high priority MPA habitats and features	**Option 3:** Monitoring of high priority habitats and features within and outside of MPAs
Monitoring type: Type 1 in MPAs and wider environment	No biodiversity conservation focussed benthic habitats monitoring by SNCBs. [Excludes other monitoring initiatives carried out by SNCBs which are targeted at biodiversity monitoring.] Rely on existing samples (i.e. samples that have already been collected), modelled data and opportunistic sampling conducted during ongoing monitoring programmes to assess prioritised MPA sites, features, and habitats. Increase the utilisation (through coordination/integration) of existing samples, modelled data and opportunistic sampling conducted during ongoing monitoring programmes to supplement data from both within and outside designated and managed areas. Increase access and use of and assess the utility of industry data.	A representative subset of high priority MPA habitats and features, based on the habitats monitoring list. Use of existing samples, modelled data and opportunistic sampling conducted during ongoing monitoring programmes to supplement samples/information. Increase the utilisation (through coordination/integration) of existing samples, modelled data and opportunistic sampling conducted during ongoing monitoring programmes to supplement data from both within and outside designated and managed areas. Increase access and use of and assess the utility of industry data.	All high priority habitats and features within MPAs and limited outside of MPA spatial sampling. Use of existing samples, modelled data and opportunistic sampling conducted during ongoing monitoring programmes to supplement samples/information. Increase the utilisation (through coordination/integration) of existing samples, modelled data and opportunistic sampling conducted during ongoing monitoring programmes to supplement data from both within and outside designated and managed areas. Increase access and use of and assess the utility of industry data.

Monitoring type	**Option 1:** Vessels of opportunity and existing data and data products	**Option 2:** Monitoring a representative subset of high priority MPA habitats and features	**Option 3:** Monitoring of high priority habitats and features within and outside of MPAs
Monitoring type: Type 2/3 for investigating pressure-state relationships and management effectiveness	None.	Monitor a representative subset of high priority MPA habitats to increase our understanding of pressure state relationships.	Monitor a representative subset of high priority MPA habitats to increase our understanding of pressure state relationships.
Monitoring type: Additional activities (e.g. R&D work)	Explore the utility of existing data collection schemes to deliver benthic monitoring objectives. Assess the risk of infraction and non-compliance. Modelling. The standardisation of data collection techniques. Assessing activities/pressure data.	As Option 1 and: Assess the use of representative MPA habitat and features to address reporting obligations. Begin to consider the effectiveness of the MPA network.	As Option 2 and: Explore and assess the effectiveness of management within MPAs. Assess the effectiveness of the MPA network.

5 Argument

5.1 Objective

This policy decision will begin to enable UK Governments to cost-effectively meet their national and international obligations for biodiversity monitoring, assessment and reporting of offshore benthic marine habitats, and to robustly inform advice on management of human activities in the offshore marine environment. Further detailed decisions will still be required regarding determining the effects of individual operations or management interventions.

5.2 Draft criteria

Criteria that were used to evaluate the effectiveness of each potential monitoring option are as follows:

1. **Maintaining and improving benthic habitat conservation status, ecosystem health, halting and reversing biodiversity loss**
    a) How confident are we that we will be able to detect changes in a range of offshore benthic habitats?
    b) When we do see changes, how confident are we that we can differentiate between natural and anthropogenic changes?
2. **National legal compliance**

    Is there a risk of non-compliance with national legislation and legal challenge?
3. **European / International Legal compliance**

    What is the risk of non-compliance under European or International legislation and legal challenge?
4. **Compliance with policy**

    What is the risk of non-compliance with ministerial commitments?
5. **Public trust**

    Will the public trust that this is the best option?
6. **Stakeholder trust**

    Will stakeholders think this is a good option?

These criteria were discussed and applied to the options at the workshop on 7 to 8 March 2017.

5.3 Context

The UK has monitoring obligations associated with various international conventions in addition to EU and UK environmental legislation. A list of the marine biodiversity obligations relevant to UK benthic habitats is provided in Table 2. Those obligations which are legally binding and explicit in their requirement for monitoring are the principal policy drivers for monitoring. The key instruments identified as requiring monitoring of benthic habitats are the EU Habitats and Marine Strategy Framework Directives. Both Directives include explicit requirements for monitoring habitats to inform periodic assessment and reporting of environmental status. Both Directives are also likely to bear the largest risk of legal challenge if their implementation is assessed as being insufficient; however, this risk is likely to change when the UK exits the EU. In addition to the explicit monitoring requirements,

under the Habitats Directive there is also an implicit need for monitoring to report on the impact of any conservation measures being established for Natura 2000 sites. Similarly, under the Marine Strategy Framework Directive (MSFD), monitoring is implicit to provide early warnings of deleterious change to allow the timely implementation of any management measures that would be required to achieve Good Environmental Status (GES). Under both Directives, environmental status will need to be assessed across the respective habitats covered by each Directive. This means that monitoring would need to be carried out both within Marine Protected Areas and the wider environment to provide quantitative data to assess the status of habitats against Favourable Conservation Status (FCS) and GES condition targets. Monitoring is also implicitly required under the national Marine Acts to allow the required reporting against whether MPA conservation objectives are being achieved.

The requirements for assessment and monitoring under national and international biodiversity policy instruments, such as the UK Government Vision for UK Seas (Defra 2002), the Marine Policy Statement (Defra 2011) and the European Biodiversity Strategy (European Commission 2011), are only vaguely defined. Therefore, these instruments were not considered further in the development of monitoring options. Even under the UK Government Vision, which is the only instrument for which assessment requirements have formally been identified, separate monitoring is not expected to occur to support environmental assessments. Instead, existing, or new data collected to fulfil monitoring requirements under European and national legislation would be brought together to support any assessments required under the policy instruments.

In addition to the biodiversity assessment obligations, there are various assessment and reporting requirements that must be met by Competent Authorities and developers for proposed plans or projects in the marine environment. These requirements include those under the EU Strategic Environmental Assessment (SEA) Directive, the EU Environmental Impact Assessment (EIA) Directive and the EU Habitats Directive, as well as the relevant UK regulations that transpose these requirements into UK law (Hinchen 2014).

To develop a scientifically robust monitoring programme for UK benthic habitats that can meet all relevant Government obligations without being specifically designed for any particular one, it is necessary to consider what monitoring is needed without being constrained by what is specified in individual policy obligations. Rather, considering the ecology of the benthic habitats in the UK and the human pressures and impacts which they are subject to both inside and outside of MPAs will allow the real needs for habitats monitoring to be identified in an objective and repeatable manner, as well as any gaps in what is existing or proposed for monitoring under currently [2017] developing obligations, such as the MSFD.

This does not, however, mean that each habitat type must be directly monitored and the variation in the options for monitoring which are presented to Governments will reflect this (i.e. options will be presented that meet UK assessment and reporting obligations to greater and lesser extents, allowing the risk of selecting each option to be determined). Instead, enough data must be collected through direct and indirect monitoring activities which can then be brought together in such a way as to allow the assessment and reporting of the status of habitat types, and to robustly inform their management.

It should be noted that this process does not explicitly take account of MPAs that may be designated as part of the tranche 3 MCZ process in Secretary of State waters or those MCZs that may be designated in Wales or Northern Ireland. These MPAs can be included in the process when the suite of sites to be designated has been identified. The development of monitoring programmes is an iterative and evolving process which will necessarily need to

be adapted and improved as more information is gathered, as targets for indicators are refined and as further MPAs are designated and managed.

The process of defining broad options for monitoring marine biodiversity components requires a consideration of what, where and how to monitor the component of interest e.g. benthic habitats, marine birds, etc. Considering these aspects of monitoring design allows cost estimates to be provided for different levels of ambition, expressed as monitoring effort and evidence provided for assessments and management. This level of detail can allow policy makers and science advisors to take an informed decision on a preferred option with associated evidence benefits, risks and broad costs but with a remaining level of flexibility. Subsequently, the preferred option will then be explored in more detail during a design and evaluation phase, where the details of implementation can be defined and tested. Variance from the original can then be further explored. It is this approach to presentation, and this assumption on next steps, that bounds the options in this paper.

The alternative, of developing fully designed, evaluated and implementable as-is monitoring designs as part of the options process would reduce flexibility, be prohibitively time consuming and would result in resources being heavily invested in developing options to a high level of detail that are ultimately not selected.

Table 2: National and international obligation for monitoring of benthic habitats [table created in 2017].

Principal policy drivers

International & national obligations	Monitoring Requirement				Explanation
	Inshore	Offshore	MPA	Wider environment	
Habitats Directive (HD 1992)	Explicit	Explicit	Implicit	Explicit	Article 11 of the Habitats Directive explicitly requires Member States to implement surveillance of the conservation status of all natural habitat types listed in Annex I of the Directive. In addition, monitoring requirements are implicit in the need to report on the impact of any conservation measures being established for Special Areas of Conservation (SACs) to maintain or achieve set conservation targets (Article 17).
Marine Strategy Framework Directive (MSFD 2008)	Explicit	Explicit	Explicit	Explicit	Article 11 of the MSFD provides explicit requirements for Member States to establish and implement coordinated monitoring programmes to support the ongoing assessment of the environmental status and the progress in achieving related environmental targets. Monitoring programmes shall be compatible within marine regions or sub-regions and shall build upon, and be compatible with, relevant provisions for assessment and monitoring laid down by Community legislation, including the Habitats and Birds Directives, or under international agreements.
Water Framework Directive (WFD 2000)	Explicit	None	Explicit	Explicit	Article 8 sets out the requirements for the monitoring of surface water status, groundwater status and protected areas. States that monitoring programmes are required to establish a coherent and comprehensive overview of water status. For surveillance monitoring of surface waters Member States must monitor parameters indicative of all biological, hydro-morphological, and general physio-chemical quality elements. For operational monitoring, Member States are required to monitor quality elements most sensitive to the pressures to which that water body is subject.

International & national obligations	Monitoring Requirement				Explanation
	Inshore	Offshore	MPA	Wider environment	
Marine and Coastal Access Act (2009) Marine (Scotland) Act Marine Act (Northern Ireland)	Implicit	Implicit	Implicit	None	Monitoring of Marine Conservation Zones (MCZs) and Nature Conservation Marine Protected Areas (NCMPAs) is implicit in fulfilling the requirement of relevant authorities to assess and report on the extent to which conservation objectives for individual MPAs have been achieved within the reporting cycle (Section 124, Subsection 3 – MCAA; Sections 70 &103 – MSA, Section 21 - Marine Act NI). Under the Marine and Coastal Access Act, relevant authorities may direct the statutory nature conservation agencies to carry out monitoring of MPAs designated under the Act (Section 124).

Additional requirements and commitments

International & national obligations	Monitoring Requirement				Explanation
	Inshore	Offshore	MPA	Wider environment	
Wildlife and Countryside Act (WCA 1981)	Implicit	None	Implicit	None	The WCA consolidated previous national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention. Section 28J implies the monitoring of SSSIs through the formation of a management scheme to conserve or restore the flora, fauna, or features of which the land (or the part of it to which the scheme relates) is of special interest. Some provisions of the W&C Act have been superseded by more recent national legislation (i.e. MCAA, MSA & Marine Act NI).

International & national obligations	Monitoring Requirement				Explanation
	Inshore	Offshore	MPA	Wider environment	
Common Fisheries Policy (CFP 2013)	Implicit (The Common Fisheries Policy is only of relevance to inshore territorial waters between 6–12 nautical miles where European fishers have historic fishing rights.)	Implicit	Implicit	None	Although the CFP provides the basis for management of fishing activities, it does not provide regulations for the achievement of biodiversity targets for deep-sea benthic habitats, thus there are no formal monitoring requirements under the policy. The European Commission favours the submission of joint recommendations for site based fisheries management measures. This requires all Member States with a vested fishing interest in the site under consideration to jointly develop proposals for fisheries management. EC guidance on submitting requests within MPAs, includes a list of 11 consideration points which include the need to measure, monitor and assess the maintenance and recovery of the features within the site (Point 9).
Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR 1998)	Explicit	Explicit	Explicit	Explicit	As a signatory to the OSPAR convention, delivery of the work programmes agreed under the convention is mandatory for the UK. Article 6 in conjunction with Annex IV (Article 2a) explicitly requires Contracting Parties to cooperate in carrying out monitoring programmes to support joint assessments of the quality status of the marine environment and to evaluate the effectiveness of the measures taken and planned for the protection of the marine environment.

International & national obligations	Monitoring Requirement				Explanation
	Inshore	Offshore	MPA	Wider environment	
Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR 1998)					The work carried out under OSPAR on monitoring and assessment has become legally underpinned by the MSFD. Failings in delivering the MSFD will lead to failings in delivering OSPAR commitments. Several commitments under OSPAR have been transposed into UK legislation, (e.g. the need to designate MPAs for threatened or declining habitats and associated assessment requirements have been legally embodied in the MCAA and the MSA).
Convention on Biological Diversity (CBD 1992)	Explicit	Explicit	Explicit	Explicit	As a signatory to the CBD, delivery of the work programmes agreed under the convention is mandatory for the UK. Article 7 explicitly requires Contracting Parties to monitor biological components important for the conservation of biological diversity and sustainable use, particularly for the purposes of delivering the provisions set out in Articles 8 to 10 (e.g. to support the regulation and management of biological resources within or outside MPAs).
Ramsar Convention on Wetlands (1975)	Explicit	None	None	Explicit	As a signatory of the Ramsar convention, delivery of the work programmes agreed under the convention is mandatory for the UK. Article 3, Section 2 implies the requirement for surveillance of any wetland sites included on the List so that any ecological changes to the site which have occurred, are occurring or likely to occur because of technological developments, pollution, or other human interference, can be recognised.

6 Option summaries

In the development of benthic habitats monitoring options, offshore benthic habitats and MPAs have been used to illustrate the application of an agreed approach to prioritising habitats and MPAs for monitoring effort across the inshore and offshore environments. The approach was developed at a workshop including JNCC, Natural England and Natural Resources Wales (and including input from SNH and DAERA beforehand) which was held in December 2016. A summary diagram of the model is provided in Figure 1. At their meeting in February 2017, the inter-agency Chief Scientists Group endorsed this model as being suitable for the development of offshore benthic habitats options, for discussion at the policy workshop in March 2017. In applying this broad model to the inshore environment in practice, it is acknowledged that some of the finer details will necessarily vary from the offshore approach.

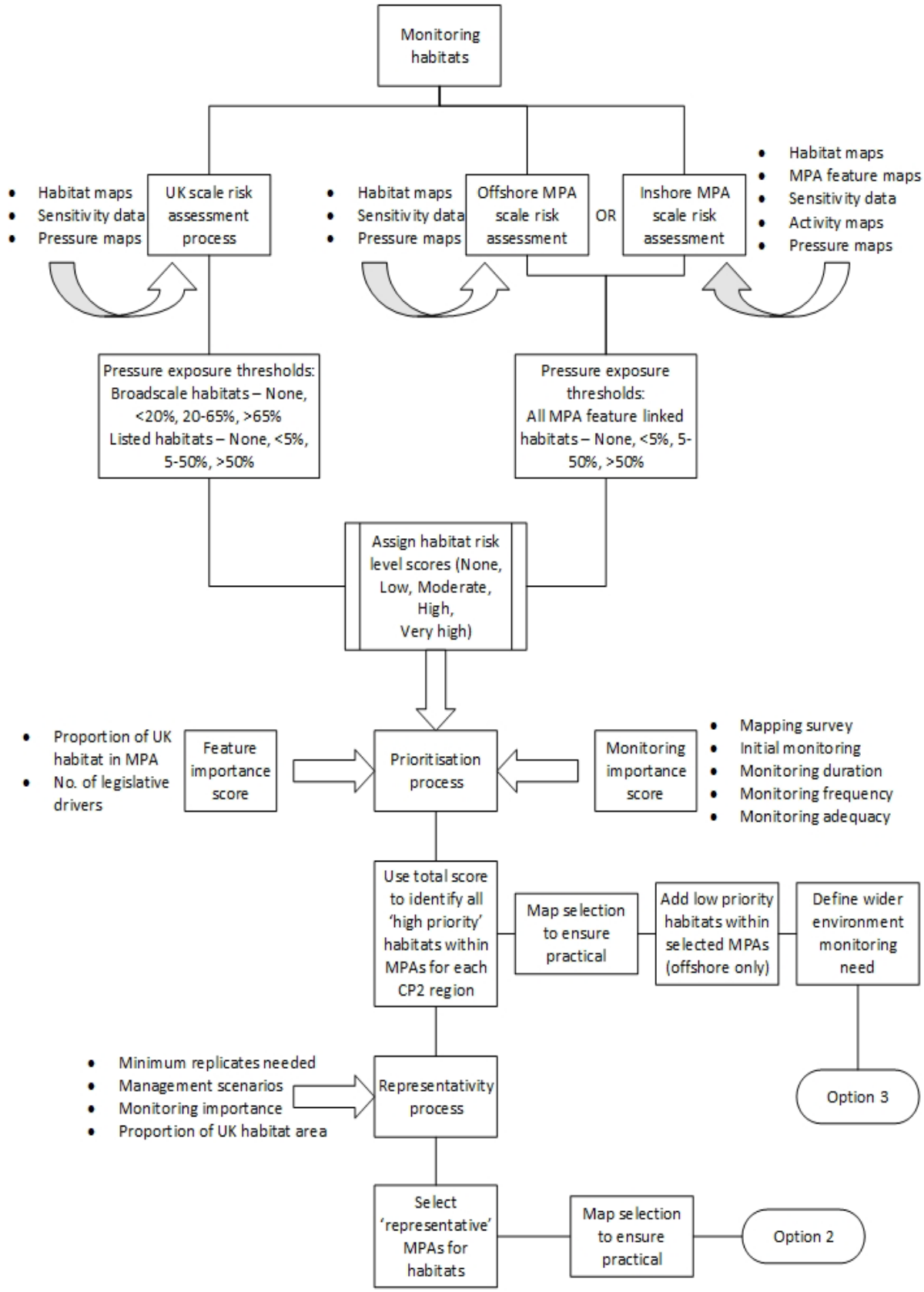


Figure 1: High level summary of the approach developed by the SNCBs for risk assessing, prioritising, and identifying representative habitats and MPAs for monitoring Options 2 and 3 [figure created in 2017].

This approach has now been applied to offshore benthic habitats and MPAs to produce a selection of habitats, MPAs and areas of the wider environment which have been prioritised for monitoring under Options 2 and 3. Option 1 constitutes no biodiversity conservation focussed benthic habitat monitoring by SNCBs, with a reliance on other existing survey data and vessels of opportunity. Option 1 has therefore not been constructed using the approach outlined in Figure 1. A summary of each option is presented below, from the most ambitious to the least ambitious.

Regardless of the option selected by Governments, further discussion will be required on the temporal frequency of monitoring to be undertaken. There will also need to be discussion around the intensity, frequency, and overall duration of monitoring required to measure the effectiveness of any management measures (e.g. fisheries closure zones), and how often such investigations will be required. Costs will be dependent on the approach to adaptive management that is favoured by Governments and regulators, the specifics of the management measures and features to be protected, and the statistical power required to support conclusions (e.g. how quickly a feature is likely to respond to a closure, for example, and on what basis and with what level of confidence regulators would be content to conclude that the management objectives have been achieved).

6.1 Option 3 – Monitoring high priority habitats and features within and outside MPAs

Option 3 includes the monitoring of high priority habitats within MPAs (plus some low priority habitats that occur within the MPAs that have been selected as high priority) and sampling of high priority habitats outside of MPAs.

The high priority habitats have been identified using the approach outlined in Figure 1. Monitoring habitats within offshore MPAs were scored in terms of their risk level at the MPA and UK scale, the importance of the habitat in terms of proportion of UK resource within the MPA and number of relevant legislative drivers and the duration, frequency, and adequacy of any existing monitoring effort. These scores were added, and the ‘high priority’ habitats were initially identified by selecting the top half (i.e. any scores of the median value or higher) of the scores within each CP2 region. These habitats and the MPAs within which they occur were then mapped in a GIS to visualise the distribution across the CP2 regions. If any MPAs had been prioritised for the monitoring of a habitat where the patch of habitat was extremely small or was already well represented within the CP2 region, it was considered whether this MPA could be removed from the Option 3 selection within the CP2 region. This decision was a practical one based around expert judgement on the feasibility of monitoring. Factors considered included the number of other habitats prioritised for monitoring within a site, habitat patch size, habitat distribution and the MPA feature to which the habitat was linked.

The resulting MPA selection was then reviewed and where an MPA also contained low priority habitats which formed part of the designated MPA feature(s), these low priority habitats were also included in the selection for Option 3. This decision was taken because with some additional sampling at a site that was already prioritised, data could be collected on lower priority habitats that would otherwise be missed within the CP2 region. This approach would therefore allow greater representativity and MPA coverage for marginal extra cost. For the inshore environment, this approach is likely to have significant cost implications and therefore it is suggested that low priority habitats would only be included for monitoring where the total additional cost associated would be less than 5% of site survey and analysis costs or where the evidence benefits would outweigh any cost above this threshold.

Option 3 also includes sampling outside of MPAs for those habitats that have been selected for monitoring within MPAs. We would seek to achieve this monitoring through taking samples en route to survey MPAs, by adapting existing wide-scale monitoring surveys such as those for fisheries stock assessments and by aligning industry monitoring approaches more closely with biodiversity conservation objectives, where possible. There have been several 'proof of concept' integrated monitoring surveys in recent years, including the ICES Report of the Workshop to Plan an Integrated Monitoring Programme in the North Sea (WKPIMP) in 2016. This report outlines how an IBTS Quarter 3 fisheries stock assessment survey could be adapted to collect information on marine benthos and other ecosystem components such as plankton and physico-chemical parameters. The approach advocates combining station based sampling with continuous recording of data on temperature, etc. The strata used within this report may not be optimal for the sampling of benthic biodiversity, but further work is recognised to identify the most suitable strata to represent the ecosystem processes of interest at the correct spatial scale. This type of integrated approach would benefit from the UK and other EU Member States being fully engaged in the integration process and sharing ideas, methodologies, and sampling designs. It has been demonstrated through this work that it should be possible in future to explore the possibility of incorporating benthic monitoring objectives into existing wide-scale fisheries monitoring surveys using a stratified random design with some sentinel stations which could be re-sampled yearly to build up a time series of data. This approach is also being tested and refined as part of the Defra funded TIME project (Truly Integrated Monitoring for Ecosystems).

It is recommended that the same level of sampling effort would be required for prioritised habitats both within and outside of MPAs (in regions which the habitat also occurs outside of MPAs), to allow meaningful comparisons to be made between the condition of habitats inside and outside of MPAs. For example, if 50 grab samples are estimated for each shallow sublittoral sand habitat within prioritised MPAs in the Southern North Sea CP2 region, we would also aim to collect 50 samples across shallow sublittoral sand outside of MPAs in the Southern North Sea region. Currently [2017], it seems feasible that this level of wider environment monitoring can most effectively be delivered through the implementation of an integrated wider environment marine monitoring programme. Such a programme would seek to adapt an existing wide-scale survey to simultaneously collect information on multiple aspects of the marine ecosystem, thus allowing a fuller understanding of ecosystem processes and the links between biodiversity components in time and space. The assumption that such a programme can be designed and implemented has been made for option 3 cost purposes i.e. no additional vessel costs have been associated with this option for wider environment monitoring, only costs for sample analysis are included.

In summary, Option 3 includes monitoring within 23 high priority MPAs out of a total of 32 offshore MPAs. Turbot Bank and North West Orkney NCMPAs have been excluded as they are designed for sandeels only and there would be no requirement to monitor the associated benthic habitat(s) for this feature. Those MPAs which have been identified as lower priority (based on the scoring method and model for identifying high priority habitats and MPAs, Figure 1) and are therefore excluded from Option 3 are as follows:

- East of Gannet and Montrose Fields NCMPA
- Firth of Forth Banks Complex NCMPA
- Fulmar MCZ
- Greater Haig Fras MCZ
- North-West of Jones Bank MCZ
- Offshore Overfalls MCZ
- Scanner Pockmark SAC

- Stanton Banks NCMPA
- West Shetland Shelf NCMPA

The remaining selection of 23 MPAs covers the full range of 14 offshore monitoring habitats. Only two MPA features are excluded from the selection (offshore deep sea muds and offshore subtidal sands and gravels), but these features would be effectively covered through the monitoring of the subtidal shelf sedimentary monitoring habitats, which are included within this option. Monitoring would also take place in the wider environment for those habitats monitored within MPAs across all six offshore CP2 regions, as part of an integrated wider environment monitoring programme.

6.2 Option 2 – Monitoring a representative subset of high priority MPA habitats

Option 2 includes the monitoring of a representative subset of the high priority habitats and MPAs which were identified for monitoring under Option 3. This option currently includes no wider environment monitoring apart from that required to carry out successful Before-After-Control-Impact (BACI) studies as part of investigating management effectiveness within MPAs.

The representative subset of the high priority habitats and sites has been identified using the approach outlined in Figure 1. Each unique high priority monitoring habitat within each CP2 region was considered in turn and the MPAs selected for Option 3 were considered again so that a representative selection of these could be identified for each region. It was considered important to have a minimum proportion (50%) of examples of high priority habitat types and a minimum number (three where present) within a region and for all management scenarios to be fully represented. Although this proportion of 50% is subject to discussion; it has already been noted that perhaps a sliding scale of 50–33% may be appropriate for monitoring habitats where there are large numbers of examples of a particular habitat in a region (e.g. greater than 10 as is likely to occur when inshore sites are considered). The best representative MPA example(s) for each habitat type were selected on this basis, using information on total priority score, monitoring importance score and proportion of UK habitat area within the MPA to inform the judgement.

The resulting habitats and the MPAs within which they occur were then mapped in a GIS to visualise the distribution across the CP2 regions. If any MPAs had been prioritised for the monitoring of a habitat or habitats where the patch of habitat was extremely small or formed part of a highly heterogeneous habitat mosaic, it was considered whether another MPA could be targeted for the monitoring of this habitat. This was done to reduce the number of MPAs targeted for monitoring (for the purposes of cost savings) and to allow the collection of the best evidence for the habitat type. This decision was a practical one based around expert judgement on the feasibility of monitoring. Factors considered included the number of other habitats prioritised for monitoring within a site, habitat patch size and habitat distribution.

The resulting MPA selection was then reviewed and where it seemed possible with marginal extra cost to also include the monitoring of a low priority habitat within a selected MPA, these habitats were also included in the selection for Option 2. This decision was taken on a case by case basis as for some sites, it is not feasible to only target monitoring of a single sediment type as the habitat is a mosaic. In some cases, low priority habitats form an important part of the feature (e.g. mixed sediments as part of a stony reef) and so these habitats should also be included. This approach would therefore allow greater representativity and MPA coverage for marginal extra cost.

In summary, Option 2 includes monitoring within 19 representative high priority MPAs out of a total of 32 offshore MPAs. Those four MPAs which have been identified as a lower priority and therefore excluded in addition to those identified under Option 3 are as follows:

- Haisborough, Hammond and Winterton SAC.
- North Norfolk sandbanks and Saturn reef SAC.
- Norwegian Boundary Sediment Plain NCMPA.
- South Dorset MCZ.

The remaining selection of 19 MPAs covers the full range of 14 offshore monitoring habitats. Only two further MPA features are excluded from the selection in addition to those excluded in Option 3 (ocean quahog aggregations and subtidal chalk). Ocean quahog populations could be effectively monitored as part of the sediment habitats at Farnes East and North East of Farnes East high priority MPAs. The subtidal chalk habitat present as part of moderate/high energy circalittoral rock at South Dorset MCZ is potentially a very small area covered by a mobile veneer of coarse sediments and cobbles, which would be very difficult to target for monitoring. High energy circalittoral rock habitat is also represented in Offshore Brighton MCZ and Wight Barfleur Reef SAC, which would be monitored as part of Option 2.

To conclude, Table 3 shows a high level summary of the number of MPAs, features and monitoring habitats included as part of Options 2 and 3 as an overall total and per CP2 region. Appendix A shows regional scale maps which display the MPAs included and excluded from the monitoring selection for both Option 2 and 3.

Table 3: High level summary of the number of MPAs, designated features and monitoring habitats that are covered under Option 2 and 3 [table created in 2017]. Values in bold (with asterisk) represent regional totals.

CP2 region	Number of MPAs			Number of feature types in MPAs			Number of monitoring habitat types in MPAs		
	CP2 region	Option		CP2 region	Option		CP2 region	Option	
		2	3		2	3		2	3
UK scale	**32 ***	19	23	**18 ***	14	16	**14 ***	14	14
Eastern Channel	**5 ***	3	4	**8 ***	5	7	**8 ***	6	7
Irish Sea	**3 ***	3	3	**5 ***	5	5	**5 ***	5	5
Northern North Sea	**11 ***	6	7	**13 ***	9	11	**7 ***	7	7
Scottish Continental Shelf	**3 ***	1	1	**2 ***	1	1	**6 ***	3	3
Southern North Sea	**4 ***	2	4	**2 ***	2	2	**7 ***	7	7
Western Channel and Celtic Sea	**6 ***	4	4	**9 ***	7	8	**7 ***	7	7

At the UK scale, all offshore monitoring habitat types are represented in both Options 2 and 3. Across the six offshore CP2 regions, there are seven instances where a monitoring habitat type does not occur within the region, and 38 occasions where a habitat type is present in the region but is not represented by an offshore MPA (as part of a designated conservation feature). For example, habitats may be present within an MPA but not as part of a designated feature and/or habitats may be represented by the inshore MPA network only and/or the habitat area could be negligible. However, at the scale of the UK, all offshore monitoring habitats are represented by Option 2 and 3 to a greater or lesser extent. The habitat types present within each CP2 region are detailed in Appendix B.

The number of examples of each habitat type selected under each of the Options varies depending on the priority of each monitoring habitat and the total number of examples present in each CP2 region, according to the rules described in Figure 1. The number of examples of each habitat type included in Options 2 and 3 is presented in Appendix C. This table also includes information on the regional area of each habitat type and the regional proportion of each habitat type included in each Option. The key difference between Option 2 and Option 3 in terms of offshore MPAs is the number of examples / replicates of each monitoring habitat which would be covered (i.e. greater representativity in terms of replication under Option 3). Please note that the wider environment monitoring outside of MPAs which is included as part of Option 3 has been excluded from the proportions.

6.3 Option 1 – Vessels of opportunity and existing data and data products

Option 1 does not include any biodiversity targeted monitoring undertaken by the SNCBs currently [2017] (i.e. no offshore MPA monitoring for conservation purposes). This option would rely exclusively on data collected for other purposes such as non-biodiversity targeted monitoring programmes, vessels of opportunity and modelled data. It would not include the establishment of a coordinated and integrated monitoring programme as described in Option 3 and would deliver only limited Type 1 monitoring for benthic habitats inside MPAs as well as wider coverage outside of MPAs on an opportunistic basis. An interrogation of the Defra 'One Monitoring' spreadsheet which aimed to capture information on all UK marine monitoring programmes and the UK Directory of Marine Observing Systems (UKDMOS) produced a draft list of existing, non-SNCB monitoring programmes which may be able to provide data on or be adapted to sample benthic habitats in the future (Table 4).

Table 4: Draft list of non-biodiversity focused monitoring programmes which may be able to provide data on benthic habitats in future for biodiversity conservation monitoring, assessment, and management purposes [table created in 2017].

Lead organisation	Monitoring activity	Comments	Frequency	Location	Monitoring type	Possible suitability for benthic habitats monitoring objectives
AFBI	Nephrops sampling	Nephrops trawl surveys are undertaken in April and August. In addition to a prawn trawl (50 mm mesh) a 2 metre beam trawl (with a 5 mm mesh to catch epifauna) is also deployed at each station.	Annual	Irish Sea	Sentinel	Nephrops abundance data collected. Epifaunal data collected could be used if methods are suitable and standardised to allow quantitative assessment for soft sediment habitats in Western Irish Sea.
AFBI	IBTS	Ground fish surveys have been conducted in Spring (March) and Autumn (October) each year since 1992. Survey uses Rockhopper trawl with 20 mm cod end cover. Data on litter has also been collected intermittently.	Bi-annual	Irish Sea	Sentinel	Additional sampling of benthic habitats could be added to IBTS fisheries surveys, if agreed. Exploration of sampling design, stratification and gear types would be required to successfully integrate objectives.

Lead organisation	Monitoring activity	Comments	Frequency	Location	Monitoring type	Possible suitability for benthic habitats monitoring objectives
AFBI	Nephrops burrow density survey	Nephrops burrow densities (burrows per m^2) have been calculated based upon extensive underwater video surveys in the Western Irish Sea each summer since 2003 (undertaken jointly by AFBI and the Marine Institute)	Annual	Irish Sea	Sentinel	Density of burrowing megafauna data collected. Video data could be analysed to determine abundance of epifaunal species if sample design is appropriate. Sediment samples could also be taken.
AFBI	CSEMP programme	CSEMP provides a coordinated approach to environmental monitoring in the UK's coastal and estuarine areas. The programme fulfils the UK's commitment to European directives including its mandatory monitoring requirements under the Oslo and Paris Convention (OSPAR) Joint Assessment Monitoring Programme (JAMP).	Annual	Irish Sea	Sentinel	Contaminants data collected at limited stations. Sampling design, methods used, and monitoring frequency could be investigated to explore the possibility of collecting benthic samples which could form part of a long term type 1 monitoring series in the Irish Sea. Benthic samples have been collected annually (five repetitions) at six stations since 1998.
Cefas	South Western Beam Trawl Survey TIME project	Multi gear ecosystem survey of the Celtic Sea, South Western Approaches and Western Channel. Deploying standardised 4 m beam trawls (x2), ring nets, Hammon grabs. Station selection will be based on a fully random stratified approach with the gears deployed at each station where appropriate.	Annual	Celtic Sea, Western Channel	Sentinel	Proof of concept survey for an integrated monitoring programme for the Celtic Seas ecosystem. If programme is ongoing and sample design is appropriate, benthic monitoring could be successfully incorporated.

Lead organisation	Monitoring activity	Comments	Frequency	Location	Monitoring type	Possible suitability for benthic habitats monitoring objectives
Cefas	IBTS	The English ground fish survey of the North Sea began in 1977 and is carried out in August / September each year. The duration of the survey is 4 to 5 weeks and extends over the whole North Sea within the 200 m depth contour. Since 1991, the survey has formed part of the International Bottom Trawl Survey series, which is coordinated by ICES.	Annual	North Sea, Western Appro-aches	Sentinel	Additional sampling of benthic habitats could be added to IBTS fisheries surveys, if agreed. Exploration of sampling design, stratification and gear types would be required to successfully integrate objectives.
Cefas	Nephrops sampling	June survey.	Annual	Farne Deeps	Sentinel	Nephrops abundance data collected. Epifaunal data collected could be used if methods are suitable and standardised to allow quantitative assessment for Farne Deeps fishing ground area.
Cefas	Nephrops burrow density survey	The surveys started in 1996 and became standardised in 2002. Annual cruises are conducted in September/October each year. Nephrops burrows are counted, other visible fauna is noted on a presence/absence basis. Sediment samples are also taken at some stations.	Annual	North Sea	Sentinel	Density of burrowing megafauna data collected. Video data could be analysed to determine abundance of epifaunal species if sample design is appropriate.

Lead organisation	Monitoring activity	Comments	Frequency	Location	Monitoring type	Possible suitability for benthic habitats monitoring objectives
Cefas	CSEMP programme	CSEMP provides a coordinated approach to environmental monitoring in the UK's coastal and estuarine areas. The programme fulfils the UK's commitment to European Directives including its mandatory monitoring requirements under the OSPAR Joint Assessment Monitoring Programme (JAMP). From 2011 the programme was run over 2 years with the North Sea, and Eastern Channel sites monitored in 2011 and the Western Channel and Irish Sea sites expected to be monitored in 2012	Bi-annual	North Sea, Eastern Channel, Western Channel, Irish Sea	Sentinel	Contaminants data collected at stations in North Sea and Celtic Sea. Sampling design, methods used, and monitoring frequency could be investigated to explore the possibility of collecting benthic samples which could form part of a long term Type 1 monitoring series in these regions.
Marine Scotland Science	IBTS	Data collected is used to provide fishery stock assessments to inform management. Sites are selected each year on a random rolling basis. Standardised trawls and CTD casts are completed at each site. Benthic sampling is conducted at selected sites only.	Annual	North Sea, Irish Sea, North Atlantic	Sentinel	Additional sampling of benthic habitats could be added to IBTS fisheries surveys, if agreed. Exploration of sampling design, stratification and gear types would be required to integrate objectives.

Lead organisation	Monitoring activity	Comments	Frequency	Location	Monitoring type	Possible suitability for benthic habitats monitoring objectives
Marine Scotland Science	Nephrops burrow density survey	Underwater TV surveys have been carried out on Scottish Nephrops grounds by Marine Scotland Science since 1992. In the first year, only the Fladen Ground was examined, but since then all the main Scottish Nephrops stocks have been surveyed annually. Since 2000, underwater TV surveys have also investigated Nephrops densities on the continental shelf edge to the west of the Hebrides at the Stanton Banks.	Annual	North Atlantic, North Sea	Sentinel	Density of burrowing megafauna data collected. Video data could be analysed to determine abundance of epifaunal species if sample design is appropriate. Sediment samples could possibly also be taken.
Marine Scotland Science	CSEMP programme	CSEMP provides a coordinated approach to environmental monitoring in the UK's coastal and estuarine areas. The programme fulfils the UK's commitment to European directives including its mandatory monitoring requirements under the Oslo and Paris Convention (OSPAR) Joint Assessment Monitoring Programme (JAMP).	Annual	Irish sea, North Atlantic, North Sea	Sentinel	Contaminants data collected at limited offshore stations in North Sea. Sampling design, methods used, and monitoring frequency could be investigated to explore the possibility of collecting benthic samples which could form part of a long term Type 1 monitoring series in this region.

Lead organisation	Monitoring activity	Comments	Frequency	Location	Monitoring type	Possible suitability for benthic habitats monitoring objectives
University of Liverpool	Dove Marine Station Monitoring Programme	A time-series of macro-benthic samples from two stations off the Northumberland coast has continued from 1971, Station P (80 m) and 1972, Station M1 (55 m), to the present. Station P is located 12 nm offshore. The study was established to investigate the persistence and variability in benthic communities. During the initial phase of the study samples were taken monthly to describe the annual cycle at these sites. However, since 1974 sampling has generally been restricted to twice a year, March, and September at M1 and January and September at P, this corresponds to the annual minima and maxima respectively in the number of individuals at each station.	Bi-annual	North Sea	Sentinel	This programme is part of the Marine Environmental Change Network (MECN) which is currently [2017] not being funded and samples are not being analysed. A long term time series of data from a sedimentary habitat in the North Sea could provide context for finer scale changes. The network could detect wide scale climate change impacts.

There is considerable uncertainty around the exact nature and implementation of an Option 1 scenario. This is because by its nature, this option would involve utilising vessels of opportunity and investigating in detail how existing data collection programmes could feed into benthic habitats monitoring objectives. The lack of MPA targeted monitoring effort is a significant risk associated with this option and it may not be possible to collect sufficient samples to draw conclusions with any confidence if surveys are not adapted to meet benthic habitats monitoring objectives. Costs for data access, additional sampling, analysis, reporting, etc., are likely to be incurred under this option but are extremely uncertain at this stage and therefore have not been presented, so as not to be misleading. The likely cuts in funding across all monitoring programmes make it difficult to determine which surveys will be ongoing and therefore may be available each year to adapt to better meet benthic habitats monitoring objectives. Indicative cost estimates for Options 2 and 3 are presented in Table 5.

Table 5: Estimated costs for implementing Options 2 and 3, considering one 6 year reporting cycle [as advised in 2017].

Option	Number of MPAs / CP2 regions to be surveyed	Assumptions on monitoring frequency	Total cost of monitoring per reporting cycle	Average yearly cost of implementation
2	20 offshore MPAs	Habitats within the selected MPAs would be monitored once per 6 year reporting cycle	£5.8 million	£1.0 million
	20 offshore MPAs	Sedimentary and rocky habitats monitored twice per 6 year reporting cycle and biogenic habitats (*Sabellaria spinulosa* reefs) monitored yearly	£12.4 million	£2.1 million
3	24 offshore MPAs	Habitats within the selected MPAs would be monitored once per 6 year reporting cycle	£7.7 million	£1.3 million
	24 offshore MPAs	Sedimentary and rocky habitats monitored twice per 6 year reporting cycle and biogenic habitats (*Sabellaria spinulosa* reefs) monitored yearly	£18.1 million	£3.0 million
	6 CP2 regions	Habitats selected for monitoring within MPAs would be monitored in the wider environment once per 6 year reporting cycle, delivered through integration with existing wider environment data collection schemes	£0.82 million	£0.14 million
	6 CP2 regions	Sedimentary and rocky habitats selected for monitoring within MPAs would be monitored in the wider environment twice per 6 year reporting cycle and biogenic habitats (*Sabellaria spinulosa* reefs) monitored yearly, delivered through integration with existing wider environment data collection schemes	£1.8 million	£0.3 million

Costs presented include an estimate of survey planning time, vessel costs, equipment hire, survey personnel, sample processing and analysis, reporting and contingency costs. The number of survey days has been estimated based on the number of samples to be taken within the habitats prioritised for monitoring within any MPA / CP2 region. Sample estimates have been made on a habitat by habitat basis using example power analyses to inform the number of samples to be collected for rock, mud, sand, and coarse and mixed sediments as initial sampling strata. Power analyses were conducted using the following parameters: 20% effect size, 0.8 power and 0.05 significance. A power analysis for each specific MPA was not possible at this stage of the process so indicative sample sizes have been estimated which will need reviewing at the implementation phase.

It should be noted that the average yearly costs for these options has been calculated by dividing the total cost by six to give an indication of the cost per year over a six-year period. Actual costs are likely to differ each year depending on how many surveys are taking place. Costs could be more evenly distributed by processing samples in a subsequent year, etc. It has also been assumed that each MPA would be monitored individually as the specifics of which MPAs could be combined in any one survey would be heavily dependent on the location of the vessel, length of survey slot, equipment availability, etc. For each option, two scenarios have been costed depending on the temporal frequency of monitoring activities (i.e. habitats monitored once per reporting cycle or habitats monitored at a frequency related to ecological characteristics and sensitivity to pressures). Further cost efficiencies would be sought at the implementation phase through integration of monitoring surveys where feasible.

To provide context, it should be noted that currently [2017] (in the absence of any option having been selected) it is the intention to monitor all offshore sites within a six year reporting cycle and sites are prioritised using a suite of factors to ensure the highest priorities are visited each year. During the period of 2014–2017, eight offshore surveys were completed with a total cost of £4.9 million i.e. a yearly cost of £1.6 million.

6.4 Discussion

For Option 1, 2 and 3 the evidence requirements delivered and associated risks / limitations are outlined in the Table 6.

Table 6: Evidence requirements, risks, and limitations of each option [table created in 2017].

Option	Evidence requirements delivered	Risks and limitations
1	Ad hoc evidence delivered at a wide and variable scale, dependent on the successful adaptation of multiple existing survey types to incorporate benthic habitats monitoring objectives and improved access to data.	Spatial and temporal resolution of data required to assess and manage MPAs effectively is not provided. Implicit monitoring requirements under the MCAA, MSA and MA(NI) to report on the conservation objectives of designated MPAs would not be met. By restricting habitats monitoring to opportunistic surveys, explicit requirements to monitor Habitats Directive Annex I features across their natural range to support FCS assessments and within the wider environment for GES assessments under MSFD would not be met,

Option	Evidence requirements delivered	Risks and limitations
1		resulting in a risk of infraction by the European Commission. Surveys would not be targeted specifically at benthic habitats monitoring and these objectives would therefore not be the highest priority, and therefore the first to be compromised. Type 2 / 3 monitoring to understand pressure – state relationships and detect the effectiveness of management measures would not be delivered. Adaptive management ambitions would not be supported by this option. Assumes that other existing monitoring programmes will continue and not be faced by similar cuts/reductions in capacity and funding. If such monitoring programmes cease or do not have capacity to take benthic habitat samples then the habitats monitoring programme would be reliant solely on modelled data and samples which have already been collected. This would result in assessments with low and declining confidence. On-going monitoring programmes may not provide the necessary statistical power to assess the condition of benthic habitats within and beyond MPAs. Inconsistencies in data collection and analysis techniques arising from augmenting different survey types may mean that data may not be comparable or of good enough quality to make robust assessments of condition at larger spatial scales or inform specific management decisions.
2	Type 1, 2 and 3 monitoring (where appropriate) would be carried out for a representative subset of high priority habitats within 19 offshore MPAs. All UK offshore monitoring habitats would be represented at the UK scale. The majority of UK offshore MPA features would be represented at the UK scale. Most (~65%) offshore MPAs (and 54% of examples of monitoring habitats) could be assessed against	Not all MPAs would be directly monitored (13 of 32 MPAs and 46% of examples of monitoring habitat types are excluded), therefore the condition of these MPAs would need to be inferred from modelled data or the condition of the relevant representative MPAs. No large scale wider environment monitoring would take place; therefore, the condition of the wider environment would need to be inferred from

Option	Evidence requirements delivered	Risks and limitations
2	their conservation objectives using direct monitoring data. Remaining MPAs could be assessed with low confidence using modelled data or inference of condition from representative MPAs. Establishment of long term time series within MPAs, pressure-state relationship monitoring to inform management, indicator development and target setting plus Type 3 monitoring to inform management decisions and adaptive management cycles. Limited monitoring outside of MPAs as part of Type 3 BACI studies to allow limited spatial scale understanding of wider environmental condition to support wider environment assessments and contextualise local change at the MPA scale.	modelled data or proxy information on the location of pressures, etc. This would result in wider environment assessments of GES and FCS having associated low confidence, and substantially limit the ability to address wider reporting requirements under National Marine Acts. This may result in a risk of infraction by the EC.Estab Limited wider environment monitoring effort would reduce our ability to determine whether changes detected at the MPA scale are part of larger scale processes / changes, such as climate change. Where knowledge of the relationship between pressure and habitat state is limited, the lack of information on wider scale trends may result in overly precautionary management measures at the MPA scale because of erroneous conclusions regarding the cause of observed local changes. Emergent wider scale issues may be missed due to lack of wider environment monitoring, causing irreversible damage to biodiversity and ecosystem services.
3	As per Option 2, and additionally: Type 1, 2 and 3 monitoring (where appropriate) would be carried out for all high priority habitats within 23 offshore MPAs and in 6 regions of the wider environment. Most (~75%) offshore MPAs (and 70% of examples of monitoring habitats) could be assessed against their conservation objectives using direct monitoring data. Remaining MPAs could be assessed with low confidence using modelled data or inference of condition from representative MPAs. Wide scale sampling of high priority benthic habitats in the wider environment through the implementation of an integrated monitoring programme would deliver data to enable improved assessments of GES and FCS in the wider	Not all MPAs would be directly monitored (9 of 32 MPAs and 30% of examples of monitoring habitat types are excluded), therefore the condition of these MPAs would need to be inferred from modelled data or the condition of the relevant representative MPAs. Low priority habitats within MPAs would also not be monitored in the wider environment and the condition of these habitats would need to be inferred from modelled data or proxy information on the location of pressures etc. This would lower the confidence in the resulting regional and UK scale assessments of GES and FCS for these habitats.

Option	Evidence requirements delivered	Risks and limitations
3	environment. These data would also allow meaningful comparisons between habitat condition inside and outside of MPAs to provide robust evidence of the effectiveness of management measures and the performance of the MPA network. A fully integrated monitoring programme would allow the collection of ecosystem level data in the wider environment to enable a more holistic understanding of trends across biodiversity components in space and time and the links between these. Emergent issues in the wider environment could be detected more effectively to reduce the risk of irreversible damage to biodiversity and ecosystem services outside of MPAs.	

7 Next steps

Each of the options presented above for the offshore benthic environment were discussed and evaluated at the policy workshop on 7 to 8 March 2017. There was also the opportunity for discussion at this workshop focusing on the application of this process to the inshore benthic environment and how that process will link to ongoing country level initiatives for prioritising and implementing marine monitoring. Once inshore monitoring options for benthic habitats and MPAs are available, the offshore options will be reviewed to ensure the required level of consistency and representativity for those habitats which occur both inshore and offshore. Further policy discussion can then take place and a preferred option for benthic monitoring can be identified.

Once an option is eventually selected, the next step in the process consists of more detailed planning of the monitoring activities (e.g. decisions on areas, gear types, choice of sampling platform, ship time, and staff). It is at this stage where practical integration of the monitoring activities through collaboration with other agencies (sharing of ship time, gear, and staff), other monitoring activities and with marine industries and NGOs can be addressed in more detail. It is expected that this process will result in cost savings, which may be substantial. A fully integrated monitoring programme for marine biodiversity is envisaged to be able to provide evidence to answer existing and emerging questions around the status and trends in biodiversity at MPA, country, regional and UK scales.

8 Policy workshop outcomes

Excerpt from final workshop report:

'Generally, an Option 2 approach, with some wider environment monitoring was favoured by all workshop participants as this enabled a representative sample, focussed on high priority sites, and enabled some wider reference data on similar habitats. There was also a recognition that the frequency of monitoring would need to vary across pressure and habitat type and that this would be revisited in the next phase of work. This Option 2 plus wider monitoring was therefore identified as the preliminary option preference for offshore benthic habitats and MPAs'.

JNCC were tasked with producing the costs for this 'Option 2.5' scenario (i.e. the representative subset of high priority MPAs under Option 2, plus the corresponding wider environment element for these high priority MPA habitats from Option 3). The costs for this preliminary option preference are presented below in Table 7. It should be noted that the costs for MPA monitoring are the same as in Option 2, as the MPA selection would the same. The cost of wider environment monitoring for this option is slightly less than presented in Option 3 as there would be slightly fewer habitats requiring monitoring in the wider environment under this Option 2.5 scenario.

Table 7: Estimated costs for implementing Option 2.5, considering one six-year reporting cycle [table created in 2017].

Option	Number of MPAs / CP2 regions surveyed	Assumptions for monitoring	Total cost of monitoring per reporting cycle	Average yearly cost of implementation
2.5	19 offshore MPAs	Habitats within the selected MPAs would be monitored once per 6 year reporting cycle	£5.78 million	£0.96 million
	19 offshore MPAs	Sedimentary and rocky habitats monitored twice per 6 year reporting cycle and biogenic habitats (*Sabellaria spinulosa* reefs) monitored yearly	£12.4 million	£2.07 million
	6 CP2 regions	Habitats selected for monitoring within MPAs would be monitored in the wider environment once per 6 year reporting cycle, delivered through integration with existing wider environment data collection schemes	£0.81 million	£0.14 million

Option	Number of MPAs / CP2 regions surveyed	Assumptions for monitoring	Total cost of monitoring per reporting cycle	Average yearly cost of implementation
2.5	6 CP2 regions	Sedimentary and rocky habitats selected for monitoring within MPAs would be monitored in the wider environment twice per 6 year reporting cycle and biogenic habitats (*Sabellaria spinulosa* reefs) monitored yearly, delivered through integration with existing wider environment data collection schemes	£1.74 million	£0.29 million

9 HBDSEG review of policy option

The preferred option selected by policy was reviewed by the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG), alongside the remaining biodiversity components, at a two-day workshop from 27 to 28 March 2018. Participants provided advice on whether an adequate level of evidence would be achieved by the policy option preferences and, if inadequate, what it would take to bring the option to a level of adequacy that would fulfil the following monitoring objectives:

- Understanding the natural variability of the biodiversity component and its role within ecosystem processes and functions.
- Understanding pressure-state relationships and facilitating the development of pressure-based monitoring to enable the sustainable management of human activities.
- Undertake robust assessments of conservation status and site condition at required scales and temporal frequencies to fulfil national and international reporting obligations.

HBDSEG developed advice on how best to address the key inadequacies identified within the policy preference and made recommendations on the minimum acceptable level of monitoring for this biodiversity component.

10 HBDSEG advice

HBDSEG did not wish to fundamentally alter the preferences put forward by policy colleagues for the offshore (and deep sea) UK benthic environments. Their advice was to strengthen the underpinning of the preferences so that the evidence base could be considered as adequate for assessment, reporting and management purposes.

It was noted that our ability to extrapolate findings from directly monitored areas to unmonitored areas has a heavy reliance on access to pressures data at the correct spatial and temporal resolutions, both for current [2017] and emerging pressures on the marine environment. It was recognised that there is also a need to collect appropriate environmental data to allow accurate interpretation of biological data and to allow causes of change to be better attributed e.g. to climate change. HBDSEG highlighted that there is little to no

evidence that using a selection of MPAs as proxies for others in terms of condition and effectiveness of management measures is scientifically valid.

It was also recognised that a strong role for industry should be highlighted, in terms of providing access to data and carrying out monitoring (e.g. Types 2/3) of new impacts through licencing agreements. There is currently [2017] a risk that the licensing process is not as robust and effective as is assumed. Industry monitoring input would also necessitate some shared protocols for monitoring data collection, so that data from multiple sources can be integrated successfully. This approach could help to calibrate and ground-truth indicator models, if monitoring targeted different levels of pressure e.g. physical disturbance.

HBDSEG advised that the Type 1 monitoring network for benthic habitats should be as wide (spatially and temporally) as possible to allow impacts of large scale pressures such as climate change to be detected and to ensure that emerging pressures (e.g. from fishing displacement), are not missed. Without this network, there is a risk that we do not understand the impacts of MPA management on the wider seas and we miss large scale, emerging pressures. HBDSEG emphasised the importance of the frequency of monitoring being ecologically relevant (e.g. linked to the natural variability of the features and any impacts from pressures).

Finally, it was acknowledged that significant efficiencies might be possible by considering all the benthic habitat option preferences together at the UK scale, when the outputs are all available.

These suggested HBDSEG amendments would ensure that the policy preference could be implemented with some confidence in the outputs in terms of informing decision making. A strong evidence base of pressures and environmental data is a pre-requisite to ensuring robust data analysis and would bring value for money in terms of allowing expensive biological data collection to be interpreted correctly. Delivery of some of these data through industry monitoring represents integration that could yield benefits to both conservation organisations, regulators, and developers. More robust, targeted, and standardised data collection on marine habitat impacts would allow advice and consents to be given from a stronger evidence base, which may allow conservation advisors to be less precautionary. A Type 1 monitoring network that operates at the relevant spatial and temporal scales and at a suitable frequency of data collection, would ensure that risks around emerging pressures and climate change were minimised.

11 Inclusion of HBDSEG advice in policy option preference

Amendments have been made to the cost profiles to reflect the additional resource required to coordinate industry data flows. These roles (one Senior Executive Officer and one Higher Executive Officer) will encompass both the offshore and deep sea benthic habitat environments and will improve access and optimisation of industry data, facilitate join-up in monitoring protocols and enable better understanding of the single and cumulative impacts of human activities and associated pressures. This will improve ability to effectively advise on licensing agreements and monitoring protocols to ensure impacts of current [2017] and new licensed activities are understood and mitigated as far as possible.

A broad additional cost has been estimated for the collection, processing, and analysis of additional environmental parameters (i.e. physico-chemical properties of sediment and water column), to ensure the correct interpretation of causes of change in biological communities and habitat structure and to improve ability to attribute variation to large-scale drivers such as climatic changes. This will also require the incorporation of existing large-scale

environmental datasets (e.g. those collected by remote sensing) to interpret changes in the context of regional or global trends. It should be noted that the specific parameters to be monitored for each habitat type/site/region need to be considered in detail at the implementation stage of this monitoring option and therefore only coarse associated costs have been provided.

HBDSEG highlighted the reliance of this option on having access to pressures data at the correct spatial and temporal resolutions. This is an assumption of the current [2017] option preference but should be considered explicitly in terms of whether the data are readily available and what the cost would be. There is an ongoing role here for the UKMMAS pressures steering group and the Productive Seas Evidence Group (PSEG). A cost has not been estimated for this element as the governance and structures already exist, but the requirement for alignment of products which can improve our ability to infer potential impacts of human activities is acknowledged and emphasised.

A summary of the costs, benefits and risks associated with the policy option and HBDSEG amended policy option, are provided in Table 8.

Table 8. Comparison of costs, benefits and risks associated with policy option and HBDSEG amended policy option [table created in 2018].

Monitoring option	Key monitoring elements	Average annual cost (£Mill)	Benefits	Risk
Policy preference (Option 2.5)	• Monitoring of high priority benthic habitats within 19 representative offshore MPAs (~60% of offshore MPAs) at ecologically relevant frequencies. • Monitoring of high priority offshore benthic habitats in the wider (outside of MPA) environment.	**2.36**	• Ability to directly assess conservation status of high priority* habitats within ~60% of MPAs and provide data for site/feature assessments (e.g. Habitats Directive, Marine and Coastal Access Act and Marine (Scotland) Act). • Wider environment monitoring will provide some data for regional assessments (e.g. MSFD), detection of emergent issues and context for MPA-scale change. • Monitoring across a range of pressure intensities (inside and outside of MPAs) will improve indicator models for assessing and inferring habitat condition. • Monitoring at ecologically relevant frequency will improve understanding of natural temporal variability of habitats, allowing earlier detection of emergent issues and higher confidence in detecting impacts from human impacts and evaluating effectiveness of management.	• No direct monitoring to determine habitat condition for any habitats within 40% of MPAs; this is likely to result in ineffective management and / or unnecessary harm to protected habitats, and / or stakeholder livelihoods. • Limited understanding of the combined impacts of human pressures on offshore habitats and pressure maps of insufficient resolution limits ability to effectively manage human activities in those areas not directly monitored. • Limited ability to detect large scale changes associated with climate change due to limited spatial extent of monitoring in the wider environment. • Impact of licensed activities on offshore habitats may be greater than anticipated especially for new activities, due to lack of join-up with industry monitoring protocols and limited access to industry data.
HBDSEG advised amendments to policy option	• Two additional roles (S and H grade) for coordinating the industry data flow to improve access and optimisation of industry data, facilitate join-up in monitoring protocols and enable better understanding of the single and cumulative impacts of human pressures. • Provision of environmental data including collection of new data and use of existing large-scale datasets (broad costs reflect sample collection/processing). • Provision of more practicable pressures products and sensitivity information by improved alignment with PSEG (not costed).	**2.43** Including (in addition to policy option): • Industry data flow coordinator (+£50K)** • Collection/processing/analysis of environmental data (+~£20K)*	• Ability to directly assess the conservation status of high priority offshore habitats within ~60% of MPAs and provide data for site/feature assessments (e.g. Habitats Directive, Marine and Coastal Access Act and Marine (Scotland) Act). • Wider environment monitoring will provide some data for regional assessments (e.g. MSFD), detection of emergent issues and context for MPA-scale change. • Monitoring across a range of pressure intensities (inside and outside of MPAs) will improve indicator models for assessing and inferring habitat condition. • Improved ability to effectively advise on licensing agreements and monitoring protocols to ensure impact of current [2017] and new licensed activities are understood and mitigated as far as possible.	• No direct monitoring to determine habitat condition for any habitats within 40% of MPAs; this is likely to result in ineffective management and / or unnecessary harm to protected habitats, and / or stakeholder livelihoods. • Limited ability to detect large scale changes associated with climate change due to limited spatial extent of monitoring in the wider environment.

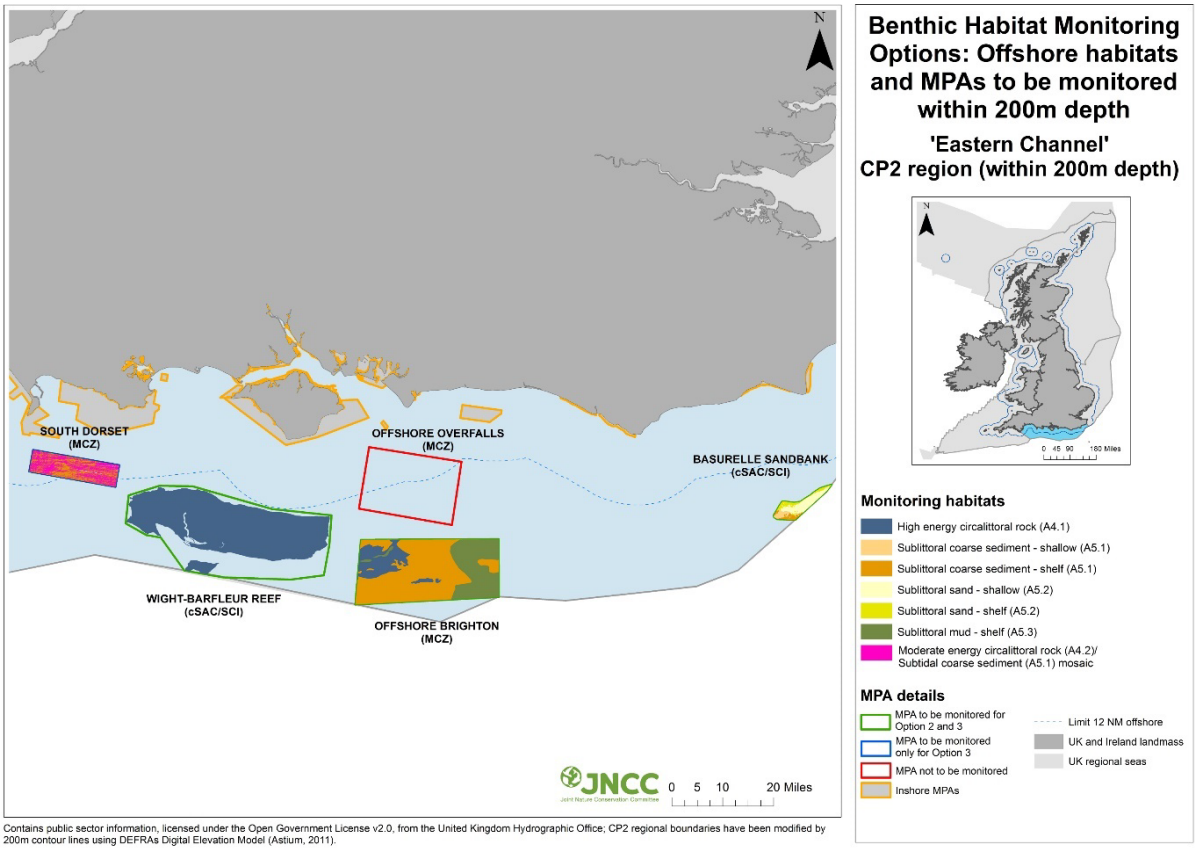
Footnote: * Cost includes one additional survey day per year (split across two surveys), processing and analysis.

**Cost includes one SEO- and one HEO-grade role split between offshore and deep sea benthic habitats.

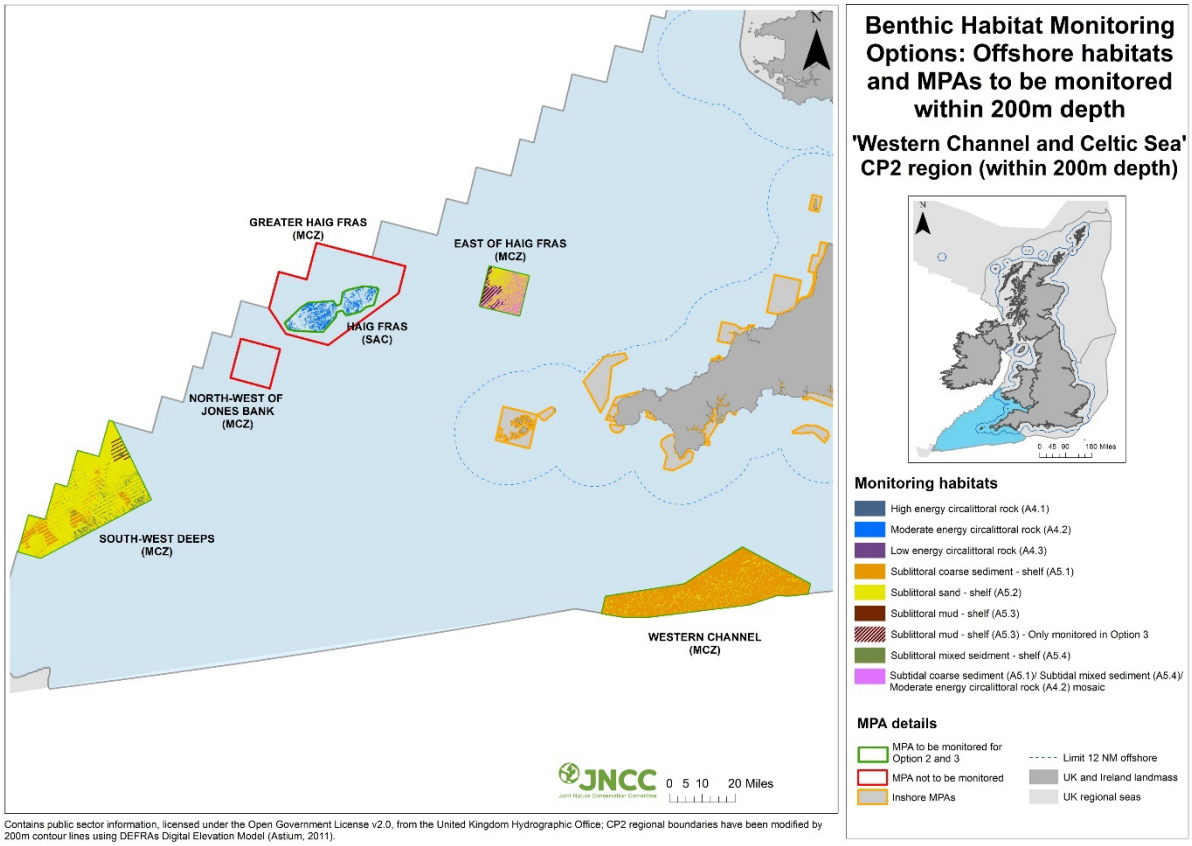
References

Webb, K., Griffiths, Y. & Proudfoot, R. 2024. The U.K. Marine Biodiversity Monitoring Programme: Development of advice on future monitoring (2019). *JNCC Report 765*, JNCC, Peterborough, ISSN 0963-8091.
https://hub.jncc.gov.uk/assets/5db2e26e-b98d-4a49-9293-76a62a25d6f7

Appendix A – Six Regional MPA maps for Options 2 and 3 [figures created in 2017]



Contains public sector information, licensed under the Open Government License v2.0, from the United Kingdom Hydrographic Office; CP2 regional boundaries have been modified by 200m contour lines using DEFRAs Digital Elevation Model (Astium, 2011).



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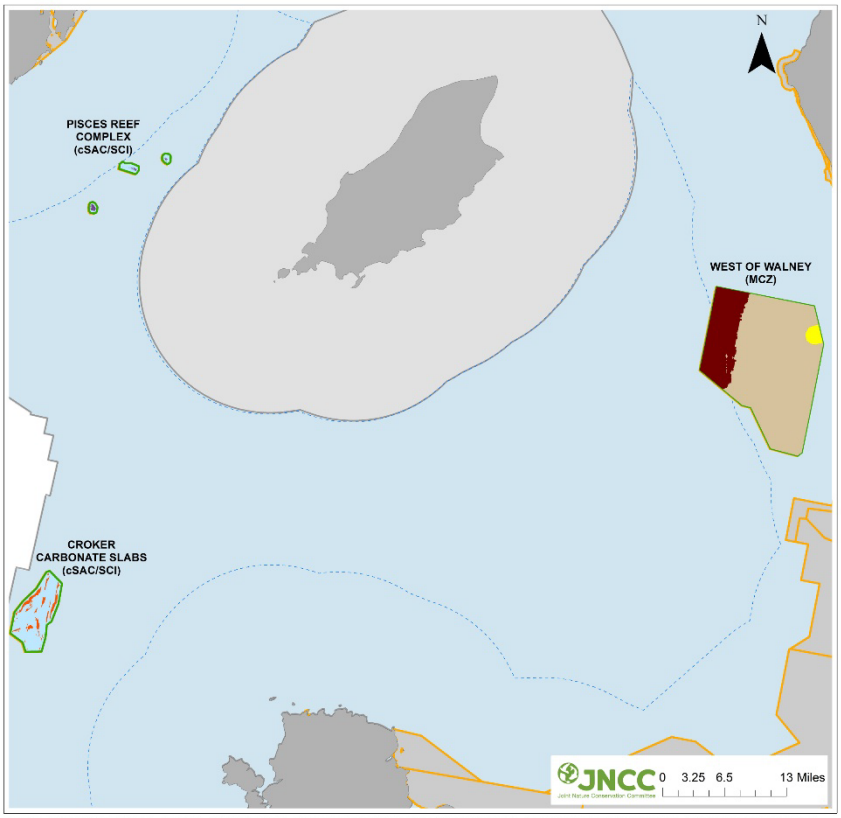

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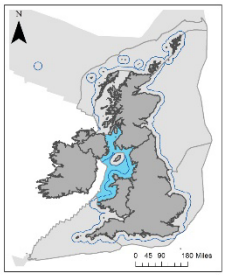
Benthic Habitat Monitoring Options: Offshore habitats and MPAs to be monitored within 200m depth

'Irish Sea' CP2 region (within 200m depth)

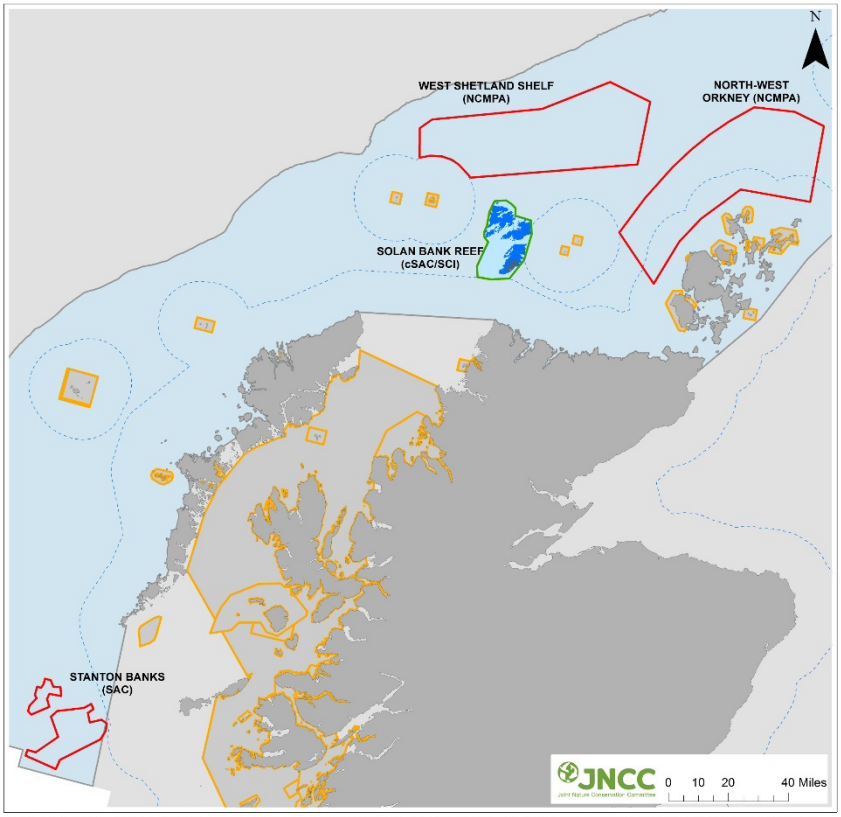


Monitoring habitats

- Low energy circalittoral rock (A4.3)
- Sublittoral sand - shallow (A5.2)
- Sublittoral mud - shallow (A5.3)
- Sublittoral mud - shelf (A5.3)
- Submarine structures made by leaking gases (A5.711, A5.712)

MPA details

- MPA to be monitored for Option 2 and 3
- MPA not to be monitored
- Inshore MPAs
- Limit 12 NM offshore
- UK and Ireland landmass
- UK regional seas



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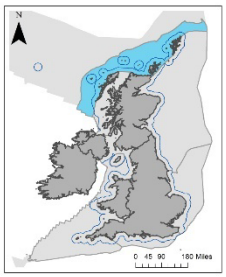
Benthic Habitat Monitoring Options: Offshore habitats and MPAs to be monitored within 200m depth

'Scottish Continental Shelf' CP2 region (within 200m depth)

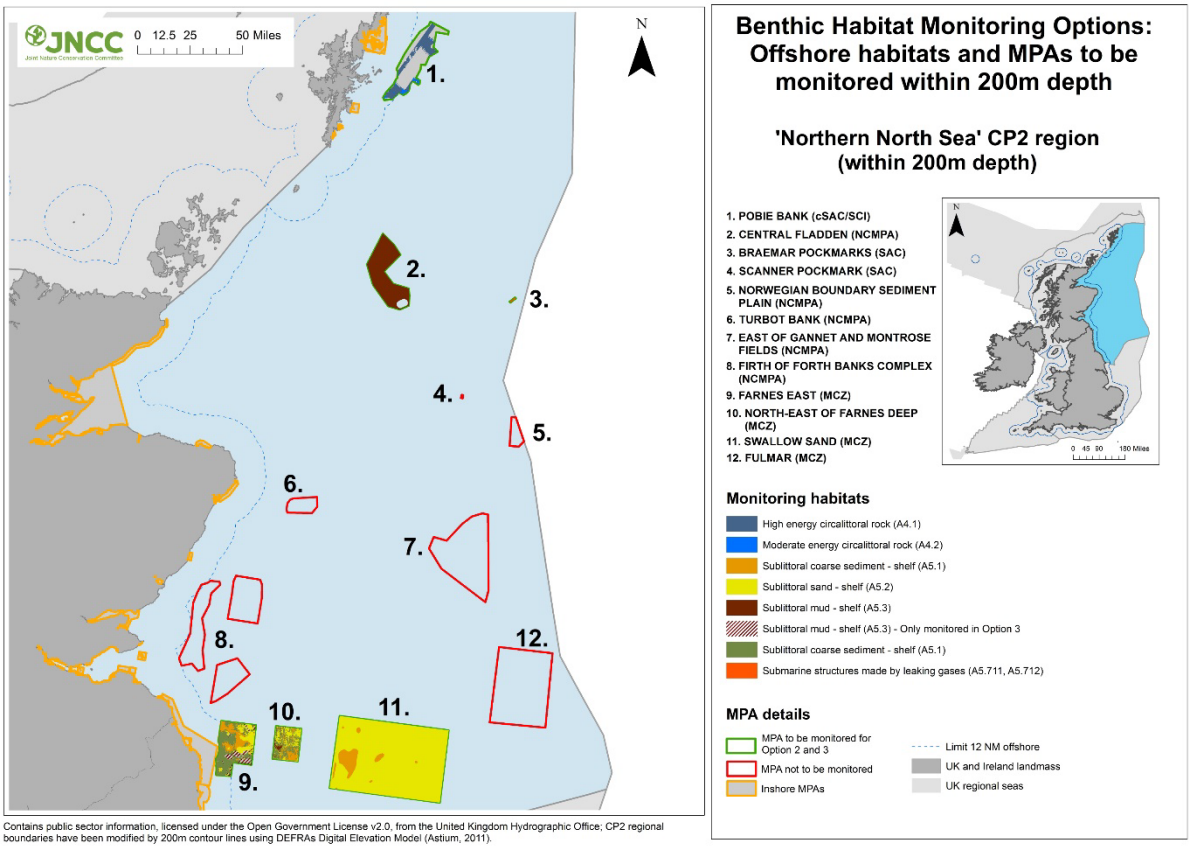


Monitoring habitats

- High energy infralittoral rock (A3.1)
- High energy circalittoral rock (A4.1)
- Moderate energy circalittoral rock (A4.2)

MPA details

- MPA to be monitored for Option 2 and 3
- MPA not to be monitored
- Inshore MPAs
- Limit 12 NM offshore
- UK and Ireland landmass
- UK regional seas



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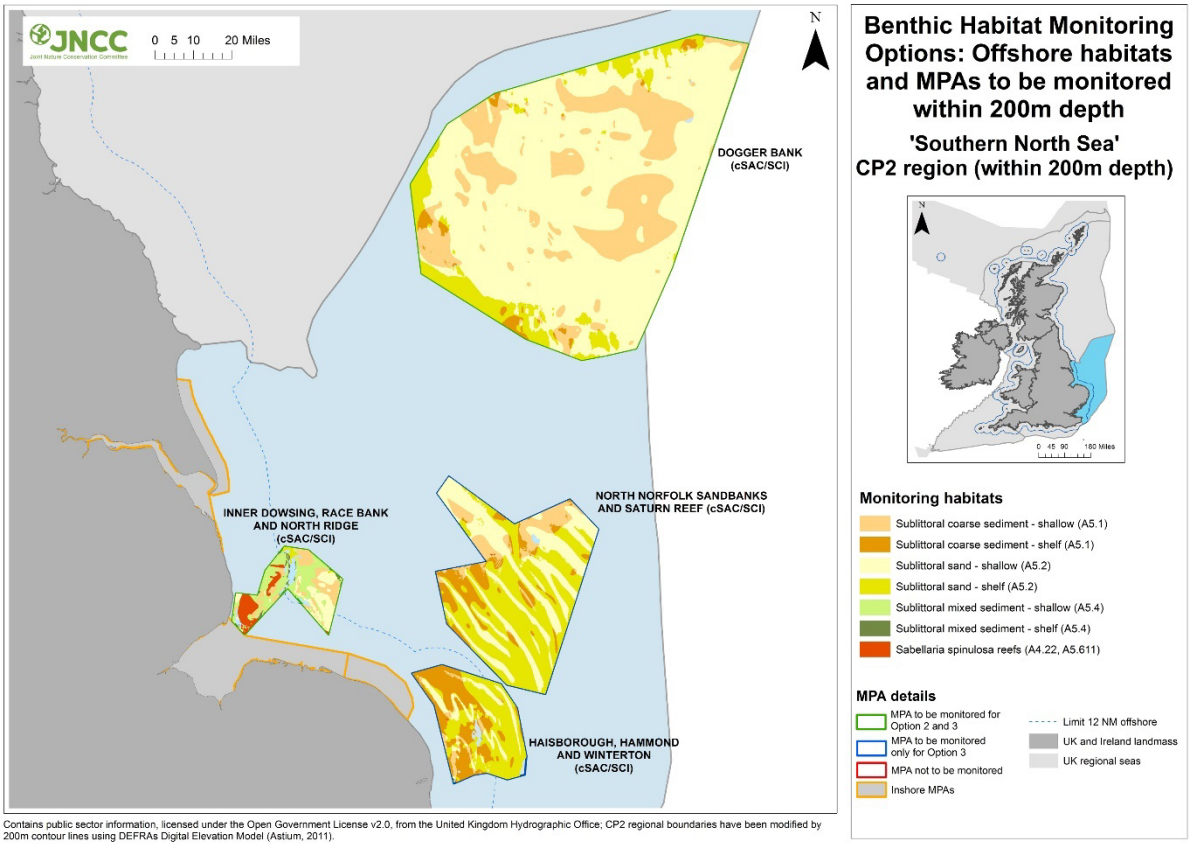

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Appendix B – Offshore monitoring habitats and their presence within offshore regions [as advised in 2017]

Offshore monitoring habitat	CP2 region					
	Eastern Channel	**Irish Sea**	**Northern North Sea**	**Scottish Continental Shelf**	**Southern North Sea**	**Western Channel and Celtic Sea**
High energy circalittoral rock (A4.1)	**Present**	Not in offshore MPA	**Present**	**Present**	Not in offshore MPA	**Present**
High energy infralittoral rock (A3.1)	Not in offshore MPA	Not in offshore MPA	Not in offshore MPA	**Present**	Not in offshore MPA	Not in offshore MPA
Low energy circalittoral rock (A4.3)	Not in offshore MPA	**Present**	Not in offshore MPA	Not in offshore MPA	Not in region	**Present**
Moderate energy circalittoral rock (A4.2)	**Present**	Not in offshore MPA	**Present**	**Present**	Not in offshore MPA	**Present**
Sabellaria spinulosa reefs (A4.22, A5.611)	Not in region	Not in offshore MPA	Not in offshore MPA	Not in region	**Present**	Not in offshore MPA
Sublittoral coarse sediment - shallow (A5.1)	**Present**	Not in offshore MPA	Not in offshore MPA	Not in offshore MPA	**Present**	Not in offshore MPA
Sublittoral coarse sediment - shelf (A5.1)	**Present**	Not in offshore MPA	**Present**	**Present**	**Present**	**Present**
Sublittoral mixed sediment - shallow (A5.4)	**Present**	Not in offshore MPA	Not in offshore MPA	Not in offshore MPA	**Present**	Not in offshore MPA
Sublittoral mixed sediment - shelf (A5.4)	**Present**	Not in offshore MPA	**Present**	**Present**	**Present**	**Present**
Sublittoral mud - shallow (A5.3)	Not in offshore MPA	**Present**	Not in offshore MPA	Not in offshore MPA	Not in offshore MPA	Not in offshore MPA
Sublittoral mud - shelf (A5.3)	Not in offshore MPA	**Present**	**Present**	Not in offshore MPA	Not in offshore MPA	**Present**
Sublittoral sand - shallow (A5.2)	**Present**	**Present**	Not in offshore MPA	Not in offshore MPA	**Present**	Not in offshore MPA
Sublittoral sand - shelf (A5.2)	**Present**	Not in offshore MPA	**Present**	**Present**	**Present**	**Present**

Offshore monitoring habitat	CP2 region					
	Eastern Channel	**Irish Sea**	**Northern North Sea**	**Scottish Continental Shelf**	**Southern North Sea**	**Western Channel and Celtic Sea**
Submarine structures (A5.711, A5.712)	Not in region	**Present**	**Present**	Not in region	Not in region	Not in region

Not in region = monitoring habitat type does not occur within CP2 region (including offshore and inshore waters). Not in offshore MPA = monitoring habitat type does not occur within an offshore MPA (as part of a conservation feature) within CP2 region. Present = monitoring habitat type is represented by offshore MPA network (as part of a conservation feature) and is therefore considered during the assessment of priority locations for monitoring.

Appendix C – Proportion and number of examples of each habitat type monitored as part of Option 2 and 3 for each offshore CP2 region [as advised in 2017]

CP2 Region	Monitoring habitat	Total area of habitat in CP2 region (km^2)	Proportion of CP2 habitat monitored (%)		No. examples of habitat type monitored		No. examples of habitat type in offshore MPAs
			Option 2	Option 3	Option 2	Option 3	
Eastern Channel	High energy circalittoral rock (A4.1)	1,472	72%	72%	2	2	2
Eastern Channel	**Moderate energy circalittoral rock (A4.2)**	**535**	**None**	**5%**	**0**	**1**	**1**
Eastern Channel	**Sublittoral coarse sediment - shallow (A5.1)**	**3,598**	**0.2%**	**0.3%**	**1**	**2**	**3**
Eastern Channel	**Sublittoral coarse sediment - shelf (A5.1)**	**8,673**	**6%**	**7%**	**2**	**3**	**4**
Eastern Channel	Sublittoral mixed sediment - shallow (A5.4)	1,011	None	None	0	0	1
Eastern Channel	Sublittoral mixed sediment - shelf (A5.4)	2,007	12%	12%	1	1	2
Eastern Channel	Sublittoral sand - shallow (A5.2)	1,715	2%	2%	1	1	2
Eastern Channel	Sublittoral sand - shelf (A5.2)	1,063	1%	1%	1	1	2
Irish Sea	Low energy circalittoral rock (A4.3)	367	0.3%	0.3%	1	1	1
Irish Sea	Sublittoral mud - shallow (A5.3)	2,453	12%	12%	1	1	1
Irish Sea	Sublittoral mud - shelf (A5.3)	5,258	2%	2%	1	1	1
Irish Sea	Sublittoral sand - shallow (A5.2)	4,482	0.2%	0.2%	1	1	1
Irish Sea	Submarine structures (A5.711, A5.712)	8*	100%	100%	1	1	1
Northern North Sea	High energy circalittoral rock (A4.1)	867	37%	37%	1	1	1
Northern North Sea	Moderate energy circalittoral rock (A4.2)	2,475	1%	1%	2	2	2

CP2 Region	Monitoring habitat	Total area of habitat in CP2 region (km^2)	Proportion of CP2 habitat monitored (%)		No. examples of habitat type monitored		No. examples of habitat type in offshore MPAs
			Option 2	Option 3	Option 2	Option 3	
Northern North Sea	Sublittoral coarse sediment - shelf (A5.1)	17,050	3%	3%	3	3	4
Northern North Sea	Sublittoral mixed sediment - shelf (A5.4)	2,048	32%	32%	2	2	4
Northern North Sea	Sublittoral mud - shelf (A5.3)	28,225	4%	4%	3	3	6
Northern North Sea	**Sublittoral sand - shelf (A5.2)**	**121,580**	**4.0%**	**4.1%**	**3**	**4**	**8**
Northern North Sea	Submarine structures (A5.711, A5.712)	9*	61%	61%	1	1	2
Scottish Continental Shelf	High energy circalittoral rock (A4.1)	5,764	1%	1%	1	1	1
Scottish Continental Shelf	High energy infralittoral rock (A3.1)	1,179	0.0%	0.0%	1	1	1
Scottish Continental Shelf	Moderate energy circalittoral rock (A4.2)	5,467	5%	5%	1	1	2
Scottish Continental Shelf	Sublittoral coarse sediment - shelf (A5.1)	33,999	None	None	0	0	1
Scottish Continental Shelf	Sublittoral mixed sediment - shelf (A5.4)	541	None	None	0	0	1
Scottish Continental Shelf	Sublittoral sand - shelf (A5.2)	34,458	None	None	0	0	2
Southern North Sea	***Sabellaria spinulosa* reefs (A4.22, A5.611)**	**453***	**25%**	**25%**	**1**	**3**	**3**
Southern North Sea	**Sublittoral coarse sediment - shallow (A5.1)**	**8,607**	**35%**	**40%**	**2**	**4**	**4**
Southern North Sea	**Sublittoral coarse sediment - shelf (A5.1)**	**9,777**	**2%**	**11%**	**2**	**4**	**4**
Southern North Sea	Sublittoral mixed sediment - shallow (A5.4)	2,238	15%	15%	1	1	1
Southern North Sea	Sublittoral mixed sediment - shelf (A5.4)	1,749	1%	1%	1	1	1

CP2 Region	Monitoring habitat	Total area of habitat in CP2 region (km^2)	Proportion of CP2 habitat monitored (%)		No. examples of habitat type monitored		No. examples of habitat type in offshore MPAs
			Option 2	Option 3	Option 2	Option 3	
Southern North Sea	**Sublittoral sand - shallow (A5.2)**	**14,767**	**59%**	**68%**	**2**	**4**	**4**
Southern North Sea	**Sublittoral sand - shelf (A5.2)**	**23,282**	**4%**	**14%**	**2**	**4**	**4**
Western Channel and Celtic Sea	High energy circalittoral rock (A4.1)	1,236	0.0%	0.0%	1	1	1
Western Channel and Celtic Sea	Low energy circalittoral rock (A4.3)	299	0.2%	0.2%	1	1	1
Western Channel and Celtic Sea	**Moderate energy circalittoral rock (A4.2)**	**1,182**	**13%**	**19%**	**1**	**2**	**2**
Western Channel and Celtic Sea	Sublittoral coarse sediment - shelf (A5.1)	32,935	5%	5%	3	3	5
Western Channel and Celtic Sea	Sublittoral mixed sediment - shelf (A5.4)	1,601	7%	7%	1	1	3
Western Channel and Celtic Sea	**Sublittoral mud - shelf (A5.3)**	**7,831**	**0.3%**	**1.2%**	**1**	**2**	**4**
Western Channel and Celtic Sea	Sublittoral sand - shelf (A5.2)	34,449	5%	5%	3	3	5

* = Total monitoring habitat area in CP2 region likely to be underestimated due to low confidence in extent outside of MPAs. Values in bold represent differences in the proportion of habitat type monitored between Options 2 and 3. Note that this table does not include the wider environment monitoring included as part of Option 3. Proportion values displayed to 1 decimal place where proportion is less than 1% or where difference between options is less than 1% when rounded.