Method for creating version 2 of the UK Composite Map of Annex I Sandbanks slightly covered by seawater all of the time

This file can be found at the following address: http://jncc.defra.gov.uk/page-3058.

1 Introduction

1.1 Requirement

Sandbanks slightly covered by seawater all of the time (hereafter referred to as Sandbanks) are listed for protection under Annex I of the Habitats Directive (92/43/EEC[1]). This means that the UK has an obligation to provide protection for this habitat through the establishment and management of Special Areas of Conservation (SACs). To aid this process, the Joint Nature Conservation Committee (JNCC) maintains a composite map of all Annex I Sandbanks in UK. This is carried out in collaboration with all of the Country Nature Conservation Bodies[2] (CNCBs) and is updated twice per six-yearly reporting period (required under Article 17 of the directive).

Version 1 of the Annex I Sandbanks layer was published in 2012 (Ellwood, 2014). The dataset was created using a standardised method (extending Klein, 2006) for detecting and delineating Sandbanks where the data allowed, in addition to compiling Sandbanks delineated by the CNCBs.

The 2016 update (version 2) incorporates new evidence that has since been collected by JNCC and the CNCBs on the presence of Sandbanks and Sandbank communities, providing a basis to update the layer where new data is available, and update the confidence of previously delineated Sandbanks with a transparent confidence assessment method that is compatible with other Annex I layers produced by JNCC.

In addition, version 1 of this dataset involved the delineation of Sandbanks as defined by the 2007 Interpretation Manual of European Union Habitats (see section 1.2). A number of UK inshore SACs were designated before these revised guidelines and Ellwood (2014) noted in the documentation for version 1 that further work should be undertaken to represent these inshore banks as designated. This update incorporates this recommendation.

1.2 Definition

The Interpretation Manual of European Union Habitats – EUR25 (CEC, 2003; also see Appendix) includes the following in its interpretation of “Sandbanks which are slightly covered by sea water all the time”:

- Permanently submerged
- Top of bank is generally in < 20 m of water depth
- Composed mainly of sandy sediment

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043

[2] Department of the Environment (Northern Ireland) (DOE), Natural England (NE), Natural Resources Wales (NRW) and Scottish Natural Heritage (SNH).

- May be non-vegetated or vegetated with *Zostera marina* (sea grass) and/or free living species of the *Corallinaceae* family (maerl)

The Interpretation Manual of European Union Habitats – EUR27 (CEC, 2007) subsequently added that a Sandbank is:

- Predominantly surrounded by deeper water.

The definition subsequently remained unchanged within The Interpretation Manual of European Union Habitats – EUR28 (CEC, 2013); also see Appendix.

The 2013 interpretation also refers to the presence of associated biological communities in its description of Sandbank feature:

- "Banks where sandy sediments occur in a layer over hard substrata are classed as Sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata"
- "Sandbanks can, however, extend beneath 20 m below chart datum. It can, therefore, be appropriate to include in designations such areas where they are part of the feature and host its biological assemblages."

1.3 Context

Topographically, Annex I Sandbanks can be formed as:

1) Sandy mounds; or
2) Tidal sandbanks that are either:
    - Open shelf ridge sandbanks;
    - Estuary mouth sandbanks; or
    - Headland associated banks.

The definition of "sandy sediments" follows that described in Appendix II of Marine Natura 2000 Project Group paper MN2KPG19_7_Sandbanks by Ridgeway and Johnston (2008). Sand is defined as sediment particles between 2 and 0.0625 mm in diameter and sandy sediment must be composed of less than 30 % gravel and have more sand than mud. Using the terminology of Folk (1954), this includes: "Gravel, sand and silt", "Gravelly, muddy sand" [gmS], "Gravelly sand" [gS], "Muddy sand" [mS], "Sand" [S], "Slightly gravelly, muddy sand" [(g)mS] and "Slightly gravelly sand" [(g)S] (Figure 1).

This differs from the narrower JNCC and CNCB's typical interpretation of "sandy sediments" in relation to the EUNIS habitat "A5.2 Sublittoral sand" (Figure 1).

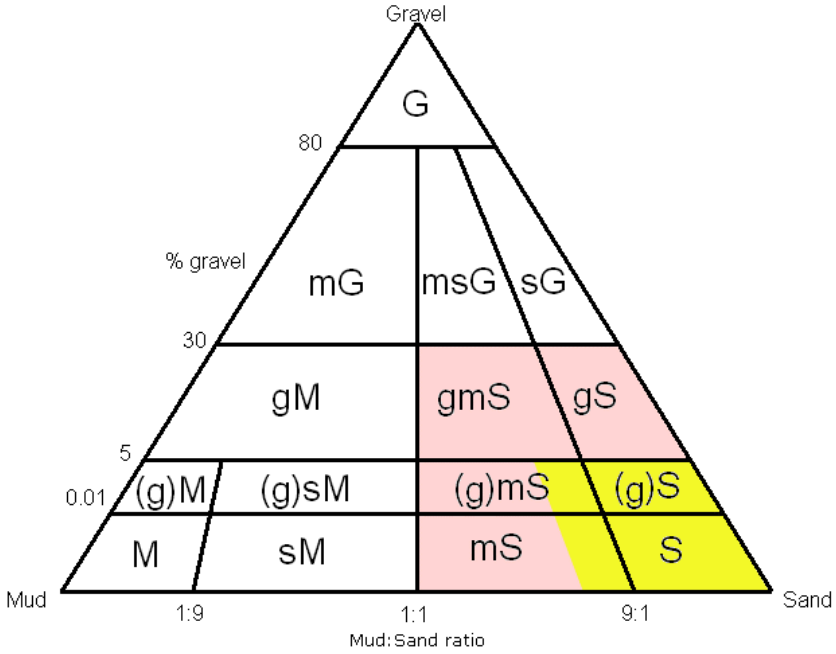

Figure 1: JNCC and CNCB typical interpretation of sand in relation to the EUNIS habitat "A5.2 Sublittoral sand" (Connor et al, 2006) in yellow in comparison to the wider interpretation in relation to Annex I Sandbanks (Ridgeway and Johnston, 2008) in red, show against the classic Folk ternary diagram.

2 Method

2.1 Data Sources

2.1.1 Delineated Sandbanks

UK Sandbanks (version 1)
Version 1 of the UK Sandbanks layer (2012) was used as a starting point. For further information on how this layer was created, please see Appendix section 7??.

Specific CNCB-provided datasets
Updated data regarding Sandbank extent within several SACs were supplied on request by Natural Resources Wales (NRW) and Scottish Natural Heritage (SNH). These data relate to the agencies' most recent understanding of the nature of the Sandbanks within the sites.

The Natural England evidence base, supplied by NE, contains current understanding of extent of Annex I Sandbank sub-features within English inshore Special Areas of Conservation (SACs), derived from a variety of survey information. These data are contained within the full database and are identifiable via the "**SAC_UID**" attribute field.

Data supplied by SNH provided their current understanding of Sandbank extent from survey data within Luce Bay and Sands, Sound of Airsaig, Sound of Barra, Sanday, Moray Firth, and Firth of Tay and Eden Estuary SACs.

Data supplied by NRW concerned updated delineations of Sandbanks within Menai Straight and Conwy Bay, and Lleyn peninsula and the Sarnau SACs based on new survey information within the sites.

JNCC/Cefas Bassurelle survey
An updated delineation of Bassurelle Sandbank was generated from multibeam data acquired by JNCC and Cefas aboard the RV Cefas Endeavour on survey CEND 03/13.

Sandbank drift and uncertainty margins advised by JNCC
JNCC and NE provided advice to Defra MMO in 2015 regarding uncertainty margins and Sandbank drift on the Sandbanks within Haisborough Hammond & Winterton, and Inner Dowsing, Race Bank & North Ridge candidate SACs /Sites of Community Importance (SCIs). Evidence collected shows that the Sandbanks are highly mobile and the previously delineated extents (in version 1 of this dataset) were likely to underrepresent the current feature. Uncertainty margins of 500 m were provided to Defra and MMO showing areas where the Sandbanks could now exist with current knowledge of bank movement. In Haisborough Hammond and Winterton cSAC/SCI an additional buffer of 1000 m was advised for Middle and North-Cross Sandbanks to account for an identified north-easterly drift, based on a projected movement over a period of 10 years since the bank delineation in 2010.

Official SAC boundaries
Following JNCC interpretation of biological community analysis within North Norfolk Sandbanks and Saturn Reef, and Bassurelle Sandbank SACs (in press), it has been determined that Sandbank communities exist throughout these two sites. The Annex I habitat has therefore been determined to extend *at least* to the SAC boundary, though possibly further. The official boundaries of these two sites are thus used as an indicator of Sandbank extent within this dataset, the underlying topographic banks delineated in version 1 of this dataset are retained as a source of additional information.

2.1.2 Additional information
Additional data were used to describe the Sandbanks in more detail and to assess confidence.

Full-coverage EUNIS level 3 layer integrating maps from surveys and broad-scale models (version 9.6)
This dataset (Ellwood, 2014), combining JNCC's survey map data holdings with EUSeaMap, was used to identify areas "composed mainly of sandy sediment".

OSPAR database of threatened and/or declining habitats (version 2015)
This dataset (Ellwood & Duncan, 2015) was used to identify areas "vegetated with *Zostera marina* (sea grass) and/or free living species of the *Corallinaceae* family (maerl)".

EMODnet Geology 1:250,000 seabed substrate
This dataset describes the sediment present at the seabed across Europe according to Folk (1954) classes, wherever there is enough information. These data were used to identify areas "composed mainly of sandy sediment" where the full-coverage EUNIS level 3 layer provided inconclusive information (see section 1.3).

Marine Recorder Snapshot version 06 July 2015
Particle size information from sediment sampling was extracted from the UK Marine Recorder[3] Snapshot (published 2016-07-06) and used to identify areas "composed mainly of sandy sediment".

British Geology Survey Marine Particle Size Dataset

[3] http://jncc.defra.gov.uk/page-1599

Particle size information from sediment sampling was extracted from this UK-wide dataset, received from BGS in 2012. These were used to identify areas “composed mainly of sandy sediment”.

JNCC biological community analysis data
JNCC analysis of infauna from ground-truthing data within North Norfolk Sandbanks and Saturn Reef, and Bassurelle Sandbank SACs (in press) was used to identify areas of Sandbank-associated biological communities within these sites that contain suitable biological communities.

Defra/Astrium 1 arc second DEM
The Defra/Astrium composite bathymetry digital elevation model (DEM) is comprised of multiple datasets from varying sources and resolutions and provides a full coverage bathymetric overview within the area of interest. These data, and the derivatives of slope and aspect, were used in determining areas that are “permanently submerged”, “predominantly surrounded by deeper water” and banks with tops “generally in < 20 m of water depth”.

2.2 Method overview

Data existing from version 1 of the Sandbank layer were taken as an initial input and baseline for the new layer.

Consultation with CNCBs identified new data providing a current understanding of the distribution of Sandbank feature within the territorial waters. These data were appended to the working dataset, superseding any underlying extents.

After the above data collation and consolidation phase, the resulting dataset was analysed on a per-feature basis against the additional information sources to determine their suitability according to the Annex I Sandbank definition (see section 2.3). These descriptors were then used in the formulation of a final confidence value (see section 2.4). SNCBs were consulted to provide judgement and additional knowledge to aid in the determination of confidence on top of JNCC held data. Comments and decisions at this stage were recorded for referral at a later date.

All features with a confidence of “High” or “Potential” were extracted from the working copy to produce the final output dataset. Several banks from the original input datasets failed to meet High or Potential confidence values, and a small number were determined to be rocky outcrops in light of new evidence.

2.3 Assessment of Sandbank descriptors

The various components of the Annex I Sandbank definition (see section 1.2), may be summarised according to one of three descriptors:

1. Topography, i.e. the shape and depth of the seabed is consistent with the Annex I definition;
2. Substrate or vegetation type, i.e. the substrate or vegetation type is consistent with that of the Annex I definition;
3. Proximity to Sandbanks and similarity of benthic communities, i.e. if the seabed adjacent to Annex I Sandbank has similar benthic communities to those on the Annex I Sandbank, this may indicate an extension of the feature.

Areas of seabed were examined and recorded as being "suitable", "less suitable or need more data" or "unsuitable" for each of these three descriptors using the criteria in Table 1. Areas for which evidence is lacking (rather than un-supportive) were included within the less suitable category. A variety of sources, described in section 2.1.2, along with expert knowledge from individuals close to the areas in question were used. Topographical suitability was attributed to features taking into potential designation date of the Sandbanks in question, Sandbanks comprising a protected feature within SACs designated pre-2007 were attributed based on the 2003 interpretation of Topography.

Table 1: Suitability criteria for Sandbank descriptors used in determining confidence in the UK Sandbank layer.

	Suitability		
Descriptor	**Suitable**	**Less suitable or need more information**	**Unsuitable**
Topography	Permanently submerged & water depth is seldom >20 m & For sites designated post-2007: Predominantly surrounded by deeper water.	Permanently submerged & water depth is seldom > 20 m & For sites designated post-2007: NOT Predominantly surrounded by deeper water OR Uncertain bank edge (e.g. Gradual transition, sand waves, poor data)	NOT Permanently submerged &/OR Top of bank NOT in < 20 m of water depth
Substrate or vegetation type	Composed mainly (>=50%) of sandy sediment - interpreted as sediment <30% gravel and more sand than mud &/OR vegetated with *Zostera marina* (sea grass) and/or free living species of the *Corallinaceae* family (maerl) & Associated biota are dependent on the sand rather than any underlying hard substrata	NOT Composed mainly of sandy sediment - i.e. sediment > 30% gravel and less sand than mud & NOT vegetated with Zostera marina (sea grass) and/or free living species of the Corallinaceae family (maerl) OR Associated biota are dependent on hard substrata underlying the sand	Hard substrata at the surface
Proximity to Sandbanks and similarity of benthic communities	Seabed is adjacent to Annex I Sandbank & data shows benthic communities are similar	Seabed is adjacent to Annex I Sandbank & little to no data available to judge similarity of benthic communities	Seabed is NOT adjacent to Annex I Sandbank &/OR data shows benthic communities are NOT similar

In inshore waters, CNCBs were contacted for expert interpretation of the features as their local knowledge of the sites provided additional information to aid suitability determination that was not always available in the form of GI data. Reasoning behind confidence decisions was recorded in the "Conf_comm" field as an audit trail for later reference.

2.4 Confidence

A new confidence assessment method was devised with two key objectives:

1. A final output that is consistent with other existing UK Annex I datasets produced by JNCC (reefs, submarine structures made by leaking gases, mudflats);
2. To determine confidence from key descriptors of the feature as described by the interpretation manual.

Areas were classed as either "High" confidence or "Potential" Sandbank from the three descriptor suitability values based on the criteria shown in Table 2. It should be noted that "High" confidence here denotes a high level of supporting background data and "Potential" Sandbank denotes where evidence indicates Annex 1 Sandbank is present but is insufficient to support high confidence. Potential does *not* denote either a lack of confidence in the data or that the area has the potential to support Sandbanks[4].

Table 2: Combination of descriptor suitability values in relation to final confidence

Topography	Substrate or vegetation type	Proximity to Sandbanks and similarity of benthic communities	Additional information	Final confidence
Suitable	Suitable	Not applicable		High
Suitable	Less suitable or need more information	Suitable		High
Suitable	Less suitable or need more information	Less suitable or need more information	Need more information, but assuming a continuation of communities from an area of high confidence Sandbank	Potential
Less suitable or need more information	Suitable	Suitable		High
Less suitable or need more information	Suitable	Less suitable or need more information	Need more information, but assuming a continuation of communities from an area of high confidence Sandbank	Potential
Less suitable or need more information	Less suitable or need more information	Suitable		High
Less suitable or need more information	Less suitable or need more information	Less suitable or need more information	Assuming a continuation from an area of high confidence bank	Potential

Input data not meeting the criteria to be attributed as "high" or "potential" as above are not included in the final dataset describing extent of Annex I Sandbank, but areas of suitable

[4] The latter interpretation of 'potential' is more consistent with the definition of the 'range' of a habitat.

sediment in less than 20 m water may still be considered as part of the 'range' of this habitat as in version 1 of this dataset.

3 Results

The GIS layer output from this work contains details of the source and decisions in the creation of the dataset, the suitability of each area in regards to the three descriptors and the final confidence (see Table 3).

Table 3: Attribute descriptions for the Sandbanks layer.

Field name	Description
POLYGON	Number of bank within SAC/area
Bank	Name for each bank
SACNAME	Name of SAC bank is present within
Identifier	Name of person/organisation who originally noted presence of the bank
Delineator	Name of person/organisation who delineated the bank boundary
Delin_Date	Date of boundary delineation
GUI	Globally unique identifier of a habitat map brought in to the dataset, if relevant.
ORIG_HAB	Additional habitat information (e.g. EUNIS, UK/EIRE classification, descriptive text) present within the original source file.
Annex1	The Natura 2000 code for the Annex 1 habitat in question (1110 for Sandbanks).
SOURCE	The original source of the data in question.
CONFIDENCE	The final confidence of the area in question – "High" or "Potential".
TOP_SUIT	The topographical suitability of the area in question – "Suitable" or "Less suitable or need more information"
SUB_SUIT	The substrate suitability of the area in question – "Suitable" or "Less suitable or need more information"
BIO_SUIT	The biological suitability of the area in question – "Suitable" or "Less suitable or need more information"
Comments	Comments recorded during the creation of the layer.

4 References

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Appendix

European Commission interpretations of 'Sandbanks which are slightly covered by sea water all the time'

5 2003

Interpretation extracted from the Interpretation Manual of European Union Habitats - EUR25 (http://www.scribd.com/doc/59569190/Interpretation-Manual-of-EU-Habitats-2003). Sentences not relevant to UK have been replaced with "…"; please consult original document for these sections.

1110 Sandbanks which are slightly covered by sea water all the time

1. Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20 m below Chart Datum. Non-vegetated sandbanks or sandbanks with vegetation belonging to the *Zosteretum marinae* and *Cymodoceion nodosae*.

2. Plants: *Zostera marina*, free living species of the *Corallinaceae* family. …
   Animals: Important wintering habitat for many bird species, in particular *Melanitta nigra* but also *Gavia stellata* and *Gavia arctica*. Resting places for seals. Invertebrate communities of sandy sublittoral (e.g. polychaetes).

3. Corresponding categories: …

4. These sandbanks can be found in association with mudflats and sandflats (1140).

5. Ericson, L. & Wallentinus, H.-G. (1979). Sea-shore vegetation around the Gulf of Bothnia. Guidefor the International Society for Vegetation Science, July-August 1977. *Wahlenbergia* 5:1-142.
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6 2013

Interpretation extracted from the Interpretation Manual of European Union Habitats - EUR28 (http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf). Sentences not relevant to UK have been replaced with "…"; please consult original document for these sections. The definition of Sandbanks here differs from EUR27 (2007) only in the stated relevant EUNIS habitats.

1110 Sandbanks which are slightly covered by sea water all the time

1. Sandbanks are elevated, elongated, rounded or irregular topographic features, permanently submerged and predominantly surrounded by deeper water. They consist mainly of sandy sediments, but larger grain sizes, including boulders and cobbles, or smaller grain sizes including mud may also be present on a sandbank. Banks where sandy sediments occur in a layer over hard substrata are classed as sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata.

"Slightly covered by sea water all the time" means that above a sandbank the water depth is seldom more than 20 m below chart datum. Sandbanks can, however, extend beneath 20 m below chart datum. It can, therefore, be appropriate to include in designations such areas where they are part of the feature and host its biological assemblages.

2. Plants: North Atlantic including North Sea - Zostera sp., free living species of the Corallinaceae family. On many sandbanks macrophytes do not occur. …
   Animals: North Atlantic including North Sea - Invertebrate and demersal fish communities of sandy sublittoral (e.g. polychaete worms, crustacea, anthozoans, burrowing bivalves and echinoderms, Ammodytes spp., Callionymus spp., Pomatoschistus spp., Echiichtys vipera, Pleuronectes platessa, Limanda limanda). …

3. Corresponding categories: …The National Marine Habitat Classification for Britain and Ireland Version 03.02: Relevant types within "Sublittoral coarse sediments (SCS), Sublittoral sands (SSA) and Sublittoral macrophytes communities (SMP)". EUNIS classification: Relevant types within "A5.1 Sublittoral coarse sediment, A5.2 Sublittoral sand, A5.4 Sublittoral mixed sediments, A5.5 Sublittoral macrophyte-dominated sediment".

4. Sandbanks can be found in association with mudflats and sandflats not covered by seawater at low tide (1140), with Posidonia beds (1120) and reefs (1170). Sandbanks may also be a component part of habitat 1130 Estuaries and habitat 1160 Large shallow inlets and bays.

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7 Extract from “Method for Creating a Composite Map of Annex I Sandbanks slightly covered by seawater all of the time” version 1.1

7.1 Data Sources

Sandbanks already delineated

- Sandbanks that have already been delineated using the sandbank slope analysis method (see **Error! Reference source not found.** for details)
- Sandbanks that have been delineated using another method

Bathymetry, slope, aspect

- Astrium 1 arc second (~25m) resolution bathymetry layer (digital elevation model (DEM)) – full UK coverage. Note that this is made up of a combination of datasets at varying resolutions that have been re-sampled to a constant 1 arc second resolution, including digital charts originally at a coarser original resolution and digital survey bathymetry originally at a finer resolution.
- Slope layer derived from above
- Aspect layer derived from above
- Contours layer derived from above
- Survey bathymetry and derived slope, aspect and contours – specific areas, high resolution and detailed. Used in preference to 1 sec DEM where present.

Substrate

- Sand polygons extracted from BGS Seabed Sediments 1:250k product, version 3
- Sand points extracted from Marine Recorder snapshot
- Reef polygons and points from UK Annex I Reefs v6 dataset, indicating potential presence of rock (and hence not sand)
- Old data layers described in section 1.1

Biology - polygon and point records of sea grass and maerl beds, which are referred to in the CEC (2003 and 2007) interpretations (see Section 1.2).

7.2 Method overview

The work undertaken at JNCC began by mapping sandbanks according to the revised interpretation by CEC (2007). The basic sandbank slope analysis method for identifying and delineating sandbanks according to this interpretation was:

1. Identify possible bank features (elevated, elongated, rounded or irregular topographic features, predominantly surrounded by deeper water) by looking at bathymetry – detailed survey bathymetry where available, otherwise Astrium 1 sec DEM
2. Check whether the area is likely to be sandy using substrate data
3. Check whether the summit is in <20m of water using bathymetry
4. Identify flanks and summit of banks using slope, aspect and bathymetry
5. Based on the approach suggested by Klein (2006)[5], manually digitise boundaries of bank using a cut-off slope value of 0.5°, or 0.1-0.5° is data resolution is low, using contours lines if suitable.
6. Where it is not possible to draw a boundary due to data quality and/or resolution, create a point, corresponding to the rough centre of the bank.

Note that Klein (2006) suggests that banks with an extent of <1km^2 may be too small to be delineated using bathymetric data alone; however, this depends on the resolution of the data.

Some SACs that were designated before the revised guidelines were published contain sandbanks that are not topographically distinct or predominantly surrounded by deeper water (i.e. meeting the CEC (2003) interpretation but not the CEC (2007) interpretation). For these sandbanks it is not possible to use the sandbank slope analysis method described above. Representing these banks in the dataset requires involvement of the agency that initially proposed the site to delineate the bank according to the same interpretation used at the time. Biotope data may aid this identification. For example, a biotope map indicating the presence of sublittoral sand may provide this data, or for more detail sea grass and maerl data were extracted from biotope maps and Marine Recorder and some of this data may help to draw some of the boundaries (Section 1.2 describes how banks may be vegetated with *Zostera* (sea grass) and/or free-living *Corallinaceae* (maerl)).

[5] Klein (2006) suggested a topographic analysis for the identification and delineation of submarine banks in German waters to aid the identification of Annex I sandbanks. Specifically, it was suggested to use the change in slope from >0.5° to <0.5° to mark the boundary between the flank of a sandbank and the surrounding seabed.

8 Annex I: Version Control

BUILD STATUS:

Version	Date	Author	Reason/Comments
1.1	23/01/16	Graeme Duncan	Revision to table 2 clarifying biological suitability.
1.0	06/12/16	Graeme Duncan	Modification following comments from JNCC staff and new references.
0.1	05/12/16	Graeme Duncan	Initial document creation to describe the method and data used to create the updated UK Sandbanks layer.

DISTRIBUTION:

Copy	Version	Issue Date	Issued To
Electronic	1.0	06/12/16	JNCC and CNCBs for initial release and feedback
Electronic	0.1	05/12/16	JNCC habitat mapping team and site leads for initial feedback.