Method for updating the UK full-coverage EUNIS level 3 seabed habitat map integrating fine- and broad-scale maps

Contents

1 Introduction

This document describes the procedure used to update the existing UK full-coverage EUNIS level 3 seabed habitat map integrating fine- and broad-scale maps. This work aims to create a map that presents the best available information on the distribution of EUNIS level 3 habitats at any location in UK waters. This data product is required for, among other things, assessments of progress towards networks of marine protected areas (MPAs) and marine spatial planning in the UK.

1.1 Specification for product

The aim was to produce a single map layer displaying the best quality EUNIS level 3 data for any given location. Furthermore, the process for producing the layer needed to be:

- Repeatable;
- Transparent;
- Easy to explain and understand;
- Objective;
- Fully documented;
- Appropriate for EUNIS level 3 habitats; and,
- Appropriate for the UK intertidal and subtidal areas

Any location would show only a single value describing the habitat at EUNIS level 3, i.e. no overlapping polygons leading to multiple possible values at a location. The data at any location should be the best available to describe the EUNIS level 3 habitat type (i.e. the most likely to be correct). EUNIS level 3 habitats (Appendix 1) describe physical habitats classified using biologically meaningful parameters – substrate type, and additionally for rock: energy and biological zone. Therefore, a method was created to choose data based on their ability to describe these physical variables; however, habitat types from other levels of the EUNIS hierarchy are included where available.

1.2 Data sources

The data used to create the final product can be categorised into:

1. **Habitat maps created from field survey data** – through JNCC's obligations to assess and report on seabed habitats at a UK scale, it retains a catalogue of the seabed habitat maps that exist for the UK. Data from these surveys were collected across a range of spatial, temporal and thematic scales, using a variety of survey techniques.

2. **UKSeaMap** – this is a broad-scale predictive habitat map created by overlaying classified oceanographic models with a broad-scale substrate map (Manca, 2019). In this product, consistency and full-coverage are the priorities.

Because this product combines these two types of input, it is sometimes referred to simply as "the combined map". For the remainder of the document we will call it "the combined EUNIS L3 survey/model map" so its parameters are more explicit.

1.3 Special case in English & Welsh territorial waters

For English territorial waters Natural England maintain its own full-coverage seabed habitat map, known as the **Natural England Evidence Base**, which we have included with minor

modifications as agreed with Natural England and described in Section 2.5. Therefore, much of the method described in this document is not applicable in English territorial waters.

On request from Natural Resources Wales (NRW), some manual changes were made in Welsh territorial waters, as described in Section 2.4.

1.4 Version history

- In 2011, JNCC created the first combined EUNIS L3 survey/model map to aid the identification of possible Marine Conservation Zones. More details about this are available from JNCC on request.

- The last public release was version 8.3, from March 2014. See Ellwood (2014) for more details.

- Since 2014, some intermediate versions have been created for specific regions and specific purposes; but weren't published.

- The version described in this document (version 9.6.6) is the latest public release.

2 Method

2.1 Method overview

1. Remove all data from English territorial waters
2. Remove UKSeaMap 2016 and replace with UKSeaMap 2018
3. Add new habitat maps from surveys
4. Remove overlaps areas from UKSeaMap 2018 and merge with habitat maps from surveys
5. Manual changes in Welsh territorial waters
6. Insert the latest NE Evidence Base to infill English territorial waters

All data sources were developed using ESRI™ shapefiles and geodatabase feature classes, and data processing was carried out in ArcGIS 10.1.

To uphold and ensure accurate data management and compatibility, attributes from inputs were standardised prior to use in compliance with the EMODnet Seabed Habitats Translated Habitat Data Exchange Format[1].

The simple three-step confidence assessment method of Lillis (2016) was used to assign a qualitative confidence between 0 and 4 to each habitat map from survey. This was used to decide which habitat map to use in the case of overlapping habitat maps to use (see section 2.3.2).

2.2 Insert new version of UKSeaMap

All processes completed within this section. are outlined in Figure 1 and were completed using Python 2.7. written in ArcPy for the ESRI™ Geoprocessing Python Console.

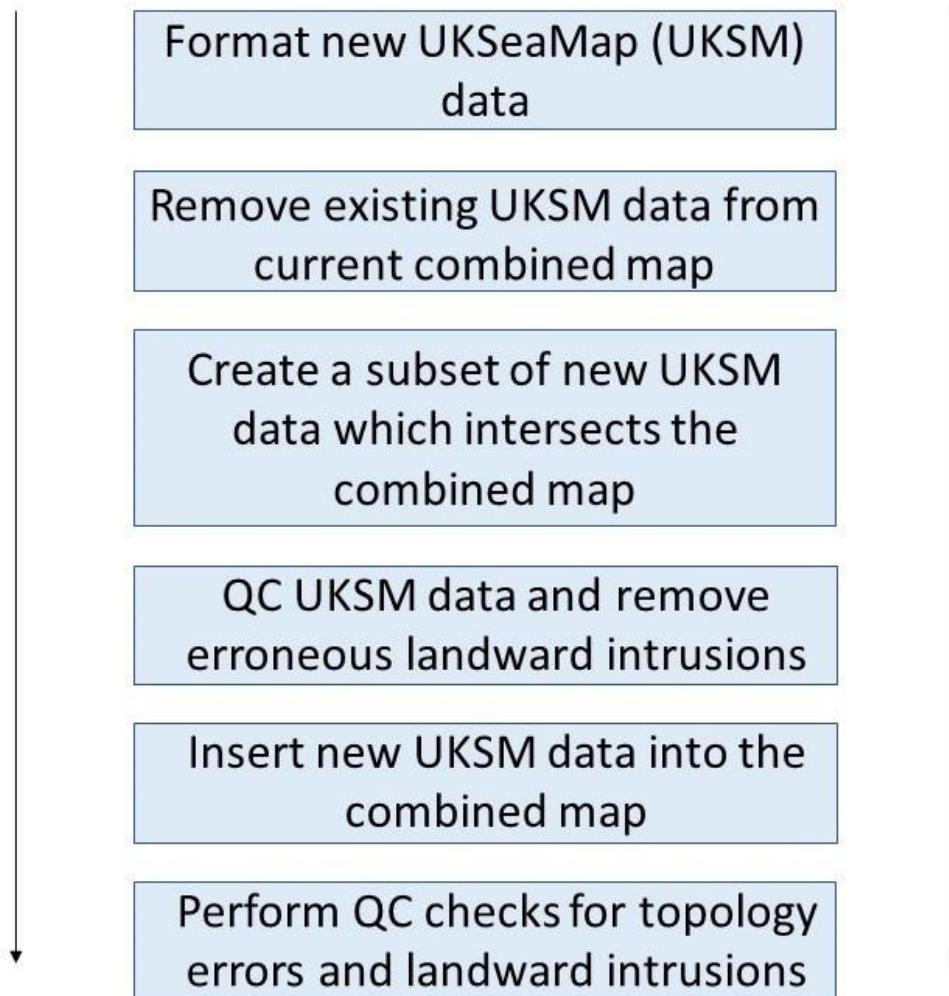[1] http://www.emodnet-seabedhabitats.eu/def [Accessed 10/05/2017]

Figure 1 UKSeaMap update process outline

2.2.1 Format new UKSeaMap data

Prior to the update process, the attributes of UKSeaMap 2018 v2 were standardised into the EMODnet Seabed Habitats Translated Habitat Data Exchange Format[1]. Additional fields were added as outlined in Table 2.

Table 1 Standardised EMODnet Seabed Habitats Translated Habitat Data Exchange Format attributes to be added to UKSeaMap2018

New attribute field	Field Type	Source of data to be used
"GUI"	"TEXT"	Set as "UKSM18"
"Polygon"	"LONG"	Copy from "OBJECTID" field
"ORIG_HAB"	"TEXT"	Copy from "AllCombD" field
"ORIG_CLASS"	"TEXT"	Set as "UKSeaMap Output"
"HAB_TYPE"	"TEXT"	Copy from "EUNIScomb" field
"VERSION"	"TEXT"	Set as "EUNIS version 2007-11"
"DET_MTHD"	"TEXT"	Set as "Correlation table"
"DET_NAME"	"TEXT"	Set as "JNCC"
"DET_DATE"	"DATE"	Set as "2018/12/17"
"TRAN_COM"	"TEXT"	Blank
"T_RELATE"	"TEXT"	Set as "="
"VAL_COMM"	"TEXT"	

2.2.2 Remove existing UKSeaMap data from the combined map

Once all UKSeaMap2018 v2 data were correctly structured using the EMODnet Seabed Habitats Translated Habitat Data Exchange Format, the existing UKSeaMap2016 was removed from a working copy of the combined map and exported as a new Geodatabase Feature class.

2.2.3 Create a subset of new UKSeaMap data

In order to identify which areas of UKSeaMap2018 v2 would be inserted into the updated combined map product, a 'Select-By-Location' query was performed to sample areas of the new UKSeaMap data which intersected the combined map (without UKSeaMap2016). Subsequently, the ESRI™ Erase Tool was used to remove any feature geometries from the new UKSeaMap2018 v2 data which coincided with combined map (excluding UKSeaMap2016).

2.2.4 Insert new UKSeaMap data into the combined map

Following this, the erased output was combined with not-intersecting UKSeaMap 2018 v2 layer with the ESRI™ Merge Tool and quality checked by visual inspection. This step of the method required significant computational processing power, therefore, should the process be repeated, performance may be improved by dissolving the data prior to sub-setting areas to be updated.

2.2.5 Perform QC checks for topology errors and landward intrusions

Topologies which were found to erroneously intrude into terrestrial areas were removed by erasing a polygon of UK terrestrial areas above Mean High Water Springs from the merged data. Finally, the corrected data were added into the working copy of the combined map using the ESRI™ Append Tool and quality checked for both topology and geometry errors.

2.3 Insert new habitat maps from surveys

All processes completed within this section are outlined in Figure 2 and were completed using Python 2.7 written in ArcPy for the ESRI™ Geoprocessing Python Console and Python 3.6 from an integrated development environment (IDE).

2.3.1 Identify new survey maps and data formatting

It was necessary to accurately identify which data stored within the EUNIS reference maps already existed within the combined map, and to subset new data to be analysed separately prior to completing the update. To achieve this, all openly available EUNIS habitats held by JNCC that were not present in the combined map, were combined into a single layer using Python 2.7. and the ESRI™ Merge Tool. Subsequently, newly merged data were aggregated by individual Generic Unique Identifier (GUI) using the ESRI™ Dissolve Tool and intersected with the combined map to highlight areas of overlap. Attributes from the newly intersected data were exported to tabular format and analysed separately using the Pandas library for Python 3.6. executed from the PyCharm IDE.

2.3.2 Decision tree analyses

To combine overlapping data into a single output, a rule-based approach was used to establish data of higher quality which should be retained or used to overwrite existing maps. The method was written into a single function in Python 3.6 based on the rules and criteria outlined in Figure 3.
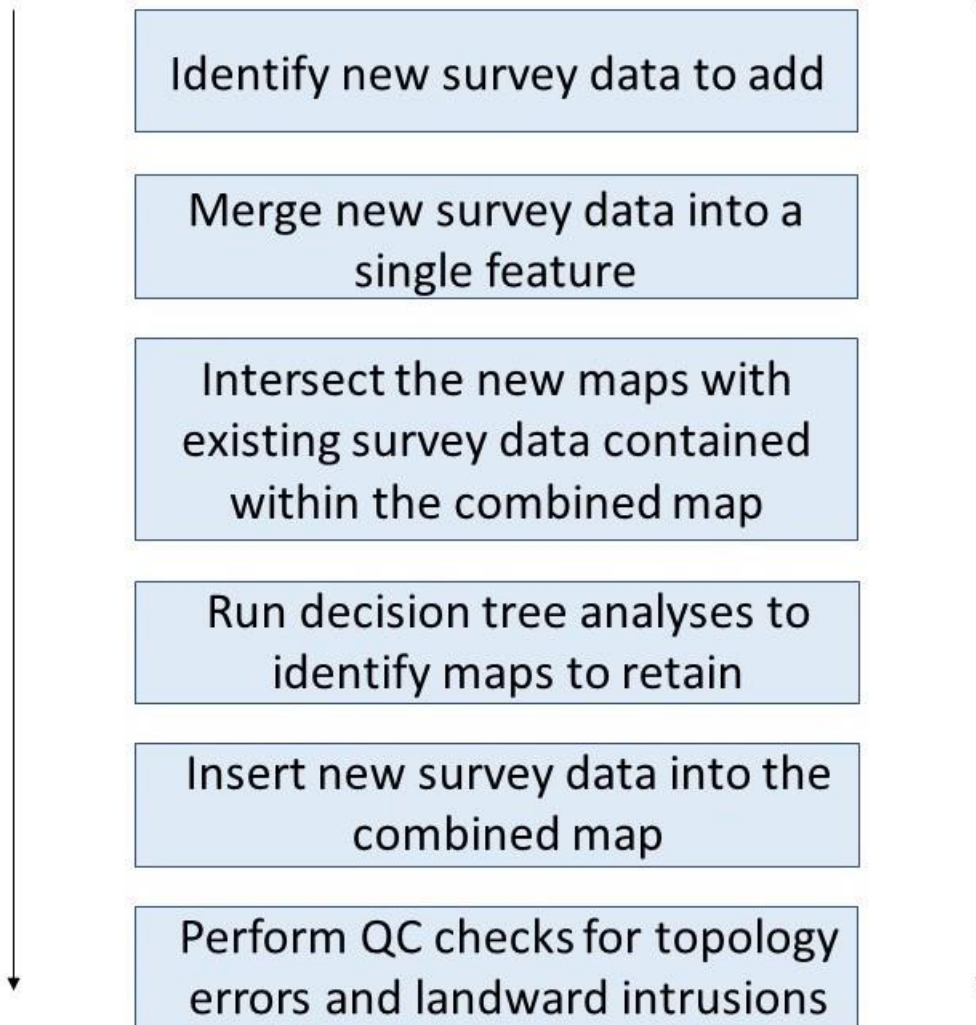
Figure 2 Survey data update process outline

The output was a single tabular overview of all intersecting maps and corresponding metadata used as inputs to the decision tree (Figure 3). Each unique pair of intersecting maps were compared for data quality, and the GUI of the 'winning' map was detailed for each analysis in a new column. The tabular outputs of the decision tree analyses were joined by attributes as a dBASE Table File (DBF) to both new and existing GUIs in the intersected survey maps layer in ESRI™ ArcGIS. Afterwards, a 'Select-By-Attribute' query was executed in Python 2.7 from the ESRI™ Geoprocessing Python Console to create a subset of the intersected data where the results of the decision tree analyses set the new map GUIs to 'lose' (not used to overwrite existing data).

The data stored within the 'losing' data layer were used to erase features from the new survey maps using the ESRI™ Erase Tool, therein, producing a new layer retaining data which either did not intersect existing survey data or were set to overwrite it. Finally, the new 'winning' survey data were used to erase overlapping features from the combined map and merged back into the dataset, ensuring that the only data within the merged areas comprised the 'winning' survey maps.
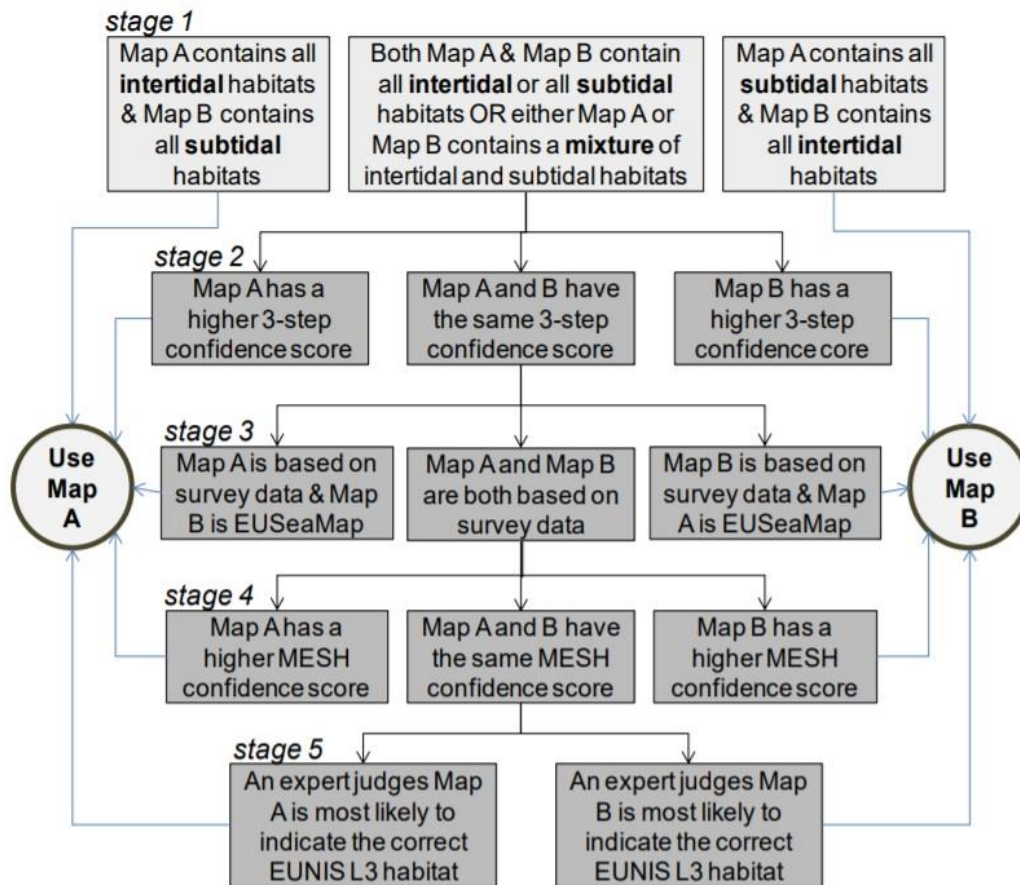
Figure 3 Five-stage decision tree: followed for each area of overlap between two maps (Ellwood, 2014).

2.4 Subsequent changes in Welsh territorial waters

NRW reviewed the initial draft product and were concerned about the substrate types shown by UKSeaMap in some areas. The outputs showed the presence of sediments (e.g. A5.1, A5.4), which contradicted their higher resolution survey data showing the presence of definite Annex I Reef. In order to combine their Annex I product, JNCC manually classified their data to the EUNIS classification using a combination of the UKSeaMap habitat descriptors energy level and biological zone, with the various substrate descriptions from the NRW Annex I Reef dataset.

Additional changes were made regarding the Phase I intertidal data product for Wales. The product included in previous versions were based on the British National Grid coordinate reference system (EPSG:27700), whereas the rest of the combined map dataset is based on the Web Mercator (Auxiliary Sphere) coordinate system (EPSG:3857). This resulted in some projection shifts of the data and misaligned the Phase I data with the remaining combined map. The original copy of the Phase I product, before it was projected to the British National Grid system, was provided by NRW and was included in the combined map as the definitive presence of the Welsh intertidal habitats, therefore rectifying the issue for future iterations of the combined map.

2.5 Reinserting the Natural England Evidence Base

The final stage of the updates to the combined map required the reinsertion of data sourced from the NE Evidence Base, which formed the portion of the data product covering all

English territorial waters. This was only completed once all UKSeaMap2018 v2 and survey data had been updated within the working copy of the combined map.

Data stored within the NE Evidence Base were clipped to English inshore waters and manipulated, creating a new layer only containing NE survey datasets with EUNIS biotope data with instances of EUSeaMap 2012 & 2016 and non-EUNIS biotope data removed. The gaps created by the removal of EUSeaMap were backfilled with any present UKSeaMap 2018 data, which was the most detailed broad-scale data available during the production of the product. The processed Evidence Base was intersected with itself to identify duplicate polygons; any duplicate polygons were removed using the Delete Identical tool on the Shape parameter.

Algorithms were developed in Python to iterate through the attributes of the NE maps, scanning for potentially erroneous data where GUI values may have been missing. Incomplete entries were calculated if the information was present but stored in another field or removed altogether if this calculation was not impossible. Prior to reinsertion, a self-intersection was completed on the NE data, and results were sorted by confidence and date (both in descending order). Finally, the duplicate entries were removed from the self-intersected data, and the maps reinserted into the working copy of the combined map.

2.6 Additional fields

In addition to the fields described by the EMODnet Seabed Habitats Translated Habitat Data Exchange Format[1], three new fields were added to the attribute table to make the EUNIS level 3 habitat codes explicit and to show confidence assessment scores (Table 2).

Table 2 Additional fields added to the combined map attribute table

New attribute field	Field Type	Source of data to be used
"EUNIS_L3"	"TEXT"	Left 4 characters from "HAB_TYPE"
Three_Step	"LONG"	Three-step confidence score (0-4) as described in Lillis (2016)
MESH_Confi	"LONG"	MESH confidence score (0-100)

3 Accessing the data product and its source data

This data product is available via the JNCC website:

https://jncc.gov.uk/our-work/marine-habitat-data-product-eunis-level-3-combined-map/

On this page you'll find links to view metadata, download the product and access it via a web mapping service.

This product is made up of many individual habitat maps and is therefore quite large. If you are only interested in one or a few of the individual habitat maps, then many of these are available individually via the EMODnet Seabed Habitats online interactive map (also maintained by JNCC).

Each individual habitat map has a metadata record on the ICES metadata catalogue, which is identifiable using the 'GUI' (globally unique identifier) in the attribute table. You can search by GUI on the EMODnet Habitats metadata search page.

4 References

Ellwood, H. 2014. Creating a EUNIS level 3 seabed habitat map integrating data originating from maps from field surveys and the EUSeaMap model.

Ellwood, H., and Duncan, G. 2015. Creating a composite OSPAR threatened and/or declining habitat map for the UK (version 1.0).

JNCC. 2015. The Marine Habitat Classification for Britain and Ireland Version 15.03 [Online]. Available from: https://mhc.jncc.gov.uk/ [Accessed July 2019]

JNCC. 2017. Marine Habitat Correlation Tables [Online]. Available from: https://mhc.jncc.gov.uk/resources#correlationtables [Accessed July 2019]

Lillis, H., 2016. A three-step confidence assessment framework for classified seabed maps, JNCC Report 591, ISSN 0963-8901. Available from: https://hub.jncc.gov.uk/assets/56e7a140-04c1-4159-bc6b-d28946ebc196 [Accessed 21 October 2019]

Manca, E. 2019. 2019 Update to UKSeaMap – a broad-scale seabed habitat map for the UK. *In prep*.

Appendix 1: EUNIS level 3 habitats in the UK

EUNIS code	EUNIS name	EUNIS code	EUNIS name
A1.1	High energy littoral rock	A6.5	Deep-sea mud
A1.2	Moderate energy littoral rock	A6.6	Deep-sea bioherms
A1.3	Low energy littoral rock	A6.7	Raised features of the deep-sea bed
A1.4	Features of littoral rock	A6.8	Deep-sea trenches and canyons, channels, slope failures and slumps on the continental slope
A2.1	Littoral coarse sediment		
A2.2	Littoral sand and muddy sand	A6.9	Vents, seeps, hypoxic and anoxic habitats of the deep sea
A2.3	Littoral mud	B1.1	Sand beach driftlines
A2.4	Littoral mixed sediments	B1.2	Sand beaches above the driftline
A2.5	Coastal saltmarshes and saline reedbeds	B1.3	Shifting coastal dunes
A2.6	Littoral sediments dominated by aquatic angiosperms	B1.4	Coastal stable dune grassland (grey dunes)
A2.7	Littoral biogenic reefs	B1.5	Coastal dune heaths
A2.8	Features of littoral sediment	B1.6	Coastal dune scrub
A3.1	Atlantic and Mediterranean high energy infralittoral rock	B1.7	Coastal dune woods
A3.2	Atlantic and Mediterranean moderate energy infralittoral rock	B1.8	Moist and wet dune slacks
		B1.9	Machair
A3.3	Atlantic and Mediterranean low energy infralittoral rock	B2.1	Shingle beach driftlines
A3.7	Features of infralittoral rock	B2.2	Unvegetated mobile shingle beaches above the driftline
A4.1	Atlantic and Mediterranean high energy circalittoral rock	B2.3	Upper shingle beaches with open vegetation
A4.2	Atlantic and Mediterranean moderate energy circalittoral rock	B2.4	Fixed shingle beaches, with herbaceous vegetation
A4.3	Atlantic and Mediterranean low energy circalittoral rock	B2.5	Shingle and gravel beaches with scrub
A4.7	Features of circalittoral rock	B2.6	Shingle and gravel beach woodland
A5.1	Sublittoral coarse sediment	B3.1	Supralittoral rock (lichen or splash zone)
A5.2	Sublittoral sand	B3.2	Unvegetated rock cliffs, ledges, shores and islets
A5.3	Sublittoral mud		
A5.4	Sublittoral mixed sediments	B3.3	Rock cliffs, ledges and shores, with angiosperms
A5.5	Sublittoral macrophyte-dominated sediment	B3.4	Soft sea-cliffs, often vegetated
A5.6	Sublittoral biogenic reefs		
A5.7	Features of sublittoral sediments		
A6.1	Deep-sea rock and artificial hard substrata		
A6.2	Deep-sea mixed substrata		
A6.3	Deep-sea sand		
A6.4	Deep-sea muddy sand		

5   Annex I: Version Control

BUILD STATUS:

Version	Date	Author	Reason/Comments
0.1	11/02/19	Liam Matear	Development of initial draft.
0.2	25/03/19	Helen Lillis	Edits
0.3	28/06/19	Jordan Pinder	Amendments following Natural England Evidence Base inclusion
0.4	15/10/19	Jordan Pinder	Amendments following edits made within Welsh waters
1.0	01/11/19	Jordan Pinder	Final edits

DISTRIBUTION:

Copy	Version	Issue Date	Issued To
0.1	0.1	11/02/19	Mapping Team for preliminary review
0.2	0.2	25/03/19	Helen Lillis
0.3	0.3	28/06/19	Helen Lillis
0.4	0.4	15/10/19	Helen Lillis
1.0	1.0	01/11/19	Public