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Mapping habitats and biotopes from acoustic datasets to strengthen the information base of Marine Protected Areas in Scottish waters – Phase 2

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Summary

The objective of this project was to generate seabed habitat maps for locations coinciding with Scottish possible Nature Conservation MPAs with full coverage acoustic datasets to as detailed a hierarchical level as possible within the Marine Habitat Classification for Britain and Ireland (version 04.05), also known as MNCR classification (Connor *et al* 2004).

Phase one of the project focused on four areas, Approaches to the Firth of Forth, Wee Bankie to Gourdon, Solan Bank to Fair Isle and the West Shetland Shelf possible MPA. Phase 1 investigated a range of mapping methods whereas phase 2 is focused on using a top-down/rule based methodology and is focused on two areas, The Eastern approaches to the Firth of Forth and an area surveyed by Ifremer (The Barra Fan and Hebrides Terrace Seamount). This report deals with the Eastern approaches to the Firth of Forth with the Hebrides Terrace Seamount area being reported separately.

The constituent polygons within the habitat/biotope maps are labelled to an appropriate level of the Habitat Classification and translated to the corresponding EUNIS code.

In order to generate seabed habitat maps for the areas the data associated with each area were required to undergo some preliminary preparation and processing to ensure suitability and compatibility with the mapping methodologies employed.

The data were then processed using a top-down approach based on the methods developed by MESH, UKSeaMap and EUSeaMap, which utilised the updated seabed substrate information provided by BGS and updated bathymetric and wavebase data.

A habitat map for the Eastern approaches to the Firth of Forth has been produced (the level of habitat detail which could be mapped was restricted to level 3 & 4 of the EUNIS classification with associated metadata and peripheral supplementary data to aid in future analysis and interpretation). A confidence assessment using the MESH confidence assessment method has been undertaken for the habitat map produced and confidence maps accompany the habitat map.

The assumptions and limitations of the data and the techniques and processes used to produce the maps are discussed to aid understanding and application of the map.

These maps make an important contribution to the evidence base for the presence and extent of MPA search features underpinning the proposition of possible MPA in Scotland's seas.

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1 Introduction

1.1 Background to Marine Protected Areas

Scottish Government is committed to a 'clean, healthy, safe, productive and biologically diverse marine and coastal environment that meets the long term needs of people and nature' (Marine Scotland 2011a). The Marine (Scotland) Act 2010[1] and the UK Marine and Coastal Access Act 2009[2] contain provisions for Scottish Ministers to designate Marine Protected Areas (MPAs) in the seas around Scotland as part of a range of measures to manage and protect Scotland's seas for current and future generations (SNH & JNCC 2012).

Work to identify MPAs is being delivered by the Scottish MPA Project, a joint project between Marine Scotland (Scottish Government), Scottish Natural Heritage (SNH), the Joint Nature Conservation Committee (JNCC), Historic Scotland and the Scottish Environment Protection Agency (SEPA) (SNH & JNCC 2012).

Marine Scotland (MS) have responsibility for marine nature conservation through the powers in the Acts, however SNH and JNCC function within the project to provide guidance and scientific advice on the selection of Nature Conservation MPAs and the development of an ecologically coherent network. SNH lead on advice concerning Nature Conservation MPAs within Scottish territorial waters and JNCC lead on advice concerning Nature Conservation MPAs in offshore waters (beyond 12 nautical miles (nm) from the coast) adjacent to Scotland. The Nature Conservation MPAs will recognise features that are rare, threatened and/or representative and which contribute to a wider MPA network (SNH & JNCC 2012; Marine Scotland 2011b).

Possible Nature Conservation MPAs have been proposed to Scottish Government based on the best available scientific evidence, incorporating stakeholder input which was sought at various stages and built into the project. The proposals are underpinned by the presence of Search Features; a range of important features for which MPAs are considered to be an appropriate conservation measure. The sufficiency of data, quality or condition of the features and the suitability of the information source has driven the identification of areas. Search Features are a subset of Priority Marine Features (PMF) in Scotland's seas. A PMF is a habitat or species which has been identified as being of conservation importance in the seas around Scotland. More information on the identification of PMFs and search features can be found in the Site Selection Guidelines and the Advice to Scottish Government on selection of Nature Conservation MPAs (SNH & JNCC 2012; Marine Scotland 2011b).

[1] http://www.scotland.gov.uk/Topics/marine/seamanagement/marineact

[2] http://www.legislation.gov.uk/ukpga/2009/23/contents

2 General objective

The objective of this project is to generate seabed habitat maps for locations coinciding with possible Nature Conservation MPAs with full coverage acoustic datasets to as detailed a hierarchical level as possible within the Marine Habitat Classification for Britain and Ireland (version 04.05)[3], also known as MNCR classification (Connor *et al* 2004).

The constituent polygons within the habitat/biotope maps were to be labelled to an appropriate level of the Habitat Classification and translated to the corresponding EUNIS[4] code. Where possible, mapping should be to the biotope and biotope complex level (e.g. EUNIS level 4 & 5).

2.1 Areas to be mapped

An area identified for which multibeam bathymetry and backscatter data were available is the Eastern Approaches to the Firth of Forth (Figure 1). Multibeam bathymetry datasets, originating from the Civil Hydrography Programme (CHP) of the Maritime and Coastguard Agency, have been processed and subsequently interpreted by remote sensing specialists and geology experts at the British Geological Survey (BGS) to produce a seabed substrate map for the area. These datasets were generated through a Memorandum of Agreement between JNCC, the National Oceanography Centre (NOC) and BGS (JNCC *et al* 2013).

[3] http://jncc.defra.gov.uk/page-1584

[4] http://eunis.eea.europa.eu/

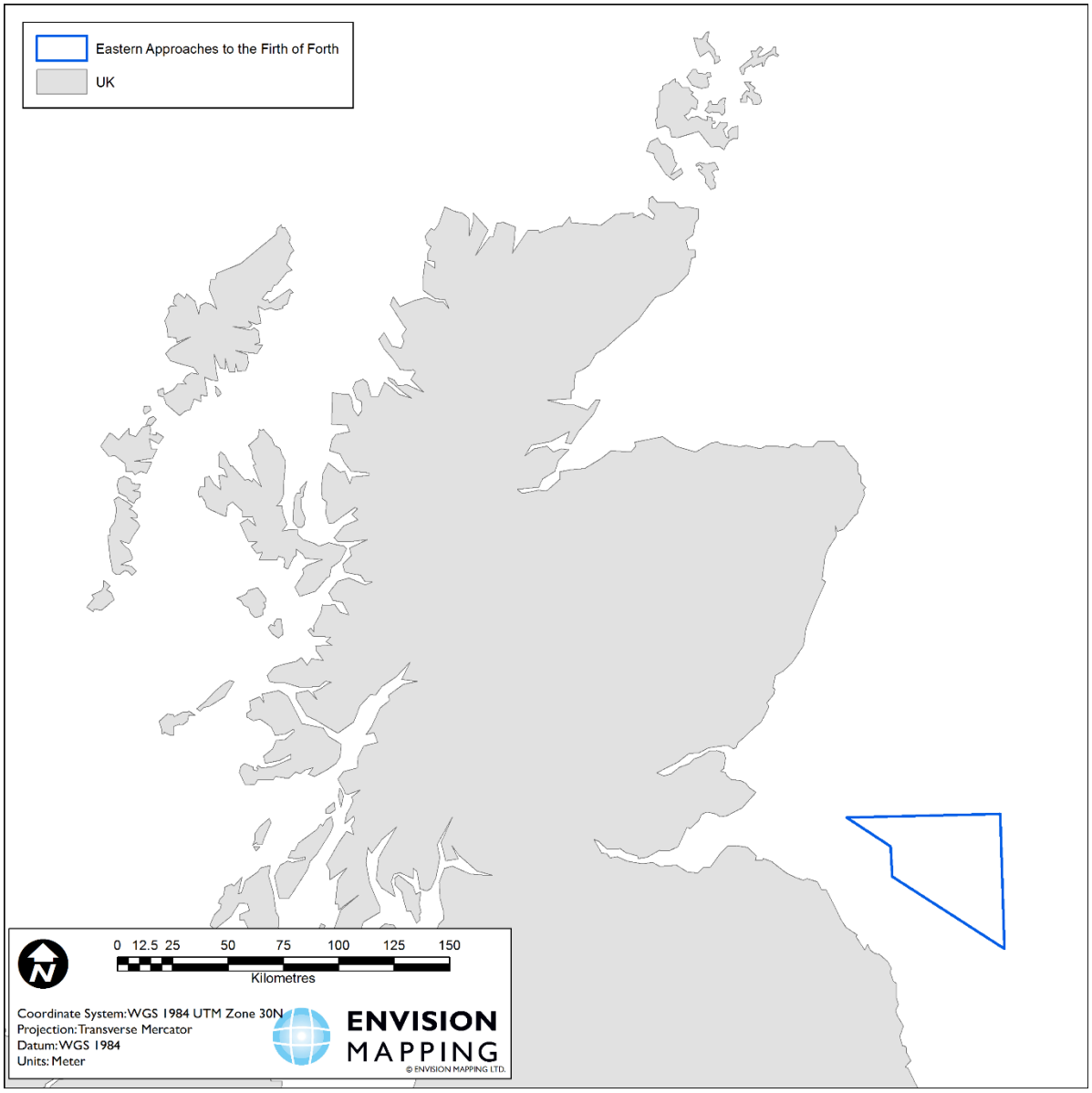

Figure 1. Outline of project area off the east coast of Scotland.

Full coverage UK-wide models of physical variables were also used in the form of wave and current disturbance used to determine energy thresholds and using light attenuation levels the biological zones can be determined for each area. These datasets are freely available from the EUSeaMap website[5].

Table 1. A summary of data available for the project area.

Area	Acoustic Data	UK wide data
Eastern Approaches to the Firth of Forth (Hi1083)	Full coverage bathymetry	Biological zone Seabed energy levels Light attenuation (EUSeaMap)

[5] http://jncc.defra.gov.uk/euseamap

The Eastern Approaches to the Firth of Forth area adjoins the Phase 1 areas of the Wee Bankie to Gourdon and the Approaches to the Firth of Forth areas (mapped as a single area) and therefore the previous areas were considered and edge-matched to ensure consistency between the areas. Maps were also produced at the same resolution (50m) to the Phase 1 Maps.

3 Methods

In order to generate a seabed habitat map the data associated with the area were required to undergo some preliminary preparation and processing to ensure suitability and compatibility with the mapping methodologies employed.

The data were then processed using a top-down rule-based approach based on the methods developed by MESH[6] (Coltman *et al* 2008), UKSeaMap[7] (McBreen *et al* 2011) and EUSeaMap (Cameron & Askew 2011; EUSeaMap 2012).

This process utilised the updated seabed substrate information provided by BGS, the current seabed energy level information available from EUSeaMap and biozone data for the littoral/circalittoral data zone boundary was used from current EUSeaMap data whereas the circalittoral/deep circalittoral boundary was updated using the current bathymetric data.

3.1 Data preparation and processing

Datasets were available as GIS files; polygon features were available for BGS seabed substrate maps and also for EUSeaMap biological zones and energy layers. The acoustic datasets used were gridded rasters for bathymetry data.

For EUSeaMap data, existing biological zones and energy layers were available but the availability of higher resolution bathymetry and light level data which had been reviewed and updated meant that these layers could be updated to provide higher resolution inputs or data which was deemed more suitable and current. The biological zones layer and seabed energy layers were therefore updated and recreated for each of the areas.

The acoustic data sets were imported into GIS where necessary, and a consistent spatial resolution (50m) for comparable datasets was implemented. It is critical to the processing of the dataset that all imagery data are spatially coincident and of identical spatial resolution.

3.2 Habitat mapping methods

Existing habitat maps for the areas have been produced by EUSeaMap, UKSeaMap 2010 and MESH – the most recent being EUSeaMap: these mapping methodologies used a rule-based/top-down process in which coarse-resolution models of physical parameters are intersected with seabed substrata data to produce a categorised map of physical habitats at EUNIS level 3/4. The less detailed (lower) level of the hierarchy was used when a more detailed level (higher) could not be allocated. As a result of the processing of multibeam surveys in the study area, since EUSeaMap, a more detailed seabed substrates map has been produced by BGS using the backscatter and bathymetry datasets with associated PSA sample data (JNCC *et al* 2013). The multibeam bathymetry have also been used to improve the EUSeaMap energy and light layers.

To incorporate these new and updated datasets the rule-based – top-down approach was employed for the area and is detailed in section 3.2.1.

[6] MESH modelling: http://www.searchmesh.net/Default.aspx?page=1951[6]

[7] UKSeaMap 2010: http://jncc.defra.gov.uk/ukseamap

3.2.1 Top-down – Rule-based mapping

Rule-based mapping used a series of input datasets which are reclassified using a system of rules or defined parameters to identify areas which have specific physical parameters associated with habitat classes. The key stages are illustrated in Figure 2.

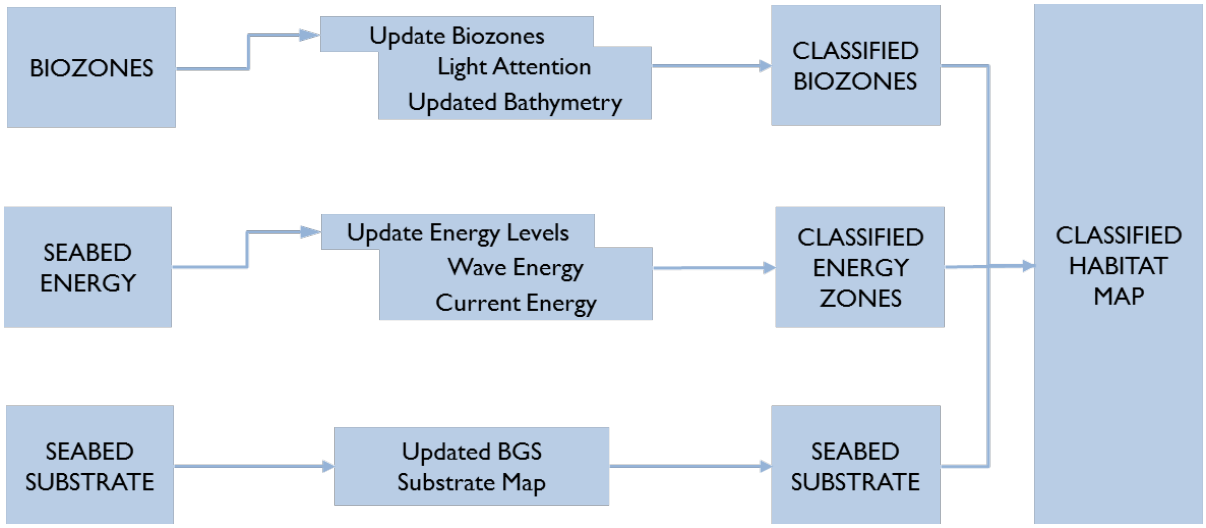

Figure 2. The key stages for a top-down mapping methodology.

A series of input datasets are required to produce the habitat map:

- biological zones, which reflect the changes in biological communities due to corresponding changes in light, energy and depth;
- seabed substrate, which reflect changes in substrate type associated with changes in biological communities; and
- energy conditions at the seabed, which incorporates information on both wave and tidal current energy;

The input dataset corresponding to the seabed substrate was provided by a recently produced seabed sediments and rock layer which was generated by BGS from the backscatter and bathymetric datasets collected as part of the MCA Civil Hydrography Program (MCHP) (JNCC *et al* 2013). The data consisted of a GIS polygon file with associated attributes for seabed substrate classified according to Folk sediment classes (Folk 1954) plus rock. The classes have subsequently been grouped these into a smaller number of simplified substrate classes which relate to the MNCR and EUNIS habitat classifications (Long 2006), with rock identified separately from sediments:

- Rock.
- Mud and sandy mud.
- Sand and muddy sand.
- Coarse sediment.
- Mixed sediment.

Figure 3 Shows these simplified categories in relation to the Folk classes

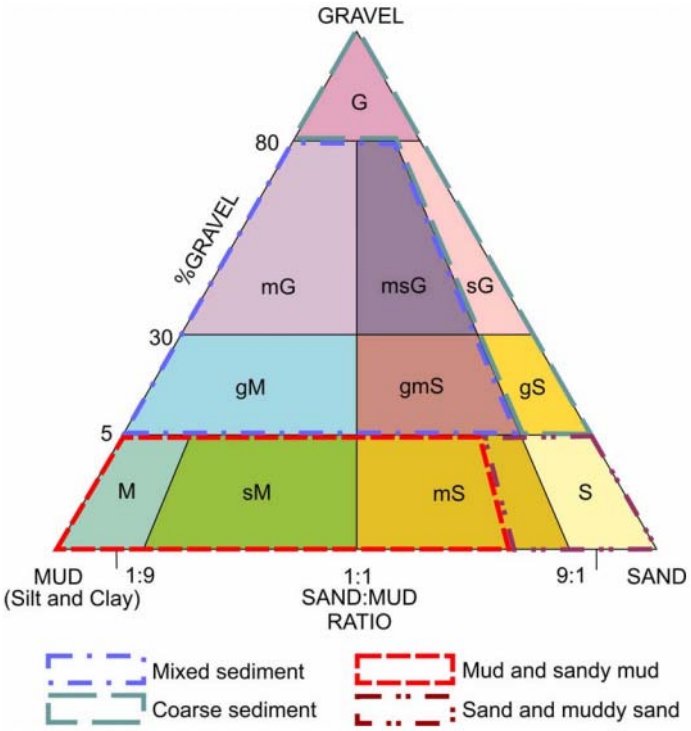

Figure 3. Folk Classification (Folk 1954) with simplified sediment classes delineated (after Long 2006).

This simplified seabed substrate polygon layer was then converted to a raster dataset with a 50m resolution (to match the bathymetry data resolution) with each pixel given a value to represent the modified classes above.

The energy layer was produced as a raster dataset using a wave energy and current energy layer from the EUSeaMap project. These layers were categorised as LOW, MEDIUM or HIGH using the same classes as EUSeaMap and summarised as:

Table 2. Seabed energy classes and the kinetic energy associated with wave and current energies.

Wave energy	Kinetic energy (kNm^{-2})
High	>1.2
Moderate	0.21-1.2
Low	<0.21

Current Energy category	Kinetic Energy (kNm^{-2})
HIGH	>1.16
MEDIUM	0.13–1.16
LOW	<0.13

Wave and current energy classes were combined using a rule-based approach. The highest category for each grid cell was selected, e.g. a cell with high wave energy and moderate current energy was assigned to a high energy category; a cell with low wave energy and moderate current energy was assigned to a moderate energy category. The resultant energy layer was produced using a resolution of 250m, which was the analysis scale used in the EUSeaMap project and suitable to be artificially increased to 50m to match the other dataset thus enabling data processing to occur. This does not alter the effective resolution of the data but simply enables the same data to be represented at a similar resolution to other data for mathematical operations.

The main EUSeaMap report refers to a boundary between the infralittoral zone and the circalittoral where 1% light reached the seabed, however this was revised during the last update of EUSeaMap when a 4.5% level was considered more appropriate for the light penetration data used (EUSeaMap 2012a, 2012b). The wavebase is used to define the boundary between the circalittoral and the deep circalittoral. As wavebase is determined by the bathymetry of the area (EUSeaMap Technical Appendix 2) the updated bathymetry was used to derive a more current wavebase dataset which in turn provide an updated circalittoral/deep circalittoral boundary.

Light penetration data were obtained from EUSeaMap and where the 4.5% limit intersected with the new bathymetric data available from the MCHP, this was used as updated delineation between infralittoral and circalittoral at a higher resolution than previously available. The resulting layer was a raster image with the same resolution (50m) as the seabed substrate and seabed energy layers – although this is artificially high as the light attenuation data was only available at a resolution of 250m.

Table 3. Data definitions for biological zones used within the mapping methodology.

Biological zone	Data definition
Infralittoral	>4.5% light penetration
Circalittoral	<4.5% light penetration to wave base
Deep Circalittoral	Wave base to 200m

The three input layers were then combined using a rule-based model which overlays the datasets to produce zones which result in areas that relate to EUNIS Level 4 for sediment and 3 for rock (hard substrata). Table 4 shows the combination of energy, biological zones and seabed substrate that occurred within the area to be mapped, other combinations would be possible but were not found to occur.

Table 4. EUNIS and MNCR Codes and their physical parameters using for mapping the Eastern approaches to the Firth of Forth.

EUNIS Code	EUNIS Name	MNCR Code	MNCR Name	Substrate	Biological zone	Energy
A4.33	Faunal communities on deep low energy circalittoral rock	NULL	Not in classification	Rock	Deep circalittoral	Low
A5.14	Circalittoral coarse sediment	SS.SCS.CCS	Circalittoral coarse sediment	Coarse Sediment	Circalittoral	Any
A5.15	Deep circalittoral coarse sediment	SS.SCS.OCS	Offshore circalittoral coarse sediment	Coarse Sediment	Deep circalittoral	Any
A5.26	Circalittoral muddy sand	SS.SSa.CMuSa	Circalittoral muddy sand	Muddy sand	Circalittoral	Any
A5.27	Deep circalittoral sand	SS.SSa.OSa	Offshore circalittoral sand	Sand	Deep circalittoral	Any

3.3 Assumptions

Certain assumptions have been made during the mapping process, which relate to the input data quality, the relationships between the physical and biological environments and then applied when producing the maps.

The spatial accuracy of all data is assumed to be correct for all map products. The spatial resolution of the mapping is effectively 50m which should be within tolerances and accuracy of most modern position fixing equipment.

The seabed substrate layer which has been used as input to the rule base mapping is predicted using geophysical acoustic data and is assumed the substrate classes identified can be detected with the geophysical acoustic data and that these substrate classes and the modified classes used with the rule-based mapping process are accurately mapped, therefore any inherent assumptions or inaccuracies within the seabed substrate map will apply to any outputs from the rule-based mapping.

Within the rule-based mapping, using physical parameters to determine the distribution of biological zones and energy regimes matched with seabed substrate assumes these parameters are accurately determined and can predict the biological habitat/biotope which occurs within the range of parameters mapped.

This range of assumptions does lead to a level of uncertainly within all maps produced and users of the maps should be aware of the maps limitations. Confidence levels, based upon fuzzy membership of mapping classes have been produced for the habitat map which can assist when using the maps but understanding the assumptions made during the mapping process can also aid in the understanding of the habitat maps. The fuzzy threshold used to derived confidence maps were those suggested with the EUSeaMap technical report (Table 5)

Table 5. Thresholds used to define the biological zones.

Biological Zone of North and Celtic Seas	Upper limit	Lower limit
Infralittoral	0m	0 to 9.0 % (Hard threshold =4.5%) light reaches the seabed
Circalittoral	0 to 9.0 % (Hard threshold =4.5%) light reaches the seabed	Wave base 1.5<L/h≤ 2.5 % (Hard threshold =2%)
Deep circalittoral	Wave base 1.5<L/h≤ 2.5 % (Hard threshold =2%)	200m

3.4 Summary of the data utilised in the processing

3.4.1 Acoustic data

The preparation and processing of the acoustic data reduces the original resolution of the data but does allow for consistency throughout the data set and seamless processing. Figure 4 shows the bathymetric dataset post-processing.

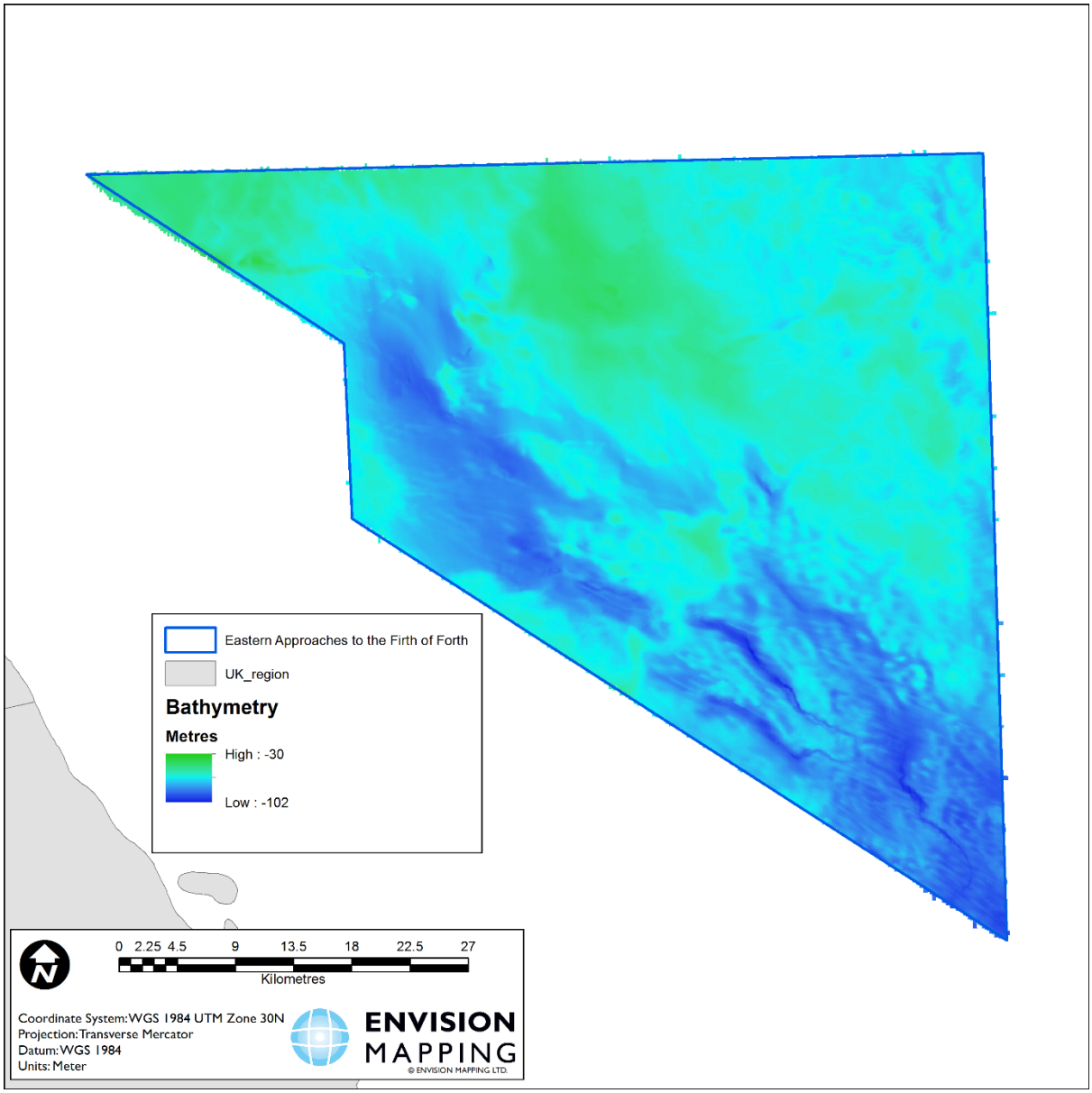

Figure 4. Processed bathymetry data for the Eastern approaches to the Firth of Forth.

3.4.2 Physical parameters

The definition for the infralittoral category of the EUSeaMap biological zones layer has been refined since the production of the existing EUSeaMap layer. A new light penetration limit of 4.5% currently defines the boundary between infralittoral and circalittoral (Askew pers. com.) and updated bathymetric data enabled an updated wavebase layer to be produced. The generation of a new biological zones layer was required to take account of this change and Figure 5 shows the EUSeaMap original biological zones layer for the areas and the new updated biological zones with the infralittoral zone not represented in the project area.

An updated seabed energy layer was also generated at a resolution matching the processed acoustic data and the newly generated biological zones layer. Figure 6 shows the original and newly produced energy layers in comparison. No noticeable change has occurred with the data processing and the vast majority of the area is represented by low energy levels.

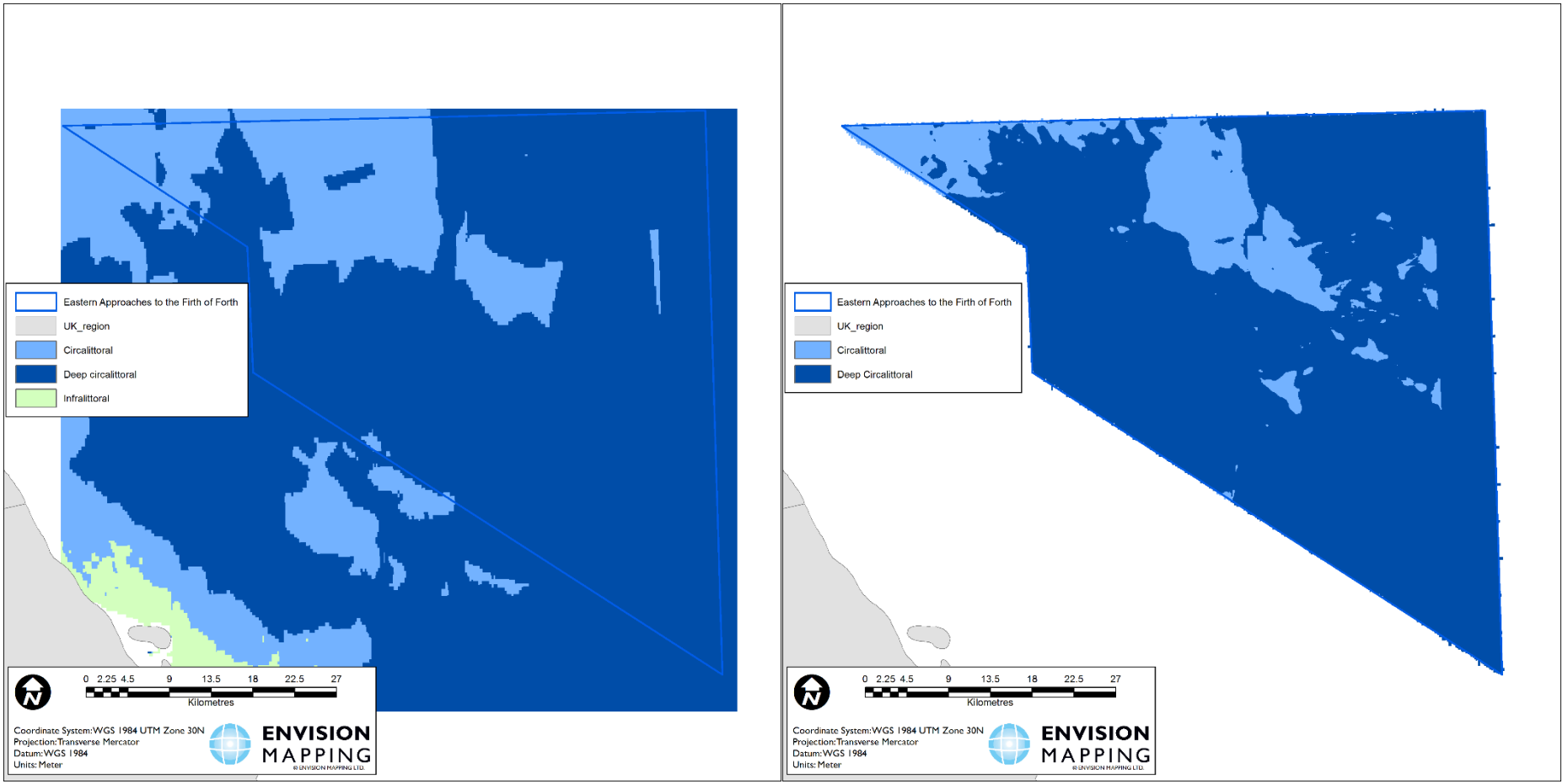

Figure 5. EUSeaMap biological zones data (left) and reclassified data (right) for the Eastern approaches to the Firth of Forth.

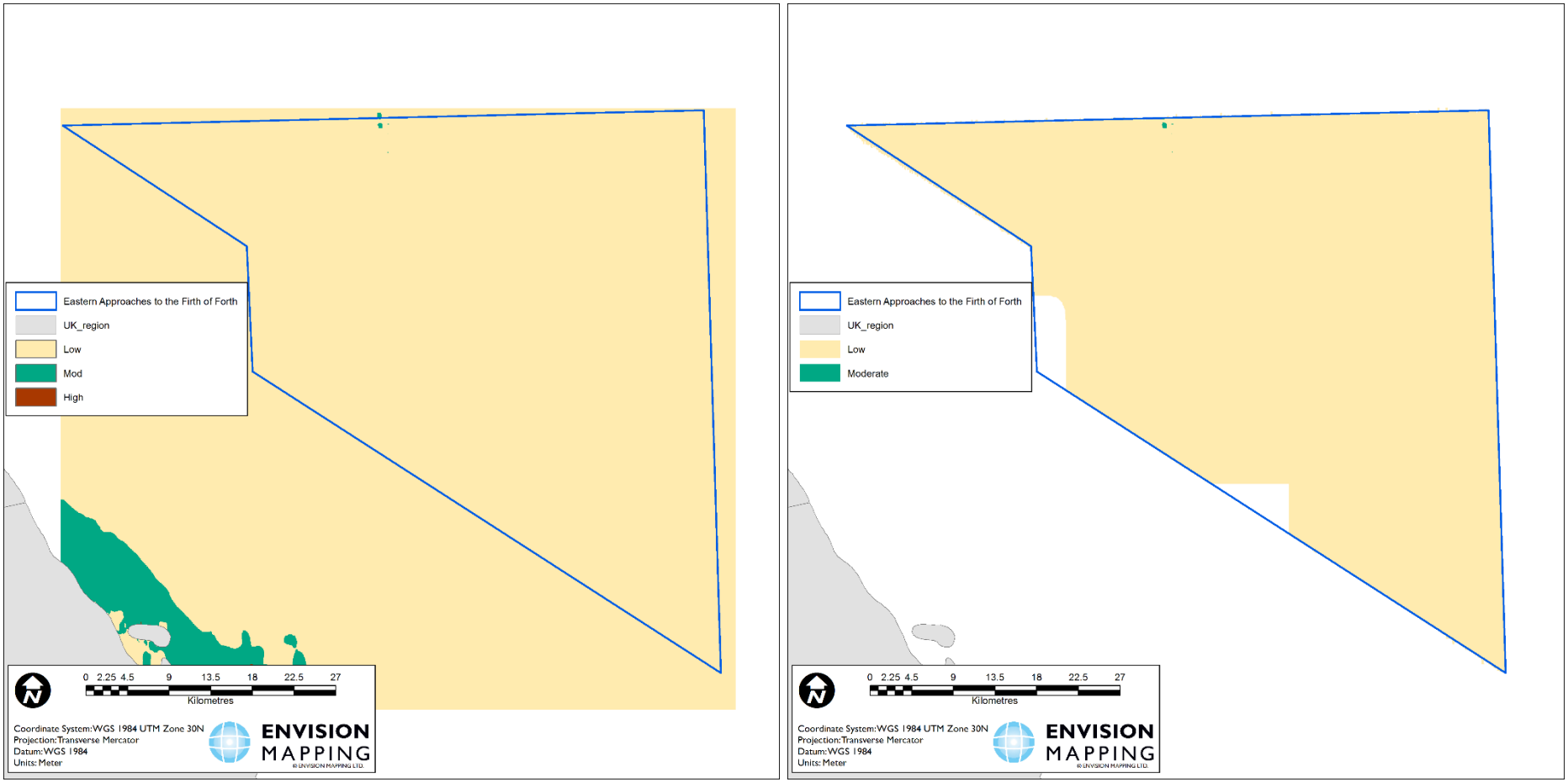

Figure 6. EUSeaMap seabed energy data (left) and reclassified data (right) for the Eastern approaches to the Firth of Forth.

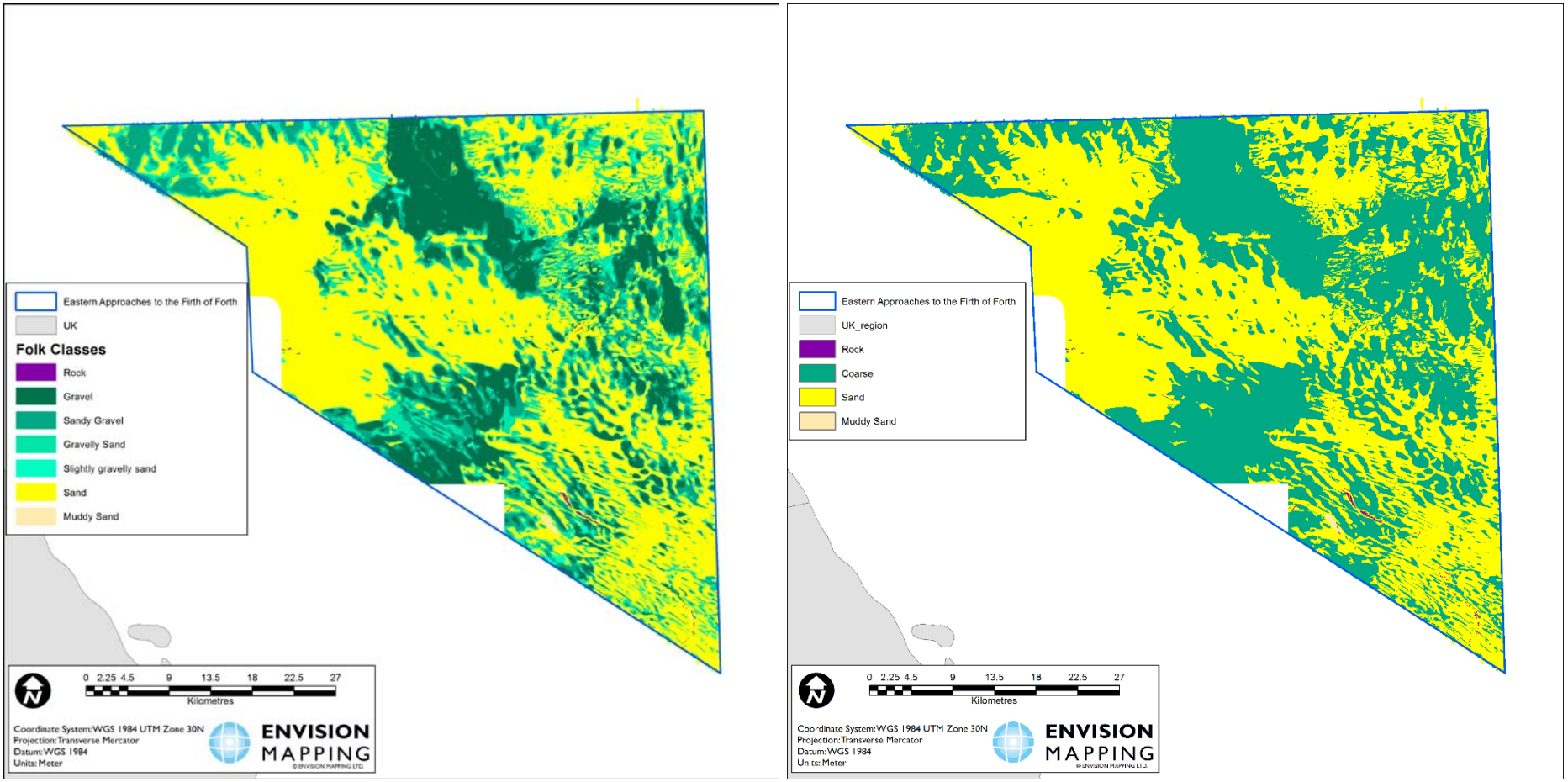

Figure 7. Seabed Substrates according to Folk classes (left) and simplified after Long (2006) (right) for the Eastern approaches to the Firth of Forth.

The top-down approach uses seabed substrate classes based upon a simplified Folk classification and the supplied BGS seabed substrate map was used with the substrates grouped using this scheme. Figure 7 shows the seabed substrates according to the Folk classification in comparison with the simplified seabed substrates.

Using these three input layers of seabed substrate, seabed energy and biological zones, the matrix shown in Table 4 was used to place all areas into the appropriate habitat category according to the rule-based top down methodology.

4 Results

The resulting maps (Figure 8 & Figure 9) produced using the top-down/rule-based mapping methodology shows the predominant seabed habitats to be coarse sediments within both the circalittoral and deep circalittoral biological zone regions and deep circalittoral sands and. There are some harder rock areas identified within the project area but these are relatively small areas confined to deep trough areas in the south-east of the area.

The bathymetry shallows towards the north of the area mapped, with a sediment bank feature, Berwick Bank, consisting of coarse material being present at the northern edges.

The physical parameter of the areas show a low energy environment with only circalittoral and deep-circalittoral habitats present with a restricted range of sediments.

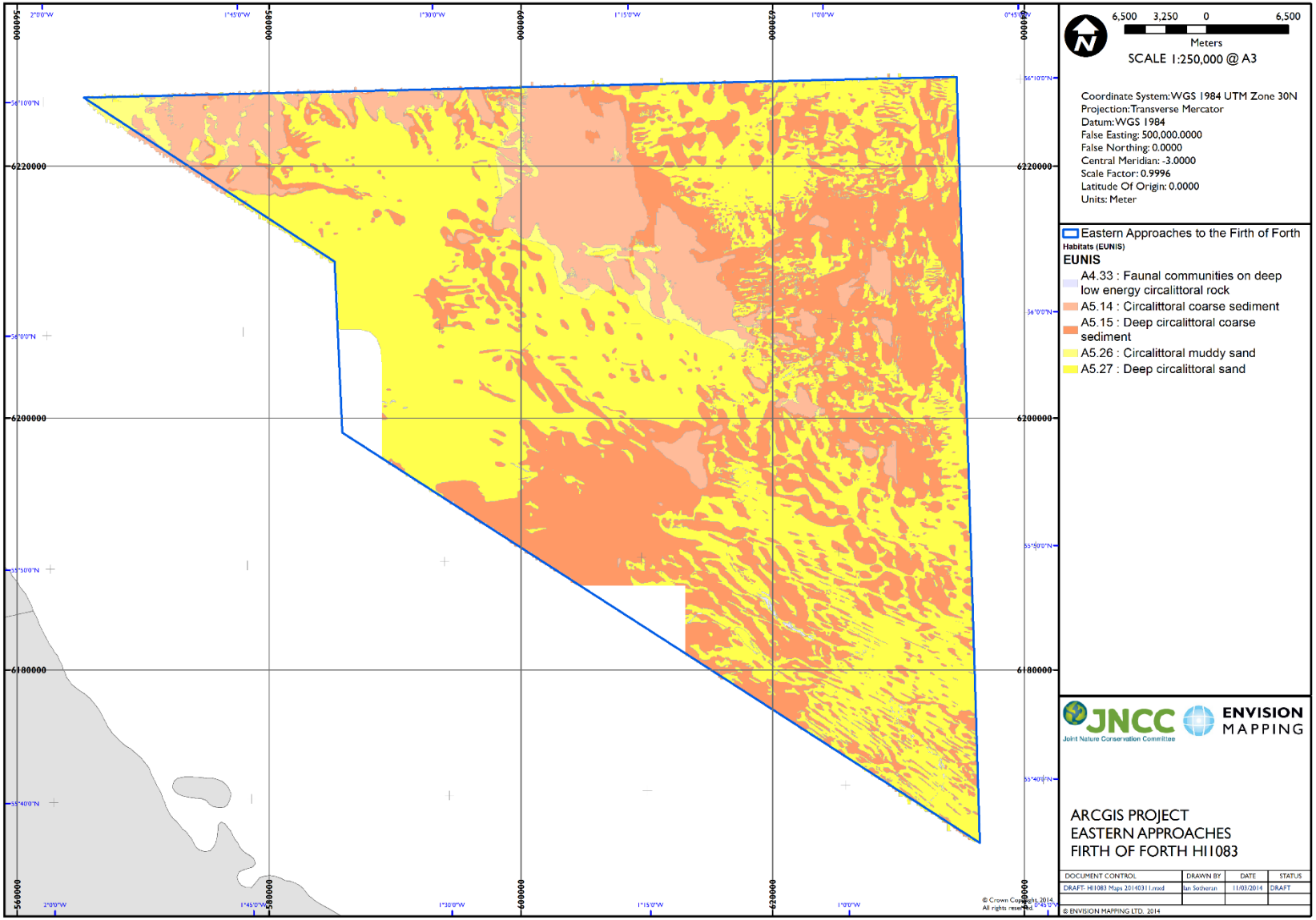

Figure 8. Top-down/Rule-based mapping habitat map (EUNIS Classificaiton) for the Eastern approaches to the Firth of Forth.

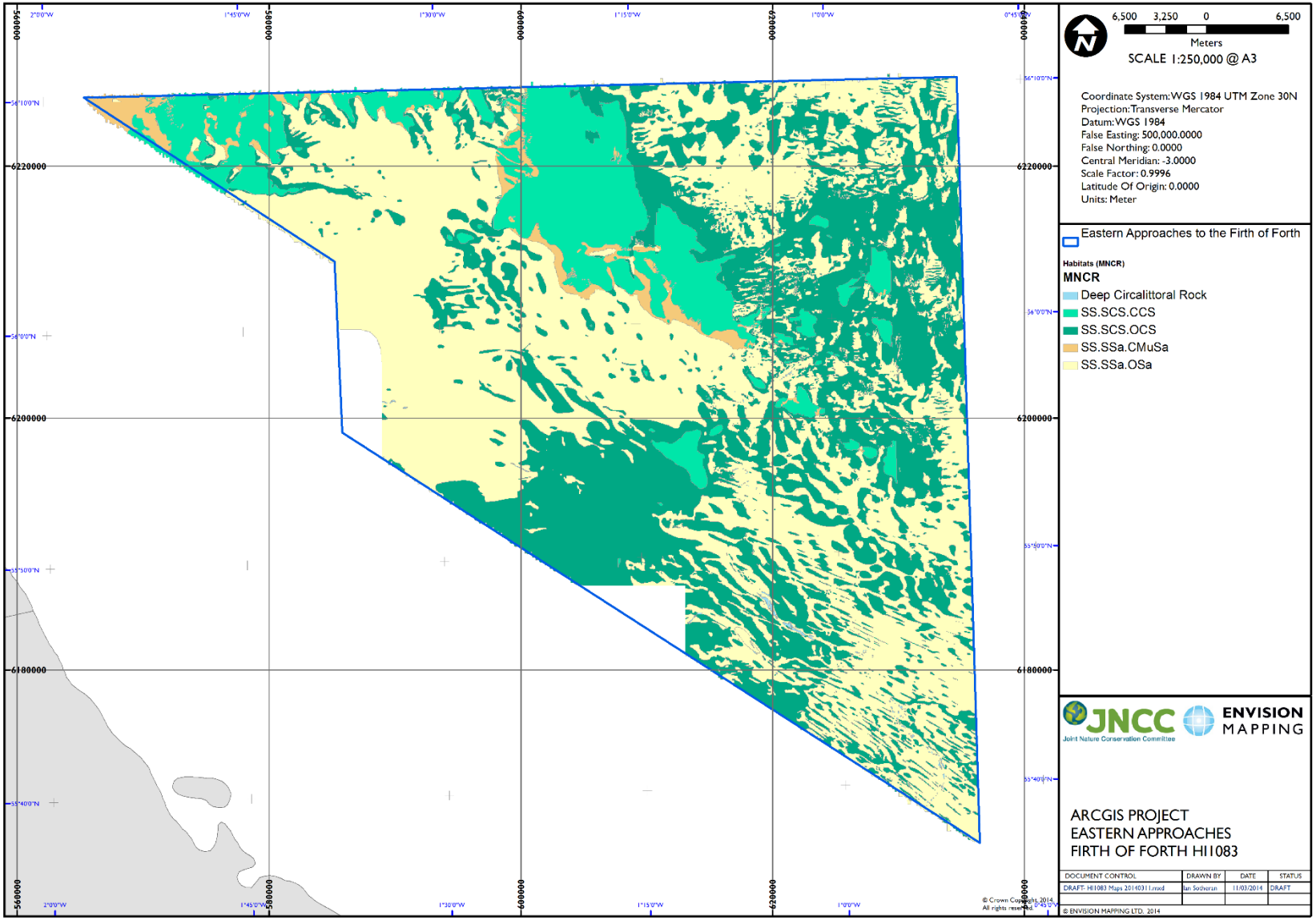

Figure 9. Top-down/Rule-based mapping habitat map (MNCR Biotope classification) for the Eastern approaches to the Firth of Forth.

5 Supplemental Information

5.1 Confidence Assessment

In order to assess the suitability of the map to its intended purpose, a confidence assessment using the MESH Confidence Assessment method (MESH 2008) has been undertaken. This approach assesses the quality and suitability of the acoustic data, the point sample data, and the interpretative techniques using a scoring system (Table 7).

The maps for the Eastern Approaches to the Firth of Forth scores 69 of a possible 100 which is reduced slightly by ground truth data vintage and as the ground truth data was for substrate identification not biological ground truth data were available. The ground truth data were used to generate the seabed substrates and the confidence assessments for these have been included within this maps assessment as the sediments are directly related to the habitats mapped.

Table 6 shows the map with its associated Globally Unique ID *(*GUI) and figure reference, the GUI code is used as the identifier for the map in the MESH confidence assessment results (Table 7).

Table 6. Map titles with associated GUIs and figure references.

Map Title	**MAP GUI**	**Figure**
Eastern Approaches to the Firth of Forth, Wee Bankie to Gourdon area Rule-based Map	GB001251	Figure 8

Table 7. MESH confidence assessment output for map produced.

MAP GUI	Remote Technique	Remote Coverage	Remote Positioning	RemoteStdsApplied	Remote Vintage	BGTTechnique	PGTTechnique	GTPositioning	GTDensity	GTStdsApplied	GTVintage	GTInterpretation	Remote Interpretation	Detail Level	Map Accuracy	Remote score	GT score	Interpretation score	**Overall score**
GB001251	3	3	3	3	3	-	3	2	3	2	1	2	33	1	1	100	50	58	**69**

5.2 Classification Certainty

In addition to the score produced for each map using the MESH confidence assessment method the process of determining biozones employs fuzzy thresholds to determine the boundaries for each biozone. In the case of the Eastern approaches to the Firth of Forth these fuzzy values are used to represent confidence in the classification of the data with regards the biozones data. Other factors such as the certainly of sediment mapping have not been incorporated within this project.

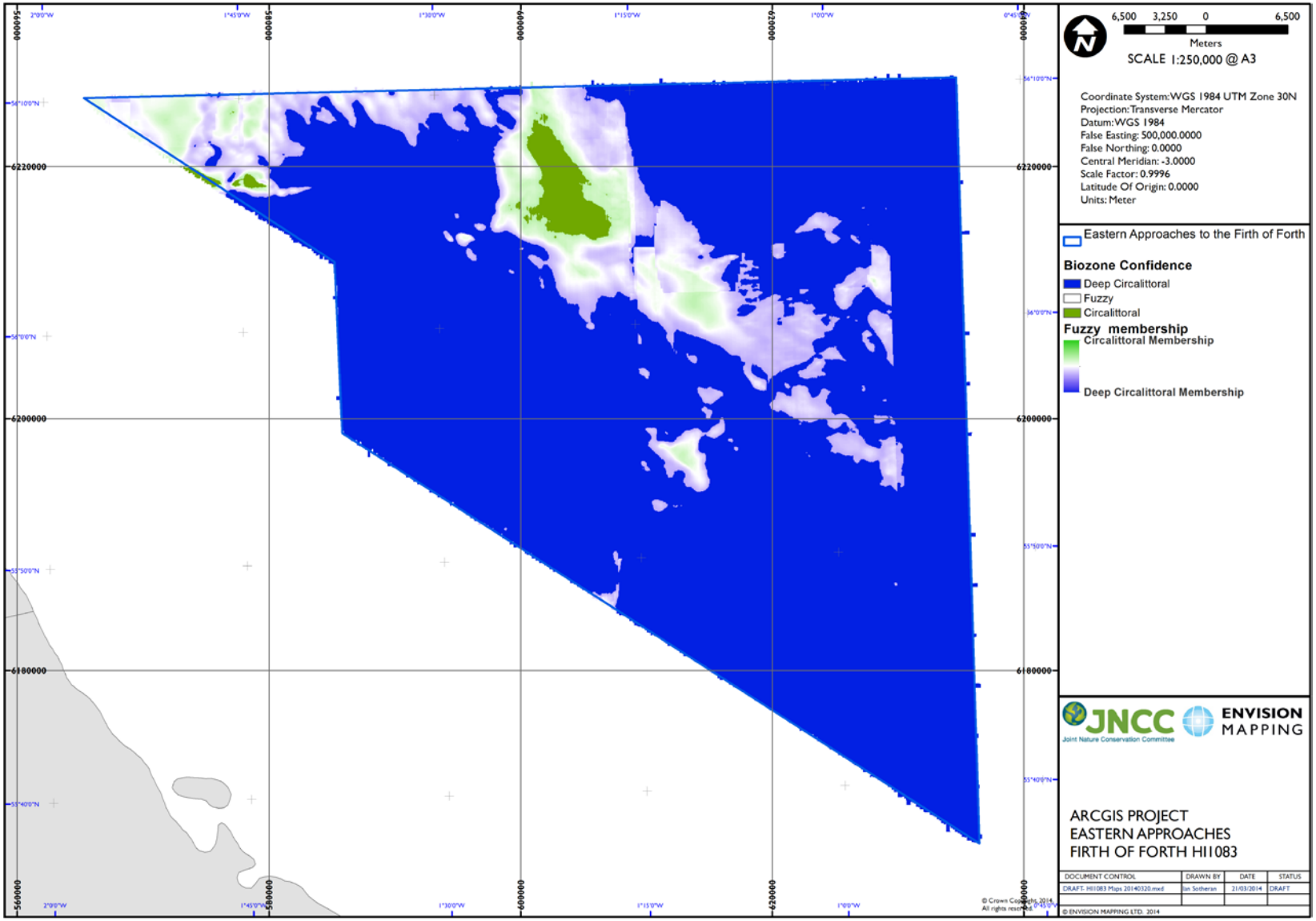

Figure 10. Certainty of classificaiton based upon fuzzy membership of the biozone classes.

6 Issues and Limitations

Effective and appropriate application of the maps produced as part of this project is dependent on an understanding and appreciation of the limitations associated with the maps and the processing which has been applied in their production.

The spatial resolution of the data used to produce the maps presented here can vary considerably not only with the spatial accuracy of data acquisition but also the spatial resolution at which habitats are detected by each form of data. The acoustic data has been processed to provide an initial resolution of ~7m but this has been reduced to 50m during processing to provide a consistent resolution and spatial parameters between all datasets used within the mapping process.

The EUNIS Classification and the MNCR habitat classification have been employed as mapping units for the maps produced as these are the most appropriate units for management purposes, but the habitat classifications are in constant development and as an increase in knowledge of the marine habitats is gathered the definitions of habitat classes can alter or be refined and it should be understood that the cut-offs and delimitations used may not be accurate, but the best understanding at the current time.

A rule-based top-down approach does have a range of assumptions associated with the processing methodology and with the datasets used. The processing operates by using a series of thresholds or exact delineations within data sets (i.e. a 200m depth limit for deep circalittoral or a 1.16Nm^{-2} limit for moderate current energy) and it is assumed these accurately or best represent the environmental conditions associated with each habitat class. The data employed with the process is also assumed to accurately represent the conditions which occur at each location mapped, whether this be the seabed substrate or the energy levels which occur. Each of these data are derived from either modelled data which has its own assumptions associated with it or by expert interpretation. The seabed substrate maps produced by BGS use sediment sample data to ground truth the multibeam and backscatter data, this sampling technique focuses on collecting a sediment sample which can be biased against sampling a surficial or hard substrate which may support an epifaunal habitat which is different to that found infaunally.

7 Conclusion

The objective of this project was to generate seabed habitat maps for the Eastern Approaches to the Firth of Forth full coverage acoustic dataset from the MCHP to as detailed a hierarchical level as possible within the MNCR and EUNIS classification schemes. This objective has been met through the delivery of EUNIS and MNCR habitat maps of the Area generated by the processing of the acoustic data sets in conjunction with modelled physical parameter data sets.

The maps will make an important contribution to the evidence base for the Scottish possible MPA, Firth of Forth Banks Complex, which coincides with the MCHP block, through best estimation of extent of search features. In this case, this latest mapping of sedimentary habitats is an improved determination of the extent of offshore subtidal sands and gravels in the area.

It is critical that such maps are used with clear understanding of how they were generated. The understanding can be supported through the use of the layers of certainty of classification.

8 Acknowledgements

The acoustic and seabed substrate datasets for the Eastern Approaches to the Firth of Forth area used in this project originated from the Agreement between the JNCC, BGS and NOC concerning the processing and interpretation of multibeam and backscatter in Scottish waters for MPA evidence and advice. The multibeam bathymetry and backscatter data were supplied by the Maritime and Coastguard Agency, the backscatter data were processed and interpreted by the British Geological Survey (BGS) into a seabed substrate map.

The energy, light and wave base data layers used in the top-down rule-based mapping were produced and made freely available by the EUSeaMap project.

We would also like to thank JNCC colleagues, particularly from the Marine Ecosystem Team, for their input and advice on the practical application and the considerations to be taken account of during the mapping to ensure it had use and benefits for multiple marine projects and programmes.

9 References

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Appendix 1: MPA Search Features

Seabed habitats and their components only – full list includes low or limited mobility species, mobile species and large-scale features (Marine Scotland 2011b).

MPA search feature	Component habitats/species	Scottish marine area
Blue mussel beds	*Mytilus edulis* beds on littoral sediments	Territorial waters
	Mytilus edulis and *Fabricia sabella* in littoral mixed sediment	Territorial waters
	Mytilus edulis beds on sublittoral sediment	Territorial waters
	Mytilus edulis beds on reduced salinity infralittoral rock	Territorial waters
Burrowed mud	Seapens and burrowing megafauna in circalittoral fine mud	Both
	Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud	Both
	Tall seapen *Funiculina quadrangularis*	Both
	Fireworks anemone *Pachycerianthus multiplicatus*	Both
	Mud burrowing amphipod *Maera loveni*	Offshore waters
Carbonate mound communities	Carbonate mound communities	Offshore waters
Coral gardens	Coral gardens	Offshore waters
Deep sea sponge aggregations	Deep sea sponge aggregations	Offshore waters
Flame shell beds	*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	Territorial waters
Horse mussel beds	*Modiolus modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata	Territorial waters
	Modiolus modiolus beds on open coast circalittoral mixed sediment	Territorial waters
	Modiolus modiolus beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata	Territorial waters
	Modiolus modiolus beds with *Chlamys varia,* sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata	Territorial waters
Inshore deep mud with burrowing heart urchins	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud	Territorial waters
Kelp and seaweed communities on sublittoral sediment	Kelp and seaweed communities on sublittoral sediment	Territorial waters
Low or variable salinity habitats	Faunal communities on variable or reduced salinity infralittoral rock	Territorial waters
	Kelp in variable or reduced salinity	Territorial waters

MPA search feature	Component habitats/species	Scottish marine area
Maerl beds	Maerl beds	Territorial waters
Maerl or coarse shell gravel with burrowing sea cucumbers	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand	Territorial waters
Native oysters	*Ostrea edulis* beds on shallow sublittoral muddy mixed sediment	Territorial waters
	Native oyster *Ostrea edulis*	Territorial waters
Northern sea fan and sponge communities	*Caryophyllia smithii* and *Swiftia pallida* on circalittoral rock	Territorial waters
	Mixed turf of hydroids and large ascidians with *Swiftia pallida* and *Caryophyllia smithii* on weakly tide-swept circalittoral rock	Territorial waters
	Deep sponge communities (circalittoral)	Both
	Northern sea fan *Swiftia pallida*	Both
Offshore deep sea muds	*Ampharete falcata* turf with *Parvicardium ovale* on cohesive muddy sediment near margins of deep stratified seas	Offshore waters
	Foraminiferans and *Thyasira* sp. in deep circalittoral fine mud	Offshore waters
	Levinsenia gracilis and *Heteromastus filifirmis* in offshore circalittoral mud and sandy mud	Offshore waters
	Paramphinome jeffreysii, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral sandy mud	Offshore waters
	Myrtea spinifera and polychaetes in offshore circalittoral sandy mud	Offshore waters
Offshore subtidal sands and gravels	*Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand	Offshore waters
	Hesionura elongata and *Protodorvillea kefersteini* in offshore coarse sand	Offshore waters
	Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	Offshore waters
	Abra prismatica, *Bathyporeia elegans* and polychaetes in circalittoral fine sand	Offshore waters
	Maldanid polychaetes and *Eudorellopsis deformis* in offshore circalittoral sand or muddy sand	Offshore waters
	Owenia fusiformis and *Amphiura filiformis* in offshore circalittoral sand or muddy sand	Offshore waters

MPA search feature	Component habitats/species	Scottish marine area
Seagrass beds	*Zostera noltii* beds in littoral muddy sand	Territorial waters
	Zostera marina/angustifolia beds on lower shore or infralittoral clean or muddy sand	Territorial waters
	Ruppia maritima in reduced salinity infralittoral muddy sand	Territorial waters
Sea loch egg wrack beds	*Ascophyllum nodosum* ecad *mackaii* beds on extremely sheltered mid eulittoral mixed substrata	Territorial waters
Seamount communities	Seamount communities	Offshore waters
Shallow tide-swept coarse sands with burrowing bivalves	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand	Territorial waters
Tide-swept algal communities	Fucoids in tide-swept conditions	Territorial waters
	Halidrys siliquosa and mixed kelps on tide-swept infralittoral rock with coarse sediment	Territorial waters
	Kelp and seaweed communities in tide-swept sheltered conditions	Territorial waters
	Laminaria hyperborea on tide-swept infralittoral mixed substrata	Territorial waters