Spatial assessment of benthic compensatory habitats for offshore wind farm impacts

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Further information

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Glossary

Abbreviation	Description	Definition
AoO	Advice on Operations	Natural England's advice identifies pressures (environmental effects) associated with the most commonly occurring marine activities, and provides a detailed assessment of the feature/sub-feature or supporting habitat sensitivity to those pressures.
BGS	British Geological Survey	The BGS provides expert services and impartial advice in all areas of geoscience. Its client base is drawn from the public and private sectors both in the UK and internationally.
-	Biogenic (reef)	A hard geomorphological structure constructed by living organisms that is topographically distinct from the surrounding seabed.
-	Biotope	A region, uniform in environmental conditions and in its distribution of habitats and plant life, operating on a particular scale.
BSH	Broad-Scale Habitat	Level 3 EUNIS marine habitat. Some BSH can be a designated feature of an MCZ.
-	Circalittoral	The region of the sublittoral zone that is dominated by animals and extends from the lower limit of the infralittoral (algae-dominated communities in the infralittoral zone). The circalittoral zone can itself be split into two sub-zones; upper circalittoral (foliose red algae present but not dominant) and lower circalittoral (foliose red algae absent)..

Abbreviation	Description	Definition
-	Compensatory measures	Practical measures taken to offset the negative impacts of developments/activities on habitats and species.
-	Ecosystem Service	The benefits people obtain from ecosystems.
EMODnet	European Marine Observation and Data Network	A network of organisations, supported by the EU's integrated maritime policy, that work together to observe the sea and process data according to international standards and make that information freely available.
ENG	Ecological Network Guidance	Natural England's and Joint Nature Conservation Committee's statutory advice and guidance on what is required to achieve the goals set out in the Marine and Coastal Access Act (2009) and associated with policy to establish an ecologically coherent network of Marine Protected Areas.
EUNIS	European Nature Information System	A comprehensive pan-European system for habitat and biotope identification.
FOCI	Features of Conservation Interest	Marine features (species and habitats) that are particularly threatened, rare, or declining. Can be designated feature(s) of an MCZ.
-	Geogenic (reef)	A hard geological structure, formed as a result of geological processes, that is topographically distinct from the surrounding seabed.
GIS	Geographic Information System	A computer system designed for sorting, analysing, manipulating, and displaying geographical data.
-	Grey literature	Research that is available in the public domain, but which has not been formally

Abbreviation	Description	Definition
		peer-reviewed (e.g. conference proceedings, reports and dissertations).
INNS	Invasive Non-Native Species	Any species that is not native to that ecosystem whose introduction does, or is likely to, cause economic, environmental, or human health harm.
-	Infralittoral	The region of the sublittoral zone that is dominated by algae and extends from the lower limit of the littoral zone to the upper limit of the circalittoral zone.
JNCC	Joint Nature Conservation Committee	The Government's statutory advisor on the marine natural environment from 12 to 200 nautical miles (nm), and UK territories.
-	Littoral	The region on the shoreline that is sometimes covered by water.
MarESA	Marine Evidence based Sensitivity Assessment	A systematic methodology to compile and assess the best available scientific evidence to determine sensitivity of a species or habitat.
MCZ	Marine Conservation Zone	A marine protected area, designated under the Marine and Coastal Access Act (2009), to assist in the conservation and recovery of the designated species and habitats within them.
MDS	Multi-Dimensional Scaling	A tool which uses a set of statistical techniques to provide quantitative estimates of similarity amongst groups of items.
MNCR	Marine Nature Conservation Review	The MNCR was initiated by JNCC (1987 to 1998) to provide a comprehensive baseline of information on marine habitats and their associated species around the coast of Britain which would aid coastal zone and

Abbreviation	Description	Definition
		sea-use management and to contribute to the identification of areas of marine natural heritage importance. The focus of MNCR work was on littoral and sublittoral benthic habitats..
MPA	Marine Protected Area	A clearly defined geographical space established and managed to achieve long-term conservation of nature with associated ecosystem services and cultural values.
-	Sublittoral	The region ranging from the low tide mark to the edge of the continental shelf comprised of the infralittoral and circalittoral zones.
-	Supralittoral	An area of the littoral zone that lies above the shoreline but is subject to seawater exposure via capillary action of the substrate or spray from wave action. Colloquially known as the splash zone.
OWF	Offshore Wind Farm	-
-	Peer-reviewed literature	Sources that have been academically peer-reviewed prior to publication.
SAC	Special Area of Conservation	Protected area designated for the conservation of important natural habitats, and of wild fauna and flora. Designated for Annex I habitat and Annex II species as defined under the EU Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora).
SPA	Special Protection Area	Protected area designated for the conservation of bird species populations. Designated for populations qualifying from Annex I to Annex V of the Council Directive

Abbreviation	Description	Definition
		79/409/EEC. Since 1994, all SPAs set up under the Habitats Directive 92/43/EEC.
SSC	Suspended Sediment Concentration	The amount of sediment particles that remain in suspension in water.

Executive summary

Large-scale offshore wind farm (OWF) developments have the potential to interact with benthic species and habitats of conservation importance. The expansion of offshore wind in English waters will increase the cumulative risk of adverse effects on the integrity of protected sites and species populations in the UK. It may also not be possible to avoid or mitigate against adverse effects on designated sites. Under these circumstances, the provision of compensatory measures will be required, where a project is consented in the knowledge that the overall coherence of the Marine Protected Area (MPA) network is maintained.

This project aims to identify benthic habitats that, whilst not classified as the same, have a similar or identical ecological function and ecosystem service provision to one another. Should it not be possible to rule out an adverse effect on one designated site/feature, it may be possible to consider habitats identified as similar for the delivery of compensatory measures. This work is intended to aid Natural England in providing advice to developers and regulatory authorities on potential compensation measures for benthic habitats; noting that specific measures would need to be developed on a case-by-case basis.

A list of 13 Annex I, Broad-Scale Habitat (BSH) and Features of Conservation Interest (FOCI) protected habitats identified as being at greatest risk of adverse effect as a result of future OWF development was provided by Natural England. From this, a further 38 habitats were identified as having the potential to provide similar or identical ecosystem service provision to the original 13 key habitats. Following an evidence review, scores for a range of ecosystem services and sensitivities were determined for each of the 51 habitats. Benthic habitat clusters were identified through multivariate analysis of the assigned ecosystem service scores.

A total of 16 benthic habitat clusters were determined, comprising habitats of similar or identical ecological function and ecosystem service provision. Broad and fine scale spatial habitat data were considered, including datasets relating to Annex I ‘Sandbanks’ and ‘Reef’, BSH (EUNIS Level 3) habitats and FOCI. The spatial extent of each habitat cluster within English waters was determined based on a wide range of publicly available datasets. Confidence was also assessed based on the number of datasets representing a given cluster present within any one area, combined with the specificity of the component datasets themselves. A series of interactive maps were produced that demonstrate both a habitat cluster’s spatial extent, and its potential confidence within a given area to provide same feature compensation.

Following review of the spatial output, findings indicate that whilst some habitats have a wider range of similar habitats available in English waters for compensatory measures should they be required, others have only limited equivalent, or close equivalent substitutes. Results highlight habitats with limited equivalent ecosystem service habitat availability, those that currently have limited spatial data availability, and those limited in both respects.

This evidence review and spatial assessment was undertaken at both a high-level and across a broad geographical scale. It was intended that this would provide Natural England with a baseline approach for identifying and assessing potential same feature compensation in English waters, for use as compensatory measures. Throughout this document, a number of constraints are identified, and recommendations made for the refinement of this present method as part of a case-by-case basis assessment. The results from this study has at this preliminary stage, indicated those potential regions to be explored should habitat compensation be required through the consenting of future OFW developments.

Contents

Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

1. Background

Addressing the UK's policy ambitions for offshore wind requires significant expansion and faster deployment of new generating capacity. Government has set out the target of delivering 50 GW by 2030. Large-scale offshore wind farm (OWF) developments have the potential to interact with benthic species and habitats of conservation importance, and there are significant concerns regarding the cumulative risk of adverse effects on the integrity of protected sites and species populations in the UK. The installation of turbines, sub-stations, inter-array cabling and export cables, and associated scour and cable protection, can impact littoral and sublittoral habitats.

Given the scale of planned OWF development (both fixed foundation and floating), and the likely implications for benthic habitats of designated sites in the North Sea, Irish Sea and Celtic Sea, it is possible that adverse effects on several Special Areas of Conversation (SACs) and Marine Conservation Zones (MCZs) may not be able to be avoided or mitigated. Some projects will therefore require the provision of compensatory measures.

The term compensatory measures is referred to here as an umbrella term to cover measures which are taken to sufficiently compensate for a negative impact on a designated site (e.g. SACs, MCZs and Special Protection Areas (SPAs)). The use of compensatory measures allows a project to be consented in the knowledge that the overall coherence of the Marine Protection Area (MPA) network (and associated features and conservation objectives) is maintained. Compensation should be considered as a last resort, where the remaining risk is 'unmitigable', and where the derogations/exceptions tests can be met. Natural England has advised that compensation may be needed for the following features:

- Annex I 'sandbanks which are slightly covered by sea water all the time' (H1110);
- Annex I 'Reefs' (H1170);
- Soft sediment MCZ Broad-scale habitat (BSH) features.

There is significant uncertainty in understanding and designing effective compensation measures in the marine environment. Natural England requires robust evidence to inform its advice on the sufficiency of proposed benthic compensatory measures. It is also necessary to assess the likelihood that compensatory measures can be delivered on a like-for-like designated feature basis; with regard to future impacts on MPAs.

Scope of works

Natural England is seeking to undertake an assessment of where benthic compensation could be delivered within English waters on a 'same designated feature' basis, with respect to benthic habitats listed within Annex I of the Habitats Directive (Council Directive 92/43/EEC), and within the MCZ Ecological Network Guidance (ENG) (Natural England

and JNCC, 2010). This would highlight habitats that whilst not classified the same, have a similar or identical ecological function and ecosystem service provision. The project's findings will help to inform Natural England in providing advice to developers and regulatory authorities on potential compensation measures for benthic habitats; noting that specific measures would need to be developed on a case-by-case basis.

MarineSpace Ltd (hereafter referred to as MarineSpace) has been commissioned by Natural England to deliver this project, which has been divided into two separate phases: 'Phase 1' and 'Phase 2' (detailed in the following sections).

Phase 1

The benthic habitats protected within SACs are Annex I habitats, and the designated features and sub-features of a given site. Features and sub-features of an MCZ may include both broad-scale habitats (BSH) (derived from EUNIS level 3 habitat type), and habitat Features of Conservation Interest (FOCI) (derived from the OSPAR List of Threatened and/or Declining Species and Habitats, the UK List of Priority Habitats). There are 25 Annex I marine, coastal, halophytic plant, dune and sea cave habitats listed within the marine SAC network, and 23 BSH and 22 habitat FOCI that are recommended to be represented and protected within the MCZ network (Natural England and JNCC, 2010; JNCC, 2021).

The aim of Phase 1 is to provide an understanding of which Annex I habitats and MCZ protected habitat features/sub-features, whilst not being entirely identical, may perform the same ecological and/or ecosystem functions. Part of the objective is to undertake an appraisal of the ecological functions and environmental requirements of the habitats, to determine what the ecological similarities and differences are across the suite of habitats assessed.

This knowledge can then potentially be used (with regard to OWF developments) to deliver 'same feature' compensation under Article 6(4) of the EU Habitats Directive (and its transposition into UK legislation), and the UK Marine and Coastal Access Act 2009 (Blake *et al.*, 2020). This review is a critical step, as it provides the evidence base to subsequently map the known distribution of overlapping Annex I and BSH and habitat FOCI features in English waters, as required under Phase 2 of the project.

The Annex I and MCZ protected features/sub-features of focus for this project are listed in Table 1.

It is important to note that Annex I habitats are often broad in scope, with BSH and habitat FOCI overlapping some of those habitat definitions and ecological functionality, whilst others may provide different services, or have dissimilar environmental requirements. Further, the definition of habitat FOCI are often contained within BSH habitat types, which in turn may fall within Annex I habitat definitions (noting that FOCI may also be directly analogous to certain Annex I habitats). It is also critical to note that certain Annex I habitats, and those meeting the criteria of MCZ habitats, may consist of sub-types which

could result in different ecological functionality. Such examples can be rocky reef habitats which can cover hard igneous formations such as basalts in the southwest of England to more friable sedimentary rocks along the south and east coasts, and soft geology such as chalk, and their associated littoral and sublittoral reef habitats. Energy exposure is also well understood as a physical force affecting the benthic communities/biotopes that may be present as sub-features associated with the broader habitat type. When considering potential compensatory measures, these differences should therefore be considered. Consideration as to the differences in habitats such as biological reefs should also be made, where the ecological functioning of a Ross worm *Sabellaria spinulosa* reef and that of a subtidal blue mussel *Mytilus edulis* bed may be similar but distinct.

The definition of 'Annex I sandbanks which are slightly covered by seawater all the time' considers the biological and ecological aspects of the habitat, as do the BSH and FOCI descriptions. However, it is relevant to note that the Annex I description also details the physical parameters of the habitat, emphasising water depth, morphology and sediment types associated with the habitat. Importantly, geomorphologically different types of 'subtidal sandbanks' exist and are designated. Examples include active and mobile banks still associated with coastal processes, those that are more fixed and dissociated with coastal processes, deeper water 'moribund' banks, and even those banks within estuaries, large shallow bays and inlets, and ria systems. Whilst differences in the component EUNIS classifications contained within Annex I-level habitats are considered within this report, differences at a geomorphological level are not. An assessment of these differences should be considered on a case-by-case basis during the development of potential compensatory packages, should differences in their ecosystem service provision be determined both relevant and significant.

Within Phase 1, distinction is drawn to the difference between various habitat levels and associated sub-types (where known/understood), with an appraisal of ecological function and sensitivity being determined for both higher level habitats, and the habitats and habitat sub-types that may be a component of them. For example, the Annex I habitat 'H1170 Reefs' is first considered independently, and then consideration of the BSH 'Moderate energy circalittoral rock', which can qualify as Annex I 'H1170 Reefs', is also conducted separately. Finally, consideration of all FOCI-level habitats that may be contained within the BSH 'Moderate energy circalittoral rock' as a component of Annex I 'H1170 Reefs' is conducted. This includes the FOCI habitats 'Subtidal chalk'; 'Ross worm (*Sabellaria spinulosa*) reef'; and 'Fragile sponge and anthozoan communities on subtidal rocky habitats'. By assessing Annex I and BSH level habitats independently, and subsequently assessing FOCI-level habitats, comparisons can be made across the suite of similar habitat types and sub-types.

Overall, the process used with Phase 1 should determine what the ecological functions are, and any similarities or differences in them, between habitats and sub-types that are classed as the same Annex 1 habitat or MCZ feature; but which are not considered identical e.g. granite and chalk reefs, *Sabellaria spinulosa* and blue mussel beds etc. This will determine if habitats which are classed as the same, or the same sub-type under

Annex 1 or MCZ ENG, but which are not identical, could potentially be used as 'same feature' compensation as their ecological functions are the same or similar.

Phase 2

There are currently 40 SACs with marine components, and 91 MCZs in English waters (inshore and offshore) (JNCC, 2020; UK Government, 2019). These MPAs form part of England's 'Blue Belt'.

The aim of Phase 2 is to spatially identify and map the locations of habitat types and sub-types in English waters that perform the same, or similar, ecological functions, as identified through delivery of Phase I. This will allow spatial visualisation of where compensatory measures could be implemented across different geographical areas (regions) for the same benthic habitat; both within English waters across this Blue Belt network, and outside of it[1].

Purpose of document

This document presents the rationale and methodology for undertaking Phase 1 and Phase 2 of the project, and its key analyses, results and plots of habitat types and sub-types.

Throughout this document, a number of potential constraints and recommendations have been stated. It will be important to consider these when applying the proposed methodology. The approach has been developed for broad-scale assessments across all English waters, to ensure it is appropriate for both regional assessments and localised assessments of specific OWF developments.

[1] Some habitat types and sub-types may have a biogeographic distribution that is predominantly outside of English waters, mostly further north within Scottish territorial waters e.g. whilst sea-pens and burrowing megafauna habitat is located within English waters in the Irish Sea, the main distribution of this habitat is associated with Scottish sea lochs.

2. Methodology

Phase 1: evidence review and habitat assessments

This section presents the key stages and rationale for undertaking an evidence review and habitats assessment of the differences and similarities between different protected benthic marine habitats, and their associated sub-types/sub-features.

Benthic Habitats to be Assessed

Natural England provided a list of 13 key marine habitats (key habitats) protected under Annex I of the Habitats Directive, and MCZ BSH and habitat FOCI under the Marine and Coastal Access Act (2006) to be the focus of the review. These habitat types and sub-types were identified based on the likelihood that they may interact with, and potentially be adversely affect by, future offshore wind development (Table 1). Throughout this report EUNIS 2012 codes are used in reference to various habitats. A comparison between EUNIS 2012 and 2019 codes is available in EUNIS (2021).

Table 1: Key habitats identified by Natural England for assessment within the present report

Habitat Type	Habitat Name
Annex I	H1110 Sandbanks which are slightly covered by seawater all the time
	H1170 Reefs
Broad-Scale Habitats (EUNIS Level 3)	Sublittoral sand (A5.2)
	Sublittoral coarse sediment (A5.1)
	Sublittoral mud (A5.3)
	Sublittoral mixed sediment (A5.4)
	Circalittoral rock (all energies; A4.1; A4.2; A4.3)
	Infralittoral rock (all energies; A3.1, A3.2, A3.3)

Habitat Type	Habitat Name
Habitats Listed as Features of Conservation Interest (FOCI)	Peat and Clay Exposures
	Ross worm (*Sabellaria spinulosa*) reefs
	Subtidal chalk
	Blue mussel beds
	Native oyster (*Ostrea edulis*) beds

Although the key habitats provided in Table 1 are considered the focus of this review, it was determined that additional habitats, extraneous to the original list provided by Natural England, may have the potential for similar types, magnitudes and distributions of ecosystem service provision. To ensure that habitats with the potential to provide similar ecosystem services were captured within this review, the list of key habitats was expanded (Appendix A presents the full list of 51 habitats that were considered for the review). The revised habitat list was developed using information provided in the ENG by Natural England and JNCC (2010; Annex 3). Correlation tables developed within the ENG report demonstrate the relationship between these 3 classes of features (Annex I, BSH and habitat FOCI), where different habitats *'contain'* or '*may contain'* another habitat (Natural England and JNCC, 2010; Annex 3). For the habitats considered within Phase 1 of this report, Annex I level habitats contain BSH level habitats. FOCI-level habitats may be contained within BSH level habitats, but they can also fall directly within Annex I level habitats.

To produce the full list of habitats for review, first a top-down approach was applied. Key Annex I-level habitats were expanded out into all constituent BSH-level habitats. Whilst many of these BSH-level habitats were key habitats listed in Table 1, a number of additional BSH-level habitats not considered key were added to the full habitat list. For example, the Annex I habitat 'H1110 Sandbanks which are slightly covered by sea water all the time' is listed as a key habitat within Table 1. Therefore, all BSH-level habitats considered components of this habitat (as listed within Natural England and JNCC, 2010; Annex 3) were added to the full habitat list, including those not included within the key habitat list e.g. 'Sublittoral macrophyte-dominated sediment'.

Following this, all BSH-level habitats (both key and additional) were expanded out into all constituent FOCI-level habitats. Again, this resulted in a number of additional FOCI-level habitats being added to the full habitat list, alongside the key FOCI-level habitats listed in Table 1.

Two key BSH-level habitats ('Sublittoral mud' and 'Sublittoral mixed sediment') are not considered components of either of the key Annex I-level habitats and are instead components of both 'H1130 – Estuaries'; and 'H1160 Large shallow inlets and bays'. These BSH-level habitats and their FOCI-level components were therefore considered in the context of these Annex I-level habitats. In all other cases BSH-levels habitats within the full habitat list are listed as components of at least one of the two key Annex I-level habitats, and whilst they may also be listed under additional Annex I-level habitats, their presence within these habitats has not been considered within this report.

Two key FOCI-level habitats: 'Subtidal chalk'; and 'Native oyster (*Ostrea edulis*) beds', can also be contained directly within Annex I-level habitats, rather than being associated with a BSH-level habitat as a component of an Annex I-level habitat. Therefore, these FOCI-level habitats have also been considered within the context of the Annex I-level habitats: '8330 Submerged or partially submerged caves'; and both '1130 Estuaries' and '1160 Large shallow inlets and bays' respectively.

During the review, FOCI habitats were assessed each time they appeared for any correlation with higher tier habitats (e.g. BSH or Annex I). For example, the FOCI 'Subtidal chalk' found within BSH 'Moderate energy **infralittoral** rock', which is a component of the Annex I 'H1170 Reefs' habitat, was identified (1170 Reefs → Moderate energy infralittoral rock → Subtidal chalk). Then in addition, a separate review of FOCI 'Subtidal chalk' was conducted. This time it was correlated with BSH 'Moderate energy **circalittoral** rock', along with Annex I 'H1170 Reefs' habitat (1170 Reefs → Moderate energy circalittoral rock → Subtidal chalk).

This methodology was applied to ensure that habitats most likely to provide similar ecosystem services to those included within Table 1 were considered for the remainder of the analysis. Appendix A presents the full list of 51 habitats that was assessed for this review, and the Habitat Assessment Workbook (in Appendix C; Tab 'Extended Habitat Relationship') illustrates the relationships between the original 13 Annex I, BSH and FOCI habitats.

Habitats descriptors for assessment

Identification of benthic habitats suitable for potential use as 'same designated feature' compensatory measures will focus on specific ecosystem services provided by the habitats. Targeting of equivalence in service provision is considered key when assessing habitat suitability; this will minimise the degree of disruption to marine ecosystem function from potential compensatory measures. In addition, similarity/dissimilarity of sensitivity to pressures (environmental effects related to Natural England's Advice on Operations (AoO) for SACs and MCZs) is also considered. The consideration of relative sensitivities to potential pressures is intended to maximise the likelihood that features introduced as part of compensatory measures will have equal or greater tolerance and longevity to those lost due to OWF development.

Ecosystem services

Ecosystem services can be defined as "…*the role played by ecosystems in enhancing or maintained human wellbeing*…*"* (Fletcher *et al.*, 2012). A total of 17 potential ecosystem services assessed in Fletcher *et al.* (2012) was reviewed. From these, a list of 18 habitat ecosystem services to be carried forward into the assessment was derived (Table 2). In some cases, ecosystem services were expanded in scope (e.g. Formation of species habitat was expanded into both 'Habitat formation – Biogenic reef' and 'Habitat formation – Burrowing'). In other cases, ecosystem services were compressed in scope (e.g. 'Water cycling', 'Water purification', and 'Water quality regulation' were combined into a single 'Water purification' service). Finally, in some cases, services were omitted, where it was determined that these services were not relevant to the use-case of this study (e.g. 'Formation of pleasant scenery'). Whilst the variations to the Fletcher *et al.* (2012) classification were qualitative, these were focussed primarily on their relevance and applicability in relation to benthic habitats.

Table 2: Habitat ecosystem services to be assessed

Ecosystem Service Name	Ecosystem Service Description
Primary production	Production of algae and plant biomass.
Secondary production – Fish	Production of faunal biomass.
Secondary production - Arthropods	
Secondary production – Molluscs	
Secondary production – Annelids	
Secondary production – Other	
Spawning and/or nursey grounds – Atlantic herring	Larval/gamete supply though the provision of suitable sites.
Spawning and/or nursery grounds – Sandeel	
Spawning and/or nursery grounds – Fish (generic)	
Spawning and/or nursery grounds - Shellfish	

Ecosystem Service Name	Ecosystem Service Description
Food web dynamics – Marine mammals	The interaction between species related to food consumption.
Food web dynamics – Birds	
Habitat formation – Biogenic reef	Formation of the physical properties of the habitats necessary for the survival of species.
Habitat formation – Burrowing	
Erosion control, formation of physical barriers and flood defence	Control of the processes leading to erosion, formation of structures that attenuate the energy of (or block) water or wind flow, e.g. protection.
Climate regulation	Modulation of regional/local climate (e.g. of temperature, or rainfall) and carbon fixation.
Biogeochemical cycling	The modification of matter through biogeochemical processes.
Water purification	Removal of contaminants from water flowing through an ecosystem (inc. through physical processes such as filtration or biological processes such as decomposition or assimilation.

Sensitivity

The full list of anthropogenic and natural pressures on benthic habitats listed under MarESA, and Natural England's AoO associated with OWF (ELECTRICITY FROM RENEWABLE ENERGY SOURCES and CABLES – construction, operation and maintenance, and decommissioning) (Natural England, 2021), was reviewed to identify

key pressures for consideration within this assessment[2]. A list of 15 pressures was identified, against which habitat sensitivities were to be assessed:

- Hydrological Pressure:
  - Temperature increase (local)
  - Sea-level rise[3]
  - Wave exposure changes; and water flow (tidal current) changes (local)
- Chemical Pressure:
  - Ocean acidification[2]
  - Contamination[4]
  - De-oxygenation
- Physical Pressure:
  - Physical change (to another seabed type)
  - Physical change (to another sediment type)
  - Habitat structure changes – removal of substratum
  - Abrasion/disturbance of the surface of the substratum or seabed[5]
  - Changes in suspended sediment solids (water clarity)
  - Smothering and siltation rate changes
- Physical Pressure (Other):
  - Electromagnetic changes (EMF)
  - Underwater noise changes
- Biological pressure:
  - Introduction or spread of invasive non-indigenous species.

Phase 1: habitat descriptor scoring

A simple scoring system was developed for scoring each of the ecosystem services and sensitivities listed above in 'Habitats Descriptors for Assessment'.

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[2] Pressures used within the Natural England AoOs follow those used within MarESA, however only pressures relevant to the specific operation being assessed are included.

[3] Included to ensure resilience in relation to any potential habitat being identified as compensation, where in fact it may subsequently be lost in the relative near future due to global climate change effects, and thus may not be 'deemed' a 'viable' compensation measure.

[4] This sensitivity the AoO sensitivities: Synthetic compound contamination (including pesticides, antifoulants and pharmaceuticals); and Transition elements and organo-metals (eg. TBT/tributyl tin) contamination.

[5] Abrasion at the surface is deemed a suitable proxy for sub-surface penetration in the context of this study. Therefore, sub-surface penetration has not been included independently.

Scores range from 0 ('Negligible') to 3 ('High'):

- 0 = Negligible
- 1 = Low
- 2 = Moderate
- 3 = High

Table 3 to Table 11 outline the scoring criteria used for each ecosystem service/group of services.

Recommendation: For an OWF project, appropriate weightings should be applied for each individual ecosystem service and sensitivity score that is of relevance to the particular habitat that may be lost. For example, in order to qualify as 'same feature' compensation, some services that a potential compensatory habitat can provide may be more important than others.

Ecosystem services

Primary production

The assessment of the ability for a habitat to support the production of biomass from environmentally available compounds and an external energy source (in many cases sunlight), was undertaken using the scoring criteria listed in Table 3.

Table 3: Scoring criteria for primary production

Score		Criteria
0	**Negligible**	The habitat itself, or the species it can support, **does not** provide any primary production.
1	**Low**	The habitat itself, or the species it can support, is likely to provide a **limited** level of primary production (in terms of spatial and/or temporal extent).
2	**Moderate**	The habitat itself, or the species it can support, is likely to provide a **moderate** level of primary production (in terms of spatial and/or temporal extent).
3	**High**	The habitat or the species it can support, is likely to provide a **high** level of primary production (in terms of spatial and/or temporal extent).

Secondary production

The assessment of a habitat's provision of secondary production was undertaken using the scoring criteria listed below in Table 4, but applied separately for the following 5 groups:

- Fish
- Arthropods
- Molluscs
- Annelids
- Other secondary producers.

Some habitats may vary in their importance for providing secondary production for these different taxonomic groups. For the purpose of this scoring system, scores were assigned based on total volume of productivity for a particular species/group of species characterising a habitat.

Table 4: Scoring criteria for secondary production

Score		Criteria
0	**Negligible**	Habitat, or the species it can support **does not** provide any secondary production.
1	**Low**	Habitat, or the species it can support is likely to provide a **limited** level of secondary production.
2	**Moderate**	Habitat, or the species it can support is likely to provide a **moderate** level of secondary production.
3	**High**	Habitat, or the species it can support itself is likely to provide a **high** level of secondary production.

Recommendation: For an OWF project, the scoring of a habitat for secondary production should also consider whether the potential habitat to be used as compensation is characterised by the same key structural and influential species to those of the impacted habitat. This consideration should be led by the level of individual species contribution to secondary biomass (e.g. *Nephrops norvegicus* for FOCI Sea-pen and burrowing megafauna).

Spawning and/or nursery grounds

The assessment of a habitat's suitability as a spawning and/or nursery ground was undertaken using the scoring criteria listed below in Table 5. This was applied separately for each of the following 4 receptor groups:

- Atlantic herring *Clupea harengus*
- Sandeel (Family: Ammodytidae)
- Fish[6]
- Shellfish.

Some habitats may vary in their suitability for provision of this service. Separate services were listed specifically for Atlantic herring and sandeel (Table 2) as these fish taxa have high degree of selectivity for sediment types. Sandeel are important to consider in the context of the increasing number of OWF developments, as sandeel play a key role as a keystone species; they are preyed upon by a variety of predators, may be vulnerable to impacts as juveniles, and adults inhabit sandy sediments for much of their time and, during breeding, they spawn demersal eggs that adhere to the substrate (Deurs *et al.,* 2012).

The descriptors of *prime, sub-prime*, *suitable* and *not suitable,* are as applied by Reach *et al.* (2013) for Atlantic herring for spawning, and Latto *et al.* (2013) for sandeel for habitat. These describe the 'preference' that these fish species have for particular sediment types (sediment classes). Within the present assessment, it is proposed that this should be adapted to align more broadly for each receptor group. For example, specific information on sediment particle size distributions will be site-specific and these data are not known at this stage. However, information on broad substrate type as part of the habitat (biotope) descriptions will be used to help to inform the preliminary scoring for this assessment.

Table 5: Scoring criteria for spawning and/or nursery grounds

Score		Criteria
0	**Negligible**	Habitat is **not suitable** to serve as spawning and/or nursery grounds. It has unsuitable structure to be selected by the receptor group (Atlantic herring, sandeel, fish, or shellfish).

[6] Finfish including teleosts and elasmobranchs.

Score		Criteria
1	**Low**	Habitat is **suitable** for providing suitable spawning and/or nursery grounds. It has adequate structure to be selected by the receptor group, but is only likely to support low densities (Atlantic herring, sandeel, fish, or shellfish).
2	**Moderate**	Habitat is **sub-prime** for providing suitable spawning and/or nursery grounds. It has acceptable structure to be selected by the receptor group but is less favourable than *prime habitat sediment* (Atlantic herring, sandeel, fish, or shellfish).
3	**High**	Habitat is **prime** for providing suitable spawning and/or nursery grounds. It has ideal structure to be selected by the receptor group (Atlantic herring, sandeel, fish, or shellfish).

Recommendation: For a OWF project, the scoring of a potential compensatory habitat to support Atlantic herring and sandeel should be refined to consider site-specific information on sediment classes as well as the broader sediments that are characterised under BSH etc. Examples of site-specific data can be sourced from British Geological Society (BGS) seabed surface sediment mapping data 1:250,000 (BGS, 2022) and the Cefas OneBenthic database (Cooper, 2020).

Food web dynamics

The assessment of a habitat's provision of primary and secondary production to provide foraging resource for higher trophic level consumers, was undertaken using the scoring criteria listed in Table 6. However, these criteria were applied separately for the following 2 groups:

- Marine mammals
- Birds.

Table 6: Scoring criteria for food web dynamics

Score		Criteria
0	**Negligible**	Habitat, or the species it can support **does not** provide any transfer of energy to support higher trophic groups.

Score		Criteria
1	**Low**	Habitat, or the species it can support is likely to provide a **limited** transfer of energy to support higher trophic groups.
2	**Moderate**	Habitat, or the species it can support is likely to provide a **moderate** transfer of energy to support higher trophic groups.
3	**High**	Habitat, or the species it can support, is likely to provide a **high** transfer of energy to support higher trophic groups.

Habitat formation

The assessment of a habitat's physical properties required for the survival of species, was undertaken using the scoring criteria listed in Table 7. However, these were applied separately for the assessment of:

- Biogenic reef features
- Burrows.

These 'features' have been assessed separately, as the associated physical requirements would be expected to differ between these formations (e.g. sedimentary properties and local hydrodynamic regime).

Table 7: Scoring criteria for habitat formation

Score		Criteria
0	**Negligible**	Habitat **does not** provide the physical properties necessary for the survival of species.
1	**Low**	Habitat is **unlikely** to provide the physical properties necessary for the survival of species.
2	**Moderate**	Habitat is **likely** to provide the physical properties necessary for the survival of species.
3	**High**	Habitat is **highly likely** to provide the physical properties necessary for the survival of species.

Erosion control, formation of physical barriers and flood defence

The assessment of a habitat, or the species it can support, to provide protection via erosion control, and/or the formation of physical barriers and defence from flooding, was undertaken using the scoring criteria listed in Table 8.

Table 8: Scoring criteria for erosion control, formation of physical barriers and flood defence

Score		Criteria
0	**Negligible**	Habitat, or the species it can support **does not** provide any erosion control, a physical barrier or flood protection.
1	**Low**	Habitat, or the species it can support is likely to provide a **limited** degree of erosion control, a physical barrier or flood protection.
2	**Moderate**	Habitat, or the species it can support is likely to provide a **moderate** degree of erosion control, a physical barrier or flood protection.
3	**High**	Habitat, or the species it can support is likely to provide a **high** degree of erosion control, a physical barrier or flood protection.

Climate regulation

The assessment of a habitat, or the species it can support, to contribute to climate regulation through carbon removal and sequestration, was undertaken using the scoring criteria listed below in Table 9.

Table 9: Scoring criteria for climate regulation

Score		Criteria
0	**Negligible**	Habitat, or the species it can support **does not** contribute to climate regulation through carbon removal and/or sequestration.
1	**Low**	Habitat, or the species it can support is likely to provide a limited contribution to climate regulation, through **low rates** of carbon removal and/or sequestration.

Score		Criteria
2	**Moderate**	Habitat, or the species it can support is likely to provide a reasonable contribution to climate regulation, through **moderate rates** of carbon removal and/or sequestration.
3	**High**	Habitat, or the species it can support is likely to provide a high contribution to climate regulation, through **high rates** of carbon removal and/or sequestration.

Biogeochemical cycling

The assessment of a habitat, or the species it can support, to locally regulate biogeochemical cycles through burrowing, bio-irrigation, respiration and feeding activities, was undertaken using the scoring criteria listed in Table 10.

Table 10: Scoring criteria for biogeochemical cycling

Score		Criteria
0	**Negligible**	Habitat, or the species it can support **does not** contribute to regulation of the biogeochemical cycle.
1	**Low**	Habitat, or the species it can support is likely to provide a limited level of biogeochemical cycling through **low rates** of burrowing, bio-irrigation, respiration, and feeding activities.
2	**Moderate**	Habitat, or the species it can support is likely to provide some level of biogeochemical cycling through **moderate rates** of burrowing, bio-irrigation, respiration, and feeding activities.
3	**High**	Habitat, or the species it can support is likely to provide biogeochemical cycling through **high rates** of burrowing, bio-irrigation, respiration, and feeding activities.

Water purification

The assessment of a habitat, or the species it can support, to locally influence water quality through contaminant uptake, filtration, assimilation or bio-irrigation, was undertaken using the scoring criteria listed in Table 11.

Table 11: Scoring criteria for water purification

Score		Criteria
0	**Negligible**	Habitat, or the species it can support **does not** contribute to regulation of water purification (quality).
1	**Low**	Habitat, or the species it can support is likely to provide a limited level of water purification through **low rates** of water exchange.
2	**Moderate**	Habitat, or the species it can support is likely to provide a reasonable level of water purification through **moderate rates** of water exchange.
3	**High**	Habitat, or the species it can support is likely to provide water purification services through **high rates** of water exchange.

Sensitivity

The criteria for scoring the sensitivity of a habitat to a particular pressure has been derived from the approach outlined by MarESA and in consideration of the approach to sensitivity assessment reported by Tillin *et al.* (2010), and is shown in Table 12. Where habitats were directly assessed by MarESA these scores were used. In cases where habitats were not assessed by MarESA, biotope derivatives were reviewed instead. It is acknowledged that these assessments can, in part, be relevant to the specific species assemblages these habitats support; and thus multiple biotope assessments belonging to these BSHs were often consulted to confirm comparable conclusions for sensitivity-pressures. A precautionary approach was taken when combining these habitats, with the highest recorded sensitivities being used for final scores.

MarESA describe sensitivity as **"…a product of: the likelihood of damage (termed intolerance or resistance) due to a pressure; the rate of (or time taken for) recovery (termed recoverability, or resilience) once the pressure has abated or been removed."**

The overall sensitivity score will reflect a habitat's (and its features') tolerance and adaptability to, and recoverability from, from each pressure.

Table 12: Scoring criteria for habitat sensitivities

Score		Criteria
0	**Negligible**	Habitat and its supporting species are determined to be **not sensitive**. It is generally tolerant of, and can accommodate or recover from, the anticipated pressure.
1	**Low**	Habitat and its supporting species are determined to be of **low sensitivity**. It has reasonable tolerance of capacity to avoid, adapt to, and accommodate, or recover from the anticipated impact.
2	**Moderate**	Habitat and its supporting species are determined to be of **moderate sensitivity.** It has a limited tolerance of capacity to avoid, adapt to, and accommodate, or recover from the anticipated impact.
3	**High**	Habitat and its supporting species are determined to be of **high sensitivity**. It has a very limited tolerance of capacity to avoid, adapt to, and accommodate, or recover from the anticipated impact.

Evidence review and confidence assessment

Evidence review

A literature review was undertaken to source evidence on the ecosystem services and sensitivities of each benthic habitat, and to inform the subsequent scoring.

The systematic evidence review employed multiple search methods, e.g. Internet search engines, opensource databases and bibliographic databases etc., and employed forward and back citation pursuit. Searches of Scopus and Google Scholar were conducted by identifying key themes specific to the scope of the Project. Both peer-reviewed literature and ‘grey’ information sources were reviewed.

The review was conducted for all available years and was not limited to information from English waters (e.g. was extended to relevant European feature data and information). Searches used a protocol of linking search theme keywords with ‘OR’ and joining to a descriptor using the ‘AND’. Reference was to websites of UK (JNCC, Natural England, UK Government, Natural Resources Wales (NRW)). Example keywords used as search terms are listed in Appendix B.

The literature and online portals listed below, formed the key evidence sources to support this review. This was supplemented by additional scientific peer-reviewed and grey literature.

- Ellis *et al.* (2012). Spawning and nursery grounds of selected fish species in UK Waters. Science Series Technical Report no. 147
- European Environment Agency (EEA) European Nature Information System (EUNIS) (European Environment Agency, 2012a-p)
- Fletcher *et al.* (2012). Marine Ecosystem Services. Natural England Commissioned Report 088
- Galparsoro *et al*. (2014). Mapping ecosystem services provided by benthic habitats in the European North Atlantic Ocean
- Joint Nature Conservation Committee (JNCC) Marine Habitat Classification for Britain and Ireland (JNCC, 2015a-p)
- JNCC UK Biodiversity Action Plan Priority Habitat Descriptions (JNCC 2008a-b)
- Marine Life Information Network (MarLIN) Habitats List (MarLIN, 2020)
- MarLIN Marine Evidence based Sensitivity Assessment (MarESA) (Tyler-Walters *et al.*, 2018)
- Natural England and JNCC (2010). Marine Conservation Zone Project. Ecological Network Guidance.

Confidence assessment

As part of the evidence review, a confidence assessment was undertaken to provide an understanding of both the availability, and quality of evidence that was used to support the habitat assessment (ecosystem services and sensitivities for each habitat listed in 'Ecosystem Services' and 'Sensitivity').

The confidence assessment has been adapted from Kvile *et al.* (2014), and provides a semi-quantitative assessment of the quality and applicability of the literature used. The quality and availability of evidence available will be scored on a scale of **1-5**:

- **Score of 0** equals '**unknown'**, meaning there is no literature available. Scores for each habitat have been assigned with reliance on specialist opinion for each habitat
- **Score of 1** equals '**inferred'**, meaning there is no literature available, but some level of reference can be drawn from comparable examples such as similar groups of habitats; and expert opinion may also be required
- **Score of 2** equals '**known'**, meaning there is some level of information available and mostly sourced from the grey literature
- **Score of 3** equals **'very well known'**, meaning there is a large amount, and high level, of information, available both in grey literature and peer-reviewed literature.

For each habitat, a score is given for both *Ecosystem Services* and *Sensitivity*, which are subsequently summed together to provide an **Overall Confidence Score (0-6)**.

It is important to recognise that literature to evidence service provision or sensitivity is likely to be more readily available than evidence of *insensitivity* or *the absence* of a particular service. In addition, at this stage it is not advisable to give individual confidence scores for every ecosystem service or sensitivity parameter listed, as evidence may not be available in every case for all habitats. Furthermore, it is not known at this time which will service, or sensitivity will be the most important or relevant consideration for specific future scenarios where compensatory measures are required.

Recommendation: For a OWF project, it is recommended that this confidence assessment approach is refined further to include a 'Screening Stage' to evaluate the ecosystems services and sensitivities that will be of greatest relevance and importance to the habitats to be considered as potential compensatory measures.

Individual confidence assessment scores can then be allocated for each 'screened in' habitat characteristic; with the summed confidence assessment score divided by number of habitat characteristics to give the final Overall Confidence Score.

Multivariate analysis – habitat comparisons

Multivariate analysis was subsequently undertaken (using Plymouth Routines in Multivariate Ecological Research (PRIMER) v.7 software) to identify similarities/dissimilarities between habitats based on respective ecosystem service characteristics.

The following descriptions of the various procedures and tests are all summaries of the full descriptions provided in the PRIMER manual (Clarke *et al.,* 2014; Clarke and Gorely, 2015). The full manuals can be consulted for detailed description of each test undertaken.

The following analysis was originally conducted for both ecosystems services and sensitivities. On inspection of statistical outputs, it was agreed to explore similarities and differences between habitats, based on ecosystem services only.

As the sensitivities being considered during compensatory measure determination will likely change on a case-by-case basis, it was determined that clustering sensitivities may obfuscate more subtle differences between habitats. Sensitivity scores should therefore be used as is to inform future compensatory measure decisions.

Multi-dimensional Scaling (MDS) two-dimensional (2-D) plots were produced to provide a visual representation of the relationships between habitats. The Bray-Curtis similarity matrix was used to create MDS plots of habitats similarities. Habitats with greater similarities are placed closer to one another, with more dissimilar habitats placed further away. The usefulness of the plots is indicated by a stress value. Stress values should be considered as follows:

- <0.05: Excellent representation of the relationships between the data;
- <0.1: Good plot with little prospect of a misleading interpretation;

- <0.2 Potentially useful although for values toward the upper end of this range too much emphasis should not be placed on the detail of the plot;
- 0.2 – 0.3: Treat these points with scepticism and consider plots at higher dimensions;
- >0.3 The points are close to random. Consider plots at higher dimensions.

As scoring of ecosystem services and sensitivities for each habitat had been limited to integers of 0-3, no pre-treatment of the data was undertaken (e.g. square-root transformation).

In addition to MDS, a cluster analysis was undertaken to find 'natural groupings' of habitats, by carrying out a simple agglomerate, hierarchical clustering, where the output is a dendrogram, displaying groupings of samples. This routine in PRIMER was run alongside the 'similarity profile' (SIMPROF) permutation test which looks for statistically significant evidence of genuine clusters across habitats.

The 'clusters' (groups of habitats), identified from the SIMPROF tests for ecosystem services were analysed further to identify similarities within each cluster. Similarity Percentage (SIMPER) tests was used to determine the relative importance of an individual habitat characteristic (e.g. primary production), in contributing to the similarities between habitats within a cluster. The SIMPER test identifies habitat characteristics (i.e. a type of ecosystem service) that typify that cluster of habitats.

The statistical output from the multivariate analysis helped to initially inform the identification of those groups of habitats suitable to be mapped as part of Phase 2.

Phase 1: quality assurance

The full list of habitats (as listed in Appendix A) was split into broad habitat types and assigned to an individual assessor to determine confidence in assessment based on the level of evidence available for each individual habitat, and to assign scores for both ecosystem services and sensitivities. Through this approach, an individual assessor was able to focus on sourcing information for similar habitats, and to understand the evidence base available.

The 5 broad groupings were:

- **Littoral rock** (A1.1, A1.2 and A1.3), and littoral and sublittoral specialist habitat sub-types (e.g. chalk, and peat and clay exposures) that can represent Annex I geogenic/rocky reef
- **Infralittoral** and **circalittoral rock** (A3.1, A3.2 and A3.3; A4.1; A4.2 and A4.3) that can represent Annex I geogenic/rocky reef (excluding those specialist habitats listed above)
- **Littoral** and **sublittoral biogenic reef** (A2.7; A4.2, A5.4 and A5.6) that can represent Annex I reef (e.g. *Sabellaria spinulosa, S. alveolata* and *Modiolus modiolus*)

- **Sublittoral coarse** and **sandy sediments** (A5.1; A5.2) that may represent Annex I Sandbanks slightly covered by sea water all the time; **Sublittoral mixed sediments** (A5.4); and **Native oyster beds** (that can be associated with A5.4)
- **Sublittoral muds** (A5.3) and **Sublittoral macrophyte-dominated sediments** (A5.5) that may represent Annex I Sandbanks slightly covered by sea water all the time (including maërl beds).

Alongside continuous internal meetings between the Project Team, a number of workshops were held, attended by the Working Group, i.e. the assessors themselves and the Project Team's Principal Scientists.

Workshop 1 (14 February 2022): The Working Group discussed and evaluated the associated habitat descriptor scores for all habitats. This collaborative review process was adopted to ensure consistency in scoring between all assessors, and to apply expert judgment from senior staff.

Workshop 2 (17 February 2022): The Working Group discussed the relative confidence assessment scores that were used to inform scoring for each of the habitats (during Workshop 1). The multivariate statistical output was also reviewed (MDS and Cluster dendrogram plots, SIMPER) to identify habitat 'clusters' (groups) to carry forward for mapping under Phase 2; and to identify any 'outliers' that should be excluded. In addition, key constraints were identified for each 'cluster', where intra-cluster variation in ecosystem services would be important considerations for any future OWF development-specific assessments.

Phase 2: spatial and confidence habitat mapping

Spatial data mapping

The following data sources from Natural England and JNCC for the production of the spatial habitat maps:

Habitat Type	Habitat Subtype	Data layer	Provider
Annex I	Reefs (biogenic & geogenic)	C20220126_Reefs_polys_v8_3_OpenData.shp	JNCC
Annex I	Large shallow inlets and bays	Complex_Features_Polys_WGS84_MHS_Open_ENG.shp	Natural England
Annex I	Estuaries	Complex_Features_Polys_WGS84_MHS_Open_ENG.shp	Natural England

Habitat Type	Habitat Subtype	Data layer	Provider
Annex I	Sandbanks	C20200428_Sandbanks_v3	JNCC
EUNIS (L3)	NA	C20220216_CombinedMapNoEvBase	JNCC
EUNIS (L4)	NA	C20220216_CombinedMapNoEvBase	JNCC
FOCI	HOCI	Input_HOCI_Polys_WGS84_MHS_Open	Natural England
FOCI	BHS	Input_BSH_Polys_WGS84_MHS_Open	Natural England

Recommendation: For a OWF project, it is recommended that regional and site-specific sediment, habitat, biotope, and feature data are also included, in order to increase spatial resolution of the assessment. This will increase confidence in assessment of presence, and ability of a particular habitat/sub-feature to be used as same feature compensation ('

Confidence Assessment – Spatial Data **Methodology**').

Figures were produced showing the extent and distribution of relevant habitats for each cluster. Layers included within each figure were determined by the habitats contained within the full habitat name of each cluster component as presented within Appendix E. As full habitat names were limited to including Annex I, BSH and FOCI-level habitats, additional EUNIS Level 4-6 habitats determined relevant to the biotope were included where available. Whilst more specific EUNIS datasets were used where available, in many cases these were not available, and therefore, the most specific EUNIS-level dataset used was at EUNIS Level 3. In some cases, these datasets are broader than the habitat they represent, and whilst this is captured by the confidence assessment criteria presented in Table 13, it should be considered whilst using the Phase 2 outputs. Additionally, some datasets used included polygons comprising multiple EUNIS-level habitats. Data indicating the extent of individual habitats within these polygons was not available. As such, these combined datasets have been included in all outputs where at least one component was determined relevant to the cluster being described. However caution should be exercised when examining the extent of these layers, especially in cases where other component EUNIS-level habitats are not relevant to the cluster. Exact spatial data layers used for each cluster are presented in Appendix F. In some circumstances EUNIS Level 4 datasets were not available. However, datasets indicating the extent of component Level 5 and

Level 6 datasets were available (e.g. a dataset for EUNIS Level 4 A2.71 and A4.22 were not available for the mapping of Cluster V, however datasets for EUNIS Level 5 A2.711, and EUNIS Level 6 A4.2212 were present). All component datasets of the listed EUNIS Level 4 categories have been utilised where available.

Confidence assessment – spatial data methodology

Phase 2 confidence assessment was undertaken to assess the confidence for the data to indicate habitat suitability at a cluster level. Scores were determined based on the data layers present at a given location. Where layers overlap, this score is additive to reflect an increasing number of habitats indicative of the cluster's presence. Datasets with a higher specificity were assigned higher scores, as were datasets directly relating to the key habitats presented in Table 1. Overall scoring per layer ranged between 1 and 4.5.

A combined confidence assessment score was determined based on the combined scores of each dataset, outlined in Table 13.

Table 13: Data parameters and weighting used in the Confidence Assessment (Adapted from: MarineSpace Ltd *et al.*, 2013)

Confidence Test	Scoring Methodology
Habitat Suitability Confidence	Scores were determined based on dataset type, with higher scores assigned to datasets reflective of more specific habitat types. An additional 0.5 points were added to datasets reflecting the specific key habitats determined for this study. 1 – Annex I Habitat 1.5 – EUNIS Level 3 Habitat (Broad Scale Habitat) 2 – EUNIS Level 4-6 Habitat* 4 – FOCI Habitat +0.5 – Key Habitat

*In some circumstances EUNIS Level 4 datasets were not available, however datasets indicating the extent of component Level 5 and Level 6 datasets were available (e.g. a dataset for EUNIS Level 4 A2.71 and A4.22 were not available for the mapping of Cluster V, however datasets for EUNIS Level 5 A2.711, and EUNIS Level 6 A4.2212 were present). All component datasets of the listed EUNIS Level 4 categories have been utilised where available.

Although each individual dataset will be scored up to a maximum of 4.5, cluster distribution will be mapped using all datasets determined to be representative of the cluster. The total confidence score for a given point will be cumulative of all overlying datasets at that point. The number of datasets used for each figure will vary depending on the availability of relevant datasets, meaning that the maximum confidence score will vary by cluster,

however the same legend will be used across all clusters. Spatial data layers used for each cluster are presented in Appendix F.

In some instances, Natural England and JNCC datasets may overlap. Where overlap occurs both datasets remain within the Phase 2 Outputs, however it should be considered that these datasets may both have been produced using the same raw data, and therefore confidence in these regions may be artificially inflated. Further investigation into the sources of each of the datasets used should be ensured should compensation be required for a given cluster and undertaken on a case-by-case basis.

An additional confidence assessment was considered which would have been based on the quality and robustness of the datasets used for the spatial mapping. This assessment would have followed a similar methodology to that detailed in MarineSpace Ltd *et al.* (2013), which was discussed and agreed with the Marine Management Organisation (MMO) Marine Aggregate Regulator Advisory Group, prior to its use in sandeel and Atlantic herring spawning habitat assessments in 2013 (MMO, 2013). However, datasets sourced from Natural England (and JNCC) for use in Phase 2 were determined not to contain sufficient supplemental data to effectively inform the confidence assessment. This was predominantly due to the fact that datasets originated from the same, or similar, sources, or were collated data (e.g. EMODnet data). As such, differences in confidence between layers would be limited (similar), reducing the utility provided by the secondary confidence assessment exercise.

The Phase 2 Confidence Assessment has been designed to provide an indicative overview of a particular area's likelihood to represent the ecosystem service provision characteristics of a given cluster. In capturing all available data layers likely to represent a cluster as a whole it is ensured that regions with a high level of data availability are given an increased degree of confidence. However, through this approach there is the potential for those areas represented by a single finer scale data layer to be scored lower than an area that is represented by a number of broader scale data layers. Whilst scoring has been designed to minimise this effect (by assigning FOCI-level data layers a score at least double that of broader data layers), it will be important to be cognisant of this whilst examining Phase 2 GIS outputs. The additional confidence assessment described above should be applied on a case-by-case basis to ensure that data layers used are of an appropriate vintage and relevance to the exact habitat being considered for compensatory measures.

3. Phase 1 output

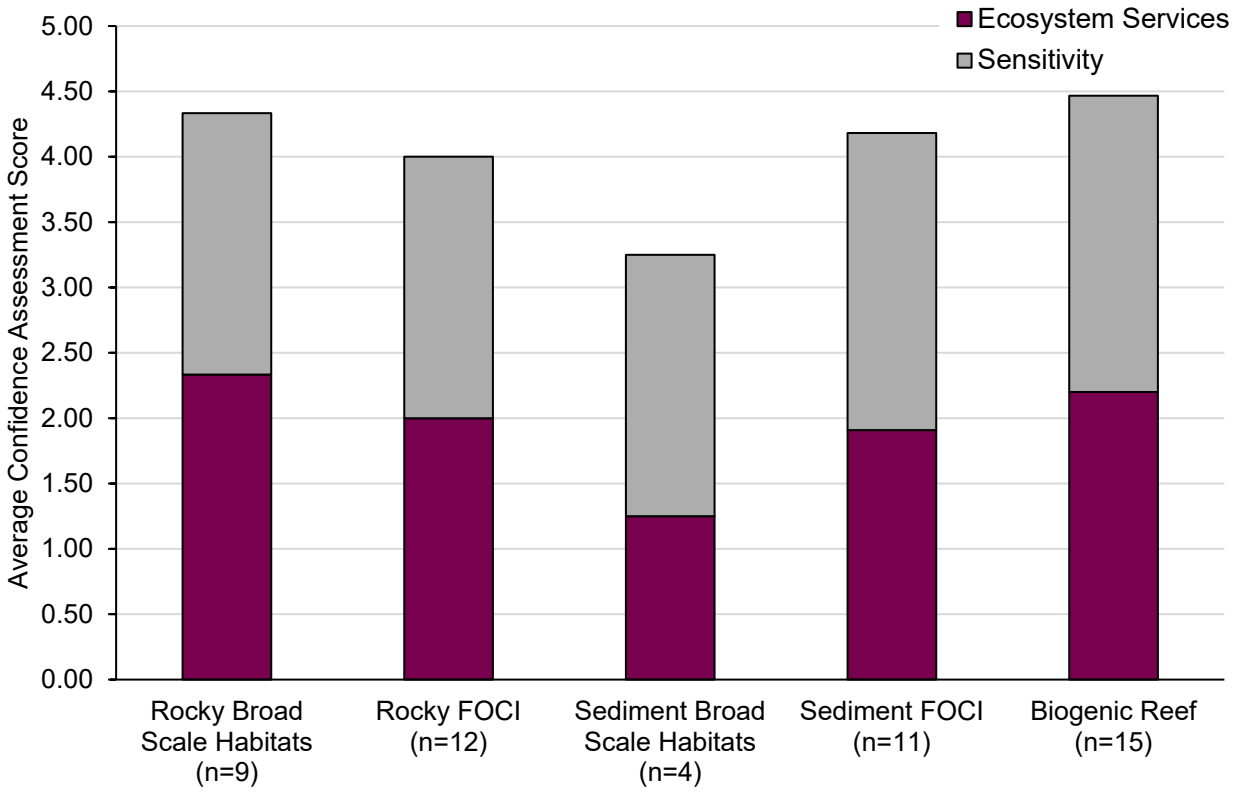
Confidence assessment and evidence data gaps

Confidence assessment scores for each habitat type/sub-type, and associated ecosystem services and sensitivity, are presented in the Habitat Assessment Workbook (Appendix C).

Figure 1 illustrates the variation in confidence assessment scores between the different broad categories of habitats that had been reviewed. Overall, a marginally higher average score was reported against the quality and availability of information regarding biogenic reefs (blue mussel, horse mussel, *Sabellaria* spp., cold water corals, and native oyster). This increased score is a result of these specialised biogenic habitats providing multiple high ecosystem services, and being of focussed conservation interest (bias), and include historically well-studied species (e.g. *Mytilus edulis* and *S. spinulosa*), with an associated abundance of relevant information. Less information was available, overall, for the BSH sedimentary habitats, where information had to, in part, be inferred from biotopes that may be supported in these broad sedimentary habitats.

With the exception of rocky BSHs (high energy littoral rock etc.), a marginally higher average confidence assessment score was determined for all of the broad groupings for information relating to sensitivity, compared to ecosystem service. This is not unexpected as much of the information on sensitivity was primarily derived from MarESA; which is a comprehensive source of information on sensitivities for a range of habitat receptors to a wide range of natural and anthropogenic pressures.

Figure 1: Average confidence assessment scores for ecosystem services and sensitivity for Broad Scale Habitat and FOCI categories (n = number of habitats scored within each category)



A key source of information for the assessment for ecosystem services was a Natural England commissioned evidence review (Fletcher *et al.,* 2012). This report presents a baseline understanding of the marine ecosystems services that are provided by BSHs and FOCIs that are likely to be protected within an MCZ. The Phase 1 review identified a potential limitation in how the available evidence base could be applied in assessment. Determination of ecosystem service provision by each habitat had to, in part, be deduced, based on a lack of evidence; where, if there was no information, it might be assumed that the habitat did not provide the relevant ecosystem service. Data on ecosystem services were identified to be lacking primarily at the BSH-level; particularly for sublittoral sediments. Fletcher *et al.* (2012) advises caution, warning that insufficient evidence should not be equated with the provision of no beneficial ecosystem service.

Much of the evidence used to inform habitat sensitivities to different pressures was derived from the MarESA sensitivities reviews. Although these are not peer-reviewed publications, a comprehensive range of resources are used to inform these pressure-sensitivity assessments; following a systematic method to compile and assess the best available scientific evidence in each case (Tyler-Walters *et al.,* 2018).

No sensitivity assessment was available for higher-level habitats (e.g. BSH Level 3 and 4), so biotope derivatives were reviewed instead. It is acknowledged that these assessments can, in part, be relevant to the specific species assemblages these habitats support; and

thus multiple biotope assessments belonging to these BSHs were often consulted to confirm comparable conclusions for sensitivity-pressures. A precautionary approach was taken when combining these habitats, with the highest recorded sensitivities being used for final scores.

A consistent finding from MarESA was that across habitats, the same set of sensitivities were either 'Not Assessed', 'Not Relevant' or reported as having 'No Evidence'[7] available (see bullet list below). In these cases, sensitivity information was assessed based on any additional information retrieved (if available in the peer-review and grey literature), and in discussions as part of Workshop 1 (see 'Phase 1: Quality Assurance').

Evidence gaps under MarESA were generally found for:

- Contamination
- Ocean acidification[8] (except for native oyster biotopes etc.)
- EMF
- Underwater noise.

With the exception of chemical pressures arising from de-oxygenation, organic enrichment and nutrient enrichment, for many MarESA assessments, potential contamination from other compounds was either stated as 'Not Assessed' or 'No Evidence'. Additional information on potential benthic responses to impacts from hydrocarbons and heavy metals was sought, as there can be indirect pathways for this pressure depending on substrate type, via the physical disturbance of the seabed during installation phase for an OWF, that can re-suspended contaminated sediments.

MarESA determined that underwater noise changes are only relevant to mobile species (fish and marine mammals etc.) and thus this pressure is considered to be 'Not Relevant' to benthic species and habitats (Tyler-Walters *et al.,* 2018). However, it is of note that research has demonstrated that anthropogenic sources of sound in coastal and marginal shelf seas, which may arise from construction, may alter infaunal invertebrate activity. This may, in turn, affect geochemical cycling of nutrients (Solan *et al.,* 2016), and recent studies have shown negative behavioural responses by the commercially important European lobster *Homarus gammarus* (Leiva *et al.,* 2021).

[7] Refer to Tyler-Walters *et al.* (2018) for a definition of each of these assessment terms.

[8] Climate change pressures were never originally incorporated into MarESA assessments. Subsequently, JNCC commissioned MarLIN to look at a specific set of climate change pressures in relation to key habitats that occurred within specific sites (of interest to JNCC). In the interests of sharing evidence, these sensitivity assessments are included on the MarESA website. However, currently not many biotopes are considered for sensitivity in relation to ocean acidification.

MarESA states ‘No Evidence’ for EMF across receptor groups. There has been a number of studies investigating the behavioural and physiological responses that marine benthic species and fish may have to EMF. However, the results from these investigations are highly species-specific, and thus there remains a knowledge gap for many marine species. Research on the potential impacts of EMF from cables (e.g. OWF transmission cables) on species supported by benthic habitats may increase over time, and a better understanding of risk alone, and in combination. In this eventuality it may be necessary to amend assessments within this review accordingly.

Recommendation: It is advised that further evidence reviews of sensitivities to underwater noise and EMF are to be re-reviewed in the future, in line with any potential research on this emerging topic of interest for benthic features.

Habitat descriptor scores

All scores for individual ecosystem services and sensitivities are presented in the Habitat Assessment Workbook (Appendix C; Tab ‘Habitat Assessment Matrix’).

Habitat comparison

Habitat clusters

Following the multivariate analysis of habitats and scores determined for their respective ecosystem service provision, an initial total of 18 habitat clusters (groupings) was determined (‘a’ to ‘r’).

The graphical MDS output for ecosystem services shows indicative overlaps between habitats and their clusters (as determined from SIMPROF) (Appendix D).

The ordination of habitats in the MDS plot for ecosystem services shows expected patterns, with sedimentary and rock habitats distinctly separated, and specialised FOCI habitats such as biogenic reefs, chalk, and peat and clay clustered (Appendix D).

Some habitats were scored identically for each ecosystem service, as they contained the same specific habitat. For example, the 4 habitats that all *contain* or *may contain* the FOCI ‘native oyster beds’, were scored the same, resulting in a 100% similarity with one another. This led to ‘native oyster beds’ forming their own distinct SIMPROF cluster for ecosystem services (‘h’); despite having a number of similarities with other habitats. As such, it was determined that using grouping based on a cut-off similarity of 80% would allow groups to capture other habitats that may provide similar ecosystem services (e.g. blue mussel beds for native oysters). Table 14 presents the composition of the 80% clusters (both by habitat and by multivariate cluster), and also provides information on the key habitats contained within each cluster, and the key ecosystem services traits shared

by each component habitat of the cluster. Habitats are named in full, alongside the 80% clusters and multivariate clusters within which they are contained in Appendix E.

Following re-alignment of the habitat groupings at 80% similarity for ecosystem services, 16 'Clusters' were subsequently identified ('I' to 'XVI'), including 5 habitat 'outliers' (Table 14: Habitat clusters at 80% similarity to be used for spatial assessment in Phase 2. Full habitat names are available in Appendix A

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
I	High Energy Infralittoral Rock	a	1	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
II	High Energy Infralittoral Rock	b	13	Annex I Reefs	NA
III	Peat and Clay exposures and Littoral chalk communities	c	2; 3; 5; 6	Annex I Reefs; FOCI Peat and clay exposures	Secondary production (molluscs); Primary production; Food web dynamics (birds)
IV	Cold-water Coral Reefs	d	46	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
V	Biogenic Annelid Reefs	e	10; 22; 45; 48	Annex I Reefs; FOCI Ross worm (Sabellaria spinulosa) reefs	Secondary production (annelids); Habitat formation (biogenic reef); Erosion control

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
VI	Littoral Rock (low and moderate energy)	f	4; 7; 8; 9	Annex I Reefs	Secondary production (molluscs, arthropods); Primary production
VII	Biogenic Bivalve Reef	g, h, i	37; 40; 44; 38; 41; 50; 51; 11; 12; 47	Annex I Reefs; FOCI Blue mussel beds; FOCI Native oyster beds	Secondary production (molluscs); Spawning/nursery (shellfish); Habitat formation (biogenic reef); Biogeochemical cycling; Water purification; Food web dynamics (birds)
VIII	Saline Lagoons	j	29	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
IX	Sublittoral Macrophyte Dominated Sediment	j	42; 43	Annex I Sandbanks slightly covered by sea water all the time	Biogeochemical cycling; Primary Production; Climate regulation
X	Subtidal Chalk (associated with seacaves)	k	49	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XI	Circalittoral Rock (all energies)	l	18; 19; 20; 21; 23; 24	Annex I Reefs; BSH High energy circalittoral rock; BSH Moderate energy circalittoral rock; BSH Low energy circalittoral rock; FOCI Subtidal chalk	Secondary Production (other, fish, arthropods)
XII	Infralittoral Rock (low and moderate energy)	m	14; 17; 15; 16	Annex I Reef; BSH Moderate energy infralittoral rock; BSH Low energy infralittoral rock; FOCI Subtidal chalk	Secondary Production (arthropods, molluscs, other, primary production)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XIII	Sublittoral Mud	n, o	32; 34; 30; 31; 33	BSH Sublittoral muds	Secondary Production (annelids, arthropods, other, molluscs); Habitat formation (burrowing); Biogeochemical cycling
XIV	Sublittoral Coarse Sediment	p	25; 26	Annex I Sandbanks slightly covered by sea water all the time; BSH Sublittoral coarse sediments	Spawning/nursery (herring); Secondary production (fish, arthropods, molluscs)
XV	Sublittoral Sand	q	27; 28	Annex I Sandbanks slightly covered by sea water all the time; BSH sublittoral sand	Secondary production (fish, arthropods, molluscs, annelids); Spawning/Nursery (sandeel, fish); Food web dynamics (birds); Habitat formation (biogenic reef, burrowing)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XVI	Sublittoral Mixed Sediments	r	35; 36; 39	BSH Sublittoral mixed sediment; FOCI Native oyster beds	Secondary production (fish, molluscs, annelids, shellfish); Spawning/nursery (shellfish); Food web dynamics (birds)

Figure 2, page 56, is a cluster dendrogram based on Bray-Curtis similarities of habitat ecosystem services scores and resultant habitat clusters (I to XVI). The clusters connected by a red dotted line, all habitats aside from 1, 3, 46 and 49 are not significantly different to each other (p>0.05, SIMPROF analysis). Horizontal dashed black line across all indicates slice at 80% similarities).

The 80% similarity cut off ('I' to 'XVI') generally aligned with the original SIMPROF clusters ('a' to 'r'). However, the use of the 80% similarity cut off resulted in some amalgamations; notably[9]:

- The amalgamation of SIMPROF clusters 'g' (file shell FOCI and horse mussel beds FOCI: 37, 40, 44), 'h' (native oyster beds FOCI: 38, 41, 50, 51), and 'i' (blue mussel beds FOCI: 11, 12, 47) to form the larger cluster 'VII' biogenic bivalve reefs
- Split of SIMPROF cluster 'j' into 2 cluster groups 'VIII' (saline lagoons FOCI: 29) and 'IX' (BSH sublittoral macrophyte dominated sediment, seagrass FOCI and maërl beds FOCI: 42, 43)
- The amalgamation of SIMPROF clusters 'n' (sea-pen and burrowing megafauna communities FOCI: 32, 34) and 'o' (BSH sublittoral mud, and mud habitats in deep water FOCI: 30, 31, 33).

This 80% cut off was automatically applied for all groupings, with the exception of the following deviations:

- Retention of SIMPROF cluster 'm' habitats that all represent BSHs low and moderate energy infralittoral rock (labelled 'XII')
- Retention of SIMPROF cluster 'q' (BSH sublittoral sand) and cluster 'r' (sheltered muddy gravels FOCI) (labelled 'XV' and 'XVI, respectively).

These 2 adjustments were made following discussions undertaken as part of 'Workshop 2', as part of the QA/QC process (see 'Phase 1: Quality Assurance').

[9] Full habitat names associated with habitat numbers provided in the bullets below are provided in Appendix A.

Table 14: Habitat clusters at 80% similarity to be used for spatial assessment in Phase 2. Full habitat names are available in Appendix A

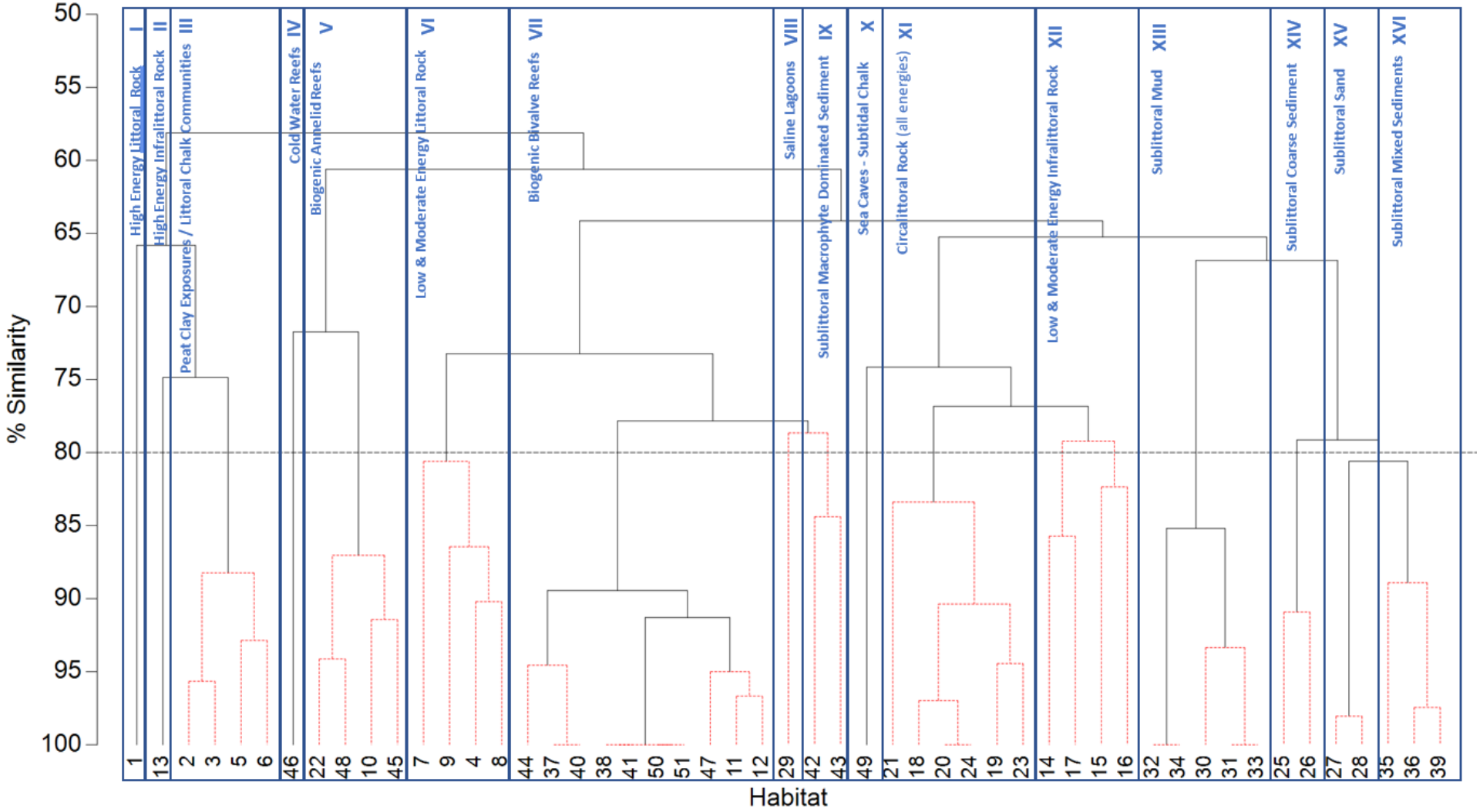
Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
I	High Energy Infralittoral Rock	a	1	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
II	High Energy Infralittoral Rock	b	13	Annex I Reefs	NA
III	Peat and Clay exposures and Littoral chalk communities	c	2; 3; 5; 6	Annex I Reefs; FOCI Peat and clay exposures	Secondary production (molluscs); Primary production; Food web dynamics (birds)
IV	Cold-water Coral Reefs	d	46	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
V	Biogenic Annelid Reefs	e	10; 22; 45; 48	Annex I Reefs; FOCI Ross worm (Sabellaria spinulosa) reefs	Secondary production (annelids); Habitat formation (biogenic reef); Erosion control
VI	Littoral Rock (low and moderate energy)	f	4; 7; 8; 9	Annex I Reefs	Secondary production (molluscs, arthropods); Primary production

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
VII	Biogenic Bivalve Reef	g, h, i	37; 40; 44; 38; 41; 50; 51; 11; 12; 47	Annex I Reefs; FOCI Blue mussel beds; FOCI Native oyster beds	Secondary production (molluscs); Spawning/nursery (shellfish); Habitat formation (biogenic reef); Biogeochemical cycling; Water purification; Food web dynamics (birds)
VIII	Saline Lagoons	j	29	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
IX	Sublittoral Macrophyte Dominated Sediment	j	42; 43	Annex I Sandbanks slightly covered by sea water all the time	Biogeochemical cycling; Primary Production; Climate regulation
X	Subtidal Chalk (associated with seacaves)	k	49	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XI	Circalittoral Rock (all energies)	l	18; 19; 20; 21; 23; 24	Annex I Reefs; BSH High energy circalittoral rock; BSH Moderate energy circalittoral rock; BSH Low energy circalittoral rock; FOCI Subtidal chalk	Secondary Production (other, fish, arthropods)
XII	Infralittoral Rock (low and moderate energy)	m	14; 17; 15; 16	Annex I Reef; BSH Moderate energy infralittoral rock; BSH Low energy infralittoral rock; FOCI Subtidal chalk	Secondary Production (arthropods, molluscs, other, primary production)
XIII	Sublittoral Mud	n, o	32; 34; 30; 31; 33	BSH Sublittoral muds	Secondary Production (annelids, arthropods, other, molluscs); Habitat formation (burrowing); Biogeochemical cycling

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XIV	Sublittoral Coarse Sediment	p	25; 26	Annex I Sandbanks slightly covered by sea water all the time; BSH Sublittoral coarse sediments	Spawning/nursery (herring); Secondary production (fish, arthropods, molluscs)
XV	Sublittoral Sand	q	27; 28	Annex I Sandbanks slightly covered by sea water all the time; BSH sublittoral sand	Secondary production (fish, arthropods, molluscs, annelids); Spawning/Nursery (sandeel, fish); Food web dynamics (birds); Habitat formation (biogenic reef, burrowing)
XVI	Sublittoral Mixed Sediments	r	35; 36; 39	BSH Sublittoral mixed sediment; FOCI Native oyster beds	Secondary production (fish, molluscs, annelids, shellfish); Spawning/nursery (shellfish); Food web dynamics (birds)

Figure 2: Cluster dendrogram based on Bray-Curtis similarities of habitat ecosystem services scores and resultant habitat clusters (I to XVI). Those clusters connected by a red dotted line are not significantly different to each other (p>0.05, SIMPROF analysis). Horizontal dashed black line indicates slice at 80% similarities



Habitat cluster descriptions

Table 14 presents the 16 clusters at 80% similarity shown in Table 14: Habitat clusters at 80% similarity to be used for spatial assessment in Phase 2. Full habitat names are available in Appendix A

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
I	High Energy Infralittoral Rock	a	1	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
II	High Energy Infralittoral Rock	b	13	Annex I Reefs	NA
III	Peat and Clay exposures and Littoral chalk communities	c	2; 3; 5; 6	Annex I Reefs; FOCI Peat and clay exposures	Secondary production (molluscs); Primary production; Food web dynamics (birds)
IV	Cold-water Coral Reefs	d	46	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
V	Biogenic Annelid Reefs	e	10; 22; 45; 48	Annex I Reefs; FOCI Ross worm (Sabellaria spinulosa) reefs	Secondary production (annelids); Habitat formation (biogenic reef); Erosion control

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
VI	Littoral Rock (low and moderate energy)	f	4; 7; 8; 9	Annex I Reefs	Secondary production (molluscs, arthropods); Primary production
VII	Biogenic Bivalve Reef	g, h, i	37; 40; 44; 38; 41; 50; 51; 11; 12; 47	Annex I Reefs; FOCI Blue mussel beds; FOCI Native oyster beds	Secondary production (molluscs); Spawning/nursery (shellfish); Habitat formation (biogenic reef); Biogeochemical cycling; Water purification; Food web dynamics (birds)
VIII	Saline Lagoons	j	29	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
IX	Sublittoral Macrophyte Dominated Sediment	j	42; 43	Annex I Sandbanks slightly covered by sea water all the time	Biogeochemical cycling; Primary Production; Climate regulation
X	Subtidal Chalk (associated with seacaves)	k	49	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XI	Circalittoral Rock (all energies)	l	18; 19; 20; 21; 23; 24	Annex I Reefs; BSH High energy circalittoral rock; BSH Moderate energy circalittoral rock; BSH Low energy circalittoral rock; FOCI Subtidal chalk	Secondary Production (other, fish, arthropods)
XII	Infralittoral Rock (low and moderate energy)	m	14; 17; 15; 16	Annex I Reef; BSH Moderate energy infralittoral rock; BSH Low energy infralittoral rock; FOCI Subtidal chalk	Secondary Production (arthropods, molluscs, other, primary production)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XIII	Sublittoral Mud	n, o	32; 34; 30; 31; 33	BSH Sublittoral muds	Secondary Production (annelids, arthropods, other, molluscs); Habitat formation (burrowing); Biogeochemical cycling
XIV	Sublittoral Coarse Sediment	p	25; 26	Annex I Sandbanks slightly covered by sea water all the time; BSH Sublittoral coarse sediments	Spawning/nursery (herring); Secondary production (fish, arthropods, molluscs)
XV	Sublittoral Sand	q	27; 28	Annex I Sandbanks slightly covered by sea water all the time; BSH sublittoral sand	Secondary production (fish, arthropods, molluscs, annelids); Spawning/Nursery (sandeel, fish); Food web dynamics (birds); Habitat formation (biogenic reef, burrowing)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XVI	Sublittoral Mixed Sediments	r	35; 36; 39	BSH Sublittoral mixed sediment; FOCI Native oyster beds	Secondary production (fish, molluscs, annelids, shellfish); Spawning/nursery (shellfish); Food web dynamics (birds)

Figure 2, and indicates whether each cluster will be carried forward to Phase 2. The table also presents if each cluster *contains* or *may contain* one or more of the original Annex I, BSH or FOCI habitat (Table 1); and lists the key ecosystem services they provide (as determined from SIMPER).

Clusters not assessed under phase 2

Cluster I: High Energy Littoral Rock

The BSH high energy littoral rock (A1.1) was identified as an outlier. This habitat scored lower for ecosystem services than less exposed equivalents (Cluster VI), which would be important for primary production (through macroalgal cover) and supporting a wider range of fauna for secondary production biomass. High energy littoral rock is currently not within scope for this project and thus is not considered further.

Cluster IV: Cold-water Coral Reefs

Cluster IV, cold-water coral reefs, is a designated Priority Marine Features (PMF) in Scotland. This feature showed some overlap in scoring with sublittoral biogenic reefs *Sabellaria* spp. in terms of habitat formation and erosion control, but was dissimilar in relation to secondary production, as this feature is characterised by coral (*Desmophyllum pertusum*[10]) and not annelids. However, there was reported to be a good overlap in overall sensitivities, with the exception that this feature is highly sensitive to de-oxygenation compared with other biogenic reef features. This feature is known to occur in the Atlantic, but within Scottish waters (NBN, 2022a), and thus presently outside the scope of this project. As such Cluster IV is not considered further.

Cluster VIII: Saline Lagoons

Cluster VIII, was represented by saline lagoons. This specialised feature will support unique assemblages of benthic fauna and can either lack, or support vegetation (halophytic algae and angiosperms etc.). Although habitat types of lagoons are often included under the EUNIS classification A5.1 (sublittoral sediment), it can itself also be classified under Annex I ('H1150 Coastal Lagoons') and may be a complex of many other habitat types. As a habitat FOCI it is presently outside scope of this project and unlikely to directly overlap OWF developments, and therefore, Cluster VIII is not considered further.

Cluster X: Subtidal Chalk Associated with Seacaves

Cluster X, the habitat FOCI 'Subtidal chalk' that may be associated with the Annex I feature 'H8330 Submerged or partially submerged sea caves' was approximately 75%

[10] Previously called *Lophelia pertusa,* now synonymized with *Desmophyllum* (Noeksema and Cairns, 2022).

similar alongside infralittoral and circalittoral rock that may also contain the FOCI ‘Subtidal chalk’. However, SIMPROF had identified this habitat as not similar to those habitats. As ‘Subtidal chalk’ will be included in Phase 2, and will be mapped as part of Cluster XI circalittoral rock, and Cluster XII infralittoral rock (low and moderate energy) groupings, Cluster X is not considered further.

Clusters to be assessed under hase 2

Cluster II: High Energy Infralittoral Rock

The BSH ‘High energy infralittoral rock’ (A3.1) was identified as an outlier at 80% similarity; however it is included within the key habitats to be considered within this assessment (Table 1) and will therefore be considered within Phase 2. This habitat scored lower for ecosystem services than less exposed equivalents (Cluster XII), which impacted scores for important for primary production (through macroalgal cover) and reduced the ability for the habitat to support a wider range of fauna for secondary production biomass.

Cluster III: Peat and Clay exposures and Littoral chalk communities

Cluster III is represented by the FOCI ‘Littoral chalk communities’ and ‘Peat and clay exposures’, of both high energy and moderate energy littoral rock. This cluster does not represent sublittoral variations of these habitats. SIMPROF reported no significant difference between any of these habitats ($p>0.05$). However, a structural split was identified within the group between high energy and moderate energy habitat. This is likely to be an artefact of the higher energy habitats scoring lower overall for ecosystem services than moderately exposed features (Table 14: Habitat clusters at 80% similarity to be used for spatial assessment in Phase 2. Full habitat names are available in Appendix A

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
I	High Energy Infralittoral Rock	a	1	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
II	High Energy Infralittoral Rock	b	13	Annex I Reefs	NA

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
III	Peat and Clay exposures and Littoral chalk communities	c	2; 3; 5; 6	Annex I Reefs; FOCI Peat and clay exposures	Secondary production (molluscs); Primary production; Food web dynamics (birds)
IV	Cold-water Coral Reefs	d	46	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
V	Biogenic Annelid Reefs	e	10; 22; 45; 48	Annex I Reefs; FOCI Ross worm (Sabellaria spinulosa) reefs	Secondary production (annelids); Habitat formation (biogenic reef); Erosion control
VI	Littoral Rock (low and moderate energy)	f	4; 7; 8; 9	Annex I Reefs	Secondary production (molluscs, arthropods); Primary production

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
VII	Biogenic Bivalve Reef	g, h, i	37; 40; 44; 38; 41; 50; 51; 11; 12; 47	Annex I Reefs; FOCI Blue mussel beds; FOCI Native oyster beds	Secondary production (molluscs); Spawning/nursery (shellfish); Habitat formation (biogenic reef); Biogeochemical cycling; Water purification; Food web dynamics (birds)
VIII	Saline Lagoons	j	29	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
IX	Sublittoral Macrophyte Dominated Sediment	j	42; 43	Annex I Sandbanks slightly covered by sea water all the time	Biogeochemical cycling; Primary Production; Climate regulation
X	Subtidal Chalk (associated with seacaves)	k	49	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XI	Circalittoral Rock (all energies)	l	18; 19; 20; 21; 23; 24	Annex I Reefs; BSH High energy circalittoral rock; BSH Moderate energy circalittoral rock; BSH Low energy circalittoral rock; FOCI Subtidal chalk	Secondary Production (other, fish, arthropods)
XII	Infralittoral Rock (low and moderate energy)	m	14; 17; 15; 16	Annex I Reef; BSH Moderate energy infralittoral rock; BSH Low energy infralittoral rock; FOCI Subtidal chalk	Secondary Production (arthropods, molluscs, other, primary production)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XIII	Sublittoral Mud	n, o	32; 34; 30; 31; 33	BSH Sublittoral muds	Secondary Production (annelids, arthropods, other, molluscs); Habitat formation (burrowing); Biogeochemical cycling
XIV	Sublittoral Coarse Sediment	p	25; 26	Annex I Sandbanks slightly covered by sea water all the time; BSH Sublittoral coarse sediments	Spawning/nursery (herring); Secondary production (fish, arthropods, molluscs)
XV	Sublittoral Sand	q	27; 28	Annex I Sandbanks slightly covered by sea water all the time; BSH sublittoral sand	Secondary production (fish, arthropods, molluscs, annelids); Spawning/Nursery (sandeel, fish); Food web dynamics (birds); Habitat formation (biogenic reef, burrowing)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XVI	Sublittoral Mixed Sediments	r	35; 36; 39	BSH Sublittoral mixed sediment; FOCI Native oyster beds	Secondary production (fish, molluscs, annelids, shellfish); Spawning/nursery (shellfish); Food web dynamics (birds)

These habitats were characterised as being important for primary production, secondary production (boring molluscs, e.g. the common piddock *Pholas dactylus*) and supporting higher trophic groups (birds), and are all highly sensitive to physical impacts (substratum change, loss and abrasion/disturbance).

Although the FOCI littoral chalk communities were not listed as one of the original habitats for assessment (Table 1) it is recommended that they are mapped together to provide a broad-scale potential same feature compensation in English waters. This should be considered in relation to littoral Annex I reef (rocky/geogenic) and FOCI peat and clay exposures.

Furthermore, if suitable spatial data are available, it is proposed that separate single feature maps are also produced presenting the known spatial distribution of these 2 FOCI. This will inform where there can be regional variation (and associated bias) in reporting of these specialised features in English waters.

Cluster V: Biogenic Annelid Reefs

Cluster V represents habitats that comprise littoral and sublittoral *Sabellaria* spp. biogenic reefs (honeycomb worm *S. alveolata* and Ross worm *S. spinulosa*). Depending on parameters such as extent and elevation of these biogenic concretions, they may also qualify as Annex I reef (e.g. see Gubbay, 2007). SIMPROF reported no significant difference between all these habitats ($p>0.05$) but with a structural split within this group, between *S. alveolata* (10 and 45) and *S. spinulosa* (22 and 48) habitats (Table 14: Habitat clusters at 80% similarity to be used for spatial assessment in Phase 2. Full habitat names are available in Appendix A

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
I	High Energy Infralittoral Rock	a	1	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
II	High Energy Infralittoral Rock	b	13	Annex I Reefs	NA

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
III	Peat and Clay exposures and Littoral chalk communities	c	2; 3; 5; 6	Annex I Reefs; FOCI Peat and clay exposures	Secondary production (molluscs); Primary production; Food web dynamics (birds)
IV	Cold-water Coral Reefs	d	46	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
V	Biogenic Annelid Reefs	e	10; 22; 45; 48	Annex I Reefs; FOCI Ross worm (Sabellaria spinulosa) reefs	Secondary production (annelids); Habitat formation (biogenic reef); Erosion control
VI	Littoral Rock (low and moderate energy)	f	4; 7; 8; 9	Annex I Reefs	Secondary production (molluscs, arthropods); Primary production

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
VII	Biogenic Bivalve Reef	g, h, i	37; 40; 44; 38; 41; 50; 51; 11; 12; 47	Annex I Reefs; FOCI Blue mussel beds; FOCI Native oyster beds	Secondary production (molluscs); Spawning/nursery (shellfish); Habitat formation (biogenic reef); Biogeochemical cycling; Water purification; Food web dynamics (birds)
VIII	Saline Lagoons	j	29	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
IX	Sublittoral Macrophyte Dominated Sediment	j	42; 43	Annex I Sandbanks slightly covered by sea water all the time	Biogeochemical cycling; Primary Production; Climate regulation
X	Subtidal Chalk (associated with seacaves)	k	49	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XI	Circalittoral Rock (all energies)	l	18; 19; 20; 21; 23; 24	Annex I Reefs; BSH High energy circalittoral rock; BSH Moderate energy circalittoral rock; BSH Low energy circalittoral rock; FOCI Subtidal chalk	Secondary Production (other, fish, arthropods)
XII	Infralittoral Rock (low and moderate energy)	m	14; 17; 15; 16	Annex I Reef; BSH Moderate energy infralittoral rock; BSH Low energy infralittoral rock; FOCI Subtidal chalk	Secondary Production (arthropods, molluscs, other, primary production)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XIII	Sublittoral Mud	n, o	32; 34; 30; 31; 33	BSH Sublittoral muds	Secondary Production (annelids, arthropods, other, molluscs); Habitat formation (burrowing); Biogeochemical cycling
XIV	Sublittoral Coarse Sediment	p	25; 26	Annex I Sandbanks slightly covered by sea water all the time; BSH Sublittoral coarse sediments	Spawning/nursery (herring); Secondary production (fish, arthropods, molluscs)
XV	Sublittoral Sand	q	27; 28	Annex I Sandbanks slightly covered by sea water all the time; BSH sublittoral sand	Secondary production (fish, arthropods, molluscs, annelids); Spawning/Nursery (sandeel, fish); Food web dynamics (birds); Habitat formation (biogenic reef, burrowing)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XVI	Sublittoral Mixed Sediments	r	35; 36; 39	BSH Sublittoral mixed sediment; FOCI Native oyster beds	Secondary production (fish, molluscs, annelids, shellfish); Spawning/nursery (shellfish); Food web dynamics (birds)

Figure 2).

In contrast to the variety of geogenic reefs in UK waters, there can be less variation in biogenic reefs (JNCC, 2022a). This cluster was characterised as providing high secondary production (annelids) and formation of biogenic reef habitats and, in addition, affording a moderate level of erosion contol and physical protection (e.g. coastal defence). Regarding overall sensitivity, these features have been grouped as part of a broader cluster, along with other biogenic reef features of horse mussel *Modiolus modiolus* beds*,* cold water coral reefs, and mäerl (Appendix D).

Although *S. alveolata* reef was not listed as one of the original habitats for assessment (Table 1), it is recommended that this habitat (mainly present in the littoral zone) is included under Phase 2, along with the habitat FOCI *S. spinulosa* reefs.

Cluster VI: Littoral Rock (low and moderate energy)

Cluster VI represents the BSHs of low and moderate energy littoral rock habitats (A1.2 and A1.3). If these habitats form part of a continuous extension into the sublittoral environment, then they may also constitute Annex I reefs (geogenic) (JNCC, 2022). Within this habitat cluster, the Habitat FOCIs of 'Intertidal underboulder communities', and estuarine rocky habitats were also included. These relatively less exposed environments were important for primary production and secondary production for molluscs (e.g. littorinid gastropods and limpets).

Littoral rocky BSH habitats and the FOCIs of this cluster were not listed as one of the original habitats for assessment (Table 1). However, given that Cluster III showed that low and moderate littoral rock may contain the FOCIs of peat and clay exposures and littoral chalk communities, it is recommended that these 2 BSH littoral rock habitats are also included under Phase 2.

Cluster VII: Biogenic Bivalve Reef

Cluster VII comprises the largest number of habitats for any cluster identified in assessment, including bivalve reefs of horse mussel *Modiolus modiolus*, native oyster *Ostrea edulis*, blue mussel *Mytilus edulis*, and file shell *Limaria hians*. Originally, SIMPROF had split this broad group into 3 (file shell beds and horse mussel beds, oyster beds, and blue mussel beds). On assessment of the pooled habitats, these all scored highly in terms of ecosystem services; between 27 for horse mussel beds, and 35 for native oyster beds. However, following an assessment of sensitivity, a difference between native oyster and blue mussel beds was identified, compared with the relatively more sensitive file shell beds.

File shell beds are designated as a PMF where they are found. They are predominantly distributed within sea lochs of west Scotland, often associated with *M. modiolus,* and supported in the sediments and nests is a highly abundant and diverse associated benthic assemblages (Trigg *et al.,* 2021). The species itself has a wider, yet patchy distribution,

where it has also been recorded in English, Welsh and Northern Irish Waters (NBN Atlas, 2022b). Both file shells and native oyster, can be both associated with the BSH sublittoral mixed sediment. Although file shells beds are not a designated feature in English waters, and are not listed in Table 1 as a key habitat to assess, it may be important to understand any overlap in potential ecosystem services.

For the purpose of Phase 2, all types of bivalve biogenic habitats will be mapped within English waters (if suitable spatial data are available); it is recommended that further refinement should be made within this group, dependant on the nature and location of a particular development that is being assessed.

Cluster IX: Sublittoral Macrophyte Dominated Sediment

Cluster IX represents the 2 habitat FOCI for seagrass beds and maërl beds (composed of free-living Corallinaceae). Both FOCI belong to the BSH sublittoral macrophyte-dominated sediment (A5.5), and are sub-types of Annex I Sandbanks slightly covered by sea water all the time. These habitats are both important due to their high conservation value, capacity to support diverse fauna, and scarcity within the UK (JNCC, 2022b).

SIMPROF found no significant difference (p>0.05) between these habitats, and they both scored highly overall for ecosystem services (31) and, generally, have high sensitivity (28). However, there are some notable inter-characteristic variations. Both habitats are important for primary production and climate regulation. However, maërl beds are important in terms of formation of biogenic habitat, whereas seagrass beds are not; but seagrass beds are critical for supporting fish and bird fauna and for erosion control and coastal defence (e.g. reduce water flow through canopy). Both habitats are between moderately to highly sensitive to physical loss of habitat and abrasion/disturbance, but with seagrass sensitive to contamination (e.g. organic enrichment) and maërl to ocean acidification. As sub-types of Annex I Sandbanks slightly covered by sea water all the time, for the purpose of this exercise, both habitats will be considered together for Phase 2 (if suitable spatial data are available). However, it is important to note that there are some differences between specific ecosystem services and sensitivities for these habitats.

Cluster XI: Circalittoral Rock (all energies)

Cluster XI included BSH level 3 circalittoral rock habitats of all energies (low A4.3, moderate A4.2, and high A4.3) and, in addition, the habitat FOCIs ‘Subtidal chalk’ (moderate energy circalittoral rock) and ‘Fragile sponge and anthozoan communities on subtidal rocky habitats’ (high and moderate energy circalittoral rock). Dependant the extent and patchiness etc., these habitats can also represent Annex I reef (geogenic) (see Irving, 2009) for more information).

SIMPROF found no significant difference between these 6 habitats (p>0.05), and following analysis these sublittoral rocky habitats were identified as important for supporting sessile epifaunal communities (e.g. ‘other’ - bryozoans, sponges, hydroids, ascidians), and mobile epifaunal such as crabs, lobsters, echinoderms, and demersal fish. However, in relation to

sensitivity, ‘Subtidal chalk’ generally aligned with other chalk habitats as being of a relatively higher sensitivity than that reported for BSHs of circalittoral rock (Appendix D).

For the purpose of this exercise, this cluster group will be assessed individually under Phase 2 and will encompass both potential Annex I reef and sublittoral chalk. However, as part of future development, consideration should be given to potential differences in a specific habitat’s sensitivities to specific pressures.

If suitable spatial data are available, it is also proposed that a separate single feature map would be produced presenting the known spatial distribution of the FOCI ‘Subtidal chalk’. This will inform where there can be regional variation (and associated bias) in reporting of this specialised feature in English waters (this is also relevant to Cluster XII).

In assessment of suitability of habitat as potential compensation for loss of Annex I geogenic reef, it will also be important to understand if this constitutes bedrock or stony reef, and the reef quality (i.e. low, medium, high as per Irving (2009)). This information should then be used to assess suitability of potential compensatory habitat options.

Cluster XII: Infralittoral Rock (low and moderate energy)

Cluster XII included BSH level 3 moderate and low energy infralittoral rock habitats (A3.2 and A3.3), and, in addition, the habitats FOCIs ‘Subtidal chalk’ (moderate infralittoral rock) and ‘Intertidal underboulder communities’ (moderate energy infralittoral rock); all of which may qualify as Annex I geogenic reef. SIMPROF found no significant difference between these 4 habitats (p>0.05), and SIMPER identified that these habitats were all important for secondary production (arthropods, molluscs and ‘other’) and primary production, where algae such as kelps, and associated detritus will provide a source.

As reported above for Cluster XI: circalittoral rock, the sensitivity of the specialised FOCI ‘Subtidal chalk’ in the infralittoral zone, does not overlap in sensitivity with the BSH level 3 infralittoral habitats, but aligns with other FOCI ‘Subtidal chalk’ habitats (Appendix D). For the purpose of this exercise, this cluster group will be assessed individually under Phase 2. As such, this will encompass both potential Annex I reef and sublittoral chalk in the infralittoral zone.

As stated above for Cluster XI (circalittoral rock), a separate single feature map for the FOCI ‘Subtidal chalk’ will also be prepared. This will inform where there can be regional variation (and associated bias) in reporting of this specialised feature in English waters.

In assessment of suitability of habitat as potential compensation for loss of Annex I geogenic reef, it will also be important to understand if this constitutes bedrock or stony reef, and the reef quality (i.e. low, medium, high as per Irving (2009)). This information should then be used to assess suitability of potential compensatory habitat options.

Cluster XIII: Sublittoral Mud

Cluster XIII is represented by BSH sublittoral mud (A5.1) and the 2 FOCI that can feature within it (sea-pen and burrowing megafauna communities, and mud habitats in deep water). SIMPROF had identified a split between these 2 FOCI (Table 14: Habitat clusters at 80% similarity to be used for spatial assessment in Phase 2. Full habitat names are available in Appendix A

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
I	High Energy Infralittoral Rock	a	1	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
II	High Energy Infralittoral Rock	b	13	Annex I Reefs	NA
III	Peat and Clay exposures and Littoral chalk communities	c	2; 3; 5; 6	Annex I Reefs; FOCI Peat and clay exposures	Secondary production (molluscs); Primary production; Food web dynamics (birds)
IV	Cold-water Coral Reefs	d	46	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
V	Biogenic Annelid Reefs	e	10; 22; 45; 48	Annex I Reefs; FOCI Ross worm (Sabellaria spinulosa) reefs	Secondary production (annelids); Habitat formation (biogenic reef); Erosion control

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
VI	Littoral Rock (low and moderate energy)	f	4; 7; 8; 9	Annex I Reefs	Secondary production (molluscs, arthropods); Primary production
VII	Biogenic Bivalve Reef	g, h, i	37; 40; 44; 38; 41; 50; 51; 11; 12; 47	Annex I Reefs; FOCI Blue mussel beds; FOCI Native oyster beds	Secondary production (molluscs); Spawning/nursery (shellfish); Habitat formation (biogenic reef); Biogeochemical cycling; Water purification; Food web dynamics (birds)
VIII	Saline Lagoons	j	29	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	
IX	Sublittoral Macrophyte Dominated Sediment	j	42; 43	Annex I Sandbanks slightly covered by sea water all the time	Biogeochemical cycling; Primary Production; Climate regulation
X	Subtidal Chalk (associated with seacaves)	k	49	Cluster not carried forward – component habitat was not included within the key habitat list and has been shown to have <80% similarity with any other key habitats	

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XI	Circalittoral Rock (all energies)	l	18; 19; 20; 21; 23; 24	Annex I Reefs; BSH High energy circalittoral rock; BSH Moderate energy circalittoral rock; BSH Low energy circalittoral rock; FOCI Subtidal chalk	Secondary Production (other, fish, arthropods)
XII	Infralittoral Rock (low and moderate energy)	m	14; 17; 15; 16	Annex I Reef; BSH Moderate energy infralittoral rock; BSH Low energy infralittoral rock; FOCI Subtidal chalk	Secondary Production (arthropods, molluscs, other, primary production)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XIII	Sublittoral Mud	n, o	32; 34; 30; 31; 33	BSH Sublittoral muds	Secondary Production (annelids, arthropods, other, molluscs); Habitat formation (burrowing); Biogeochemical cycling
XIV	Sublittoral Coarse Sediment	p	25; 26	Annex I Sandbanks slightly covered by sea water all the time; BSH Sublittoral coarse sediments	Spawning/nursery (herring); Secondary production (fish, arthropods, molluscs)
XV	Sublittoral Sand	q	27; 28	Annex I Sandbanks slightly covered by sea water all the time; BSH sublittoral sand	Secondary production (fish, arthropods, molluscs, annelids); Spawning/Nursery (sandeel, fish); Food web dynamics (birds); Habitat formation (biogenic reef, burrowing)

Cluster Code	Cluster Name	Component multivariate clusters	Component habitats	Key habitats contained within cluster	Defining ecosystem services
XVI	Sublittoral Mixed Sediments	r	35; 36; 39	BSH Sublittoral mixed sediment; FOCI Native oyster beds	Secondary production (fish, molluscs, annelids, shellfish); Spawning/nursery (shellfish); Food web dynamics (birds)

Figure 2; Appendix D). However, both sets of habitats offer suitable physical properties for burrowing and provide secondary production for annelids, which are the dominant faunal group in fine silty sediments (in both abundance and diversity). As such, for the purpose of this assessment, they have been brought together as a single cluster (Cluster XIII).

Although neither FOCI is listed within Table 1 as a focal habitat for assessment, and the distribution of these habitats are mainly concentrated in Scottish waters where they are comparable to listed PMFs, they will remain in this cluster. However, these characteristic Scottish habits have a restricted distribution in the Irish Sea, a region that is, and may become increasingly important for OWF projects that are to be considered across different jurisdictions e.g. English and Scottish waters. However, it is important to note that although there is overlap between these 2 FOCI (with biotopes represented in both), there are also differences between them; mainly attributable to depth (see JNCC (2014a) for detailed habitat definitions).

Cluster XIV: Sublittoral Coarse Sediment

Cluster XIV is represented by the BSH sublittoral coarse sediment (A5.3), that can also feature the FOCI sublittoral sands and gravels, which itself, may qualify as a sub-type of Annex I Sandbanks slightly covered by sea water all the time (‘gravelly and clean sands’; JNCC, 2022). SIMPROF reported no significant difference between these 2 habitats within the cluster (p>0.05). In addition, both are potentially important habitats for provision of suitable spawning habitat for Atlantic herring, and secondary production for both fish and invertebrates. These coarse sediments, however, also overlap other sedimentary habitat groups (e.g. BSH sublittoral sands and associated FOCI sublittoral sands and gravels) in their sensitivity to physical change in seabed and sediment type pressures (Appendix D).

Despite this overlap in sensitivity to pressures that can arise from OWF developments, it will be prudent to spatially assess coarse sediments separately to sublittoral sands (and their component habitats). This will allow recognition of the natural division in substrate utilisation between Atlantic herring for spawning, and sandeel for spawning and supporting habitat, of which the latter prefers sandier substrates.

Cluster XV: Sublittoral Sand

Cluster XV is represented by the BSH sublittoral sand (A5.2) that can also feature the FOCI sublittoral sands and gravels, which itself, may qualify as a sub-type of Annex I Sandbanks slightly covered by sea water all the time (‘gravelly and clean sands’; JNCC, 2022). SIMPROF reported no significant difference between these 2 habitats in this cluster (p>0.05), and both are potentially important habitats for providing suitable habitat for sandeel, secondary production for both fish and invertebrates, and support higher trophic levels (birds).

As stated above for cluster XIV (sublittoral coarse sediment), there is an overlap between sublittoral sands and sublittoral coarse (and associated FOCI sublittoral sands and gravels) in their sensitivity to physical change in seabed and sediment type pressures

(Appendix D). However, due to habitat partitioning between sandeel and Atlantic herring, separate spatial assessments will be carried out for each of these 2 cluster groups.

Cluster XVI: Sublittoral Mixed Sediments

Cluster XVI is represented by the BSH sublittoral mixed sediments (A5.4). This can also feature the FOCI sheltered muddy gravels. SIMPROF reported no significant difference between these 2 habitats within the cluster ($p>0.05$) and all are important for secondary production (fish, molluscs, annelids), and support potential spawning and/or nursery habitats for shellfish (e.g. native oyster), and foraging birds.

The BSH sublittoral mixed sediment is commonly present within both estuarine and coastal environments. This relates to this BSH's importance for the provision of suitable substratum for the development of biogenic bivalve reefs of file shell and native oyster (see Cluster VII descriptions above).

4. Phase 2 output

Maps showing the extent and distribution of relevant habitats, and the habitat suitability confidence, are presented in the form of interactive-PDFs, which allow the user to choose to display or hide each layer for easier viewing (Appendices H to V). The maps are described in the following sections. Habitat Map Descriptions

Cluster II: High Energy Infralittoral Rock (Appendix H)

Cluster II comprises a single habitat – EUNIS Level 3 habitat 'High Energy Infralittoral Rock' (A3.1). Datasets representative of this cluster are limited to Annex I – Reef, and EUNIS Level 3 'High Energy Infralittoral Rock' (A3.1). Annex I – Reef is present across large regions of the south coast, including wide regions off the east coast of Cornwall around the Isles of Scilly. This habitat is also found along stretches of the northeast, with smaller areas present across the rest of the English coastline including North Norfolk and Morecambe Bay. The EUNIS Level 3 'High Energy Infralittoral Rock' (A3.1) dataset was most present surrounding the Cornish coast and Isles of Scilly, in distinct stretches across the south coast (notably around Selsey Bill) and northeast coast.

As this cluster as a whole is represented by just two datasets, confidence appears as low across English waters. This is largely an artefact of this cluster comprising a single habitat, which itself it broad relative to the FOCI-level habitats typically found across clusters. An assessment of the individual sources comprising the EUNIS Level 3 'High Energy Infralittoral Rock' (A3.1) dataset should therefore be undertaken on a case-by-case basis in order to increase confidence in the extent and presence of this cluster.

Cluster III: Peat and Clay Exposures and Littoral chalk Communities (Appendices I, J and K)

Cluster III is represented by several habitat layers, with the FOCI-level habitats 'Littoral chalk communities' and 'Peat and Clay Exposures' being the most specific to the cluster. Appendix I displays the broad scale Annex I and EUNIS L3 habitats, whereas Appendices J and K display the known spatial distribution of 'Littoral chalk communities' and 'Peat and clay exposures' respectively, which are mapped separately to highlight where than be regional variation in reporting of these specialised features in English waters. These communities are scarce across English waters, and whilst the broader ecosystem service value of this cluster is not necessarily greater than more widely distributed habitats, they support a number of specialised species. Littoral chalk communities can be found in small patches along the Cornish coastline, around the Isle of Wight, surrounding Margate and Ramsgate, and sparsely along the northeast coast. Peat and clay exposures are present on the east coast, with habitat indicated around Whitstable, the Blackwater Estuary, Hamford Water, and along the north Norfolk coast. Data on the EUNIS-level habitats

relevant to this cluster are only present in a limited coastal area of northeast England on the Scottish boarder.

Confidence is generally greatest wherever FOCI-level habitats are present, with the majority of these areas being located within the extent of Annex I – Reef habitat. However, in some circumstances these FOCI are located independent of Annex I – Reef, in which case confidence is reduced. Given the reduced confidence associated with this sparce distribution, it will be essential to carry out further site-specific ground truthing work to confirm presence of this habitat clusters should compensatory measures be required.

Cluster V: Biogenic Annelid Reefs (Appendix L)

Cluster V is represented by a wide range of datasets across all available levels of data specificity (Annex I; EUNIS Level 3; EUNIS Level 4-6; FOCI). Honeycomb worm (*Sabellaria alveolata*) reefs extent is present to the northwest across much of the Cumbria coast and within Morecambe Bay, within the Mouth of the Severn and Bridgewater Bay (both within the Bristol Channel), and along the north Cornwall coast. The FOCI-level habitat 'Honeycomb worm (*Sabellaria alveolata*) reefs/Blue mussel (*Mytilus edulis*) beds' is only present within Morecambe Bay. Ross worm (*Sabellaria spinulosa*) reefs are distributed within the mouth of the Bristol Channel to the south of Swansea Bay, to the east of the Isle of Wight on the south coast, along much of the eastern East Anglia coastline from the Thames Estuary to Mundesley, off the mouth of the Humber, and between Hartlepool and Tynemouth to the northeast.

Confidence is high in scattered areas across English waters, with the most abundant region of high confidence being the East Anglia coastline. Wide areas of lower confidence are shown further offshore, where datasets are limited to Annex I and EUNIS-level data. These regions may have the potential to support FOCI-level habitats represented within this cluster; however, confidence is reduced as a result of either a lack of these habitats, or a lack of data supporting their presence. Further assessment as to the confidence of available data should be made on a case-by-case basis.

Cluster VI: Littoral Rock (Low and Moderate Energy) (Appendix M)

Cluster VI is represented by a number of datasets, with the FOCI-level habitats 'Estuarine rocky habitats' and 'Intertidal under boulder communities' being the most specific within the cluster. EUNIS-level data is limited for this cluster within English waters, with habitats A1.2 and A1.3 being present in only a limited coastal area of northeast England on the Scottish boarder. Estuarine rocky habitats are present across certain regions of the Cumbria coastline, with larger areas of this habitat present in the Bristol Channel. The habitat is present within a number of estuaries and inlets across the Cornish coast, either side of the Solent, and between Blackwater estuary and Orwell estuary. Scattered areas of habitat are found along the east coast between Bridlington and Scarborough, and off the Northumberland coast. Intertidal under boulder communities are found predominantly

along the Cornish coast out to the Isles of Scilly, and as far east as Portland Bill. Smaller regions of the habitat are present off the Scarborough and Northumberland coast.

Low data availability restricted the breadth of confidence assessment, with areas of highest confidence represented by the location of the FOCI-level habitats described above. Highest confidence for this habitat was along the Cornish coast, however the addition of EUNIS-level datasets will likely allow for a more thorough confidence assessment of this cluster. This should be undertaken on a case-by-case basis.

Cluster VII: Biogenic Bivalve Reef (Appendix N)

Cluster VII is represented by a range of datasets at all levels. The FOCI-level habitat 'Blue mussel (*Mytilus edulis*) beds' is the most specific dataset representative of the cluster. Blue mussel beds can be found along the southern edge of Solway Firth transitioning into a scattered distribution throughout Morecombe Bay. This scattered population trend continues throughout Sussex Bay, Dungeness, The Wash, and extends north from Budle Bay to Fenham Flats.

Confidence for this habitat is highly variable around English Waters. Areas of highest confidence are associated with the presence of FOCI-level habitats from Sussex Bay to Dungeness, with scattered areas of very high confidence in The Wash. These high confidence areas are also associated with EUNIS Level 3 habitat A2.7 off the Norfolk coast. EUNIS-level habitat presence (A5.1 and A5.4) is associate with regions of moderate confidence offshore across English waters. Low confidence areas were apparent inshore, particularly in estuaries and channels where data is limited to Annex I datasets. Further assessment of the confidence of available data should be performed for this cluster on a case-by-case basis.

Cluster IX: Sublittoral Macrophyte Dominated Sediment (Appendix O)

Cluster IX is represented by a number of datasets at all levels, with the FOCI-level habitats 'Seagrass beds' and 'Maerl beds' being most specific to the cluster. Maerl beds are largely distributed throughout Falmouth Bay but are only present in sparse areas along the rest of the English coastline between Portland Bill and Selsey Bill. Seagrass beds have a much greater distribution in this region where they are found from the Isles of Scilly to a number of estuaries and inlets along the southern Cornish coastline on the east coast of the Isle of Wight. Whilst these beds are predominantly located in the sheltered areas of Portsmouth, Langstone, and Chichester harbour, smaller scattered areas of this habitat are also found along the coastline of the Thames Estuary and Clacton-on-Sea.

High confidence areas for this habitat are shown around the Isles of Scilly, in Falmouth Bay, and in smaller scattered areas around the northern Isle of Wight. These high-confidence areas are predominantly represented by areas of FOCI-level habitat presence. Wide areas of low confidence are shown further offshore, and in the inshore

areas of The Wash and the Bristol Channel. Further assessment on the confidence of this cluster should be undertaken on a case-by-case basis.

Cluster XI: Circalittoral Rock (All Energies) (Appendices P and Q)

Cluster XI is represented by multiple datasets across all levels of available data, with the FOCI-level habitats ‘Fragile sponge and anthozoan communities on subtidal rocky habitats’ and ‘subtidal chalk’ being the most specific. Fragile sponge and anthozoan communities on subtidal rocky habitats has a minimal distribution along the English coastline, with a small area to the east of the Isles of Scilly, and a slightly greater distribution in Lyme Bay. Subtidal chalk, whilst having a minimal presence off the north coast of the Isle of Wight and the nearby estuaries, is predominantly distributed around the coast of North Foreland, offshore from Clacton-on-Sea, and further along the Norfolk coastline up to Blakeney Point. The broad scale Annex I, EUNIS L3 and FOCI habitats are all displayed in Appendix P, whereas Appendix Q displays the known spatial distribution of ‘Subtidal chalk,’ which is additionally mapped separately to inform where there is regional variation (and associated bias) in reporting of this specialised feature in English waters.

Areas of intermediate confidence are scattered throughout English waters and are largely located offshore. These are associated with the presence of EUNIS Level 3 habitats (A4.1 and A4.2). High confidence regions are closely associated with the Norfolk Coastline and Clacton-on-Sea, predominantly in areas where the FOCI ‘Subtidal chalk’ habitat is present. Between these areas of high and intermediate confidence are low confidence areas covering the majority of the English coastline. These regions may have the potential to support the FOCI-level habitats that are represented within this cluster; however, this reduced confidence result either from a lack of habitat presence or a lack of available data. This cluster therefore requires further assessment on a case-by-case basis.

Cluster XII: Infralittoral Rock (Low and Moderate Energy) (Appendix Q and R)

Cluster XII is represented by datasets at all levels, with the most specific corresponding with the FOCI-level habitats ‘Intertidal underboulder communities’ and ‘Subtidal chalk’. As with Cluster XI, ‘Subtidal chalk’ is also provided in a separate map (Appendix Q) to inform where there is regional variation (and associated bias) in reporting of this specialised feature in English waters. Intertidal underboulder communities are very sparsely distributed along English Coastlines. The majority of this habitat can be found on the north coast of Cornwall between Port Quin Bay and Constantine Bay. A very small amount of this habitat can be found around the Isles of Scilly, in Wembury Bay, and around Start Point on the South Coast. Subtidal chalk, whilst having a very minimal presence of the north coast of the Isle of Wight and the nearby estuaries, is predominantly distributed around the coast of North Foreland, offshore from Clacton-on-Sea, and further along the Norfolk coastline up to Blakeney Point.

Confidence is highest around the Isles of Scilly and the Norfolk coast, with the most abundant region of confidence associated with the presence of FOCI-level habitats. Wider areas of low confidence are shown offshore where data availability is limited to Annex I and EUNIS-level habitats. Low confidence regions may have the potential to support FOCI-level habitats however further assessment is required on a case-by-case basis for this cluster.

Cluster XIII: Sublittoral Mud (Appendix S)

Cluster XIII is represented by multiple datasets that range across all levels. The most specific within this cluster are the FOCI-levels habitat ‘Mud habitats in deep water’, and EUNIS Level 3 ‘Sublittoral mud’ (A5.3). Mud habitats in deep water has a minimal distribution, limited to the offshore region of the northern Northumberland Coast. Sublittoral muds however are widely distributed throughout English Waters. Large offshore expanses are centred in the eastern Irish Sea, in the Celtic Sea northwest of the Isles of Scilly, and offshore of the Norfolk Coast and Northumberland Coast. Distribution of this habitat is predominantly offshore.

Moderate confidence was assigned to small areas in the eastern Irish Sea, and in the northern region of the Northumberland Coast associated with the presence of ‘Mud habitats in deep water’. However, all inshore waters were classified as low confidence. Confidence is relatively low throughout English waters, likely due to the lack FOCI-level habitats and resultant reliance on presence of Annex I habitats for use in confidence assessment. These areas have potential to support the FOCI-level habitats represented by this cluster; however, it is not possible at this stage to specify if the low level of confidence is due to a lack of habitat presence or a lack of available data. Therefore, this cluster requires further assessment on a case-by-case basis.

Cluster XIV: Sublittoral Coarse Sediment (Appendix T)

Cluster XIV is represented by datasets across all levels of available data, with the FOCI-level habitat ‘Subtidal sands and gravels’ only present in a single discrete area in the north coast of the Isle of Wight within the Solent. Therefore, data within this cluster is largely limited to Annex I and EUNIS habitats. The EUNIS habitat ‘Sublittoral coarse sediments’, A5.1, is common within English waters with a patchy distribution across much of the south coast and along the east coast. Annex I sandbanks are most common on the east coast.

With the exception of the isolated FOCI-level habitat on the south coast, highest confidence is present in regions where both Annex I and EUNIS-level habitats overlap, most notably within the Dogger Bank and North Norfolk Sandbanks and Saturn Reef SACs. As this cluster is so broad it is recommended that should an area within this cluster require compensatory measures, the specific features of the area should be considered on a case-by-case basis to ensure that an equivalent area is identified appropriately.

Cluster XV: Sublittoral Sand (Appendix U)

Cluster XV has limited data available, partially due to the cluster comprising only 2 habitats, 1 at FOCI-level, and 1 at EUNIS-level. Data for the FOCI-level habitat ‘Subtidal sands and gravels’ is only present in a single discrete area in the north coast of the Isle of Wight within the Solent. Therefore, data within this cluster is largely limited to Annex I and EUNIS habitats. The EUNIS habitat ‘Sublittoral sand’, A5.2, is present across much of English waters, but most commonly found off the west coast of Cornwall, and within much of the English Channel on the east coast. Annex I sandbank habitats are present across much of the East Anglia coast.

With the exception of the isolated FOCI-level habitat on the south coast, highest confidence is present in regions where both Annex I and EUNIS-level habitats overlap, most notably within the Dogger Bank and North Norfolk Sandbanks and Saturn Reef SACs. As this cluster is so broad it is recommended that should an area within this cluster require compensatory measures, the specific features of the area should be considered on a case-by-case basis to ensure that an equivalent area is identified appropriately.

Cluster XVI: Sublittoral Mixed Sediments (Appendix V)

Cluster XVI is represented by a range of datasets across levels, with the FOCI-level habitat ‘Sheltered muddy gravels’ providing the representative example of this cluster. This FOCI is present across much of the UK, including within Morecambe Bay, and along much of the south coast from Falmouth to Chichester Harbour. The habitat is also present across much of the Outer Thames region, within the Humber Estuary, Tyne Estuary and around Holy Island on the Northumberland Coast. The EUNIS-level habitat ‘Sublittoral mixed sediment’, A5.4, is abundant offshore much of the English coastline, and present in combination with ‘Sublittoral coarse sediment’, A5.1, off the west coast of Cornwall.

Confidence is highest within estuaries in which FOCI-habitats are present. Areas of overlap between EUNIS-level habitats and other levels are limited, with the aforementioned areas of highest confidences usually the result of combined Annex I-level and FOCI-level habitats. Confidence assessments of this cluster should be undertaken on a case-by-case basis to ensure that datasets specific to the local environment are considered.

5. Conclusion and summary recommendations

The Phase 1 (evidence review) and Phase 2 (spatial assessment) output has provided preliminary findings for the identification of potential same feature compensation for benthic habitats in English waters. Through undertaking this exercise, a number of limitations in interpretation of the spatial outputs have been identified. The spatial assessment of the different habitat clusters indicates a wide range of habitat suitability confidence scores between clusters. Disparity between scores stems from a number of factors, with limited data availability for certain clusters likely to be the most significant.

In some cases, the defining habitats associated with a given cluster are infrequent within English waters, and therefore the low occurrence presented by the data represents an accurate illustration of the cluster's extent (e.g. Cluster III: Peat and Clay exposures and Littoral chalk communities). However, in some cases it is possible that defining habitats are under-reported in available datasets for English waters as opposed to being sparse in their distribution. Whilst these scenarios may be presented similarly within the habitat suitability confidence scores, it is likely that these scores originate from separate causes: habitat scarcity, and limited data availability, respectively.

Other clusters identified within this study are represented by a wide range of datasets and habitat suitability scores. Cluster V 'Biogenic Annelid Reefs', and Cluster VII 'Biogenic Bivalve Reefs' indicate areas of potential compensatory habitat across a number of regions within English waters. Whilst the abundance of spatial data relevant to these clusters may primarily be due to the relatively wide distribution of these habitats within English waters, it may also be an artefact of the greater number of surveys that have been undertaken specifically for their identification of these habitats relative to others. Therefore, datasets relevant to more widely distributed habitats are likely to be both more numerous and of a higher specificity than those for less abundant habitats. Whilst this increases the confidence of the habitat suitability confidence scores in areas where data availability is high, it has the potential to mask areas that may be suitable for habitat compensation, but which have been under-reported in physical surveys.

Clusters comprising just 1 or 2 habitats are likely to be represented by a low number of spatial datasets, and this will thereby limit the associated habitat suitability confidence scores. As would be expected, this is reflected in the low overall confidence for Clusters II, IX, XIV and XV, when compared to clusters comprising a greater number of habitats. This disparity in confidence scores is further exacerbated when clusters of limited size do not contain a FOCI-level dataset (or a FOCI-level dataset of only limited extent); spatial datasets that are assigned high confidence. It should be recognised that whilst these habitat clusters are comprised of a small number of habitats and have limited confidence scores, these habitats are however, less prescriptive and more widespread than specialised habitats. As a result, appropriate compensatory habitats for these clusters will likely be available from a far wider pool when compared to more specialised habitats.

Findings presented within this report provide indicative results of potential compensatory benthic habitats in English waters. Should compensatory measures be determined as being necessary during future offshore wind development, it is recommended that specific considerations and studies are undertaken on a case-by-case basis. Certain habitat ecosystem services and sensitivities would be expected to be more important than others when considering the potential impact from a specific development on a particular habitat. Areas presenting a high level of habitat suitability confidence (with consideration for the points given above) for a given cluster may provide a good starting point for further investigation. Additionally, whilst the methods developed within this report for both the spatial and confidence mapping exercises are well suited to broad-scale investigation, methods should be adapted dependent on the data available and habitat types being considered in future work. Whilst additional data may lead to an increase in habitat suitability confidence for a given area, it is recommended that contemporary ground-truthing be undertaken to ensure that future determinations remain accurate regardless of data vintage before any compensatory measures are finalised.

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Appendices

Appendix A

Benthic habitats assessed within phase 1

Complete benthic habitat list determined following expansion. All habitats shown were scored and included in statistical analysis through Phase 1. Full relationships between habitats are provided in Appendix C, with arrows within the Habitat Names indicating habitat hierarchy.

Habitat Number	EUNIS Code of Broad Scale Habitat within Habitat	Habitat Name
1	A1.1	BSH - High energy littoral rock
2	A1.1	1170 Reefs → High energy littoral rock → Peat and clay exposures
3	A1.1	1170 Reefs → High energy littoral rock → Littoral chalk communities
4	A1.2	BSH - Moderate energy littoral rock
5	A1.2	1170 Reefs → Moderate energy littoral rock → Peat and clay exposures
6	A1.2	1170 Reefs → Moderate energy littoral rock → Littoral chalk communities
7	A1.2	1170 Reefs → Moderate energy littoral rock → Intertidal underboulder communities
8	A1.3	BSH - Low energy littoral rock
9	A1.3	1170 Reefs → Low energy littoral rock → Estuarine rocky habitats
10	A2.7	1170 Reefs → Littoral biogenic reefs → Honeycomb worm (Sabellaria alveolata) beds
11	A2.7	BSH - Littoral biogenic reefs

Habitat Number	EUNIS Code of Broad Scale Habitat within Habitat	Habitat Name
12	A2.7	1170 Reefs → Littoral biogenic reefs → Blue mussel beds
13	A3.1	BSH - High energy infralittoral rock
14	A3.2	BSH - Moderate energy infralittoral rock
15	A3.2	1170 Reefs → Moderate energy infralittoral rock → Subtidal chalk
16	A3.2	1170 Reefs → Moderate energy infralittoral rock → Intertidal underboulder communities
17	A3.3	BSH - Low energy infralittoral rock
18	A4.1	BSH - High energy circalittoral rock
19	A4.1	1170 Reefs → High energy circalittoral rock → Fragile sponge and anthozoan communities on subtidal rocky habitats
20	A4.2	BSH - Moderate energy circalittoral rock
21	A4.2	1170 Reefs → Moderate energy circalittoral rock → Subtidal chalk
22	A4.2	1170 Reefs → Moderate energy circalittoral rock → Ross worm (Sabellaria spinulosa) reef
23	A4.2	1170 Reefs → Moderate energy circalittoral rock → Fragile sponge and anthozoan communities on subtidal rocky habitats
24	A4.3	BSH - Low energy circalittoral rock
25	A5.1	BSH - Sublittoral coarse sediment

Habitat Number	EUNIS Code of Broad Scale Habitat within Habitat	Habitat Name
26	A5.1	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral coarse sediment → Sublittoral sands and gravels
27	A5.2	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral sand
28	A5.2	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral sand → Sublittoral sands and gravels
29	A5.2	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral sand → Saline lagoons
30	A5.3	BSH - Sublittoral mud
31	A5.3	1130 Estuaries → Sublittoral mud → Mud habitats in deep water
32	A5.3	1130 Estuaries → Sublittoral mud → Sea-pen and burrowing megafauna communities
33	A5.3	1160 Large shallow inlets and bays → Sublittoral mud → Mud habitats in deep water
34	A5.3	1160 Large shallow inlets and bays → Sublittoral mud → Sea-pen and burrowing megafauna communities
35	A5.4	BSH - Sublittoral mixed sediment
36	A5.4	1130 Estuaries → Sublittoral mixed sediment → Sheltered muddy gravels
37	A5.4	1130 Estuaries → Sublittoral mixed sediment → File shell beds

Habitat Number	EUNIS Code of Broad Scale Habitat within Habitat	Habitat Name
38	A5.4	1130 Estuaries → Sublittoral mixed sediment → Native Oyster Beds
39	A5.4	1160 Large shallow inlets and bays → Sublittoral mixed sediment → Sheltered muddy gravels
40	A5.4	1160 Large shallow inlets and bays → Sublittoral mixed sediment → File shell beds
41	A5.4	1160 Large shallow inlets and bays → Sublittoral mixed sediment → Native Oyster Beds
42	A5.5	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral macrophyte-dominated sediment → Seagrass beds
43	A5.5	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral macrophyte-dominated sediment → Maerl beds
44	A5.6	1170 Reefs → Sublittoral biogenic reefs → Horse mussel (Modiolus modiolus) beds
45	A5.6	1170 Reefs → Sublittoral biogenic reefs → Honeycomb worm (Sabellaria alveolata) beds
46	A5.6	1170 Reefs → Sublittoral biogenic reefs → Cold-water coral reefs
47	A5.6	1170 Reefs → Sublittoral biogenic reefs → Blue mussel beds
48	A5.6	1170 Reefs → Sublittoral biogenic reefs → Ross worm (Sabellaria spinulosa) reef
49	NA	8330 Submerged or partially submerged caves → Subtidal chalk

Habitat Number	EUNIS Code of Broad Scale Habitat within Habitat	Habitat Name
50	NA	1130 Estuaries → Native Oyster Beds
51	NA	1160 Large shallow inlets and bays → Native Oyster Beds

Appendix B

Keywords used as search terms for ecosystem service and sensitivity scoring

Acidification

Algae

Annelid

Annex I

Benth*

Biogeochemical

Biogenic

Bird

Blue Carbon

Burrow*

Broad-scale Habitats/BSH

Carbon cycling/sequestration/storage

Chalk

Clay/Peat and Clay

Climate regulation

Coastal defence/protection

Contamination

Disease

Disturbance

Ecosystem engineer

Ecosystem service

Eelgrass

Electromagnetic Field/EMF

Erosion

Fish

File shell/Flame shell

Food web

Herring

Invasive

Macroalgae

Mäerl

Marine mammal

Modiolus

Mollusc

Mussel

Mytilus

Nursery

Noise

Non-native

Ostrea edulis

Oyster

Pathogen

Peat/Peat and Clay

Polychaete

Primary Producti*

Producti*

Prey

Purification

Reef

Rock

Sandbank

Secondary Product*

Sediment

Sensitivity

Sabellaria

Sandbank

Sandeel

Seagrass

Shellfish

Spawning

Temperature

Trophic

Appendix C

Phase 1 habitat assessment workbook

Refer to separate document ‘NECR443 Appendix C Habitat Assessment Workbook_v1.1’, for the following information and data:

- Extended habitat relationships between Annex I, BSH and habitat FOCI;
- Work-shop finalised habitat scores (ecosystem services and sensitivity);
- Confidence assessment scores of the evidence base (ecosystem services and sensitivity).

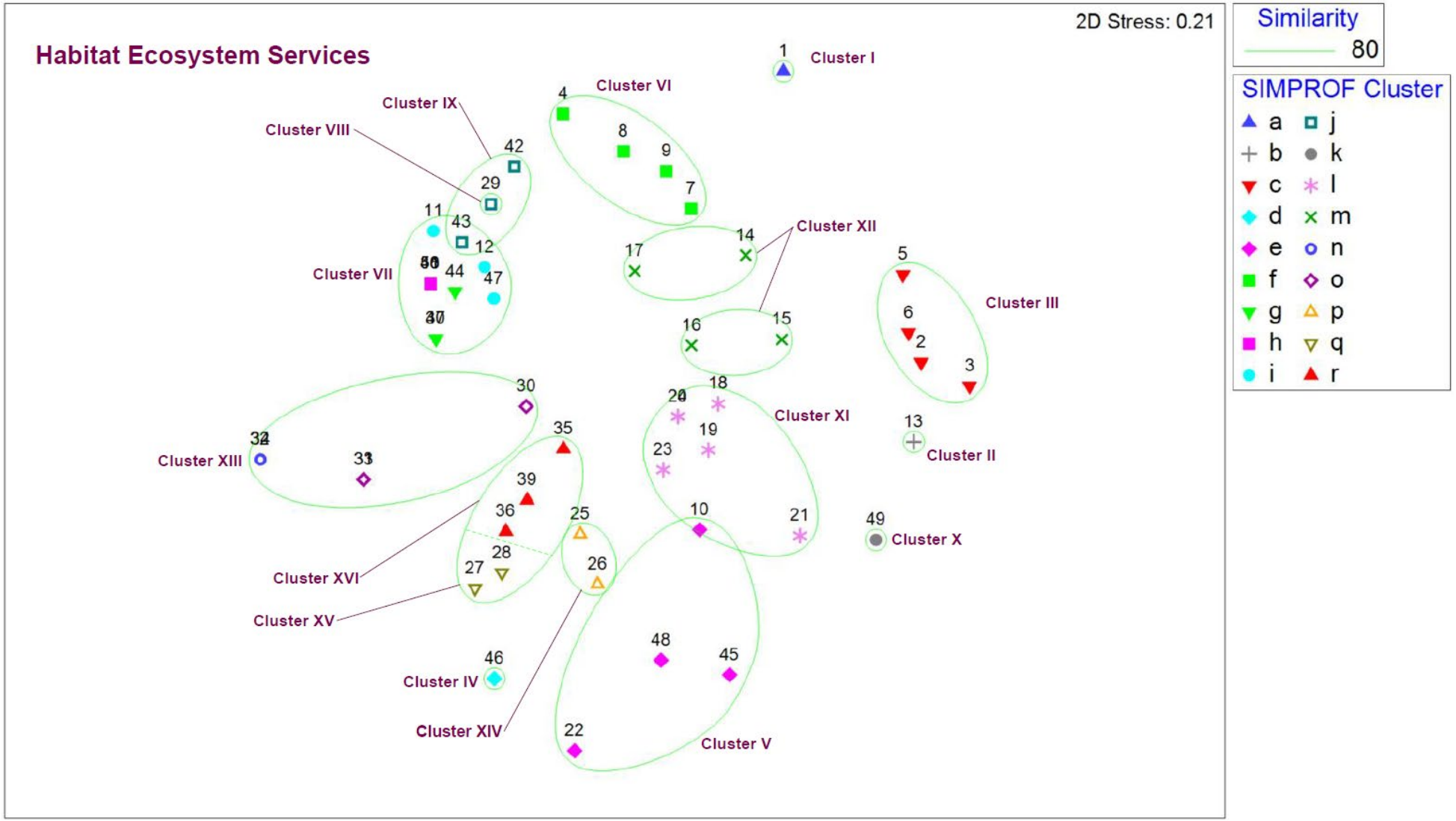
Appendix D

Phase 1 Bray-Curtis Multidimensional Scaling Plot Output

Two-dimensional MDS ordination of benthic habitat ecosystem services scores, based on Bray Curtis similarities with modified 80% Similarity Clusters labelled. Habitats within SIMPROF clusters are not significantly different to each other (p>0.05).

The plot has been reproduced in text form to detail data that are included in the clusters:

- Cluster I: 1 SIMPROF Cluster a
- Cluster II: 13 SIMPROF Cluster b
- Cluster III: 2, 3, 5, 6 SIMPROF Cluster c
- Cluster IV: 46 SIMPROF Cluster d
- Cluster V: 10, 22, 45, 48 SIMPROF Cluster e
- Cluster VI: 4, 7, 8, 9 SIMPROF Cluster f
- Cluster VII: 11, 12, 47 SIMPROF Cluster i, 30, 44 SIMPROF Cluster g, 43 SIMPROF Cluster j, 50 SIMPROF Cluster h
- Cluster VIII: 29 SIMPROF Cluster j
- Cluster IX: 29, 42, 43 SIMPROF Cluster j
- Cluster X: 49 SIMPROF Cluster k
- Cluster XI: 10 SIMPROF Cluster e, 18, 19, 20, 21, 23 SIMPROF Cluster l
- Cluster XII: 14, 15, 16, 17 SIMPROF Cluster m
- Cluster XIII: 30, 33 SIMPROF Cluster o, 32 SIMPROF Cluster n
- Cluster XIV: 25, 26 SIMPROF Cluster p
- Cluster XV: 27, 28 SIMPROF Cluster q
- Cluster XVI: 35, 36, 39 SIMPROF Cluster r


Habitat Ecosystem Services
2D Stress: 0.21
Similarity
80
SIMPROF Cluster
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r
Cluster I
Cluster II
Cluster III
Cluster IV
Cluster V
Cluster VI
Cluster VII
Cluster VIII
Cluster IX
Cluster X
Cluster XI
Cluster XII
Cluster XIII
Cluster XIV
Cluster XV
Cluster XVI

Appendix E

Phase I habitat clusters

Habitat clusters determined by ecosystem service provision using SIMPROF procedure and 80% similarity. Clusters not carried forward to Phase II are greyed out.

Habitat Number	SIMPROF Cluster	80% Similarity Cluster	Habitat Name
1	**a**	**I**	BSH - High energy littoral rock
13	**b**	**II**	BSH - High energy infralittoral rock
2	**c**	**III**	1170 Reefs → High energy littoral rock → Peat and clay exposures
3	**c**	**III**	1170 Reefs → High energy littoral rock → Littoral chalk communities
5	**c**	**III**	1170 Reefs → Moderate energy littoral rock → Peat and clay exposures
6	**c**	**III**	1170 Reefs → Moderate energy littoral rock → Littoral chalk communities
46	**d**	**IV**	1170 Reefs → Sublittoral biogenic reefs → Cold-water coral reefs
10	**e**	**V**	1170 Reefs → Littoral biogenic reefs → Honeycomb worm (Sabellaria alveolata) beds
22	**e**	**V**	1170 Reefs → Moderate energy circalittoral rock → Ross worm (*Sabellaria spinulosa*) reef
45	**e**	**V**	1170 Reefs → Sublittoral biogenic reefs → Honeycomb worm (Sabellaria alveolata) beds
48	**e**	**V**	1170 Reefs → Sublittoral biogenic reefs → Ross worm (*Sabellaria spinulosa*) reef

Habitat Number	SIMPROF Cluster	80% Similarity Cluster	Habitat Name
4	**f**	**VI**	BSH - Moderate energy littoral rock
7	**f**	**VI**	1170 Reefs → Moderate energy littoral rock → Intertidal underboulder communities
8	**f**	**VI**	BSH - Low energy littoral rock
9	**f**	**VI**	1170 Reefs → Low energy littoral rock → Estuarine rocky habitats
37	**g**	**VII**	1130 Estuaries → Sublittoral mixed sediment → File shell beds
40	**g**	**VII**	1160 Large shallow inlets and bays → Sublittoral mixed sediment → File shell beds
44	**g**	**VII**	1170 Reefs → Sublittoral biogenic reefs → Horse mussel (*Modiolus modiolus*) beds
38	**h**	**VII**	1130 Estuaries → Sublittoral mixed sediment → Native Oyster Beds
41	**h**	**VII**	1160 Large shallow inlets and bays → Sublittoral mixed sediment → Native Oyster Beds
50	**h**	**VII**	1130 Estuaries → Native Oyster Beds
51	**h**	**VII**	1160 Large shallow inlets and bays → Native Oyster Beds
11	**i**	**VII**	BSH - Littoral biogenic reefs
12	**i**	**VII**	1170 Reefs → Littoral biogenic reefs → Blue mussel beds

Habitat Number	SIMPROF Cluster	80% Similarity Cluster	Habitat Name
47	**i**	**VII**	1170 Reefs → Sublittoral biogenic reefs → Blue mussel beds
29	**j**	**VIII**	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral sand → Saline lagoons
42	**j**	**IX**	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral macrophyte-dominated sediment → Seagrass beds
43	**j**	**IX**	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral macrophyte-dominated sediment → Maerl beds
49	**k**	**X**	8330 Submerged or partially submerged caves → Subtidal chalk
18	**l**	**XI**	BSH - High energy circalittoral rock
19	**l**	**XI**	1170 Reefs → High energy circalittoral rock → Fragile sponge and anthozoan communities on subtidal rocky habitats
20	**l**	**XI**	BSH - Moderate energy circalittoral rock
21	**l**	**XI**	1170 Reefs → Moderate energy circalittoral rock → Subtidal chalk
23	**l**	**XI**	1170 Reefs → Moderate energy circalittoral rock → Fragile sponge and anthozoan communities on subtidal rocky habitats
24	**l**	**XI**	BSH - Low energy circalittoral rock

Habitat Number	SIMPROF Cluster	80% Similarity Cluster	Habitat Name
14	**m**	**XII**	BSH - Moderate energy infralittoral rock
17	**m**	**XII**	BSH - Low energy infralittoral rock
15	**m**	**XII**	1170 Reefs → Moderate energy infralittoral rock → Subtidal chalk
16	**m**	**XII**	1170 Reefs → Moderate energy infralittoral rock → Intertidal underboulder communities
32	**n**	**XIII**	1130 Estuaries → Sublittoral mud → Sea-pen and burrowing megafauna communities
34	**n**	**XIII**	1160 Large shallow inlets and bays → Sublittoral mud → Sea-pen and burrowing megafauna communities
30	**o**	**XIII**	BSH - Sublittoral mud
31	**o**	**XIII**	1130 Estuaries → Sublittoral mud → Mud habitats in deep water
33	**o**	**XIII**	1160 Large shallow inlets and bays → Sublittoral mud → Mud habitats in deep water
25	**p**	**XIV**	BSH - Sublittoral coarse sediment
26	**p**	**XIV**	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral coarse sediment → Sublittoral sands and gravels
27	**q**	**XV**	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral sand
28	**q**	**XV**	1110 Sandbanks which are slightly covered by sea water all the time → Sublittoral sand → Sublittoral sands and gravels

Habitat Number	SIMPROF Cluster	80% Similarity Cluster	Habitat Name
35	**r**	**XVI**	BSH - Sublittoral mixed sediment
36	**r**	**XVI**	1130 Estuaries → Sublittoral mixed sediment → Sheltered muddy gravels
39	**r**	**XVI**	1160 Large shallow inlets and bays → Sublittoral mixed sediment → Sheltered muddy gravels

Appendix F

Phase 2 spatial data sources

Spatial data sources used for mapping each habitat cluster. Note that (L3) refers to EUNIS Level 3, and (L4) refers to EUNIS Level 4 and all available constituent EUNIS-level layers. In addition to 80% clusters, Phase 2 figures were produced for 3 FOCI indicated at the bottom of the table. Where habitats listed in 'Spatial Data Layers Included' were presented in combination with other habitats in a single polygon these layers were also included, with all included habitats listed in the Legend of the figure. In some cases layers listed within this Appendix are not visible on the Phase 2 outputs due to these layers not having a presence within English waters, or data not being available. They have been left within this Appendix to indicate that they were considered during output synthesis.

80% Similarity Cluster	Cluster Name	Spatial Data Layers Included
II	High energy Infralittoral rock (outlier habitat)	**Annex I**: Reef (datasets with geogenic components)**;** **EUNIS (L3):** A3.1 Atlantic and Mediterranean high energy infralittoral rock
III	Peat and Clay exposures and Littoral chalk communities	**Annex I:** Reef (datasets with geogenic components); **EUNIS (L3):** A1.1 high energy littoral rock; **EUNIS (L3):** A1.2 moderate energy littoral rock; **FOCI:** Peat and Clay Exposures; **FOCI:** Littoral chalk communities
V	Biogenic Annelid Reefs	**Annex I** Reefs (datasets with biogenic components); **EUNIS (L3):** A2.7 Littoral biogenic reefs; **EUNIS (L3):** A4.2 Atlantic and Mediterranean moderate energy circalittoral rock; **EUNIS (L3):** A5.6 Sublittoral biogenic reefs; **EUNIS (L4):** A2.71 Littoral *Sabellaria* reefs; **EUNIS (L4):** A4.22 *Sabellaria* reefs on circalittoral rock; **EUNIS (L4):** A5.61 Sublittoral polychaete worm reefs on sediment; **FOCI:** Ross worm (Sabellaria

80% Similarity Cluster	Cluster Name	Spatial Data Layers Included
		spinulosa) reefs; **FOCI:** Honeycomb worm (Sabellaria alveolata) reefs
VI	Littoral Rock (low and moderate energy)	**Annex I:** Reef (datasets with geogenic components); **EUNIS (L3):** A1.2 Moderate energy littoral rock; **EUNIS (L3):** A1.3 Low energy littoral rock; **FOCI:** Underboulder communities; **FOCI:** Estuarine rocky habitats
VII	Biogenic Bivalve Reef	**Annex I:** Reefs (datasets with biogenic components); **Annex I:** Large shallow inlets and bays; **Annex I:** Estuaries; **EUNIS (L3):** A2.7 Littoral biogenic reefs**;** **EUNIS (L3):** A5.4 Sublittoral mixed sediment**;** **EUNIS (L3):** A5.6 Sublittoral biogenic reefs**;** **EUNIS (L4):** A2.72 Littoral mussel beds on sediment**;** **EUNIS (L4):** A4.24 Mussel beds on circalittoral rock**;** **EUNIS (L4):** A5.62 Sublittoral mussel beds on sediment**;** **FOCI:** File shell beds (expected Scottish waters only)**;** **FOCI:** Blue mussel beds**;** **FOCI:** Horse mussel (Modiolus modiolus) beds**;** **FOCI:** Native oyster (Ostrea edulis) beds
IX	Sublittoral Macrophyte Dominated Sediment	**Annex I** Sandbanks; **EUNIS (L3):** A5.5 Sublittoral macrophyte-dominated sediment; **EUNIS (L4):** A5.51 Maërl beds; **EUNIS (L4):** A5.53 Sublittoral seagrass beds; **FOCI:** Seagrass beds; **FOCI:** Maërl beds

80% Similarity Cluster	Cluster Name	Spatial Data Layers Included
XI	Circalittoral Rock (all energies)	**Annex I:** Reef (datasets with geogenic components); **EUNIS (L3):** A4.1 Atlantic and Mediterranean high energy circalittoral rock; **EUNIS (L3):** A4.2 Atlantic and Mediterranean moderate energy circalittoral rock; **EUNIS (L3):** A4.3 Atlantic and Mediterranean low energy circalittoral rock; **FOCI:** Subtidal chalk; **FOCI**: Fragile sponge and anthozoan communities on subtidal rock habitats
XII	Infralittoral Rock (low and moderate energy)	**Annex I:** Reef (datasets with geogenic components); **EUNIS (L3):** A3.2 Atlantic and Mediterranean moderate energy infralittoral rock; **EUNIS (L3):** A3.3 Atlantic and Mediterranean low energy infralittoral rock; **FOCI:** Subtidal chalk; **FOCI:** Intertidal underboulder communities
XIII	Sublittoral Mud	**Annex I:** Large shallow inlets and bays; **Annex I:** Estuaries; **EUNIS (L3):** A5.3 Sublittoral mud; **FOCI:** Sea pen and burrowing megafauna communities (expected Scottish waters only); **FOCI:** Mud habitats in deep waters
XIV	Sublittoral Coarse Sediment	**Annex I:** Sandbanks; **EUNIS (L3):** A5.1 Sublittoral coarse sediment; **FOCI:** Subtidal sands and gravels
XV	Sublittoral Sand	**Annex I:** Sandbanks; **EUNIS (L3):** A5.2 Sublittoral sand; **FOCI:** Subtidal sands and gravels

80% Similarity Cluster	Cluster Name	Spatial Data Layers Included
XVI	Sublittoral Mixed Sediments	**Annex I:** Large shallow inlets and bays; **Annex I:** Estuaries; **EUNIS (L3):** A5.4 Sublittoral mixed sediments; **FOCI:** Sheltered muddy gravels
n/a	FOCI - Peat & Clay Exposures	**FOCI**: Peat and clay exposures
n/a	FOCI - Littoral Chalk communities	**FOCI:** Littoral chalk communities
n/a	FOCI Subtidal Chalk	**FOCI:** Subtidal chalk

Appendix G

Phase 2 Confidence Assessment ScoresSeveral key habitat scores in the table have been left blank as they were not available.

Habitat Type	Habitat Name	Habitat Type Score	Key Habitat Score	Total Score
Annex I	Estuaries	1	-	**1**
Annex I	Large shallow inlets and bays	1	-	**1**
Annex I	Reef	1	0.5	**1.5**
Annex I	Sandbanks	1	0.5	**1.5**
EUNIS 3	A1.1: High energy littoral rock	1.5	-	**1.5**
EUNIS 3	A1.2: Moderate energy littoral rock	1.5	-	**1.5**
EUNIS 3	A1.3: Low energy littoral rock	1.5	-	**1.5**
EUNIS 3	A2.7: Littoral biogenic reefs	1.5	-	**1.5**
EUNIS 3	A3.1: Atlantic and Mediterranean high energy infralittoral rock	1.5	0.5	**2**
EUNIS 3	A3.2: Atlantic and Mediterranean moderate energy infralittoral rock	1.5	0.5	**2**
EUNIS 3	A3.3: Atlantic and Mediterranean low energy infralittoral rock	1.5	0.5	**2**
EUNIS 3	A4.1: Atlantic and Mediterranean high energy circalittoral rock	1.5	0.5	**2**
EUNIS 3	A4.2: Atlantic and Mediterranean moderate energy circalittoral rock	1.5	0.5	**2**

Habitat Type	Habitat Name	Habitat Type Score	Key Habitat Score	Total Score
EUNIS 3	A4.3: Atlantic and Mediterranean low energy circalittoral rock	1.5	0.5	**2**
EUNIS 3	A5.1: Sublittoral coarse sediment	1.5	0.5	**2**
EUNIS 3	A5.2: Sublittoral sand	1.5	0.5	**2**
EUNIS 3	A5.3: Sublittoral mud	1.5	0.5	**2**
EUNIS 3	A5.4: Sublittoral mixed sediment	1.5	0.5	**2**
EUNIS 3	A5.5 Sublittoral macrophyte-dominated sediment	1.5	-	**1.5**
EUNIS 3	A5.6: Sublittoral biogenic reefs	1.5	-	**1.5**
EUNIS 4	A2.71: Littoral Sabellaria reefs	2	-	**2**
EUNIS 4	A2.72: Littoral mussel beds on sediment	2	-	**2**
EUNIS 4	A4.22: Sabellaria reefs on circalittoral rock	2	-	**2**
EUNIS 4	A4.24: Mussel beds on circalittoral rock	2	-	**2**
EUNIS 4	A5.51: Maërl beds	2	-	**2**
EUNIS 4	A5.53: Sublittoral seagrass beds	2	-	**2**
EUNIS 4	A5.61: Sublittoral polychaete worm reefs on sediment	2	-	**2**
EUNIS 4	A5.62 Sublittoral mussel beds on sediment	2	-	**2**
FOCI	Blue mussel beds	2.5	0.5	**3**

Habitat Type	Habitat Name	Habitat Type Score	Key Habitat Score	Total Score
FOCI	Estuarine rocky habitats	2.5	-	**2.5**
FOCI	File shell beds	2.5	-	**2.5**
FOCI	Fragile sponge and anthozoan communities on subtidal rock habitats	2.5	-	**2.5**
FOCI	Honeycomb worm (Sabellaria alveolata) reefs	2.5	-	**2.5**
FOCI	Horse mussel (Modiolus modiolus) beds	2.5	-	**2.5**
FOCI	Intertidal underboulder communities	2.5	-	**2.5**
FOCI	Littoral chalk communities	2.5	-	**2.5**
FOCI	Maërl beds	2.5	-	**2.5**
FOCI	Mud habitats in deep waters	2.5	-	**2.5**
FOCI	Native oyster (Ostrea edulis) beds	2.5	0.5	**3**
FOCI	Peat and Clay Exposures	2.5	0.5	**3**
FOCI	Ross worm (Sabellaria spinulosa) reefs	2.5	0.5	**3**
FOCI	Sea pen and burrowing megafauna communities (expected Scottish waters only)	2.5	-	**2.5**
FOCI	Seagrass beds	2.5	-	**2.5**
FOCI	Sheltered muddy gravels	2.5	-	**2.5**
FOCI	Subtidal chalk	2.5	0.5	**3**
FOCI	Subtidal sands and gravels	2.5	-	**2.5**

Habitat Type	Habitat Name	Habitat Type Score	Key Habitat Score	Total Score
FOCI	Underboulder communities	2.5	-	**2.5**

Appendix H

Habitat Map of Cluster II: High Energy Infralittoral Rock

Refer to separate document ‘Appendix H Cluster II High Energy Infralittoral Rock.pdf’

Appendix I

Habitat Map of Cluster III: Peat and Clay Exposures and Littoral chalk Communities

Refer to separate document ‘Appendix I Cluster III Peat Clay and Littoral Chalk.pdf’

Appendix J

Habitat Map of Feature of Conservation Interest: Littoral Chalk Communities

Refer to separate document ‘Appendix J FOCI Littoral Chalk.pdf’

Appendix K

Habitat Map of Feature of Conservation Interest: Peat and Clay Exposures

Refer to separate document ‘Appendix K FOCI Peat Clay.pdf’

Appendix L

Habitat Map of Cluster V: Biogenic Annelid Reefs

Refer to separate document ‘Appendix L Cluster V Biogenic Annelid Reef.pdf’

Appendix M

Habitat Map of Cluster VI: Littoral Rock (Low and Moderate Energy)

Refer to separate document ‘NECR443 Appendix M Cluster VI Littoral Rock Low Mod.pdf’

Appendix N

Habitat Map of Cluster VII: Biogenic Bivalve Reef

Refer to separate document ‘NECR443 Appendix N Cluster VII Biogenic Bivalve Reef.pdf’

Appendix O

Habitat Map of Cluster IX: Sublittoral Macrophyte Dominated Sediment

Refer to separate document ‘NECR443 Appendix O Cluster IX Sublittoral Macrophyte Sediment.pdf’

Appendix P

Habitat Map of Cluster XI: Circalittoral Rock (All Energies)

Refer to separate document ‘NECR443 Appendix P Cluster XI Circalittoral Rock.pdf’

Appendix Q

Habitat Map of Feature of Conservation Interest: Subtidal Chalk

Refer to separate document ‘NECR443 Appendix Q FOCI Subtidal Chalk.pdf’

Appendix R

Habitat Map of Cluster XII: Infralittoral Rock (Low and Moderate Energy)

Refer to separate document ‘NECR443 Appendix R Cluster XII Infralittoral Rock Low Mod.pdf’

Appendix S

Habitat Map of Cluster XIII: Sublittoral Mud

Refer to separate document ‘NECR443 Appendix S Cluster XIII Sublittoral Mud.pdf’

Appendix T

Habitat Map of Cluster XIV: Sublittoral Coarse Sediment

Refer to separate document ‘NECR443 Appendix T Cluster XIV Sublittoral Coarse Sediment.pdf’

Appendix U

Habitat Map of Cluster XV: Sublittoral Sand

Refer to separate document ‘NECR443 Appendix U Cluster XV Sublittoral Sand.pdf’

Appendix V

Habitat Map of Cluster XVI: Sublittoral Mixed Sediments

Refer to separate document ‘NECR443 Appendix V Cluster XVI Sublittoral Mixed Sediments.pdf’

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