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**JNCC Marine Habitat Classification for Britain and Ireland: Overview of User Issues**

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## Summary

The JNCC's Marine Habitat Classification for Britain and Ireland has been widely used by Government bodies, academic institutions, the private sector and regional projects. It is generally thought to be highly beneficial, but a number of concerns have surfaced as the JNCC Classification continues to be used for a widening range of purposes. There is now scope to further develop the JNCC Classification in response to issues highlighted by users. This paper summarises user issues in order to identify and prioritise future development work.

The majority of user issues described stem from fundamental limitations of its hierarchical structure, and gaps in coverage. Users often have problems assigning Biotopes because the community they have found occurs in slightly different environmental conditions (biological zone, sediment, energy) to Biotopes with matching communities. In addition, users often cannot assign a Biotope simply because some biological communities have not been identified yet due to a lack of information. More clarity is also needed on how users can decide whether the biological community in their sample is sufficiently similar to an existing Biotope for it to be assigned. A number of recommendations for development are made in the conclusion of this paper based on user issues identified.

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# 1 Introduction

The JNCC's Marine Habitat Classification for Britain and Ireland (hereafter 'the JNCC Classification') (Conner *et al* 2004) has been widely used by Government bodies, academic institutions, the private sector and regional projects. It is used in both a 'bottom up' manner to classify biotopes found during field surveys and a 'top down' manner to assign biotopes to mapped or modelled areas. The JNCC Classification is generally thought to be highly beneficial but a number of concerns have surfaced as the JNCC Classification continues to be used for a widening range of purposes. Many issues stem from how it was initially developed; originally it was mainly used for classifying survey results from well-studied coastal areas surveyed as part of the Marine Nature Conservation Review (MNCR) (Hiscock 1998).

There is now scope to further develop the JNCC Classification in response to issues highlighted by users. JNCC recognises that the JNCC Classification needs to be kept up to date and has therefore appointed a permanent member of staff who will be responsible for the revision and upkeep of the JNCC Classification as well as responding to related queries. This revision of the JNCC Classification is considered timely for a number of reasons:

- i. Due to the survey methodologies available during the time of the MNCR (1987-1998), the JNCC Classification does not provide good coverage of biotopes in sublittoral areas deeper than 50m, and no coverage of deep sea areas deeper than 200m.

Developments in technology have made it easier to survey deeper waters. These technological advances, coupled with legislative drivers, have led to a dramatic increase in surveys in UK offshore waters over the last decade. JNCC and others have been undertaking offshore surveys in deeper waters not covered by the JNCC Classification; for example, to gather evidence for proposed or newly designated offshore Special Areas of Conservation (SACs), Marine Conservation Zones (MCZs) and Scottish Marine Protected Areas (sMPAs). Statutory Nature Conservation Body (SNCB) surveys within territorial waters can also include deeper areas. In addition, surveys of deep waters are frequently undertaken by private industry for environmental impact assessments. Assigning biotopes to offshore survey data is very challenging due to gaps in the JNCC Classification.

- ii. The structure of the JNCC Classification has some drawbacks for predictive mapping.

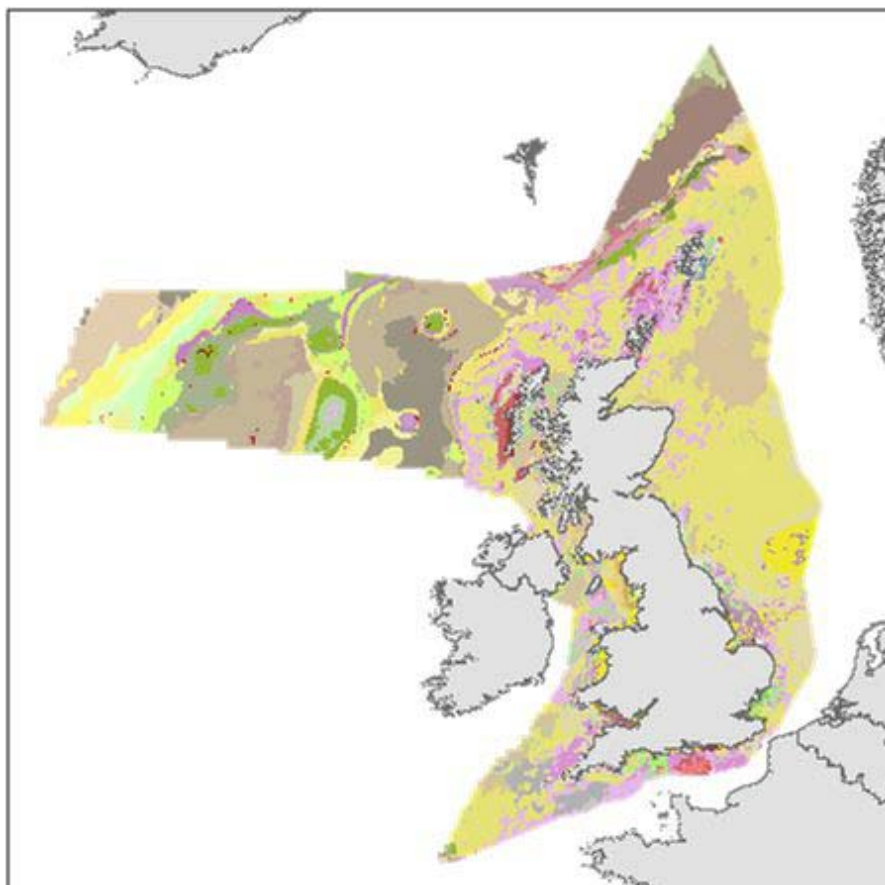
Since 2007, the JNCC Classification and its European equivalent, the marine section of the EUNIS (European Nature Information System) habitats classification (hereafter referred to as EUNIS) have been used in various attempts to produce predictive seabed habitat maps on regional, national or international scales, to meet requirements such as biodiversity monitoring programme design, identification of MPAs, assessments of habitat distribution and extent, and marine planning (Figure 1.1).

- iii. New European legislation is re-focusing attention on habitat classifications systems.

The Marine Strategy Framework Directive and its requirement for consistent broad-scale seabed maps for European waters mean that EUNIS is now receiving increased attention – as the foundation for these consistent maps. This increased attention has brought to light flaws with EUNIS (Galparsoro *et al* 2012) and a revision of the structure of EUNIS is planned over the next 1-2 years. It is necessary for the JNCC Classification to inform changes made to EUNIS and also to reflect any shifts

in thinking agreed at the European level. Therefore work on revising the JNCC Classification needs to take place soon in order for the UK to input suggestions for inclusion in EUNIS.

- iv. The JNCC Classification is an evolving tool and should be revised at intervals taking into account any new discoveries or suggestions for changes to descriptions. The last significant update to the JNCC Classification was in 2004 – a review of issues and progress is overdue.



**Figure 1.1:** Predictive seabed habitat map produced for UKSeaMap 2010 using EUNIS level 3 habitat types (McBreen *et al* 2011)<sup>1</sup>

The aim of this paper is to highlight to users the current limitations of the JNCC Classification to allow them to make a more informed choice when biotoping. The production of this paper has also helped JNCC to identify areas that need modification and to prioritise future work.

This paper collates comments on the JNCC Classification from various sources. It was compiled based on listed references, and additional issues were highlighted by a further thorough review of the Classification and associated guidance specifically for this paper.

Use of the JNCC Classification has shown up a number of areas where improvements could be made to assist users. These areas include:

- General issues with the overall hierarchy structure, guidance and naming of habitats;

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<sup>1</sup> <http://jncc.defra.gov.uk/ukseamap>

- Specific issues with environmental factors that are used to divide up the Classification – biological zone, substrata, energy, salinity, biology and topography;
- Consideration of factors not addressed in the Classification at the moment (human impacts, biogeography, other environmental factors), and;
- Issues in using the JNCC Classification for monitoring listed habitats.

This paper will summarise user issues which have emerged covering all the areas highlighted above.

## 1.1 Background

The JNCC Classification was first developed in 1996 following JNCC's MNCR (Figure 1.2) to provide a practical system for the consistent description of habitat types. The uptake of this standard classification system would then assist with various conservation tasks such as assessing trends and status, prioritising action and mapping habitats. The JNCC Classification was updated in 2004 based on reanalysis of data using PRIMER statistical software, and incorporating new sublittoral sediment data (Connor *et al* 2004). This resulted in some restructuring of where habitat types were placed and the addition of some new habitat types. The JNCC Classification formed the basis of the marine section of the 2004 Europe-wide EUNIS habitat classification of the European Environment Agency (Davies & Moss 2004), although the marine section of EUNIS has some structural differences and includes some additional habitat types within and beyond UK waters. The latest version of the EUNIS habitat classification is EUNIS 2007-11. This version is currently more developed for UK waters than the JNCC classification, the main difference being the inclusion of a section for deep sea habitats. Unlike EUNIS, the JNCC Classification is aimed primarily at classifying benthic communities of invertebrates and seaweeds, and not pelagic communities.



Figure 1.2: An MNCR survey team

There are various tools available for using the JNCC Classification which can be found on the JNCC website<sup>2</sup>:

- Introductory text explaining how the JNCC Classification was developed and how it should be used (Connor *et al* 2004).
- Spreadsheet showing the full hierarchical list of habitat type codes.
- Translation tables for habitat type codes from the 1996 version to the 2004 version of the JNCC Classification and equivalents in other systems such as EUNIS.
- Descriptions of each habitat type code and matrix diagrams.
- Physical and biological comparative tables which display all habitat types with their characterising variables. These allow the query of data to find habitat types with similar properties for a particular variable.

In addition to downloading the documents above, users can view an online expandable hierarchy of various levels with descriptions, which allows easier cross-reference of habitat types<sup>3</sup>.

*Box 1: Note on terminology*

There is some confusion over the terms 'habitat' and 'biotope' which are often used interchangeably as general terms for biological communities and their associated abiotic environment but are also referred to in specific levels in the JNCC Classification hierarchy (the hierarchy is as follows: level 1 Environment > level 2 Broad **habitats** > level 3 Main **habitats** > level 4 **Biotope** complexes > level 5 **Biotope** > level 6 Sub-**biotope**). This means a statement such as 'there are a small number of sublittoral sediment biotopes' is unclear – does 'biotopes' mean just those sublittoral sediment habitats defined to level 5 or all habitat types defined within the sublittoral sediment section of the hierarchy at various levels? As noted in Section 2.3, consistent definitions for these terms need to be established and used consistently. For the sake of clarity, this paper will use the term 'habitat type' when referring generally to types occurring at any level of the Classification, and use the specific name of the level capitalized (e.g. Main habitat, Biotope) when referring just to those habitat types occurring within that level.

## 1.2 Hierarchy structure

In order to discuss issues with the JNCC Classification it is necessary to first understand exactly what each level means in terms of environmental factors used to define it. It is useful to have a look at the levels in the expandable hierarchy and click on some of the habitat type descriptions to see what information is provided about them. Table 1.1 gives a summary of what each level of the hierarchy represents to help readers' understanding. Throughout this paper Level 1 will be referred to as the 'highest' level, with subsequent levels being 'lower' or 'down' from Level 1. The levels in the 1996 version did not include the level 1 environment levels but in the 2004 version the levels were altered to match EUNIS; however, the old JNCC Classification levels are still sometimes referred to in work. With the new system, the number of parts in the code is one less than the number of levels as level 1 'marine' does not have a code.

<sup>2</sup> <http://jncc.defra.gov.uk/marinehabitatclassification>

<sup>3</sup> NOTE: the colour coding refers to 1996 version. For recent 2004 version pink = level 2, purple = level 3, etc



**Table 1.1:** Summary of levels in the JNCC Classification

Level	Level name	Factors considered	e.g. Habitat name	e.g. Habitat code
Level 1	Environment		Marine	n/a
Level 2	Broad habitat	Biological zone, substrate	Littoral sediment	LS
Level 3	Main habitat	Biological zone, substrate energy, biogenic features i.e. reef/ macrophytes	Littoral sand	LS.LSa
Level 4	Biotope complex	Biological zone, substrate, energy, topographic features, salinity, mobility, broad biological communities	Barren or amphipod dominated mobile sand shores	LS.LSa.MoSa
Level 5	Biotope	Biological zone, sub-zone, substrate, energy, topographic features, salinity, mobility, biological community with characterising species	Amphipods and <i>Scolelepis</i> spp. in littoral medium-fine sand	LS.LSa.MoSa. AmSco
Level 6	Sub-Biotope	Biological zone, sub-zone, substrate, energy, topographic features, salinity, mobility, biological community with characterising species, disturbance	<i>Eurydice pulchra</i> in littoral mobile sand	LS.LSa.MoSa. AmSco.Eur

## 2 JNCC Classification user issues

### 2.1 JNCC Classification structure

Issues with the positioning of specific environmental variables in the hierarchy are discussed in the sections 2.4 to 2.10; this section will look at the overall type of system used to classify habitats.

The JNCC Classification is a hierarchy whereby each level 'down' is more specific than the last. One of the rules of the hierarchy is that habitat types are not replicated in different parts. The use of this hierarchy implies that a habitat type can only occur within the conditions specified in its 'parent' habitat in the level above (Table 1.1); for example, level 4 'kelp with cushion fauna and/or foliose seaweeds' ([IR.HIR.KFaR](#), **Figure 2.1**) is grouped under level 3 'high energy infralittoral rock' so it should, in theory, be only found associated with that energy regime, zone and substratum. In reality, the boundaries of habitat types are not so strictly defined. The biotopes are located in the section of the JNCC Classification where they are most common, but this does not necessarily mean they are always exclusive to the environmental conditions described. IR.HIR.KFaR is most common on high energy infralittoral rock, but a detailed look at the physical comparative table<sup>4</sup> reveals it can sometimes occur in moderately exposed conditions and in the littoral zone. This means that some samples assigned to IR.HIR.KFaR based on the biological community could occur in physical conditions slightly different to those specified in the name. This issue is particularly true for more generalist biotopes which can occur in a wide range of conditions, for example, [SS.SMx.CMx.OphMx](#) can occur in the infralittoral, circalittoral and offshore circalittoral on sand, coarse or mixed sediments. It could also be the case that a biotope was described originally based on an atypical occurrence and in the future it is discovered in different physical conditions to those defined in the name. As a large amount of the seabed remains unexplored it is likely an assemblage will be found outside the previously specified range, but this does not necessarily mean the assemblage is a different one.

<sup>4</sup> Download from <http://jncc.defra.gov.uk/marinehabitatclassification>



**Figure 2.1:** Kelp with cushion fauna and/or foliose seaweeds (IR.HIR.KFaR).

Feedback from users indicates that it is a common problem to find Biotopes on different substrate types, across more than one biological zone or more than one energy class. The stony reef survey east of Shetland Isles (Foster-Smith *et al* 2009)<sup>5</sup> found that assigning Biotopes created artificial divisions between similar communities. Those areas assigned to [CR.HCR.DpSp.PhaAxi](#) were biologically very similar to [CR.MCR.EcCr.CarSp](#) (Figure 2.2) but these two Biotopes are in very different parts of the JNCC Classification as one has been assigned to high energy rock and the other to moderate energy rock. Analysis undertaken for a Dogger Bank survey (Diesing *et al* 2009)<sup>6</sup> highlighted that although some infaunal communities were exclusively linked to either infralittoral or circalittoral coarse sediment the most common infaunal community occurred in both. A similar pattern was found for fine sand.



**Figure 2.2:** [CR.HCR.DpSp.PhaAxi](#) (left) and [CR.MCR.EcCr.CarSp](#) (right).

When the JNCC Classification was developed, it was used only for describing the biological communities present. More recently the upper levels of the Classification have been used as proxies for the communities present and are themselves listed as habitats of importance to be protected within Marine Conservation Zones, and under the Marine Strategy Framework Directive. It is now important that the habitat type assigned accurately describes **both** the physical environment and the biological community. The hierarchy structure can make this difficult. Using the [SS.SMx.CMx.OphMx](#) example, an area surveyed might broadly be considered to be Infralittoral Coarse Sediment but based on the biology a section could be most similar to SS.SMx.CMx.OphMx occurring in atypical conditions. If SS.SMx.CMx.OphMx was assigned it would appear as Circalittoral Mixed Sediment when aggregated to level 3. This would conflict with neighbouring biotopes assigned within Infralittoral Coarse Sediment, and would not match a modelled level 3 broad-scale habitat map of the area produced using

<sup>5</sup> <http://jncc.defra.gov.uk/pdf/web433.pdf>

<sup>6</sup> [http://jncc.defra.gov.uk/pdf/web\\_429.pdf](http://jncc.defra.gov.uk/pdf/web_429.pdf)

physical data. Although it is ultimately the species present that is most important, it causes confusion when the habitat name conflicts with the physical data, especially to policy makers without a detailed knowledge of classification.

An additional complication caused by the hierarchy is that environmental variables are introduced at different levels in different parts of the JNCC Classification, according to the predominant environmental drivers for each group of habitat types. This can make it confusing for broad-scale mapping because maps may have to contain habitat types of various levels. For example, if a user wishes to map the infralittoral zone consistently, they will need to map a combination of Level 3 and Level 4 habitat types. This is not necessarily a problem but it may be more logical for the user if habitat types within the same level were more equivalent. Inconsistencies in the introduction of different biological zones and other environmental variables are discussed further in sections 2.4 onwards.

## 2.2 Naming of habitat types

The naming of habitat types at each level should reflect the definition of what each level represents. In order for habitat types in the same level to be comparable there could be a need to introduce a standard naming system. A review of current habitat type names shows there are some inconsistencies in what is included at levels 4 - 6.

Level 4 (Table 1.1) names contain various combinations of the following types of information:

### *Relevant for all habitat types*

- Biological community type (e.g. mussel and/or barnacle communities)
- Specified biological taxa without reference to 'community' (e.g. mussels and fucoids)
- General name for a well recognised habitat (e.g. saltmarsh)
- Biological zone information taken from level 3 name (e.g. sublittoral)
- General term referring to biological zone (e.g. shores)
- Substrata information taken from level 2 name (e.g. mixed sediment)
- Additional abiotic variable not defined at level 3 (e.g. variable salinity)

### *Relevant for rock habitat types only*

- Energy information taken from level 3 name (e.g. moderate energy)
- Specific details about energy (e.g. tide-swept sheltered conditions)

### *Relevant for sediment habitats only*

- More detailed substrata information than level 3 (e.g. fine sand)

Level 5 and 6 (Table 1.1) names contain a similar mix of information. Some level 5 rock biotope names contain more refined information about biological zone and energy (e.g. 'lower eulittoral' instead of 'littoral', 'exposed to moderately exposed' in reference to wave energy instead of 'high energy') and some level 5 sediment Biotope names contain more specific sediment information (e.g. 'clean stone gravel' instead of 'coarse').

The inconsistency in naming reflects the wider issue of what is meant by each level. It is not necessarily a problem if users ensure they read all the associated descriptive information, but could lead to general confusion. A standardised approach to Biotope naming would to ensure the same information is consistently conveyed in the name in the most efficient way.

## 2.3 Guidance

The introductory section of the JNCC Classification (Connor *et al* 2004) gives detailed background on how it was developed and guidance on its use. It should be noted that the 1997 version of the introduction (Connor *et al* 1997) contains additional information on how the JNCC Classification was developed to the 2004 introduction. If read thoroughly, it should enable users to correctly assign habitat types. However, there are a number of areas where guidance could be improved.

### 2.3.1. Provide a clear summary of how to use the JNCC Classification

The introductory text provides a lot of useful information including a section outlining all of the tools available for assigning habitat types and how they can be used; however, it is very detailed and long so it is likely that some users do not read it thoroughly or forget key details over time. It may be useful to provide a separate summary of how to use the JNCC Classification. This could include a clear step by step guide to the process of assigning a habitat type, and when to use each of the tools. For example, the EUNIS guidance (Davies & Moss 2004) provides a clear key for assigning level 2 and level 3 (Table 1.1) habitat types (Figure 2.3). The summary could also have a clear troubleshooting section stating what to do if the user cannot find an appropriate Biotope to assign as this is not explicitly stated in the introductory text. Further guidance may also be needed for selecting the appropriate category for variables using various methods; for example, how to identify which sediment type a sample has based on video interpretation or particle size analysis of grab samples. Specific guidance for assigning habitat types to mapped areas could also be helpful. The MESH signature catalogue<sup>7</sup> contains example photographs and backscatter signatures for many Biotopes. These could be added to the Biotopes' descriptive text in the JNCC Classification to help users with identification. JNCC has now produced some additional guidance for internal use on how to assign a biotope (Parry 2014 unpublished). This may also be helpful to other users and is available on request from [MarineHabitatClassification@jncc.gov.uk](mailto:MarineHabitatClassification@jncc.gov.uk).

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<sup>7</sup> <http://www.rebent.org/mesh/signatures/>

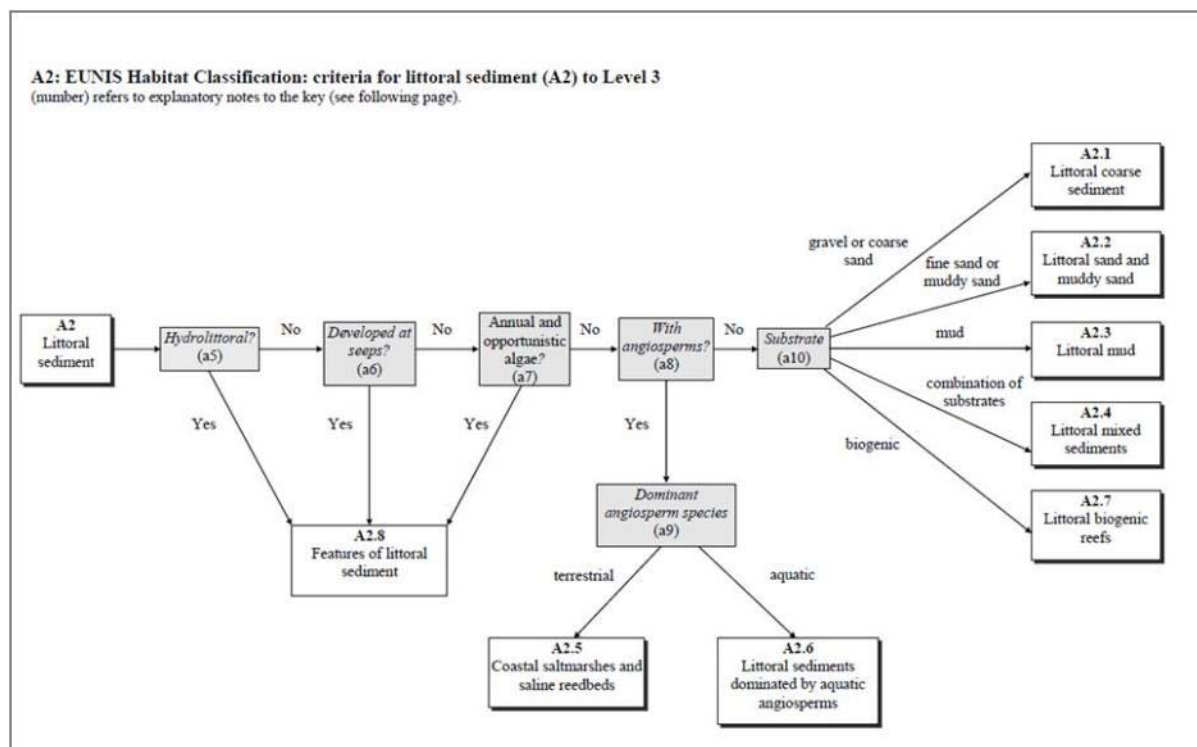


Figure 2.3: Example of EUNIS key for assigning a level 3 habitat type

### 2.3.2. Clarify use of terminology for habitat types

As noted in [Box 1](#), there is some confusion over the use of the words ‘habitat’ and ‘biotope’. The introductory text attempts to provide definitions for these, however, this guidance could be clearer and other definitions could be considered. It is apparent from the habitat type descriptions and the naming of the levels that it is intended that ‘habitats’ comprise abiotic factors and the associated community, and that ‘biotope’ is a type of habitat, although this definition is not explicitly stated in the introductory section. The MESH Guide to Habitat Mapping<sup>8</sup> (MESH project 2008) states, “the use of the term ‘habitat’ refers to both the physical environment and its associated biological community, and is thus synonymous with the term ‘biotope’”. Whether it is valid to consider a biotope as a certain type of habitat could be debated. A summary paper from the MESH Atlantic EUNIS workshop (Galparsoro *et al* 2012) suggests that the terms habitat, biotope, biocoenosis, facies and association are often used incorrectly in the EUNIS Classification. Further work is needed to agree definitions which are used consistently throughout the JNCC Classification language.

The definitions provided for the different levels (Table 1.1), in particular levels 2 and 3, need to be updated. Level 2 Broad habitats are defined as “*extremely broad divisions of national and international application for which EC Habitats Directive Annex I habitats are the approximate equivalent*”. However, level 2 habitat types are actually much broader in spatial scale (e.g. Littoral Rock, Sublittoral Sediment) and the divisions result in Annex I habitats being divided between them, often occurring several places. Annex I habitats are actually represented at various different levels or not at all (e.g. biogenic reefs occur at level 3 for sediment and level 4 for rock; seagrass occurs at level 4; sandbanks not represented). The level 3 Main habitats are defined as “*very broad divisions of national and international application which reflect major differences in biological character. They are equivalent to the intertidal Sites of Special Scientific Interest (SSSI) selection units*”. Examples of intertidal SSSI selection units are specific types of saltmarsh, the strandline, and specific types of

<sup>8</sup> [http://www.searchmesh.net/pdf/MESH%20Guide%20Synopsis%20\(web\).pdf](http://www.searchmesh.net/pdf/MESH%20Guide%20Synopsis%20(web).pdf)



vegetated shingle beach. The definition needs some revision as, at level 4 in the JNCC Classification, 'saltmarsh' ([LS.LMp.Sm](#)) and 'shingle and gravel shores' ([LS.LCS.Sh](#)) are actually only included as a single category not divided into different types. If the JNCC Classification structure and hierarchy is altered the level names will need to change accordingly.

## 2.4 Zonation

### 2.4.1. Lack of deep-sea section

The most significant gap in coverage is for deep waters of over 200m in depth which are not included in the JNCC Classification. Currently deep water habitats (e.g. **Figure 2.4**) should strictly only be defined as deeper variants of habitats in the classification, or new habitat types suggested and submitted to JNCC. A high-level deep-sea section of the EUNIS classification was developed in 2007 – A6 “deep sea bed”. This has received criticism from the scientific community for various reasons: few level 5 biotopes are described, and large topographic features are included at the same level as substratum, and ‘deep sea bed’ is not subdivided further into smaller biological zones. Work has been undertaken by JNCC in collaboration with deep-sea specialists to develop a deep-sea section which will be published in 2014. The deep-sea section will not follow the same structure as the existing JNCC Classification and will try to address many of the issues raised in this paper.



**Figure 2.4:** Deep-sea habitats identified on the Anton Dohrn Seamount.

### 2.4.2. Inclusion of biological zones at different levels

Users frequently comment that it is confusing for the infralittoral and circalittoral zones to be introduced at level 2 for rock, but not until level 4 for sediment (Table 2.1). The system is structured this way because infralittoral and circalittoral sediment communities do not differ as much from each other as infralittoral and circalittoral rock communities. It would, however, be possible to define many level 4 sediment habitat types as either infralittoral or circalittoral. ‘Sublittoral macrophyte-dominated communities’ ([SS.SMp](#)) only occur in only the infralittoral zone, and, depending on the reef building species, ‘sublittoral biogenic reefs’ ([SS.SBR](#)) may be split into those that occur in the infralittoral zone (e.g. *Sabellaria alveolata* and subtidal *Mytilus edulis* beds) and those that occur in the circalittoral zone (e.g. *Sabellaria spinulosa*, *Modiolus*). ‘Offshore circalittoral’ is included at level 4 for some, but not all, sediments, and not for rock. It may be logical to include ‘offshore circalittoral rock’ and ‘offshore circalittoral sediment’ categories at level 2 if it is found to be biologically relevant.

It should also be noted that use of the term ‘offshore’ rather than ‘deep’ may not be appropriate. Generally the EUNIS classification uses ‘deep circalittoral’ where the JNCC

Classification currently uses ‘offshore circalittoral’. Legally, the term offshore refer to any area of UK waters beyond 12nm, hence ‘offshore’ is no longer appropriate for use in habitat classification systems. Furthermore, within the JNCC Classification the term ‘deep’ is sometimes used interchangeably with ‘offshore’ in habitat type names. For example, within ‘offshore circalittoral mud’ there is the biotope ‘*Styela gelatinosa*, *Pseudamussium septemradiatum* and solitary ascidians on sheltered **deep** circalittoral muddy sediment’ ([SS.SMu.OMu.StyPse](#)) but also ‘*Levinsenia gracilis* and *Heteromastus filiformis* in **offshore** circalittoral mud and sandy mud’ ([SS.SMu.OMu.LevHet](#)). This inappropriate terminology and inconsistency needs to be resolved.

**Table 2.1:** Summary of JNCC Classification upper levels showing how zones are introduced at different levels for rock and sediment (adapted from MMO 2012<sup>9</sup>)

= LEVEL 3		Rock			Sediment					
= LEVEL 4		High energy	Mod energy	Low energy	Coarse	Sand		Mud		Mixed
Littoral		HLR	MLR	LLR	LS.LCS	LS.LSa		LS.LMu		LS.LMx
Sublittoral	Infra-littoral	HIR	MIR	LIR	SS.SCS	SS.SSa		SS.SMu		SS.SMx
					ICS	IFiSa	IMuSa	IFiMu	ISaMu	IMx
	Circa-littoral	HCR	MCR	LCR	SS.SCS	SS.SSa		SS.SMu		SS.SMx
					CCS	CFiSa	CMuSa	CFiMu	CSaMu	CMx
Offshore circalitt.				SS.SCS	SS.SSa		SS.SmU		SS.SMx	
				OCS	OSa	OMu		OMx		

### 2.4.3. Inconsistent depth ranges given for habitat types in the same biological zone

The depth ranges given in the descriptions for habitat types are not inherited directly from their parent habitat types but in fact reflect depth ranges recorded during the collection of the field data used to define the JNCC Classification. This means the depth ranges given in habitat type descriptions are often smaller than the generally accepted boundaries for the biological zones they occur in and thus do not cover the whole range they could potentially occur. The various habitat types do not currently have depth ranges that cover the whole range of possible depths up to 200m. This makes it difficult to assign a type to samples which fall in the gaps. For example, no rock habitats have depth ranges that extend deeper than 50m but this is just because no rock habitats had been surveyed in waters deeper than 50m when the JNCC Classification was developed and not because rock cannot occur below 50m. Users may assume a sample cannot belong to a habitat type if it falls outside to depth range given. As an example, the Mid Irish Sea reefs habitat mapping report<sup>10</sup> (Dalkin 2008) noted that records of circalittoral Biotopes [SS.SCS.CCS.PomB](#) and [SS.SMx.CMx.FluHyd](#) were found at depths of 90 to 120m which falls well beyond the deeper 50m limit given for circalittoral coarse sediment, and it was suggested that the depth bands given for the circalittoral Biotopes should be extended to cover slightly deeper habitats. It would be more intuitive for habitat types defined by their physical environment only to be given a potential depth range which matches the range of the biological zone it occurs in. The habitat description pages should make it clear that depth ranges given are only where it has previously been recorded – not the total possible range.

In reality, biological zones are defined by the make-up of their biological communities rather than depth boundaries as these vary regionally. Numerous factors influence biological zone including the amount of light reaching the seabed, disturbance of the seabed by waves and currents, and salinity, but depth is often used as a proxy for these. EUSeaMap (Cameron & Askew 2011) and UKSeaMap 2010 (McBreen *et al* 2011) defined set boundaries for

<sup>9</sup> <http://www.marinemangement.org.uk/evidence/documents/1014.pdf>

<sup>10</sup> [http://jncc.defra.gov.uk/pdf/jncc411v2\\_web.pdf](http://jncc.defra.gov.uk/pdf/jncc411v2_web.pdf)

biological zones within the Greater North and Celtic Seas based on a variety of physical parameters: light penetration for the boundary between the infralittoral and circalittoral zones, the wave base for the boundary between the circalittoral and deep circalittoral zones, and depth was used to delimit the boundaries between deep-sea zones (as proposed by Howell (2010)) as it was believed to be the best proxy for other environmental factors based on the data and information available. For bottom-up use of the JNCC Classification the user can sometimes assign the habitat type with the appropriate biological zone based on biological communities, regardless of depth (e.g. if it is seaweed dominated it is infralittoral not circalittoral). There are situations where it is difficult to identify a biological zone using biological communities; for example, infralittoral areas with strong tidal currents can be dominated by suspension feeders rather than seaweeds. Taking into account what is discussed above, although it is artificial to set rigid depth boundaries for biological zones it would be useful, as a guide, to provide a consistent range for upper and lower depth boundaries for habitat types based on their defined biological zone.

## 2.5 Substratum

### 2.5.1. Lack of clarity on which sediment classification system to use

A consistent method needs to be used for assigning sediment types to ensure diverse users are assigning habitat types in the same way.

There are a number of ways to define sediment texture classes according to grain size. Wentworth (1922) is the most commonly used system for describing individual grain sizes, with 11 categories varying in size from 0.002mm for clay particles to over 256mm for boulders (**Table 2.2**). Names for aggregations of these particles where there is no mixing follow a similar trend but it is rare to have such unmixed particles; “most such sediments are composed of particles of several or many grades and the names suggested ... with definite numerical limits cannot properly be applied to them” (Wentworth 1922). Folk (1954) is the most commonly used system for describing the complete range of mixtures of gravel, sand, silt, and clay which combine to form sediments. In this system he defines 15 sediment texture classes according to the relative proportions of mud (clay and silt particles in Wentworth (1922)), sand (very fine to very coarse sand grains in Wentworth (1922)) and gravel (granule to boulder in Wentworth (1922)). This is commonly visualised in a ternary diagram (Figure 2.5). Considering only three broad grades of grain size means that some detail is lost compared with the more detailed Wentworth classes; for example, you cannot tell whether sandy sediment comprises fine sand or medium sand.

It is unclear from the JNCC Classification introduction exactly how the sediments were categorised when coming up with Biotope descriptions. It states in the JNCC Classification introductory text that “for sediment habitats, biotopes are shown in relation to sediment type using a modified Folk triangle approach”. The MNCR rationale and methods report (Hiscock 1996) states that sediment should be defined using the Wentworth scale, and that the proportion of each grain size category should be noted, but does not mention how to derive the sediment texture classes used in the Biotope names based on the sediment proportions. The actual MNCR recording forms used (Connor & Hiscock 1996) have specific MNCR sediment categories which are different to the Wentworth scale (see **Table 2.2**). In particular, the UKSeaMap 2010 technical report 3 on substrate data (McBreen & Askew 2011)<sup>11</sup> highlighted that there is a mismatch between the particle size boundary between gravel and

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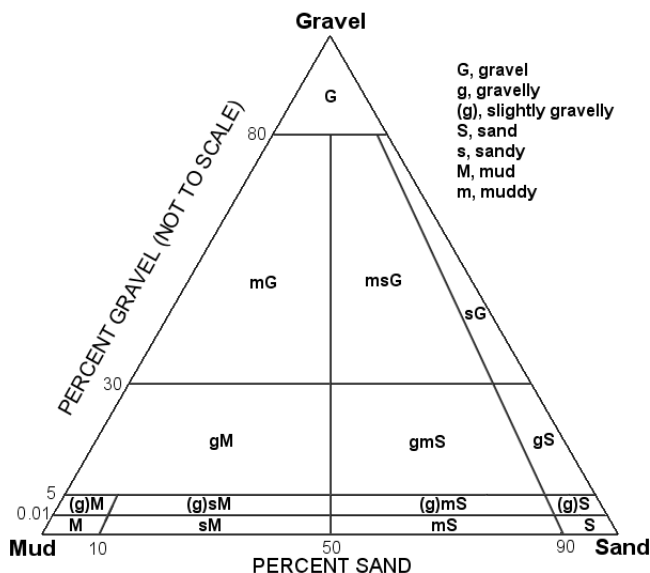
<sup>11</sup> [http://jncc.defra.gov.uk/pdf/UKSeaMap2010\\_TechnicalReport\\_3\\_Substrate2.pdf](http://jncc.defra.gov.uk/pdf/UKSeaMap2010_TechnicalReport_3_Substrate2.pdf)



sand in the Wentworth scale and the MNCR sediment categories. If the habitat names used in the JNCC Classification are derived from these MNCR sediment categories it will be difficult to decide which habitat type to assign to grab sample data that is typically classified using the Wentworth or Folk scales. The MNCR method was primarily intended for recording visual observations from the field rather than from PSA data, which may be why different categories were adopted.

**Table 2.2:** Visualisation of differences in terminology between the MNCR sediment classification (Connor & Hiscock 1996) and other systems – adapted from Table 1 from UKSeaMap 2010 technical report (McBreen & Askew 2011)

Mm	phi	Wentworth (1922)	Folk (1954)	Connor & Hiscock (1996)
2048	-11	Boulder gravel	Gravel	Very large boulders
1024	-10			Large boulders
512	-9			Small boulders
256	-8			Cobbles
128	-7	Pebble gravel		Pebbles
64	-6			Gravel
32	-5			Coarse sand
16	-4			Medium sand
8	-3			Fine sand
4	-2			
2	-1	Granule gravel	Sand	
1	0	Very coarse sand		
0.5	1	Coarse sand		
0.25	2	Medium sand		
0.125	3	Fine sand		
0.063	4	Very fine sand		
0.031	5			
0.016	6		Mud	
0.008	7			
0.004	8			
0.002	9	Clay		



**Figure 2.5:** Folk Classification trigon

There is a mixture of sediment type terminology throughout the JNCC Classification. At level 3 of the JNCC Classification sediment habitat types were divided into four broad categories (coarse sediment, sand, mud and mixed sediments) that were not specifically defined. For

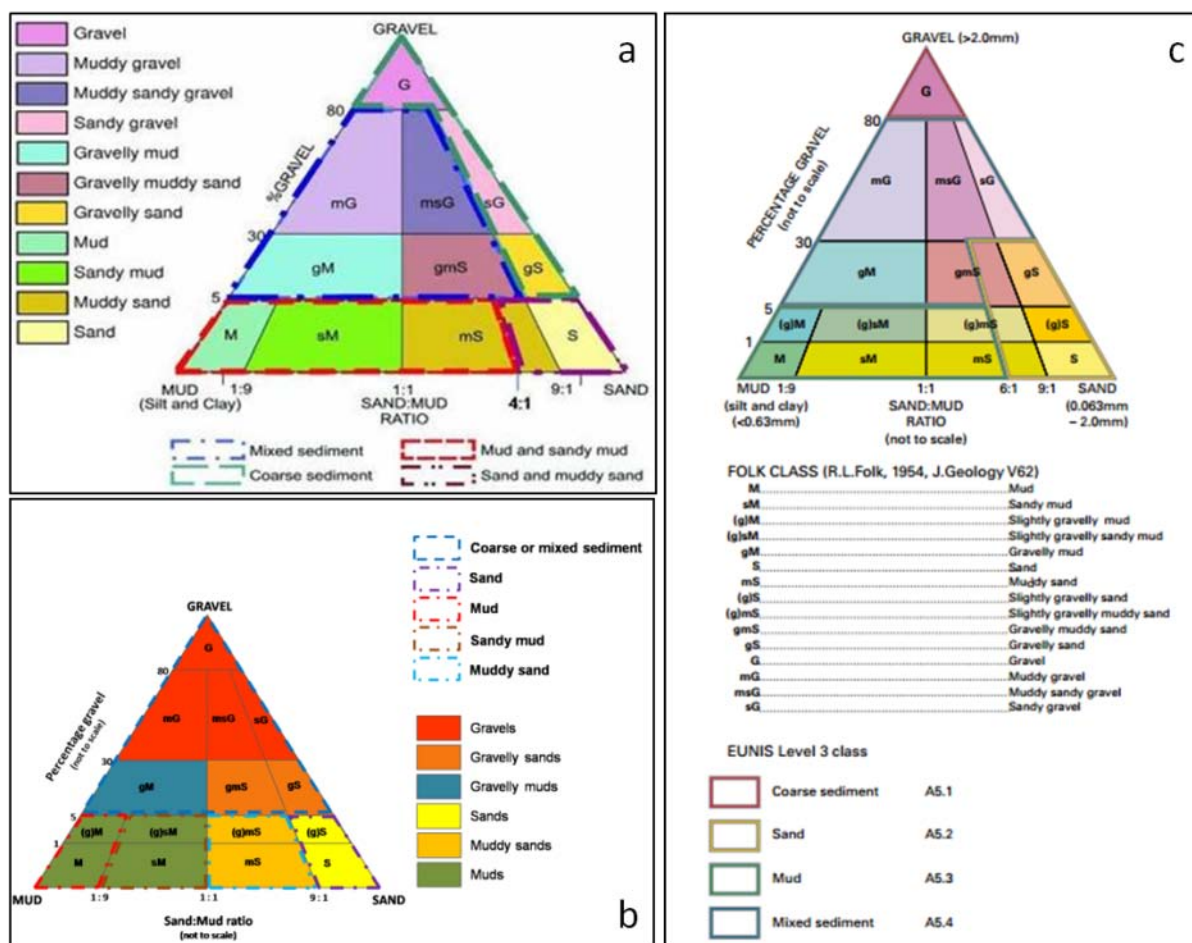
broad-scale mapping purposes these four categories have been defined by grouping Folk classes. There is debate amongst users as to what the most biologically relevant Folk class groupings are. The groupings defined in **Figure 2.5a** (Long 2006<sup>12</sup>) have been the most commonly used to date (e.g. in UKSeaMap 2010 (McBreen *et al* 2011) and EUSeaMap (Cameron & Askew 2011)) but many users have had difficulties with matching habitat types using these definitions and some have suggested the boundaries between classes should be altered. Alternative boundaries were suggested for the Western Mediterranean section of EUSeaMap (Cameron & Askew 2011; **Figure 2.6b**) and the REC survey of the South Coast (James *et al* 2010; **Figure 2.6c**). Further analysis of data would be required to assess which boundaries are most biologically relevant. Analysis undertaken during development of the original JNCC Classification was limited as data were divided into different level 3 (Table 1.1) groups before analysis because the datasets were too large for PRIMER so relationships between them were not fully explored (Connor *et al* 2004). Despite user issues with the level 3 sediment definitions outlined by Long (2006) it is unlikely that these will be altered in the future. Changing the definition of the level 3 sediment types would have huge knock on consequences for conservation work as level 3 habitats are now protected as Marine Conservation Zone Broad-scale Habitats and a large amount of work has been undertaken based on existing definitions.

At level 4 some habitat types are divided by sediment type again (Table 1.1), for example 'sand and muddy sand' is split into 'fine sand' and 'muddy sand'. These terms are taken from different types of sediment classification which is not helpful; fine sand is a term for a particular sediment fraction from the Wentworth scale and muddy sand refers to a mixture of mud and sand fractions from the Folk classification. In addition, there is no option for coarse or medium sand, which sometimes appears in level 5 Biotope names under coarse sediment (e.g. [SS.SCS.ICS.HeloMsim](#); *Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand).

At level 5 more specific sediments are included in some Biotope names; coarse sediment includes shingle, gravel, sandy gravel, gravely sand, cobbles and pebbles, coarse sand and mixed gravely sand. It appears the naming of sediment is roughly based on the MNCR sediment categories. Where a mixture is present various wording is used, none of which is based on rigidly defined proportions, for example, 'gravely sand', 'sand with gravel and pebbles', 'gravel and pebbles'. Some wording refers to Wentworth scale categories not in the MNCR list like clay and fine mud. It needs to be clarified which methodology should be used, and terminology in the JNCC Classification descriptions should be changed to be consistent. It is likely that some biological communities can occur on other sediment types to those specified in the Biotope name, so it may be appropriate for the sediment type to just be specified as the broader level 3 categories. If sediment descriptions are too specific it could result in numerous Biotopes with the same dominant species but slightly different sediments being identified.

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<sup>12</sup> [http://www.searchmesh.net/PDF/GMHM3\\_Detailed\\_explanation\\_of\\_seabed\\_sediment\\_classification.pdf](http://www.searchmesh.net/PDF/GMHM3_Detailed_explanation_of_seabed_sediment_classification.pdf)



**Figure 2.6:** (a) BGS modified Folk diagram used for UKSeaMap (Long 2006); (b) Folk divisions used for Western Mediterranean section of EUSeaMap (Cameron & Askew 2011); (c) Folk divisions recommended from South Coast REC survey (James *et al* 2010).

## 2.5.2. Distinction between rock and sediment

There is a lack of clarity amongst users on distinction between rock and sediment. Hard substrata are generally defined as supporting attached epifauna. There are some exceptions; for example, *Sabellaria* reef can develop on sand. Whether substrate can support attached epifauna depends on particle size and also stability. An internal JNCC document was produced, but not published, by the lead author of the original Classification (Connor 2009) that defines the difference between hard and soft substrata using particle size and stability (**Table 2.3**). Bedrock and boulders were defined as always being ‘hard’, whilst pebbles and cobbles were only hard if they were relatively stable. Small pebbles (MNCR gravel) can support both attached epifauna and infauna if stable which makes it neither hard nor soft. It is recommended that stable pebbles and cobbles which have attached epifauna are classified under ‘rock and other hard substrata’. Unstable pebbles and cobbles are grouped under ‘coarse sediments’ with gravelly sand, sandy gravel and gravel. These definitions have been included in a JNCC biotoping guidance document (Parry 2014; unpublished) which is available on request from [MarineHabitatClassification@jncc.gov.uk](mailto:MarineHabitatClassification@jncc.gov.uk). It should be noted that the Folk classification includes pebbles and cobbles under as ‘gravel’ meaning these would be classed as coarse sediment using the modified Folk trigon (**Figure 2.6a**) regardless of stability.

**Table 2.3:** Summary definition of rock and sediment substrata (adapted from Connor 2009)

MNCR sediment category	Bedrock	Boulder	Cobble	Pebble	Gravel	Coarse sand	Medium sand	Fine sand	Mud
Particle Size	N/A	>256 mm	64-256 mm	16-64 mm	4-16 mm	1-4 mm	0.25-1.0 mm	63µm - 0.25mm	<63µm
Stability ↑ Scour ↓	Can support infauna (sediment)					Can support attached epibiota (rock)			

### 2.5.3. Mixed substrata or rock/sediment mosaics

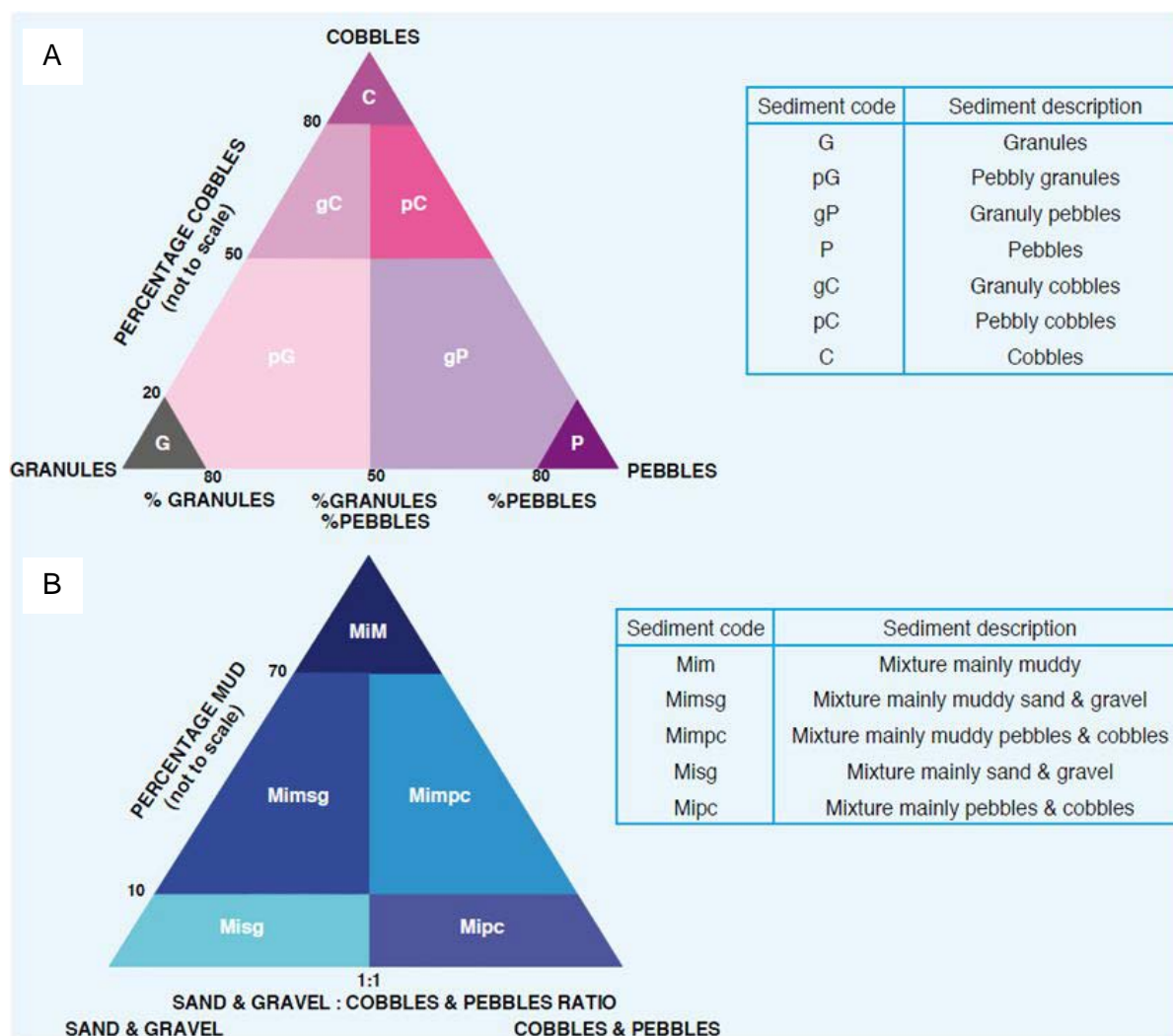
There is some confusion amongst users over the definition of mixed **substrata** and mixed **sediment**, both terms used in the JNCC classification. ‘Mixed substrata’ comprises both stony material (stable pebbles, cobbles and/or boulders) and some sediment. It can support attached epifauna and infauna and could be considered as a mosaic or transition habitat. Mixed sediment consists of mud, sand and gravel; unlike mixed substrata, mud is an essential component and the gravel component does not have to include stony material. Mixed substrata biotopes are placed in the rock section if stony material is dominant but this can be confusing as they can have infaunal communities in the interstitial sediment. Several mixed sediment biotopes (e.g. [SS.SMx.CMx.CIloModHo](#)) include a proportion of pebbles (which includes large shell pieces), cobbles and boulders meaning they could also be classed as mixed substrata. These biotopes are often defined just by the epifauna attached to the rock present and consequently have a biological community more similar to a rock community; for example ‘*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment’ ([SS.SSa.IFiSa.ScupHyd](#)) is likely to be similar to ‘*Flustra foliacea* and *Haliclona oculata* with a rich faunal turf on tide-swept circalittoral mixed substrata’ ([CR.HCR.XFa.FluHocu](#)) which falls under ‘circalittoral rock’. Such biotopes could belong in the rock rather than the sediment section.

A new internal JNCC biotope guidance document (Parry 2014 unpublished) recommends that areas with both rock and sediment are described as a mosaic and assigned both a rock and a sediment biotope, with the dominant biotope listed first. The mixed substrata biotopes currently described in the JNCC classification are likely to be mosaics of both a rock and a sediment biotope. It would help users if only the dominant component (rock or sediment) was described, particularly if the species listed are only associated with that substrate. It may be that mixed substrata biotopes are simply mosaics of two existing biotopes in the Classification and, if so, they could be removed. For example, it could be argued that [LR.HLR.FT.FserTX](#) is a mosaic of [LR.HLR.FT.FserT](#) and [LS.LSa.MuSa.Lan](#).

There are various ways in which users have tried to classify types of mixed substrata. The stony reef survey East of Shetland isles (Foster-Smith *et al* 2009)<sup>13</sup> defined rocky sediments based on the relative proportions of rock, sand and cobble present, displayed in a ternary diagram in a similar way to the Folk (1954) sediment classification. The MALSF synthesis study of the central and eastern Channel (James *et al* 2011) defined areas with both rock and sediment as mosaics. Areas with a thin layer of sediment covering rock were identified

<sup>13</sup> <http://jncc.defra.gov.uk/pdf/web433.pdf>

during South Coast Regional Environmental Characterisation (REC) surveys areas and suggested as a new substrate type for the JNCC Classification. The HABMAP project (Robinson et al, 2009) produced a ternary diagram to give further detail about the composition of coarse sediments based on relative proportions of granules, cobbles and pebbles (Figure 2.7a) and a ternary diagram to describe sediment mixtures based on relative proportions of mud, sand & gravel and cobbles & pebbles (Figure 2.7b). Further work would be needed to establish if mixed substrata do indeed have their own unique communities, and weren't just transition zones showing a mosaic of rock and sediment communities in a dynamic environment, if mixed substrata types were included in the Classification.



**Figure 2.7:** Classification scheme used by the HABMAP project a) for sediments with grain sizes of >2mm, and b) for sediment mixtures (adapted from Robinson *et al* 2009).

#### 2.5.4. Inconsistent identification of sediment types by users

The lack of prescriptive definitions for the sediment types mean they are inconsistently identified, depending on the relative importance given to biology and geology when assigning a biotope. Some combinations of communities are found in a range of sediment types but if they occur only in one part of the classification hierarchy they can only be associated with one sediment type. A bottom-up approach in which the biology is favoured in the assignment of a biotope may therefore lead to a different sediment type being assigned than a top-down approach that looks primarily at the grain sizes. An example of this can be found in comparing predictive maps produced in the Irish Sea for HABMAP and UKSeaMap



2010 (Ellwood *et al* 2011). HABMAP (Robinson *et al* 2009) used a bottom-up approach in which physical parameters were matched to pre-classified point samples of biotopes. It was found that, for example, sandy gravel and gravely sand was associated with some mixed sediment Biotopes; these are usually associated with coarse sediment when applying a top-down approach (**Figure 2.5**) and were mapped as such in UKSeaMap 2010. The technical report on substrata for UKSeaMap 2010 (McBreen & Askew 2011) also highlighted considerable overlap between biotopes assigned to mixed and coarse sediment. Results from a CCW survey of NW Anglesey (unpublished) found it was difficult to differentiate between mixed and coarse sediments as they were biologically very similar and were only split based on the percentage of fine sediment which could not be estimated easily from video footage.

### 2.5.5. Structural issues

There are some cases where it appears that a coarse or mixed sediment Biotope has been placed in the wrong part of the JNCC Classification as the substrate mentioned in the description is different to the level above. This indicates that coarse sediment communities are not always different from mixed sediment communities. See below for specific Biotopes with a sediment mismatch:

- '*Mytilus edulis* and *Fabricia sabella* in littoral mixed sediment' ([LS.LSa.St.MytFab](#)) within 'littoral sand' not 'littoral mixed sediment'
- 'Barren littoral coarse sand' ([LS.LSa.MoSa.BarSa](#)) within 'littoral sand' not 'littoral coarse sediment'
- '*Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment' ([SS.SMx.IMx.CreAsAn](#)) (lacks a mud component) within 'infralittoral mixed sediment' not 'infralittoral coarse sediment'
- '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' ([SS.SMx.CMx.FluHyd](#)) (lacks a mud component) within 'circalittoral mixed sediment' not 'circalittoral coarse sediment'
- '*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment' ([SS.SMx.CMx.OphMx](#)) (lacks a mud component) within 'circalittoral mixed sediment' not 'circalittoral coarse sediment'

There is some confusion over the position of habitat types with clay sediments; '*Mytilus edulis* and piddocks on eulittoral firm clay' ([LR.MLR.MusF.MytPid](#)) is grouped with rock and other hard substrata habitat types, whereas '*Polydora ciliata* and *Corophium volutator* in variable salinity infralittoral firm mud or clay' ([SS.SMu.SMuVS.PoICvol](#)) is under mud habitat types. This may be because the type of clay community differs. Hard clay can have boring fauna and attached epifauna and thus is more similar to rock (as with [LR.MLR.MusF.MytPid](#)) and soft clay just has infauna more similar to mud (as with [SS.SMu.SMuVS.PoICvol](#)).

### 2.5.6. Substratum types not fully covered in JNCC Classification

Fossilised peat is mentioned in one Biotope name within 'high energy littoral rock' ([LR.HLR.FR.RPid](#)) but not elsewhere. Biotopes on artificial substrates are found within features of circalittoral and infralittoral rock, but could also occur in the littoral zone. Methane Derived Authigenic Carbonate formed from leaking gases is not mentioned as a substrate type but could be added to the JNCC Classification system where appropriate. The JNCC Solan Bank survey (Whomersley *et al* 2010)<sup>14</sup> found carbonate communities were similar to

<sup>14</sup> [http://jncc.defra.gov.uk/PDF/jncc430\\_webversion.pdf](http://jncc.defra.gov.uk/PDF/jncc430_webversion.pdf)

soft rock communities (Figure 2.8), and recommended they could be added to this section of the JNCC Classification.



**Figure 2.8:** Methane Derived Authigenic Carbonate rock sample from Solan Bank survey showing evidence of biological boring.

## 2.6 Energy

‘Energy’ is used to characterise rock habitat types at level 3 (Table 1.1), but there is some debate as to the biological relevance of this division, and whether it is appropriate at level 3. ‘Energy’ refers to the combination of the effects of wave exposure and tidal streams. An area of high energy may have high wave exposure but weak tidal streams, high wave exposure and strong tidal streams, or just strong tidal streams in a sheltered location. An area of low energy is sheltered and has weak tidal streams.

The JNCC Classification defines seven categories for exposure which are identified in the field based on the aspect of the coast (related to the direction of the prevailing or strong winds), fetch (distance to the nearest land), the degree of open water offshore and the depth of water adjacent to the coast (Table 2.4). Tidal stream categories are defined based on set ranges for maximum tidal current strength in knots or m/second (Table 2.5). Issues with classifying habitats using energy are discussed below.

**Table 2.4:** Tidal stream category definitions (Connor *et al* 2004)

Category	Description
<i>Extremely exposed</i>	This category is for the few open coastlines which face into prevailing wind and receive oceanic swell without any offshore breaks (such as islands or shallows) for several thousand km and where deep water is close to the shore (50m depth contour within about 300m, e.g. Rockall).
<i>Very exposed</i>	These are open coasts which face into prevailing winds and receive oceanic swell without any offshore breaks (such as islands or shallows) for several hundred km but where deep water is not close (>300m) to the shore. They can be adjacent to extremely exposed sites but face away from prevailing winds (here swell and wave action will refract towards these shores) or where, although facing away from prevailing winds, strong winds and swell often occur (for instance, the east coast of Fair Isle).
<i>Exposed</i>	At these sites, prevailing wind is onshore although there is a degree of shelter because of extensive shallow areas offshore, offshore obstructions, a restricted (<90°) window to open water. These sites will not generally be exposed to strong or regular swell. This can also include open coasts facing away from prevailing winds but where strong winds with a long fetch are frequent.
<i>Moderately exposed</i>	These sites generally include open coasts facing away from prevailing winds and without a long fetch but where strong winds can be frequent.

<i>Sheltered</i>	At these sites, there is a restricted fetch and/or open water window. Coasts can face prevailing winds but with a short fetch (say <20km) or extensive shallow areas offshore or may face away from prevailing winds.
<i>Very sheltered</i>	These sites are unlikely to have a fetch greater than 20km (the exception being through a narrow (<30°) open water window, they face away from prevailing winds or have obstructions, such as reefs, offshore.
<i>Extremely sheltered</i>	These sites are fully enclosed with fetch no greater than about 3km
<i>Ultra sheltered</i>	Sites with fetch of a few tens or at most 100s of metres.

**Table 2.5:** Wave exposure category definitions

Category	Tidal current (maximum at surface)	
	knots	m/sec
<i>Very strong</i>	>6	>3
<i>Strong</i>	3-6	>1.5-3
<i>Moderately strong</i>	1-3	0.5-1.5
<i>Weak</i>	<1	(<0.5
<i>Very weak</i>	Negligible	

### 2.6.1. It is difficult to define energy levels in the field

The UKSeaMap 2010 technical report 4 on energy (McBreen *et al* 2011)<sup>15</sup> states it was difficult to delineate thresholds as there was a high amount of variance in the data from Marine Recorder. There are also a large number of records in Marine Recorder for which energy is 'uncertain'. A JNCC-commissioned report on assigning biotopes to Seasearch data (MCS/SEASEARCH 2007)<sup>16</sup> found that confusion over energy level was a major source of inconsistencies in Biotopes assigned. Energy level is clear at the extremes, such as sea lochs or offshore islands but for most sites the energy levels are somewhere in the middle and there are wide overlaps between the definitions. There is a low level of agreement between assessors since if the wrong energy level is selected you are taken down differing paths to different Biotopes, even where the fundamental Biotope is apparent. The MESH Atlantic EUNIS workshop (Galparsoro *et al* 2012) highlighted that regional perceptions of energy across Europe differ according to the typical ranges in a region.

### 2.6.2. Energy is not included in sediment descriptions

The 'energy' of a certain area will also have an effect on biological communities in sediment habitats. This generally due to the impact on sediment grain size; high energy areas have coarser sediments because the finer sediments are washed away. At level 3 (Table 1.1), sedimentary habitats are divided by sediment type, which show some correlation with energy. UKSeaMap 2010 technical report 5 (Ellwood *et al* 2011) discusses whether sediment type makes a reliable proxy for energy. Analyses found that mixed sediments with mud, and mud/sandy mud were generally only low energy as expected. However, other sediment types do not show such fidelity to energy classes.

Habitat types with high energy unstable boulders and cobbles occur in the sediment section of the JNCC Classification rather than the rock section. Unlike their stable rock counterparts they are not explicitly labelled as 'high energy' or grouped separately from other coarse sediments which occur in lower energy environments. Some level 5 (Table 1.1) sediment Biotopes are labelled 'mobile' 'tide-swept' or 'unstable' but they are not split from other lower

<sup>15</sup> [http://jncc.defra.gov.uk/pdf/UKSeaMap2010\\_TechnicalReport\\_4\\_Energy.pdf](http://jncc.defra.gov.uk/pdf/UKSeaMap2010_TechnicalReport_4_Energy.pdf)

<sup>16</sup> [http://jncc.defra.gov.uk/pdf/jncc418v1\\_web.pdf](http://jncc.defra.gov.uk/pdf/jncc418v1_web.pdf)



energy Biotopes. Biological communities on the **same** sediment type can vary depending on how mobile the sediment is, for example infralittoral mobile fine sand communities are species poor, whereas more sheltered infralittoral fine sand can support semi-permanent tube building amphipods and polychaetes. More research would be needed to identify Biotopes that occur in sediments of different energy, particularly in deeper waters.

## 2.7 Salinity

### 2.7.1. Inconsistent inclusion of salinity as a variable

Communities 'in variable salinity' (estuaries) and 'reduced salinity' (lagoons) are split from other habitat types at level 4 (Table 1.1) for littoral rock, circalittoral rock, and sublittoral sediment, but salinity is only mentioned in level 5 Biotope names for littoral sediment and infralittoral rock and they are grouped with other fully saline Biotopes with similar biology. Within sublittoral sediments, lagoon and estuarine habitat types are divided at level 4; however, in other parts of the classification variable salinity habitat types can also occur in reduced salinity conditions. There are some occasions where the salinity range given for a Biotope falls outside the range given for the level above (e.g. '*Ascophyllum nodosum* with epiphytic sponges and ascidians on variable salinity infralittoral rock' ([IR.LIR.Lag.AscSpAs](#))).

### 2.7.2. Lack of Atlantic lagoon biotopes

It was highlighted in the MESH Atlantic EUNIS workshop (Galparsoro *et al* 2012) that specific reduced salinity lagoon Biotopes have been defined for the Baltic region within EUNIS, but not for the Atlantic. In the JNCC Classification reduced salinity lagoon habitat types are included at level 4 (Table 1.1) but no level 5 Biotopes are described.

### 2.7.3. Salinity is not recorded as standard during surveys

At level 4 (Table 1.1), variable salinity biological communities described are very similar to those occurring in full salinity so it could be difficult to decide which habitat type to assign.

## 2.8 Biology

### 2.8.1. Inconsistent inclusion of 'biogenic reef' and 'macrophyte-dominated' habitats

It could be considered that biogenic reef and macrophytes alter the substratum and so should be separated from other habitats at the same level as different substrata are introduced. In the current JNCC Classification biogenic reef and macrophyte-dominated habitats are divided from other habitats at level 3 for sediments but not for rock. Some biogenic reef forming species have their own level 4 habitat type in circalittoral rock (e.g. [CR.MCR.CMus](#), Circalittoral mussel beds on rock), but none appear for littoral or infralittoral rock. Some of the littoral rock biotopes are effectively biogenic reef but are not identified as such (e.g. [LR.HLR.MusB.MytB](#), *Mytilus edulis* and barnacles on very exposed eulittoral rock). Most biotopes on littoral and infralittoral rock are macrophyte-dominated but are not identified as such. This is counter-intuitive to the user and makes identifying biotopes which match listed habitats more complicated; for example, Annex I reef is not simply all those biotopes grouped under any level 3 biogenic reef habitat.

### 2.8.2. Lack of information on biological communities

The composition of the biological community is used to characterise habitat types at level 4 (Table 1.1) for rock and level 5 for sediment. The number of Biotopes defined for each level 4 Main Habitat varies across different parts of the JNCC Classification depending on available data. Rock habitats of the littoral and infralittoral zones are very well defined as MNCR fieldwork focused on coastal areas. A great deal fewer habitat types are defined for circalittoral sediments, but this does not necessarily reflect any natural homogeneity – more likely a smaller survey effort in those areas means some habitat types have not yet been recorded.

### 2.8.3. Level of detail for biological community is inconsistent

The names of Biotopes and Sub-biotopes both include specific dominant species, and specific information about environmental conditions. In some cases, level 5 and 6 Biotope names are more similar to level 4 (Table 1.1) names than other Biotopes; for example, the Biotope 'faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' ([CR.MCR.EcCr.FaAlCr](#)) contains no species information as is usual for level 5. This means it covers a wider range of biological communities than most other Biotopes (Figure 2.9). Other Biotopes which could be more appropriate at level 4 include:

- Oligochaetes in littoral mobile sand
- Polychaetes in littoral fine sand
- Sponges and shade-tolerant red seaweeds on overhanging lower eulittoral bedrock and in cave entrances
- Cushion sponges and hydroids on turbid tide-swept sheltered circalittoral rock
- Seapens and burrowing megafauna in circalittoral fine mud



Figure 2.9: Range of biological communities included under Biotope [CR.MCR.EcCr.FaAlCr](#)

There is not currently a system in place to standardise which characterising species are included in the biotope name. Biotopes names which include very specific characterising species for may lead users to identify new, similar Biotopes which differ by only one characterising species.

### 2.8.4. Lack of guidance on deciding when a community matches a biotope description

This makes it difficult for users to decide when they have new Biotope. Users frequently are forced to select the more general Biotopes listed as they are the only ones which fit, thus creating a bias towards those more general types.

### 2.8.5. Biotopes inconsistently defined due to differences in the method used to collect data

It has been recognised that some Biotopes may not be fully described as the description only refers to either epifauna or infauna, depending on the method used. The data supporting various biotopes was collected by widely different sampling methods. To work around this problem, habitat types were defined for the REC survey of the English Channel (James *et al* 2011) by mapping both epifaunal and infaunal habitats and overlaying them. It could be sensible to identify which method was used to collect data defining each Biotope. Ideally each Biotope would contain information about both infauna and epifauna, with the exception of rock sediments which lack infauna. Robinson *et al* (2009) flagged up the issue that some Biotopes can only be identified if the method used for sampling is the same as the method used to originally define that Biotope. For example, the characteristic species defining [SS.SCS.ICS.HeloMsim](#) (*Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand) are tiny polychaetes that would be grossly under sampled using all but the finer meshes for sieving sediment. The 1mm sieve used as standard on offshore surveys would not retain meiofauna such as these polychaetes (Figure 2.10). For dive surveys there is a limit to the amount of time available underwater to catalogue species present so it is likely that the number of species recorded is not complete and biased towards conspicuous species making it difficult to assign a matching Biotope from the JNCC Classification.



Figure 2.10: 1mm sieve used to extract benthic fauna

## 2.9 Topography

The introductory text (Connor *et al* 2004) explains that the JNCC Classification does not use a marine landscape approach so consequently it does not currently contain any large topographic features. The EUNIS deep sea section (Davies & Moss 2004) includes habitat type categories for topographic features such as canyons, channels, slope failures and slumps on the continental shelf, deep sea trenches and raised features of the deep sea bed including seamounts, oceanic ridges and carbonate mounds. However, large features such as these are likely to contain numerous different Biotopes with different sediments, and potentially even cross biological zones in the case of seamounts, as explained in Howell (2010). Similar habitats could occur on different features so these would be replicated in different parts of the JNCC Classification. More research would be required to identify whether any biological communities are specific to certain topographical conditions if topography was to be added to the JNCC Classification.

Small topographic 'features' such as 'Littoral caves and overhangs' ([LR.FLR.CvOv](#)) and 'Infralittoral surge gullies and caves' ([IR.FIR.SG](#)) are currently included in the JNCC

Classification as they are smaller scale than habitats and are known to have specific communities. However, these features are much smaller scale than other habitats assigned at the same level. The 'features' also cause problems for monitoring at level 3 as broad-scale level 3 maps would merge them with other categories at the same level based on their physical attributes (e.g. littoral rockpools in low energy areas would fall within 'Low energy littoral rock').

It would be helpful for JNCC Classification descriptive text to mention which features a habitat type may occur in. This information can be taken from the correlation tables. It is standard protocol for field survey data entered into Marine Recorder to include a field for marine landscape feature, so it would be possible for users to query data and identify which habitats occur on each feature.

## 2.10 Factors not Currently Considered

### 2.10.1 Biogeography

Some habitat classification systems define habitat types using biogeography as environmental conditions can vary significantly between biogeographic regions. Some biological communities may be unique to a certain region, and the same biological community may occur in different environmental conditions in different regions. Howell (2010) describes how deep sea communities vary between the Arctic and Atlantic regions, with difference in water movements causing biological zones with similar communities to occur at different depths in the two regions.

Various options for the structure of a new deep sea classification were discussed at a EUNIS deep-sea workshop at the University of Plymouth in April 2012. EUNIS are considering taking this work forward using one of two main approaches to incorporate biogeography: 1) use a top-down approach to divide all habitat types between regions at level 2 or 3, or 2) use a bottom-up approach to identify level 5 Biotopes unique to a region in their name. The problem with using the first approach is that communities which occur in more than one region are replicated in the JNCC Classification and there would not be continuity across regions meaning resulting maps and assessments may not be comparable. The EUNIS habitat classification (Davies & Moss 2004) currently uses the second approach to identify habitat types specific to the Mediterranean or Baltic. However, no research has been conducted to assess whether any of the other habitat types are specific to a biogeographic region. The second approach makes it harder to find all habitats occurring in one region, but it would be possible to query comparison tables and select just those from a certain region if biogeographic region was included as a field. The new deep-sea section for the JNCC Classification will include biogeographic region with biological zone at level 2.

### 2.10.2 Other environmental factors

Variables not currently considered in the JNCC Classification include non-tidal currents, productivity, organic matter, seabed chemistry, and food and larval supply; however, the relationships between these variables and communities are not well understood so it is not feasible to include them in the JNCC Classification as high level habitat drivers.

### 2.10.3 Human Impacts

There are a small number of Biotopes which represent impacted communities ('*Prasiola stipitata* on nitrate-enriched supralittoral or littoral fringe rock' ([LR.FLR.Lic.Pra](#)), '*Capitella capitata* and *Thyasira* spp. in organically-enriched offshore circalittoral mud and sandy mud' ([SS.SMu.OMu.CapThy](#))) but no consensus has been made as to how they should appear in

the Classification, or if they should be included at all. One argument is that the Biotopes in the Classification should just be the natural state. However, no areas are completely unimpacted. Users would be likely to find impacted communities for which they would be unable to assign a habitat type if only 'natural' biotopes were included. It is important that impacted biotopes are identified as such in the Classification to help with impact assessments. More research is needed into how biotopes change from one state to another due to various impacts. Research into relationships between Biotopes and human impacts would be highly relevant to work on developing a UK monitoring programme and responding to the Marine Strategy Framework Directive.

### 3 Use for monitoring listed habitats

The most common use for the Classification is to assign habitat types to mapped areas in order to monitor and assess status and trends of habitats listed under various instruments. A correlation table has been produced to display which JNCC Classification habitat types correlate to EUNIS habitat types, Habitats Directive Annex I habitats, OSPAR threatened and/or declining habitats and UK BAP habitats (now Habitats of Principal Importance under the NERC and Nature Conservation (Scotland) Acts). This is available to download from the JNCC website<sup>17</sup>. Work is in progress to update this with additional lists of habitats which need to be monitored under more recently developed legislation – Features of Conservation Importance identified for Marine Conservation Zones, Search Features identified for Nature Conservation MPAs in Scotland and special and predominant habitats which need to be monitored for the Marine Strategy Framework Directive. In order for the JNCC Classification to be a useful tool for monitoring listed habitats, the habitat types listed in the JNCC Classification should cover all habitats of conservation importance, and it should be easy to identify which correlate to each. The Classification system was developed before many of the legislative instruments that specify listed habitats came into force. It is clear the correlation tables need to develop along with new obligations. In some cases one JNCC habitat type is equivalent to a listed habitat (e.g. JNCC 'littoral mud' is equivalent to UK BAP 'intertidal mud' with a 1:1 relationship), and in other cases several JNCC habitat types would be combined to identify a listed habitat (e.g. all habitat types mentioning *Sabellaria* combined to map *Sabellaria* reef) – i.e. a many:1 relationship. The listed habitats which can currently be fully matched to biotopes using the JNCC Classification include broad littoral habitats which are roughly equivalent to the level 2 or 3 JNCC categories (e.g. high energy infralittoral rock), as well as some habitats which occur only in more shallow waters (mussels, *Sabellaria spinulosa*, seagrass, saltmarsh, maerl).

Numerous listed habitats could only be partially matched for a number of reasons. Some examples of these are provided below.

- Listed habitat can occur in deeper waters, or different biological zones, than those defined in the JNCC Classification (cold water corals, sponges, seapens, habitats defined by substrate type).

E.g. A biotope map could not define any habitat types deeper than 200m as that is the deepest limit given in habitat type descriptions.

- Listed habitat can occur on several substrate types, but a habitat type is only defined with one type of substrate in the Classification (cold water corals, sponges, *Sabellaria alveolata*, serpulids, oyster beds).

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<sup>17</sup> <http://jncc.defra.gov.uk/marinehabitatclassification>



E.g. A biotope map may show areas of ‘Deep sponge communities on circalittoral rock’ ([CR.HCR.DpSp](#)), but areas of coarse sediment with sponges would just be defined as ‘Circalittoral coarse sediment’ as no sponge habitat types are available in the JNCC Classification for that substrate.

- The specific environmental conditions of the listed habitat is explicit for only some equivalent habitat types (tide-swept channels, saline lagoons, sheltered muddy gravels, estuarine rocky habitats).  
E.g. All tide-swept channels could not be identified from a biotope map as, although some habitat types are specific to tide-swept areas and are identified as such (e.g. ‘Fucoids in tide swept area’ ([LR.HLR.FT](#))), many other habitat types occur in tidal streams of any strength and hence isolating tide-swept channels from these broader habitat types is not possible.

In reality, maps of listed habitats can be produced using other methods than just selecting records where the tagged Biotope mentions the relevant taxa; for example, the species lists for samples can be used. However, users want a quick and simple way of finding out where listed habitats occur that does not involve a complex re-classification approach with all the associated errors.

The JNCC Classification lacks habitat types for sparse amounts of reef-building species or macrophytes. Some new Biotopes with clumps of *Sabellaria* were proposed in the REC survey report for the South Coast (James *et al* 2010). If Biotopes were defined for aggregations of reef-building species, consideration is needed as to where habitat types such as these would best be placed; for example, would sparse *Sabellaria* on circalittoral sand fall under ‘polychaete worm reefs on sublittoral sediment’ or ‘circalittoral coarse sediment’?

## 4 Conclusion

### 4.1 Key findings

The majority of issues users have with assigning Biotopes using the JNCC Classification stem from fundamental limitations of its hierarchical structure. Users often have problems assigning Biotopes because the community they have found occurs in slightly different environmental conditions (biological zone, sediment, energy) to Biotopes with matching communities. The ranges provided for physical variables in biotope description pages can mislead users; it should be made clear that these describe only where the biotope has been found to date, and not its full potential range. The common situation where data fits the biological community described in a biotope but not the physical conditions results in two problems: i) very similar new Biotopes are proposed that have essentially the same biological community but have to be broken up based on environmental factors, and ii) data is ‘shoe-horned’ into a biotope which has a matching biological community but different physical conditions meaning it cannot be accurately aggregated up to higher levels or compared to level 3 broad habitat maps.

The inclusion of different variables in habitat definitions at different levels in different sections of the JNCC Classification does not seem intuitive for users and makes mapping more complicated. In particular, users often do not understand why infralittoral and circalittoral are divided at level 3 for rock and level 4 for sediment. Some variables (salinity, biogenic, macrophyte-dominated) are only used to define sediment habitats but not rock which makes mapping listed habitats more complicated. It can be hard to identify energy conditions used to define rock habitats, and the level 3 rock ‘features’ are too small to be reflected in maps

produced at that level. Overall, the inclusion and position of these defining variables needs further consideration.

Gaps in coverage are also a key limitation of the JNCC Classification. Users often cannot assign a Biotope simply because some biological communities are yet to be identified due to a lack of information. The addition of a deep-sea section and analysis of more recent offshore data will help to identify further biotopes and fill the gaps.

Guidance is needed on how to identify the correct substrate type as there is currently inconsistency between users. Mixed terminology is used to describe substrates in the JNCC Classification and categories may not be biologically relevant so further work is needed to provide better definitions.

There is also the more complicated issue of how users can decide whether the biological community in their sample is sufficiently similar to an existing Biotope for it to be assigned. It could be that the characterising species listed for Biotopes are too specific. More consideration is needed as to which characterising species are included in the Biotope name and at what point a community becomes a new Biotope. Some biotopes are defined by infauna and others by epifauna which needs to be considered when biotoping.

Other issues highlighted refer to how biogeography, human impacts, and other previously unconsidered environmental factors could be represented in the JNCC Classification.

## **4.2 Recommendations for future work**

The following areas need further consideration:

### **1. Overall structure**

- a. Reconsider position/inclusion of variables used to define level 2/3 and some level 4 habitats (biological zone/ substrate / energy/ salinity/ biogenic reef/ macrophyte dominated/ features)
- b. Revise categories/ provide definitions for broad substrate types
- c. Consider defining functional biology categories for sublittoral sediment habitats at level 4
- d. Consider organisation of biotopes based on epifauna / infauna

### **2. Additions to the classification**

- a. Addition of a deep-sea section
- b. Addition of new biotopes based on new data, particularly deeper sediment biotopes
- c. Replication of existing biological assemblages in new Biotopes where they may occur in several places in the classification

### **3. Guidance**

- a. Outline methodology for matching Biotopes/ defining a new Biotope using species composition
- b. Develop best practice guidance for analysing video data to assign a Biotope
- c. Produce step by step guide to biotoping
- d. Provide training courses on biotoping

### **4. Supporting material**

- a. Revise display of known depth range and distribution of habitats in description pages
- b. Add description pages for new biotopes

- c. Update correlation tables
- d. Put in place mechanism for submission of proposed biotopes and regular updates of the JNCC Classification
- e. Update of Marine Recorder to include new/revised biotopes
- f. Retag biotopes for past survey data if resources allow
- g. Update website to display revised classification

In order to assess the value of changes suggested above, survey data, including newly collected data, needs to be reanalysed. Analysis would preferably be undertaken using the best available statistical software which can handle much larger datasets than PRIMER as this was a limiting factor on analysis of original MNCR data.

The following work has already been undertaken to act on these recommendations:

- Prioritisation of the issues outlined here and any additional common issues; suggested by users
- Development of a deep-sea section; and,
- Production of brief step by step guide to assigning a biotope.

The next steps for work on the JNCC Classification are to:

- Conduct a cost-benefit analysis to decide whether proposed changes are viable;
- Consider the exact questions which need to be answered through further data analysis;
- Analyse survey data to identify and describe new offshore biotopes; and,
- Revise the JNCC Classification and add in new biotopes.

It should be noted that further work on the JNCC Classification and the extent of further analysis depends on resources available. The JNCC Classification needs to be fit for JNCC and SNCB purposes so it could be that the most logical solution is not appropriate for existing pieces of work that depend on the JNCC Classification. The current JNCC Classification, and related EUNIS Classification, is now embedded in existing work and even the wording of national and European legislative instruments such as the MSFD. Therefore, further work on the JNCC Classification needs to strike a balance between minimising consequences for existing work while ensuring that the JNCC Classification is a fit-for-purpose tool. It is vital that any changes are well documented and links to previous systems are made clear.



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## Appendix I

### BUILD STATUS:

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1.1	28.12.12	Megan Parry	Draft with internal comments
2.0	16.12.12	Megan Parry	Final internal draft
3.0	20.02.13	Megan Parry	Shortened version following comments from NA. First draft
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4.0	12.03.13	Megan Parry	Final draft
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