THE NATIONAL MARINE HABITAT CLASSIFICATION FOR BRITAIN AND IRELAND

VERSION 03.02
INTRODUCTORY TEXT

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February 2003

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Recommended citation:

Connor, D.W., Allen, J.H., Golding, N., Lieberknecht, L.M., Northen, K.O. and Reker, J.B. 2003. *The national marine habitat classification for Britain and Ireland. Version 03.02. Introductory Text*. Joint Nature Conservation Committee, Peterborough. www.jncc.gov.uk/marinehabitatclassification (date of download)

ISBN 186107 544 8

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Summary

A fully revised version of the national classification of benthic marine habitats (seashore and seabed habitats and their associated communities of species) for Britain and Ireland is published online at http://www.jncc.gov.uk/marine/biotopes/default.htm. It was originally developed by JNCC's Marine Nature Conservation Review (MNCR) as part of the EC Life Nature-funded BioMar project (Connor *et al.* 1997 a, b).

The classification provides a tool to aid the management and conservation of marine habitats. It has been developed through the analysis of empirical data sets, the review of other classifications and scientific literature, and in collaboration with a wide range of marine scientists and conservation managers. It is fully compatible with and contributes to the European EUNIS habitat classification system (http://mrw.wallonie.be/dgrne/sibw/EUNIS/home.html).

An outline of the rationale, uses, overall structure and development methods is given, together with a full listing of newly defined and revised classification types, a detailed description of each type, distribution maps and, where possible, colour photographs.

The classification is presented in hierarchical format, and through a series of habitat matrices. It comprises:

		Number of types defined
Level 1	Environment (marine)	1
Level 2	Broad habitat types	5
Level 3	Main habitats	24
Level 4	Biotope complexes	43*
Levels 5 & 6	Biotopes and sub-biotopes	256*

*excluding Sublittoral Sediments

IMPORTANT

This classification supersedes version 97.06

Users of the classification must ensure they state which version has been used in any reports, data interpretation or field survey

Acknowledgements

The development and success of the classification has only been possible through the considerable input and tremendous enthusiasm of a wide variety of people. Expertise from scientific and conservation management perspectives, with international through to local standpoints, and with views on both general philosophies and practical considerations have been essential to ensure the classification has developed as a robust scientific but practical tool for marine nature conservation and environmental management. We are very grateful to all those involved, for both the many positive comments which have encouraged us and the criticisms which have helped to sharpen the end product.

The following have particularly contributed to the present version:

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Introduction to the national marine habitat classification

The online publication presents a national classification of marine habitats for the shores and seabed around Britain and Ireland. It has been substantially revised and updated from the previous version which was developed by JNCC's Marine Nature Conservation Review (MNCR) as part of the EC Life Nature-funded BioMar programme (Connor *et al.* 1997a, b). This new version reflects the continuing needs of end-users for improved information about each habitat, which is presented in a variety of interactive ways in this web-based version. As a result of re-analysis of field data, including new data from recent surveys in Special Areas of Conservation (SACs), a number of new habitat types have been described. The classification has been restructured, both to reflect improved understanding of the inter-relationship of habitat types and to align itself more closely with the European EUNIS habitat classification system (http://mrw.wallonie.be/dgrne/sibw/EUNIS/home.html).

Rationale and need for a habitat classification

Purpose and scope

Seabed habitats and the communities of species that occupy them are an essential component of the marine ecosystem and our overall understanding of ecosystem function must relate seabed habitats to hydrography, nutrient cycling, plankton changes and the distribution of wide-ranging species (i.e. fish stocks, marine mammals, birds). A greater understanding of the distribution, extent and status or quality of marine habitats is required to facilitate the protection of threatened and rare habitats and, more generally, the assessment of the state of the marine environment. Such information is also needed to improve spatial and strategic planning of human activities, in particular to promote the wiser use of habitats where there are competing demands (e.g. fishing, sand and gravel extraction, wind energy generation, nature conservation). As such, information on marine habitats needs to play a major role in the ecosystem-based approach to management of the marine environment that is now widely advocated at national and international levels (Defra 2002; North Sea Conference 2002).

This habitat classification has, consequently, been developed as a tool to aid the management and conservation of marine habitats. It provides an ecologically-based classification of seashore and seabed features, aimed primarily at classifying benthic communities of invertebrates and seaweeds in a way which is meaningful both to detailed scientific application and to the much broader requirements for management of the marine environment. The classification is relevant to the habitat requirements of more mobile species, such as fish and marine mammals, but these are not its primary focus. Whilst the corresponding European EUNIS classification also includes water column (plankton) habitats, this aspect has not yet been developed here.

The classification aims to provide comprehensive coverage, by including habitats for artificial, polluted or barren areas as well as more natural habitats, which encompass:

1. **Marine, estuarine and brackish-water (lagoon) habitats -** It also includes reference to saltmarsh habitats described in the National Vegetation Classification (NVC) (Rodwell 2000; Doody *et al.* 1993) as these are regularly covered by the sea, and NVC types which occur in brackish lagoons (Rodwell 1995).
2. **Rock and sediment habitats.**
3. **Upper shore to coastal waters -** From the supralittoral or splash zone and strand-line on the shore out to the 200 nm limit. The habitats beyond the near-shore subtidal zone (about the 3 mile/5 km limit) and below about 50 m depth are less well described here, due to more limited availability of data; more types will be defined as data become available.
4. **Plant and animal communities, including epibiota and infauna -** Types are defined using both their fauna and flora. Most benthic marine habitats include sedentary animals and small mobile animals which are an integral part of the community, whilst in many habitats, especially in deeper water, there are no plants (seaweeds or marine angiosperms)

to characterise the habitats. Sediment types are defined both by their epibiota (surface-dwelling animals and plants) and their infauna (animals living in the sediment).

5. **Britain and Ireland -** It covers habitats throughout Britain and Ireland and, through a widely-accepted broad framework, is readily expandable to include offshore continental shelf habitats and other areas in the north-east Atlantic, Mediterranean and Baltic Seas. This is being achieved through the EUNIS classification.

Requirements of a habitat classification system

To underpin management and conservation of the marine environment, a habitat classification system should:

- be scientifically sound, adopting a logical structure in which the types are clearly defined on ecological grounds, avoiding overlap in their definition and duplication of types in different parts of the system, and ensuring that ecologically-similar types are placed near to each other and at an appropriate level (within a hierarchical classification);
- provide a common and easily understood language for the description of marine habitats;
- be comprehensive, accounting for all the marine habitats within its geographic scope;
- be practical in format and clear in its presentation;
- include sufficient detail to be of practical use for conservation managers and field surveyors but be sufficiently broad (through hierarchical structuring) to enable summary habitat information to be presented at national and international levels or its use by non-specialists;
- be sufficiently flexible to enable modification resulting from the addition of new information, but stable enough to support ongoing uses. Changes should be clearly documented to enable reference back to previous versions (where possible, newly defined types need to be related back to types in earlier versions of the classification).

The following considerations were taken into account in establishing the classification:

- its intended application by a variety of users and at various scales (environmental managers, marine scientists and field surveyors working at local, national and international levels);
- the variety of intended applications;
- the variation in the scale of physical and biological features (recognising that marine ecosystems operate at a wide variety of scales, e.g. whole estuaries, individual mussel beds);
- the different levels of detail in available data;
- the different skill levels of future users and their different methods of survey.

Applications

A number of applications for the habitat classification system have been identified:

- to provide a practical system for the consistent description of habitat types;
- to map habitats to assess their geographical distribution;
- to map habitats to assess their extent;
- to provide categories for the assessment of the state of marine biological communities;
- to assess changes in habitat distribution and extent over time, to provide information on quality status, and rate of change in habitat distribution;
- to assess the relative importance of particular habitats (i.e. which habitats are rare or of national or regional importance) and the implications of this for prioritising management and

conservation action. Such assessment can lead to the listing of habitats for conservation action (e.g. Red lists);

- to enable the nature conservation value of habitats at specific sites to be assessed, such as in the identification of marine protected areas (MPAs);
- to enable an assessment of the extent of protection afforded to habitats by existing or proposed MPAs and the degree to which this provides sufficient protection;
- to enable the range and intensity of human activities that occur in particular habitats, and the degree to which such habitats are affected by those activities, to be systematically assessed;
- to facilitate presentation of habitat information at a scale and level of detail that enables appropriate management action to be taken. Such presentation should be flexible to address a variety of biodiversity and management issues;
- habitat mapping information needs to be used in conjunction with other spatial information in Geographical Information Systems (GIS), particularly activities, management and conservation areas, and other environmental data sets.

Nature of the marine environment

The habitat scale in characterising the marine environment

The marine environment can be described or characterised at a number of different scales, ranging from ocean-level processes through to those that occur at species and genetic level (Connor *et al*. 2002). The scales of relevance here are ecological units (referred to as "seascapes" in Connor *et al.* 2002), habitats and species; their inter-relationship can be expressed as follows:

- **Species** provide the globally accepted original classification of biological diversity, with well-established rules of taxonomy to distinguish between different types. Their classification is arranged in a hierarchy of genera, families, orders, classes and phyla.
- **Habitats** comprise suites of species (communities or assemblages) that consistently occur together, but which are derived from different parts of the taxonomic hierarchy (e.g. kelps, molluscs and fish in a kelp forest habitat). Their classification can also be structured in a hierarchy (biotopes, biotope complexes, broad habitats), reflecting degrees of similarity.
- **Ecological Units** comprise suites of habitats that consistently occur together, but which are often derived from different parts of the habitat classification hierarchy (e.g. saltmarsh, intertidal mudflats, rocky shores and subtidal mussel beds in an estuary).

The approach to classification or characterisation at each scale differs, each adopting differing factors to suit the requirements at that scale. Whilst the classification (taxonomy) of species, and to a lesser degree habitats, is now well established the ecological units concept and their characterisation is a more recent approach to characterisation of the marine environment (Laffoley *et al*. 2000 and Day & Roff 2000, who refer to ecological units as "seascapes"). The development of a typology of transitional and coastal water features for the EC Water Framework Directive[1] is broadly akin to the ecological units scale, and practical development of the concept is underway for the Irish Sea (Irish Sea Pilot - see http://www.jncc.gov.uk/marine/irishsea_pilot/default.htm).

Characterisation of habitats and ecological units is often confused, with some classifications attempting to inter-mix the two. For instance, the features listed in Annex I of the EC Habitats Directive[2] are a mixture of ecological units and broad habitat types. The present classification and the

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[1] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

[2] Council Directive 92/43 EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora.

EUNIS system, where ecological units are termed **habitat complexes**, recognises the relationship between the two, but does not attempt to integrate them into a single hierarchical classification.

Environmental influences at the habitat scale

Each species tends to live within a certain environment; that is, it has a preference for a combination of environmental factors (a niche), such as the substratum, temperature, salinity and hydrodynamic conditions that it is able to live within. The tolerance to different environmental conditions varies between species; it can be rather broad for some very common species but much more tightly defined for others. The niche occupied by a species may vary both temporally and spatially and is influenced not only by its physiological requirements and tolerance to change but also by the interactions between species, i.e. competition and predator-prey relationships.

In any particular place on the shore or seabed, a suite of species will occur, each adapted to the particular environmental conditions of that place, such as the conditions of an intertidal mudflat. Where such a suite of species occurs in other locations under similar environmental conditions, it can be defined as a community (or association or assemblage) of species which is occurring within a particular habitat type. The collective term biotope is now in common usage to encompass both of these biotic and abiotic elements.

Shore and seabed habitats are colonised primarily by seaweeds (on the shore and in shallow water) and by marine invertebrates from a wide range of phyla. Lichens (in the splash zone), higher plants (especially in saltmarshes) and fish contribute to a lesser degree. In contrast to terrestrial habitats, it is commonplace for marine habitats to be characterised, i.e. dominated, by animals rather than plants, and for the substratum to provide the main structure to the habitat (rather than plants such as in a forest).

Only a proportion of habitats have obvious dominant species (e.g. kelp forests, mussel beds, maerl beds). Many, particularly in deeper water, support a mosaic of species, none of which is particularly dominant, which may exhibit a degree of patchiness over the seashore or seabed and, in some cases, vary markedly with time. In these respects the species offer a much less robust mechanism for structuring a classification system than does the physical habitat in which they occur.

In the marine environment, there is a strong relationship between the abiotic nature of the habitat and the biological composition of the community it supports. Most communities appear to occur within a recognisable suite of environmental factors, although some occur within a more tightly-defined set of factors (habitat). One of the most important factors influencing species composition is the type of substratum present, which can be broadly divided into rock and sediment (the latter is closely linked to the hydrodynamic regime) whilst in estuaries salinity is an important factor. Community structure is additionally modified by biological factors such as recruitment, predation, grazing and inter-species competition. Species may modify habitats by their boring, accretion and bioturbation. The most important habitat attributes which appear to influence community composition are described in Table 1.

Table 1 Environmental factors which influence community structure

Factor	*Rocky habitats*	*Sediment habitats*
Substratum	Varies from bedrock, through boulders to stony plains, often mixed with sediment. The degree of stability of the rock is important, with algae and animals increasingly able to colonise smaller stones in more sheltered stable conditions.	Ranges from shingle (mobile cobbles and pebbles), through gravel and sand to very soft mud and muddy gravels. The type of sediment, mainly determined by the dynamics of water movement at the site, is highly important in structuring community composition, although salinity may become more critical in upper estuarine conditions.

Zonation: emersion / immersion on the shore (desiccation); depth in the subtidal (illumination) ***(see Figure 1 and Table5 for further details)***	A major factor, related to the length of time the rock is exposed by the tide, which leads to very marked horizontal bands of zonation on most rocky coasts. Supralittoral and littoral fringe zones on the extreme upper shore are lichen dominated. The main eulittoral zone is characterised by barnacles, mussels or fucoid algae, the infralittoral by kelps and the circalittoral by animals.	Much less obvious than on rocky coasts, but with a zone of drying on the upper shore and a more water-logged/saturated zone on the lower shore. With increasingly finer sediments the saturated zone extends further up the shore. Very sheltered areas often support saltmarsh vegetation at extreme high water level. Shallow subtidal sediments reflect a high degree of wave disturbance and high temperature/salinity fluctuations, with increasingly more stable conditions with depth.
Exposure to wave action	Marked differences result due to different wave exposures. Exposed shores are usually animal (mussel and barnacle) dominated, whilst sheltered shores are fucoid algal dominated. Such differences can occur over only 10's of metres at certain sites, such as opposite sides of a headland. In the subtidal a similar pattern is exhibited, but is increasingly more masked by tidal-current influence with depth.	Principally expressed by the resultant grade of sediment, with coarse sands on exposed coasts and fine muds on sheltered coasts. Areas subject to periodic (seasonal) wave action may exhibit sub-climactic communities.
Strength of tidal currents	Strong offshore currents affect many coasts and have a particularly marked influence on circalittoral communities, with lessening effects in shallow water and on the shore (where the influence of wave action predominates). However constricted sections of some inlets, particularly the narrows in sealochs, can have very strong currents which affect both the shallow subtidal and the lower shore zones, significantly increasing species richness.	Contributes, with wave action, to determining sediment grade and consequent community type. In estuaries and sealochs this can lead to coarser sediments than would normally be expected in wave-sheltered areas. The lower shore of some inlets by the main channel can have tide-swept sands and gravels with distinctive species-rich communities.
Salinity	The majority of rocky coasts are subject to full salinity, but within marine inlets are subject to increasing freshwater influence. Variable salinities (in estuaries) lead to species-poor examples of open coast communities whilst the very limited areas of rock in permanently reduced salinities (in lagoons) may support quite distinct communities. Localised freshwater influence often results in the growth of ephemeral green algae on the shore.	Variable and reduced-salinity conditions are typical of sediment shores within inlets, especially estuaries, and play an important role, alongside sediment type, in determining community type. Salinity eventually becomes the more important structuring factor in the upper reaches of estuaries and in lagoons.
Temperature (relates to biogeography)	National differences in water temperature give more species-rich communities in the south and west and more species-poor communities in the north and east.	

Topography	Topography has a marked influence on the variety of communities which may occur. Variations in topography (resulting from a particular rock type) which lead to vertical faces, overhangs, gullies, caves and rockpools all increase habitat and micro-habitat diversity compared with uniform areas of rock.	Variations in the slope of the beach can indicate differing degrees of saturation, whilst drainage channels may be subject to increased freshwater influence or currents. In the subtidal, variation in slope has little influence on community type, although the presence of dunes can affect small-scale community structure. Larger features such as sandbanks usually indicate coarser sediments compared with surrounding sediment plains.
Geology	The rock type is significant in two respects, affecting overall topography (see above) and the surface texture for colonisation. Soft limestones and chalks have a pitted surface which can affect species composition, whilst these types, plus peats and clays, are soft enough to be bored by piddocks and other species.	Not applicable.
Oxygenation	Not generally applicable, as most rocky habitats are subject to full oxygenation. Severe deoxygenation can lead to reduction in species and the presence of bacterial growths.	More sheltered fine sediments tend to become anoxic below the surface, giving a distinct black layer. Severe deoxygenation significantly reduces species richness.
Wave surge	On exposed coasts gullies subject to wave surge have distinct animal-dominated communities. Wave surge on vertical rock tends to give communities typical of more exposed sites (e.g. *Alaria esculenta* occurring on moderately exposed vertical rock).	Influences sediment grade and result in highly-mobile species-poor habitats.
Scour, turbidity and siltation	Sand scour and sediment in suspension can encourage growth of ephemeral algae and sometimes mussels (*Mytilus* spp.) and tube-worms (*Sabellaria* spp.). Siltation in sheltered areas often restricts the growth of algae.	A high degree of scour and turbidity may result in species-poor communities.
Shading	Shaded faces on the shore encourage the growth of species intolerant of desiccation.	Not applicable.
Organic carbon	Not applicable.	Significant in many sediment communities. Organic enrichment can alter community structure and lead to increased numbers of opportunist species e.g. capitellid worms.
Hydrographic regime (residual currents); water quality	The overall hydrographic regime and water quality characteristics of an area play an important role in determining community composition. Key aspects of these factors are discussed above. In addition to these, residual current flow is also very important, as it may affect larval distribution and water quality aspects such as nutrient levels as well as water temperature, salinity and turbidity.	

In addition to habitat factors, biological and anthropogenic influences affect community composition. Some aspects of anthropogenic influence are outlined in Table 2.

Table 2 Summary of anthropogenic influences on community structure

Physical disturbance	Physical disturbance by trampling (such as from tourism) can impact significantly on rocky shore communities. Disturbance of rock communities in the subtidal is generally less marked. Activities, such as fisheries for crabs and lobsters, tend to result in only limited changes in the balance of species composition within biotopes but may rarely result in significant shifts in community composition. Where dredging (for scallops) occurs close to rocky habitats, delicate species can be damaged.	Disturbance of sediment types is widespread, particularly through benthic fisheries activities and aggregate extraction; such disturbance can have significant effects on community composition and may, in some cases, result in completely altered biotopes compared with fully natural conditions. Areas subject to prolonged sedimentary disturbance may exhibit highly variable, sub-climactic communities.
Pollution	Severe pollution may reduce species richness (pollution effects are not well studied).	Pollution may reduce species richness, encourage higher densities of opportunist species, e.g. capitellid polychaetes, or alter community structure.

Terminology: the terms biotope, habitat and community

A biotope is defined as the combination of an abiotic habitat and its associated community of species. It can be defined at a variety of scales (with related corresponding degrees of similarity) and should be a regularly occurring association to justify its inclusion within a classification system.

A habitat is taken to encompass the substratum (rock, sediment or biogenic reefs such as mussels), its topography and the particular conditions of wave exposure, salinity, tidal currents and other water quality characteristics (e.g. turbidity and oxygenation) which contribute to the overall nature of a place on the shore or seabed.

The term community is used here to mean an association of species which has particular species, at certain densities, in common.

Although communities are influenced by biological interactions (e.g. predation, recruitment processes) and by interference from certain human activities, their overall character is very strongly determined by the nature of the surrounding abiotic conditions. This consistent relationship between the biotic and abiotic elements is fundamental to the structure of the classification system. Types can be defined at a variety of scales, enabling the development of a hierarchical classification of types. The degree of similarity varies depending upon the scale considered, with more broadly defined types (e.g. sheltered rocky shores) having a lower level of similarity compared with more finely defined types (e.g. a lower shore sheltered rocky biotope).

Whilst the term habitat, as used here, is its more accepted scientific meaning, the term is more widely used, for instance in the EC Habitats Directive, to also include the community of species living in the habitat; the common use of the term is, therefore, synonymous with the term biotope.

Classification development - approach and methods used

Review of classification systems and literature

Before embarking on the development of the MNCR BioMar classification (Connor *et al*. 1997a, b), a review of existing classification systems was undertaken (Hiscock & Connor 1991). From these, proposals for a classification structure (Connor *et al*. 1995 a,b) were developed that drew upon the best features of the existing systems, whilst avoiding their weaker aspects. There was subsequent wide consultation on the proposed classification structure, including through two European workshops held during the EC-funded BioMar project (Hiscock 1995; Connor 1997). These workshops helped ensure broad acceptance of the proposed structure and its wide applicability across European seas.

In addition to a review of classification schemes, an extensive review of the literature describing marine habitats was also undertaken. This helped formulate the initial lists of types which might form the basis of the classification. For this the scientific literature was of considerable help for sediment habitats (a traditional area for marine studies) but relatively poor for rocky habitats (which, in the subtidal, attracted attention only relatively recently through use of SCUBA diving techniques). These initial lists of types were then refined on the basis of new dedicated field surveys, data analyses and field trials.

Consultation and testing

Phases of external consultation and testing of the classification system have been essential to ensure the classification is as robust and usable as possible.

The advice of external consultees has been important in two key areas:

- Marine scientists have contributed expertise in their understanding of the marine environment and its communities, both from a generic perspective and with specific knowledge of communities at particular sites around the country. Of particular importance has been advice on the relationships of environmental factors to community structure and the spatial and temporal dynamics of the marine environment.
- Environmental and conservation managers and end-users have helped define their end needs for the classification system. This has been reflected both in terms of the overall structure of the classification, such as the orientation of biotope complexes to mapping and sensitivity needs, the type of information given in the description of each classification type, and the demands of field application.

Field surveys and other data acquisition

The MNCR undertook a programme of field surveys throughout Britain between 1987 and 1998, collecting data suitable to develop the classification. In addition, data were acquired from the published literature and through collaboration with a wide variety of academic, government and other organisations. Comparable data were collected in Ireland through the BioMar project between 1992 and 1996. The data comprise information on the nature of each site (such as substratum, wave exposure and height or depth surveyed), the type of sampling undertaken, the site's location and the species present (together with an indication of their abundance) within discrete habitats at the site. In total, data for over 16,000 sites comprising more than 36,000 habitat records from around Britain and Ireland have been collated and entered onto the MNCR database. The programme, survey methods and database are described in Hiscock (1996). The database includes a module which holds definitions of each classification type, linked to a national dictionary of marine species and to the field survey data. The field survey data have been made widely accessible via the web-based MERMAID application (www.jncc.gov.uk/mermaid) and via the National Biodiversity Network (www.searchnbn.org) from an MS Access-based ‘relational’ database.

Data analysis

For the 1997 classification, data analyses using the TWINSPAN and DECORANA clustering and ordination techniques were employed to help define the types. The analytical processes adopted are described in Mills (1994).

The 1997 version has been revised and refined to develop the present version, through extensive re-analysis of the dataset, using additionally the analytical techniques available in PRIMER (Clarke & Warwick, 2001). The data were initially divided into the broad habitat types shown in the primary habitat matrix, namely littoral rock, littoral sediment, infralittoral rock, circalittoral rock and sublittoral sediment. Due to the large size of the datasets within each broad habitat, some further *a priori* divisions of the data were necessary before analysis was possible. This was generally based on the divisions adopted at level 3 (main habitat and biotope complex) in the 1997 classification. There was additionally some analysis of data derived from habitats which lie on the borderline between these major types. Analysis within each broad habitat was led by a specialist for that habitat type; the analysis was undertaken as outlined below.

Littoral rock

As the biotopes defined in version 97.06 were generally considered satisfactory, analysis focused on clarifying the boundaries between closely related types and confirming the validity of certain less-well defined types. This included attention to the inter-relationship of fucoid-dominated types regarding the bedrock/boulder/mixed substrata and fully marine/variable salinity transitions and examination of the various red algal-dominated types. Additionally new data from intertidal caves enabled substantial development of the classification here. On the basis of these analyses, some restructuring at biotope complex level was necessary.

Littoral sediment

For the *littoral sediment* section of the classification, a complete re-analysis of the existing data on the MNCR database was carried out. The overall process is outlined in Figure 2 and described below.

Due to the size of the littoral sediment dataset (>4000 records), some *a priori* division was necessary prior to analysis to provide data sets that could be handled within PRIMER: the data were divided based on the sediment type, into gravels and sands, muddy sands, sandy muds, muds and mixed sediments (the major divisions of the 1997 classification). Semi-quantitative epifaunal data were considered to be of less value than quantitative infaunal data for the purposes of the initial analysis and were thus excluded. Epifaunal data were however used to define types where a significant proportion of species would be sampled in epibiota sampling techniques, and/or where few infaunal samples were available, e.g. mussel beds. Epibiota records for the remaining littoral sediment types were assigned once the types had been defined using infaunal data.

Cluster analysis was carried out on each of these datasets, based on species matrices listing individual counts per m^2 in each sample, using the PRIMER software package (Clarke & Warwick, 2001). The data were divided up into small clusters of biologically similar records, based on the resulting dendrograms. Comparative tables were produced, comparing the species data and physical data between each of the small clusters. Where no notable differences existed between the physical and biological characteristics of the small data clusters, those clusters were amalgamated into larger groups which would form the basis for separate types. Where similar biological and physical profiles appeared from clusters derived from different main habitat datasets, those data were joined and re-analysed using the same clustering methods as described above. This was the case particularly for parts of the data from the ‘gravels and sands’ and the ‘muddy sands’ datasets, and the ‘muddy sands’ and ‘mud’ datasets. This re-analysis was carried out to ensure that the *a priori* divisions of the data did not artificially force divisions of otherwise coherent clusters.

The resulting preliminary groups of records for each type were then checked to ensure cohesion of both the environmental and species data within each group. Individual records assigned to a group were thus checked against the profile for the group as a whole. Records where the data appeared to differ significantly from the average for the group (e.g. by having a different sediment type, salinity regime or dominant species) were examined carefully and removed if considered inappropriately assigned to that group.

For the littoral sediment section, data which do not form part of the core biotope groups (e.g. epifaunal records, and infaunal data which did not form clusters) was manually assigned to as low a level in the classification hierarchy as possible after the analysis and the type descriptions were completed. The physical and biological profiles from the core records for each type were then used to group types of similar character into the broader biotope complexes and these in turn were assigned to one of the six main habitats for Littoral sediment, derived from the level 3 EUNIS classification.

Infralittoral rock

As the biotopes defined in version 97.06 were generally considered satisfactory, analysis focused on clarifying the boundaries between closely related types and confirming the validity of certain less-well defined types. This included particular attention to the tide-swept kelp types and the inter-relationship of highly grazed and poorly grazed kelp habitats. On the basis of these analyses, some restructuring at biotope complex level was necessary.

Circalittoral rock

Due to the complexities of this part of the classification, especially the more subtle differences between types on the open coast, a full re-analysis of the data was undertaken. This followed a similar approach to that described for littoral sediment and as outlined in Figure 2.

Sublittoral sediment

A full re-analysis of the existing data on the MNCR database in addition to data supplied by the sublittoral specialist was carried out (approximately 10,000 records in total). This followed a similar approach to that described for littoral sediment and as outlined in Figure 2. Data were split according to sediment type, data type (infaunal or epibiota) and sampling technique (where appropriate). Poor quality data was also removed prior to analysis for later manual assessment. Cluster analysis was undertaken using either PRIMER for infaunal data (as described for the littoral sediments) or TWINSPAN for epibiota data (following the guidelines in Mills, 1994). Clusters of biologically similar records were produced and assessed using comparative tables. Clusters with poor species definition or highly variable physical characteristics were further sub-divided until more homogenous groups were derived. Where similar biological and physical profiles appeared from clusters derived from different main habitat datasets those data were combined and re-analysed using the same clustering methods as described above in order ensure that the *a priori* divisions of the data did not bias the results of the analysis.

Where similar biological and physical profiles were found in clusters from datasets of differing sampling method or those with different types of data (e.g. epibiota or infauna) the groups were re-analysed where possible at a lower level of resolution (either presence-absence or on the MNCR SACFOR scale) using PRIMER or TWINSPAN such that the differences in data type were reduced. As for the littoral sediments the resulting groups were then checked for cohesion with regard to the physical and biological data, and individual records assigned to the groups were checked against the profiles of the groups as a whole and re-assigned if necessary. Any remaining records, e.g. lower quality records, were manually assigned to as low a level in the classification as possible. Due to the large number of uncertain records currently assigned at the biotope complex or main habitat level these records were assigned separately using a combination of TWINSPAN cluster analysis and expert judgement.

The physical and biological profiles from the core records for each type were then used to group types of similar character into the broader biotope complexes and these in turn were assigned to one of the six main habitats for sublittoral sediment, derived from the EUNIS classification. The physical and biological profiles of the epibiota and infaunal driven biotopes were also examined in order to try to overlay the epibiota biotopes over their respective infaunal counterparts on the biotope matrix (sediment trigon).

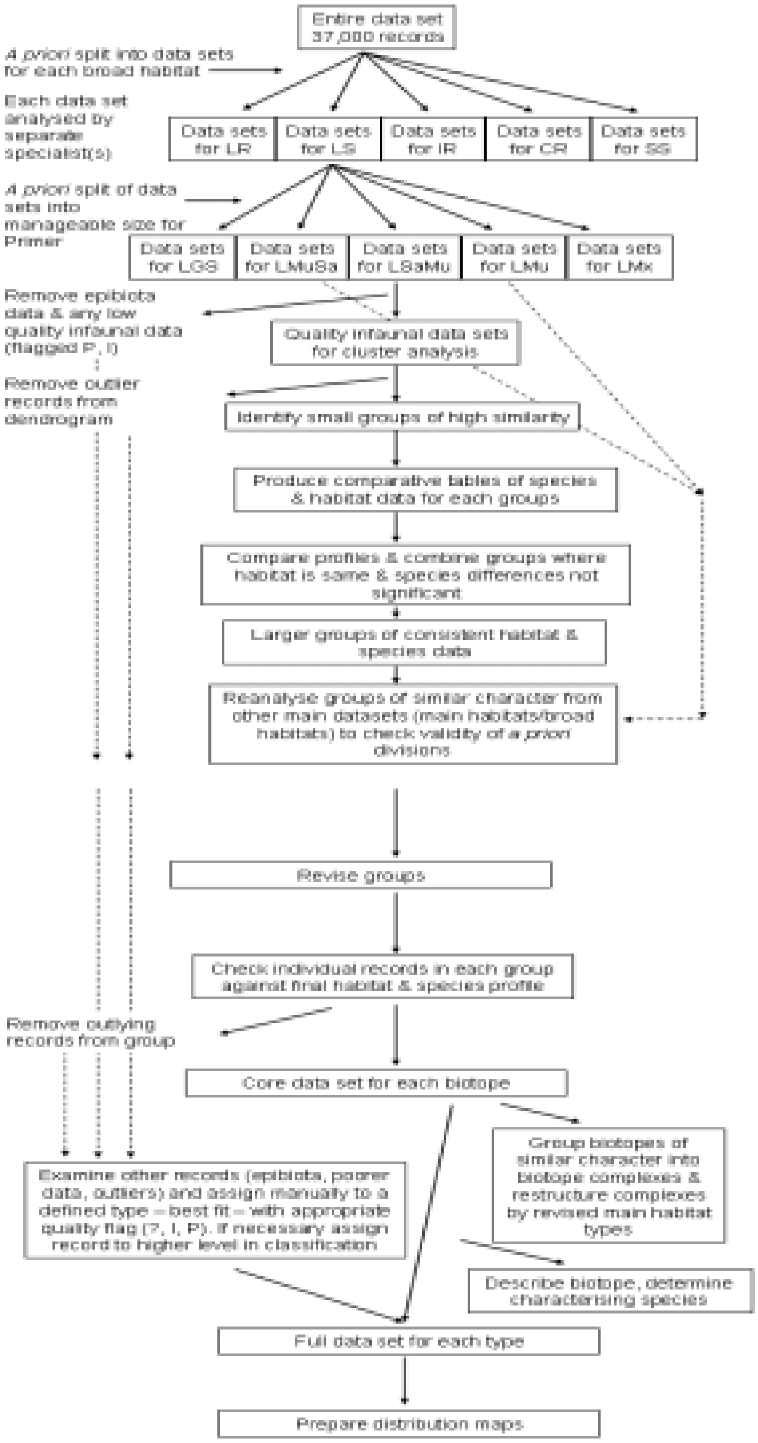

Figure 2 Overview of the data analysis process carried out during the development of the littoral sediment classification

Structure of the classification

A framework for the classification (EUNIS levels 2 and 3)

Whilst the classification has been developed for nature conservation purposes and hence needed to be biologically driven, the dynamic nature of certain populations of species, and sometimes whole communities, meant it was essential to identify the habitat within which the community (of potentially varying composition) occurs to ensure types defined would be robust over time. Full use is also made of the habitat attributes to provide a structure to the classification which is both logical and easy to use. In this way much more significant use of habitat characteristics is made than for many terrestrial classifications, where vegetation alone is often the prime determinant of the classification's structure. The classification is presented in such a way as to allow access via either the habitat attributes through a series of habitat matrices or the biological community in a hierarchical classification of biotopes and higher types.

Each of the environmental gradients outlined in Table 1 can be considered to form an axis within a multi-dimensional matrix. Each community develops according to a suite of environmental conditions (and biological influences) which lie within such a multi-dimensional matrix, reflecting varying biological character according to its position along each particular gradient. Although the degree of importance of each habitat attribute varies for differing communities, the first two, namely substratum and the vertical gradient or zonation, appear to play a highly significant role in all communities. They are also the most easily and reliably recorded attributes in the field and are readily mapped. These factors combine to make the attributes of substratum and zonation the most appropriate for structuring the upper end of the classification.

The primary habitat matrix of substrata versus zonation (Table 3) illustrates the framework adopted for the classification. It represents EUNIS levels 2 and 3 in the hierarchical classification and has been developed to reflect the most significant changes in biology at a scale appropriate to an internationally applicable classification. Table 4 outlines the rationale behind the divisions adopted for these two levels in the classification.

Table 3 Framework for the habitat classification - the primary matrix (EUNIS levels 2 and 3). Letters in [ ] refer to codes. * indicates where various codes are inserted at a lower level in the hierarchy.

<table>
<tr><th></th><th>SUBSTRATUM</th><th colspan="4">ROCK</th><th colspan="6">SEDIMENT</th></tr>
<tr><th></th><th>ZONE</th><th>High energy rock
[H*R]
(wave exposed or very tide-swept)</th><th>Moderate energy rock
[M*R]
(moderately wave-exposed or tide-swept)</th><th>Low energy rock
[L*R]
(wave sheltered and weak tidal currents)</th><th>Features on rock
[F*R]
(rockpools, caves)</th><th>Coarse sediment
[CS]
Mobile cobble & pebble, gravel, coarse sand</th><th>Sand
[Sa]
Clean sands & non-cohesive muddy sands</th><th>Mud
[Mu]
Cohesive sandy muds & muds</th><th>Mixed sediment
[Mx]
Heterogeneous mixtures of gravel, sand & mud</th><th>Macrophyte-dominated sediment
[Mp]</th><th>Biogenic reefs
[BR]</th></tr>
<tr><td>LITTORAL</td><td>LITTORAL
[L]
(splash zone, strandline & intertidal)</td><td>High energy littoral rock
[HLR]</td><td>Moderate energy littoral rock
[MLR]</td><td>Low energy littoral rock
[LLR]</td><td>Features on littoral rock
[FLR]</td><td>Littoral coarse sediment
[LCS]</td><td>Littoral sand
[LSa]</td><td>Littoral mud
[LMu]</td><td>Littoral mixed sediment
[LMx]</td><td>Littoral macrophyte-dominated sediment
[LMp]</td><td></td></tr>
<tr><td rowspan="2">SUBLITTORAL [S]</td><td>INFRA-LITTORAL
[I]
(shallow subtidal)</td><td>High energy infralittoral rock
[HIR]</td><td>Moderate energy infralittoral rock
[MIR]</td><td>Low energy infralittoral rock
[LIR]</td><td>Features on infralittoral rock
[FIR]</td><td rowspan="2">Sublittoral coarse sediment
[SCS]</td><td rowspan="2">Sublittoral sand
[SSa]</td><td rowspan="2">Sublittoral mud
[SMu]</td><td rowspan="2">Sublittoral mixed sediment
[SMx]</td><td rowspan="2">Sublittoral macrophyte-dominated sediment
[SMp]</td><td rowspan="2">Sublittoral biogenic reefs
[SBR]</td></tr>
<tr><td>CIRCA-LITTORAL
[C]
(nearshore deeper and offshore subtidal)</td><td>High energy circalittoral rock
[HCR]</td><td>Moderate energy circalittoral rock
[MCR]</td><td>Low energy circalittoral rock
[LCR]</td><td>Features on circalittoral rock
[FCR]</td></tr>
</table>

Table 4 Rationale behind the main divisions adopted in the primary habitat matrix (EUNIS levels 2 and 3)

Rock, Sediment	A primary distinction is made between communities which develop on hard substrata (epibiota) and those which can develop in soft sediments (infauna). Sediments can support distinctive epibiota as well as infauna. The term rock is used in a broad sense to indicate hard substrata such as bedrock, boulders, stable cobbles, artificial substrata and biogenic substrata. Sediments also include pebbles and cobbles which are essentially mobile (shingle) or may have a small proportion of stones and shells on the surface, supporting epibiota. Where biogenic substrata develop on substantially sediment substrata, they are included in the sediment section of the classification.
Littoral, Sublittoral (Infralittoral, Circalittoral)	These represent the major divisions in a vertical gradient from the terrestrial environment to the edge of the continental shelf (about 200 m depth). The main factors which control the zonation are immersion, thermal stability, light, wave action and salinity. They interact in a complex manner to produce a general zonation pattern, applicable to both rock and sediment habitats throughout Europe and beyond. Table 5 illustrates the inter-relationship of the factors for each zone, and Figure 1 provides a typical schematic profile of this zonation pattern.
High energy rock, Moderate energy rock, Low energy rock	These are defined on an energy gradient, reflecting exposure to wave action or tidal currents, or a combination of both (note, this energy gradient was reflected in the 1997 classification, but expressed as ‘exposure’; the resulting confusion with wave exposure has now been removed). This energy gradient is broadly paralleled in sediment habitats, where coarse clean sediments occur in high energy conditions and fine muds occur in low energy conditions. Although the effects of wave action and tidal currents can be significantly different, there are many instances where the increase in tidal current strength in wave-sheltered habitats gives rise to communities similar to those found on more wave-exposed coasts but in reduced tidal currents. For example, increased currents in the infralittoral zone change the kelp *Laminaria saccharina* communities of very wave-sheltered sites to *Laminaria hyperborea* communities similar to those on open, more wave-exposed coasts. Very strong tidal currents in the circalittoral appear to override the effect of wave action to a large extent, giving rise to a suite of associated communities of barnacles, cushion sponges and the hydroid *Tubularia indivisa* which are less obviously affected by wave action. These communities are similar in character to those of surge gullies which are subject to extreme wave action.

Coarse sediments, Sands, Muds, Mixed sediments, Macrophyte communities on sediments, Biogenic Reefs	The particular sediment grade, typically derived from the hydrodynamic conditions of the site, strongly influences community structure. The four main divisions adopted here reflect major changes in species character, particularly related to the amount of silt or clay in the sediment. In addition, some sediments support communities of macrophytes (angiosperms and seaweeds) which attach to small stones and shells on the sediment surface, whilst on others biogenic reefs develop in which a particular species aggregates to form a stable surface upon which other species can live. With both macrophyte and biogenic reef communities the underlying sediment may support infaunal communities according to the particular sediment type; however the prominent character of the epibiota communities has led to a preference to group such biotopes under these separate major categories.

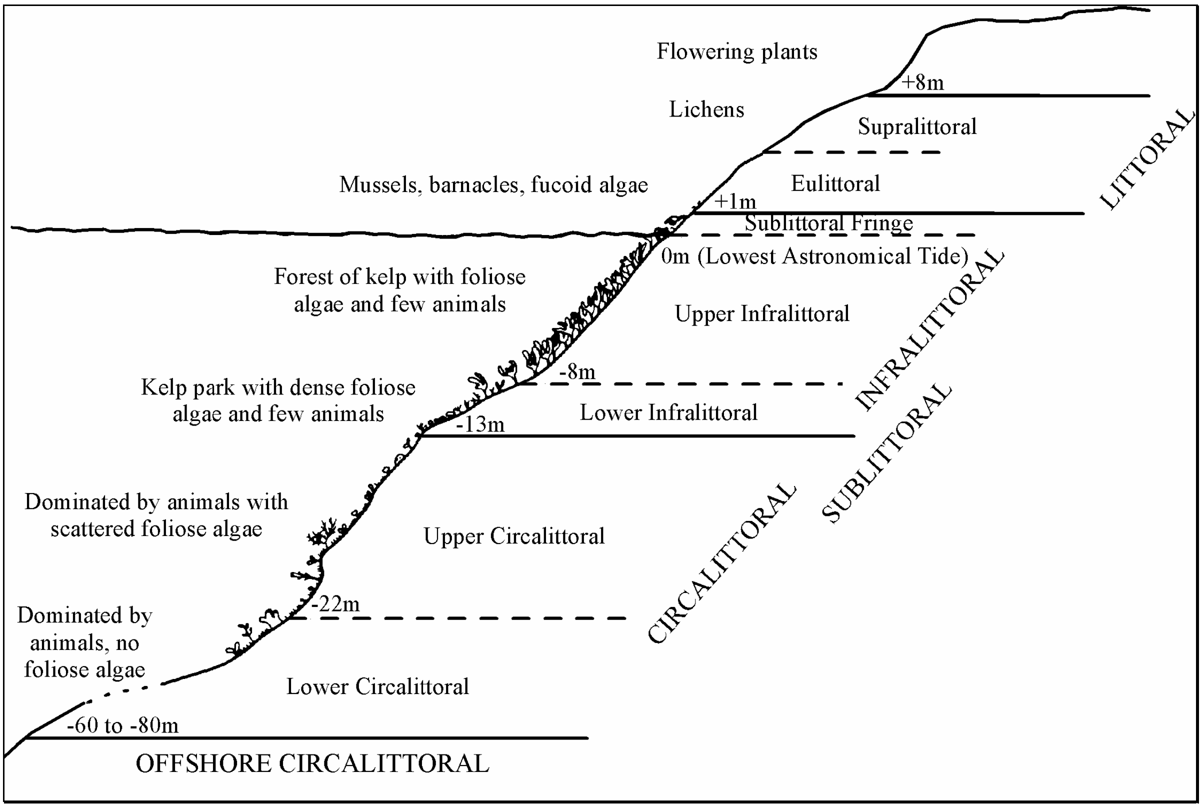

Figure 1 Profile of a rocky shore and seabed showing the biological zones (modified from Hiscock *ed.* 1996); heights and depths given are typical values for south-west Britain. In sediment habitats a similar vertical zonation for the main zones is found.

Table 5 Marine biological zones and the factors determining them

Zone	*Typical upper boundaries around Britain and Ireland*	*Immersion*	*Thermal stability*	*Light*	*Salinity*	*Wave action*
Adlittoral		Spray only	Highly variable	Photic	Saline influence	None
Supralittoral	+10 to +6 m	Spray and splash	Highly variable	Photic	Euryhaline	Highly variable
Eulittoral	+7 to +4 m MHWS	Regular immersion and emersion	Highly variable	Photic	Euryhaline	Highly variable
Infralittoral	+1 to 0 m MLWS	Immersed (intermittent spring tide emersion of sublittoral fringe)	Variable - eurythermal	Euphotic	Euryhaline	Variable
Circalittoral	-5 to -20 m	Immersed	Moderately variable - mesothermal	Mesophotic (sparse algae, algal crusts)	Mesohaline / Stenohaline	Moderately variable
Circalittoral offshore	-40 to -80 m	Immersed	Stable - stenothermal	Aphotic	Stenohaline	Stable
Bathyal	-200 m	Immersed	Very stable - stenothermal	Aphotic	Stenohaline	Stable

Development of a hierarchical classification

It was considered essential to develop a hierarchical classification structure in which broader, higher types in the classification could be more finely divided to support more detailed use. The development of the hierarchy comes from both a top-down and a bottom-up approach:

Top-down classification

Taking the marine environment as a whole, it can be sub-divided into a series of broad habitat categories, based largely on their physical character as described here. At the very broadest level, differentiation can be made between rock and sediment habitats, and between those on the shore (intertidal) and those in the subtidal or deep ocean. These high-level divisions can be further subdivided on the basis of different types of sediment (e.g. gravel, mud), different degrees of wave exposure on rocky coasts (exposed, sheltered) and varying depth bands below the low water mark (e.g. shallow water where light penetrates, deeper water with little light). Such broad-scale differences in habitat character are readily understood by non-specialists and provide classification types that are easily mapped; however, they also have ecological relevance as they reflect major changes in habitat character upon which species depend (see above).

The top-level types depicted in the primary habitat matrix show the levels 2 and 3 in the hierarchical classification. It is important to note that these top-level categories were developed after consideration of how best to classify biological data at the lower end of the classification.

Bottom-up classification

Field survey, whether on the shore or in the subtidal, reveals that different places support different communities of species. The precise combination of species and their relative abundance varies from place to place and is dependent both on environmental characteristics and upon interactions between species. Visits to different sites that have similar environmental characteristics, such as sediment type and depth, show certain levels of similarity in their species composition. Multivariate analysis of the data from field surveys (e.g. grabs, diver observations) groups these data into clusters that have similar character – this forms the basis of defining the types at the lower end of the classification (levels 5 and 6). These can themselves be grouped into higher types with similar character (level 4), thus forming the basis for the bottom-up approach to development of the classification based on real field sample data.

The two approaches have been merged together into a single hierarchy, thus catering for broad-scale application in management and mapping and fine-scale application for detailed survey, monitoring and scientific study. The levels can be differentiated in relation to their degree of biological distinctiveness, to the ability to discriminate types by various methods of remote and *in situ* sampling, to the ease of recognition by workers with differing skill levels and to the end use of the classification for conservation management at various scales.

Six levels in the hierarchy have thus been developed, equating directly to the levels in the EUNIS classification:

Level 1 Environment (marine) – A single category is defined within EUNIS to distinguish the marine environment from terrestrial and freshwater habitats.

Level 2 Broad habitats **-** These are extremely broad divisions of national and international application for which EC Habitats Directive Annex I habitats (e.g. reefs, mudflats and sandflats not covered by seawater at low tide) are the approximate equivalent.

Level 3 Main habitats **-** These serve to provide 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 (for designation of shores in the UK) (Joint Nature Conservation Committee 1996) and can be used as national mapping units.

Level 4 Biotope complexes **-** These are groups of biotopes with similar overall physical and biological character. Where biotopes consistently occur together and are relatively restricted in their extent, such as rocky shores and very near-shore subtidal rocky habitats, they provide better units for mapping than the component biotopes, better units for management and for assessing sensitivity than the individual biotopes. They are relatively easy to identify, either by non-specialists or by coarser methods of survey (such as video or rapid shore surveys), thereby offering opportunities for data collection by a wide range of people and without recourse to specialist species identification skills.

Level 5 Biotopes **-** These are typically distinguished by their different dominant species or suites of conspicuous species. On rocky substrata, most should be readily recognised by workers with a basic knowledge of marine species, although quantitative sampling will be necessary in many of the sediment types. The vast majority of available biological sample data are attributable to this level (or the sub-biotope level), which is equivalent to the communities defined in terrestrial classifications such as the UK National Vegetation Classification (e.g. Rodwell 1995). Intertidal and subtidal sediment biotopes may cover very extensive areas of shore or seabed.

Level 6 ***Sub-biotopes*** **-** These are typically defined on the basis of less obvious differences in species composition (e.g. less conspicuous species), minor geographical and temporal variations, more subtle variations in the habitat or disturbed and polluted variations of a natural biotope. They will often require greater expertise or survey effort to identify.

The primary habitat matrix provides an overview of levels 2 and 3 in the classification, while the biotope matrices show the relationship of biotopes and sub-biotopes to key environmental factors within each main section of the classification. For each of the broad habitats, structure diagrams have been created to show the relationship between the types at the lower levels of the classification hierarchy. All the types in the classification are listed in hierarchical order in the hierarchical list.

Distinguishing and defining types

To ensure consistency across the classification in how types are defined, a working definition as to what constitutes a biotope, enabling its distinction from closely-related types, has been developed. The following criteria are applied:

1. The entity can be distinguished on the basis of a consistent difference in species composition based on:

   - different dominant species, some of which (e.g. mussels and kelps) may be structurally important; and
   - the co-occurrence of several species characteristic of the particular habitat conditions (even though some of these may occur more widely in other combinations).

   A combination of both the presence and abundance of the most 'obvious' species in a community is used. Sub-biotopes are often defined using less conspicuous species.

2. It occurs in a recognisably different habitat (but acknowledging that distinct communities may develop in the same habitat through change with time). Sub-biotopes are often defined on the basis of more subtle habitat differences. Some highly subtle differences may be critical in determining community structure (e.g. water circulation/exchange patterns in sealoch basins, oxygenation levels in the water column/sediment, sediment structure other than grain size composition). The separate divisions of habitat factors used in field recording are not necessarily reflected in the end division of types.

3. It is a recognisable entity in the field, i.e. it is not an artefact of data analysis.

4. The assemblage of species recurs under similar habitat conditions in (at least several) widely-separate geographical locations. Associations of species confined to a small geographical area are considered unlikely to represent a recurrent community (unless the habitat is considered unique), but should rather be treated as a variation of a more widely occurring type.

5. As a working guide the biotope extends over an area at least 5 m x 5 m, but can also cover many square kilometres, such as for extensive offshore sediment plains. For minor habitats, such as rockpools and overhangs on the shore, this 'minimum size' can be split into several discrete patches at a site. Small features, such as crevices in rock or the biota on kelp stipes, are described as features of the main biotope rather than biotopes in their own right. Some entities, by virtue of their extent around the coast, may warrant description despite showing only minor differences in species composition; such types are often treated as sub-biotopes.

6. It is a single entity in the field, although there may be some spatial variation or patchiness from one square metre to the next. Therefore each area of shore or seabed should correlate to only one biotope defined in classification (a 1:1 relationship of field units to classification units). Whenever possible, the surface species characteristics of sediment habitats (their epibiota) are described in association with the sediment infauna as a single entity, rather than treated as separate communities. Note however that the nature of available data has severely restricted the clear association of these two aspects in the classification as they are typically derived from differing survey techniques. Thus in the present classification there remain units defined primarily on the basis of their epibiota or their infauna but which, given further research, will be shown to be the same biotope. Epibiota-derived biotopes may also ‘overlay’ a number of infaunal biotopes, which are differentiated by more subtle environmental differences, and thus need to be referred to a higher unit in the classification.

The following considerations are also taken into account in deciding whether to establish a biotope:

- There is a need to recognise that it is commonplace to have no distinct boundary between two different 'types', but a gradual transition, such that distinction of types is somewhat arbitrary at particular reference points or nodes along a continuum. Additionally, some communities may be largely transitional (in a temporal sense) in nature and whilst recognisable in the field represent a stage between two or more ‘stable’ biotopes. In some areas, e.g. due to periodic disturbance, a community may be held in a transitional or sub-climactic state for prolonged periods and certain habitats may be so variable that the position of a biotope along a gradient cannot be accurately defined. These factors are of critical importance when assessing typicality of a site to a particular type or its quality or conservation importance.

- Where different associations are shown to occur within the same habitat, they may be spatial or temporal mosaics caused by factors such as grazing, disturbance or chance recruitment. These should be linked together in the classification as, for conservation purposes, it is important to manage or protect the habitat in which several communities may occur over time.
- To produce a practicable working classification it has been necessary at times to be general rather than specific in splitting different types, so that an excessively and unnecessarily complex classification is not developed (bearing in mind the end units that are necessary for practical use).
- Separation of communities can be related to conservation value - does the type add variety (of habitat or species) to a particular stretch of coast. This relates to natural habitats and excludes artificial, polluted or disturbed habitats which should not be considered of high conservation value although they may support distinct communities.

How to use the classification

Habitat matrices

The primary habitat matrix (table 3) provides a general framework for the classification and shows the level 2 and 3 types. In addition, more detailed matrices have been created for each of the broad habitats, showing the distribution of individual biotopes and sub-biotopes (levels 5 and 6) in relation to key habitat factors. The format of these matrices has changed significantly from previous versions of the classification to better depict the relationship of biotopes to habitat factors. For the rocky habitats, biotopes are shown in relation to energy levels, whereas for sediment habitats, biotopes are shown in relation to sediment type using a modified Folk triangle approach (Folk 1954).

The matrices aim to provide a rapid indication of the range of biotopes that could occur under particular habitat conditions, e.g. moderate energy infralittoral rock or intertidal sandflats. They can be used to indicate which closely related biotopes should be considered before determining to which type a sample record should be assigned.

Presentation of the biotopes and sub-biotopes within these matrices has a number of benefits:

- It helps to display the relationship of a biotope to other closely related types and to clarify the main habitat parameters which contribute to its structure. These relationships are less clear in a more conventional listing of types (e.g. the hierarchical listing).
- It enables the identification of dissimilar communities within apparently similar physical environments. Here, although there may be subtle physical factors which drive such differences in biological composition, other factors such as seasonal change, chance recruitment, grazing pressures or pollution effects may account for the differences and allow such communities to be linked within the classification.
- It also facilitates the undertaking of new ecological survey in a more structured manner, by enabling the full range of habitats in an area to be identified and sampled.

All habitat matrices can be viewed on the classification website.

Hierarchy structure diagrams

Hierarchy structure diagrams have been created for each of the broad habitats, providing an overview of all the lower level units within each broad habitat type. These can be printed out together with the text for each section of the classification, or they can be viewed on the classification website.

Hierarchical list of types

A full hierarchical list of types is given on the classification website, where each title contains a hyperlink to its full description. The types are presented in hierarchical order, to help bring together those types which are most similar to each other in character.

Search by keyword

On the classification website, there is the possibility to search for specific biotope descriptions using keywords, or a known title or biotope code.

Comparative Tables

The comparative tables enable a rapid comparison of the species composition and principal physical characteristics between a given set of biotopes. This is a useful way of highlighting the main differences and similarities between biotopes, particularly when they are closely related within the classification hierarchy. Both the physical and biological comparative tables are generated from the MNCR database, using only the core data sets for each type. In the physical comparative tables, the proportion of the core biotopes falling within given physical categories (e.g. shore height, salinity) is shown for each type. The biological tables have a format similar to a species matrix, with each column representing a biotope, and the rows showing the proportion of core biotope records containing a given species.

The tables are presented in the form of spreadsheets, which can be downloaded from the classification website. The website also contains more detailed information on the layout of the spreadsheets. The new spreadsheet format of the tables means that the combination of biotopes displayed at any one time is user-defined, thereby allowing a greater degree of flexibility in their use compared to the paper format of the 1997 version of the classification.

Layout of descriptions for each type

Descriptions for each type are laid out as follows:

Code	A unique letter code, reflecting the level of the described type within the classification hierarchy.
Title	The title gives the key biological and physical features of the type, with emphasis on the features which help to distinguish it from closely related types of the same level in the hierarchy. The habitat part of the title usually includes the zone, substratum and another key habitat factor. To avoid becoming overly clumsy the titles <u>do not cover</u> all habitat characteristics or characterising species, and common names are not given (although they are given in the text description). **NOTE: It is <u>very important</u> to refer to the full description and to the habitat matrices to determine the full nature of the type and not to rely on the title alone.**
Habitat characteristics	The typical habitat characteristics of the type for salinity, wave exposure, tidal currents, substratum, zone, height or depth band and, where appropriate, other factors critical to that particular type. The range given for each factor tends to be broader for higher types and more tightly defined for lower types. When assigning samples to types, it should be noted that in some cases the type may occur outside the range given, though care should be taken to ensure that another type has not been described to cover the example being considered. All heights and depths are corrected to chart datum.
Previous code	Codes used in versions 6.95, 96.7, and 97.06 (Connor *et al*. 1995 a, 1996, 1997 a, b) are given where different to the current code. Where communities from previous versions have been combined or split, previous codes are shown as far as possible. Some communities in the revised classification are newly defined and may not relate directly to types in the previous classification.
Description	An account of the general nature of the habitat and community characteristics, and its micro-habitat features (e.g. crevices, under-boulders, kelp stipes) if present.
Situation	Describes the general situation on the shore or in the sublittoral, in relation to other types (i.e. along gradients of substratum, zonation, wave exposure, tidal currents, salinity etc.).
Temporal variation	This section outlines the known natural temporal dynamics of the type described, such as seasonal changes in community structure or physical environment. In general, much more information is needed for this section. In some cases separate types may have been defined because there is a lack of knowledge that the communities are temporal variations within a single habitat type.
Similar types	Attention is drawn to similar types which should be considered before firmly assigning a field record to a particular type. The main similarities and principal distinguishing features are described for each similar type. The characterising species lists and comparative tables should be consulted for further details.

Characterising species

A list of those species which contribute most to the overall similarity between core records assigned to the type, i.e. characterise the type, with associated information on their frequency of occurrence, their individual contribution to the similarity within the core data set of records, and the typical abundance at which they occur.

For each type, characterising species have been determined using the SIMPER routine in PRIMER (Clarke & Warwick, 2001). For a given set of records (in this case, core records of each type), SIMPER indicates and ranks the individual contribution of each species to the overall similarity within the data set. Both the frequency of occurrence of each species within the dataset and their abundance (using either the SACFOR abundance scale (epifaunal data) or numeric counts (infaunal data)) are taken into account during this process. Species that contribute more than 1% to the overall similarity of the records within the data set are defined as 'characterising species', and listed in a characterising species table. Those that contribute less that 1% are not listed. Species which qualify according to the SIMPER routine, but are Present or Rare on the MNCR SACFOR scale and present in fewer than 20% of the records, are occasionally excluded from the characterising species table.

Care has been taken to mention each of the characterising species in the descriptions for each type. Sometimes additional species are mentioned that are particularly indicative (faithful) of that type or characteristic of a biogeographic region, but which have not qualified as 'characterising species' according to the SIMPER routine.

The <u>% contribution to similarity</u> column of the table shows the contribution of each characterising species to the similarity within the type, i.e. the higher the contribution, the higher the importance of the species. The number of species in the table reflects the species diversity within each type. In types with a high species richness, a large number of species each contribute with a relatively low amount to the similarity within the group. If a type has low diversity, then a small number of species contribute with relatively large amounts to the overall similarity and hence fewer species are listed in the table. In a few cases, a long species list indicates low overall similarity of records within the type.

The <u>% frequency of occurrence</u> column of the table shows the occurrence of a species within a certain type. The symbols represent percentage occurrence in the samples as follows:

●●●●● Occurs in 81-100% of the records for the type
●●●● Occurs in 61-80% of the records for the type
●●● Occurs in 41-60% of the records for the type
●● Occurs in 21-40% of the records for the type

The <u>Typical abundance</u> column of the table shows the mean SACFOR abundance for each characterising species within the samples where it is present. Quantitative infaunal counts have been converted to the MNCR abundance scale for compatibility of data presentation. For types where the core records are exclusively quantitative infaunal records (e.g. most of the littoral sediment types), an additional column is included in the characterising species table, showing mean counts per m^2 for each species within the core data set.

Distribution	Map showing the distribution of the type, based on field data held by the JNCC. The maps distinguish confirmed records from those tentatively assigned to that type.
Photographs	Photographs to illustrate the general appearance of each type. Many types can be expected to change in their species composition and overall appearance between sites and over time; the photographs may therefore not fully reflect all appearances of the type.

Species nomenclature

All species names are given according to Howson & Picton (1997), excepting for angiosperms, which follow Stace (1991), and lichens, which follow Purvis *et al.* (1992). Guiry & Dhonncha (2002) provides a later checklist for algae and additional useful information; the present publication and database does not yet follow this revised checklist.

Understanding the codes

A letter coding system has been adopted in preference to a fully numerical coding system or an alpha-numeric system (as used in the NVC and EUNIS systems). This has a number of advantages. It enables the construction of intuitive codes which can readily be related to their respective types without recourse to the full type title. Furthermore, it enables changes to the order in which the types are presented without the need to change a numerically sequenced code. This was particularly useful in the early development phase of the classification, but has continued to be of use during subsequent revisions of the classification.

Construction of codes follows a few simple rules, which achieve consistency throughout the classification whilst aiming to keep the resultant codes relatively short and intuitive. Familiarity with the rules for code construction and with the types themselves, by those working regularly with the classification, results in rapid use of codes as a short-hand means of referring to the types defined.

Codes are defined for each level in the classification. Within a level, they comprise one or several elements. They are based on the following rules:

1. Broad habitat and main habitat codes are based on habitat factors or gross biological features (e.g. macrophytes and biogenic reefs).
2. Biotope complex, biotope and sub-biotope codes are based wherever possible upon the most characteristic taxa (which preferably also dominate spatially/numerically) (preferably no more than two per biotope complex, biotope or sub-biotope).
3. Where the biological composition is too complex to derive a simple code, features of the habitat are used (e.g. VS for variable salinity).
4. Codes for habitat factors, higher taxa and descriptive community features (e.g. park, crustose) are derived from a standard lexicon (Table 6).
5. Codes for species names are derived using the first three letters of a genus or higher taxon name (e.g. Ala for ***Ala****ria*, Chr for **Chr**ysophyceae). Where more than one species from a genus is used in the classification, the code is derived using the first letter of the genus and the first three letters of the specific name (e.g. Ldig for ***L****aminaria* ***dig****itata*).
6. Within the code each new element of the code starts with a capital letter.
7. As far as practical the code elements are unique, but some duplication is adopted in the interests of keeping codes short. The code for any given type (i.e. for the level defined, regardless of whether it is stringed with higher codes – see below) is always unique.
8. All the biotope/sub-biotope codes are unique, so users familiar with the classification can refer to individual biotopes using only the codes for these levels in the hierarchy.
9. The full codes are compiled using the code for each level in the hierarchy, separated from the next level by a full stop, starting with the broad habitat (level 2), followed by the main habitat, biotope complex and so on. For example LS.LSa.MoSa.AmSco.Eur:

2	broad habitat	littoral sediment	LS
3	main habitat	littoral sand	Lsa
4	biotope complex	mobile sand	MoSa
5	Biotope	Amphipods and *Scolelepis* spp.	AmSco
6	Sub-biotope	*Eurydice* sub-biotope	Eur

NOTE: to avoid confusion, others using the classification should <u>not</u> erect similar codes for types not currently described in the national classification.

Table 6 Standard lexicon of codes

Code	Meaning	Type	Level	Old Code	Comments
Al	Algae	Taxon group	3,4,5	Al	
Am	Amphipods	Taxon group	3,4,5	A	
An	Anemones	Taxon group	3,4,5	An	
Angi	Angiosperms	Taxon group	3,4,5	Ang	
As	Ascidians	Taxon group	3,4,5	As	
Axi	Axinellid sponges	Taxon group	3,4,5	Axi	
B	Barnacles	Taxon group	3,4,5	B	
Bar	Barren	Community feature	3,4,5	Bar	
Bo	Boulders	Habitat factor	3,4,5	Bo	
BR	Biogenic reefs	Taxon group	1,2		
Br	Brachiopods	Taxon group	3,4,5	Br	
Bri	Brittlestars	Taxon group	3,4,5	Bri	
Bv	Bivalves	Taxon group	3,4,5	Bv	
Bwn	Brown seaweeds (Phaeophyceae)	Taxon group	3,4,5	Bwn	
By	Bryozoans	Taxon group	3,4,5	By	
C	Circalittoral	Habitat factor	1,2	C	
Ca	Calcareous	Community feature	3,4,5	Ca	
Cape	Cape-form (kelp)	Community feature	4,5		
CC	Crustose coralline algae	Taxon group	3,4,5	CC	
Chr	Chrysophyceae	Taxon group	3,4,5	Chr	
Cir	Cirratulid polychaetes	Taxon group	3,4,5		
Clay	Clay	Habitat factor	3,4,5		
CoAs	Colonial ascidians	Taxon group	3,4,5		
Cr	Crusts/crustose	Community feature	3,4,5	C	
CrBy	Crustose bryozoans	Taxon group	3,4,5	ByC	
Cri	Crisiid bryozoans	Taxon group	3,4,5	Cri	
Crl	Coral (reefs e.g. Lophelia)	Taxon group	3,4,5		
CrSp	Crustose sponges	Taxon group	3,4,5	SC	
Cru	Crustaceans	Taxon group	3,4,5	Cr	
CS	Coarse sediment	Habitat factor	1,2		
Cum	Cumaceans	Taxon group	3,4,5		
Cup	Cup corals (Scleractinia)	Taxon group	3,4,5	Cup	
CuSp	Cushion sponges	Community feature	3,4,5	CuS	
Cv	Caves	Habitat factor	3,4,5	Cv	
Dec	Decapods	Taxon group	3,4,5	D	
Dp	Deep (circalittoral)	Habitat factor	3,4,5		
Ec	Echinoderms	Taxon group	3,4,5		
Eph	Ephemeral (seaweeds)	Community feature	3,4,5	Eph	
ErSp	Erect sponges	Taxon group	3,4,5	ErS	
Est	Estuarine	Habitat factor	3,4,5	Est	
F	Features (e.g. rockpools, caves)	Habitat factor	1,2		

F	Fucoids	Taxon group	3,4,5	F
Fa	Fauna	Taxon group	3,4,5	Fa
Fi	Fine (sand or mud)	Habitat factor	3,4,5	
Fil	Filamentous (seaweeds)	Community feature	3,4,5	Fi
File	File shells	Taxon group	3,4,5	
Fo	Foliose (seaweeds)	Community feature	3,4,5	Fo
For	Foraminiferans	Taxon group	3,4,5	For
Fou	Fouling	Community feature	3,4,5	
FS	Full salinity (marine)	Habitat factor	3,4,5	FS
Ft	Forest (kelp)	Community feature	3,4,5	Ft
G	Green seaweeds (Chlorophyceae)	Taxon group	3,4,5	G
G	Gully (surge)	Habitat factor	3,4,5	G
Gv	Gravel/gravelly	Habitat factor	3,4,5	
Gz	Grazed (seaweed communities)	Community feature	3,4,5	Gz
H	High energy (very wave/tide exposed)	Habitat factor	1,2	E
H	Hydroids	Taxon group	3,4,5	H
Hap	Haptophyceae	Taxon group	3,4,5	
Ho	Holothurians	Taxon group	3,4,5	Ho
I	Infralittoral	Habitat factor	1,2	I
K	Kelps	Taxon group	3,4,5	K
L	Littoral	Habitat factor	1,2	L
L	Low energy (wave/tide sheltered)	Habitat factor	1,2	S
Lag	Lagoonal	Habitat factor	3,4,5	Lag
LgAs	Large (solitary) ascidians	Taxon group	3,4,5	SoAs
Lic	Lichens	Taxon group	3,4,5	L
M	Moderate energy (Moderately wave/tide exposed)	Habitat factor	1,2	M
MaSp	Massive sponges	Community feature	3,4,5	MaS
Meg	Megafauna (burrowing)	Community feature	3,4,5	Meg
MEst	Mid estuarine	Habitat factor	3	
Mo	Mobile	Habitat factor	3,4,5	Mob
Mp	Macrophytes (angiosperms or seaweeds)	Taxon group	1,2	
Mrl	Maerl	Taxon group	3,4,5	Mrl
Mu	Mud/muddy	Habitat factor	1,2	MU
Mus	Mussels	Taxon group	3,4,5	M
MuSa	Muddy sand	Habitat factor	3,4,5	MS
Mx	Mixed sediments (gravel, sand & mud mixtures)	Habitat factor	1,2,3,4,5	MX & Mx
O	Offshore circalittoral	Habitat factor	1,2	CO
Ol	Oligochaetes	Taxon group	3,4,5	Ol
Ov	Overhangs	Habitat factor	3,4,5	Ov

Oy	Oysters	Taxon group	3,4,5	Oy
Pb	Pebbles	Habitat factor	3,4,5	
Pid	Piddocks (bivalves)	Taxon group	3,4,5	Pid
Pk	Park (kelp)	Community feature	3,4,5	Pk
Po	Polychaetes	Taxon group	3,4,5	P
R	Red seaweeds (Rhodophyceae)	Taxon group	3,4,5	R
R	Reef (biogenic)	Habitat factor	1,2	
R	Rock (bedrock, boulders, stable cobbles & pebbles)	Habitat factor	1,2	R
Rkp	Rockpools	Habitat factor	3,4,5	Rkp
RS	Reduced salinity	Habitat factor	3,4,5	RS
S	Salinity (Full, Variable, Reduced, Low)	Habitat factor	3,4,5	S
S	Sublittoral	Habitat factor	1,2,3,4,5	S
S & Sed	Sediments	Habitat factor	1,2,3,4,5	S & Sed
Sa	Sands/sandy	Habitat factor	1,2,3,4,5	Snd & S
SaMu	Sandy mud	Habitat factor	3,4,5	SMu
Scr	Scoured	Habitat factor	3,4,5	Scr
SfR	Soft rock	Habitat factor	3,4,5	SfR
SG	Surge gully	Habitat factor	3,4,5	SG
Sgr	Seagrass	Taxon group	3,4,5	Sgr
Sh	Shingle	Habitat factor	3,4,5	Sh
Sm	Saltmarsh	Taxon group	3,4,5	Sm
SmAs	Small (solitary) ascidians	Taxon group	3,4,5	
Sp	Sponges	Taxon group	3,4,5	S
Spn	Seapens	Taxon group	3,4,5	Sp
St	Strandline	Habitat factor	3,4,5	
Sw	Seaweeds	Taxon group	3,4,5	Sw
Syn	Synaptid holothurians	Taxon group	3,4,5	Syn
T	Tide-swept	Habitat factor	3,4,5	T
Tal	Talitrid amphipods	Taxon group	3,4,5	Tal
Tb	Tube/tube-building	Community feature	3,4,5	Tube
Tf	Turf	Community feature	3,4,5	Tf
Tw	Tubeworms	Taxon group	3,4,5	Tw
UEst	Upper estuarine	Habitat factor	3	
Ven	Venerid bivalves	Taxon group	3,4,5	Ven
VS	Variable salinity	Habitat factor	3,4,5	VS
Vt	Vertical	Habitat factor	3,4,5	V
X	Mixed (rocky) substrata (boulders, stones & sediment mixtures)	Habitat factor	3,4,5	X
XFa	Mixed fauna	Taxon group	3,4,5	XFa
XFoR	Mixed foliose red seaweeds		4	
XK	Mixed kelps	Taxon group	3,4,5	XK

YG	Yellow & grey lichens	Taxon group	3,4,5	YG	
	Exposed	Habitat factor	1,2	E	Replaced by H (high energy)
	Gravels and clean sands	Habitat factor	1,2	GS	Replaced by CS (coarse sediments)
	Marine	Habitat factor	3,4,5	Mar	Replaced by FS (full salinity)
	Moderately exposed	Habitat factor	1,2	M	Replaced by M (moderate energy)
	Sheltered	Habitat factor	1,2	S	Replaced by L (low energy

Field recording and data management

MNCR field recording techniques are described in Hiscock (1996), with Appendix 8 providing the guidance on how to complete MNCR field recording forms (available to download at http://www.jncc.gov.uk/marine/biotopes/intro/field.htm). The terms used in the habitat classification and data presented here are described in the next section.

Procedural Guidelines for a wide range of field sampling techniques are given in the Marine Monitoring Handbook (Davies *et al*. 2001), which is available to download at http://www.jncc.gov.uk/marine/mmh/Contents.htm.

The Marine Recorder database application has been specifically developed to accept marine biological data from a wide range of survey techniques, including the data held originally in the MNCR database. The application can be downloaded from http://www.esdm.co.uk/MarineRecorder/index.html and includes a dictionary of the habitat classification types.

Terms used for field recording and habitat definition

The following definitions are taken from guidance notes for MNCR field recording (Appendix 8 in Hiscock 1996). Some terms are modified for use in the classification.

***Salinity* -** The categories are defined as follows (the points of separation approximate to critical tolerance limits for marine species):

Fully marine	30-40 ‰
Variable	18-40 ‰
Reduced	18-30 ‰
Low	<18 ‰

***Wave exposure* -** These categories take account of the aspect of the coast (related to direction of prevailing or strong winds), the fetch (distance to nearest land), its openness (the degree of open water offshore) and its profile (the depth profile of water adjacent to the coast). Estimation of wave exposure requires inspection of charts and maps.

Extremely exposed	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 (50 m depth contour within about 300 m, e.g. Rockall).
Very exposed	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 (>300 m) 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).
Exposed	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.
Moderately exposed	These sites generally include open coasts facing away from prevailing winds and without a long fetch but where strong winds can be frequent.

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

In the habitat classification ***exposed*** (as in *exposed littoral rock*) encompasses the *extremely exposed*, *very exposed* and *exposed* categories, whilst ***sheltered*** (as in *sheltered littoral rock*) encompasses *sheltered* to *ultra sheltered* categories.

***Tidal currents (or streams) (maximum at surface)* -** This is maximum tidal current strength which <u>affects</u> the actual area surveyed. <u>Note for shores and inshore areas this may differ considerably from the tidal currents present offshore</u>. In some narrows and sounds the top of the shore may only be covered at slack water, but the lower shore is subject to fast running water.

Very strong	>6 knots	(>3 m/sec.)
Strong	3-6 knots	(>1.5-3 m/sec.)
Moderately strong	1-3 knots	(0.5-1.5 m/sec.)
Weak	<1 knot	(<0.5 m/sec.)
Very weak	Negligible	

In the habitat classification tide-swept habitats typically have moderately strong or stronger tidal currents.

Zone* -** These definitions primarily relate to rocky habitats or those where algae grow (e.g. stable shallow sublittoral sediments). For use of the terms ***infralittoral and ***circalittoral*** in the classification, especially for sediments, refer also to Table 5.

Supralittoral	Colonised by yellow and grey lichens, above the *Littorina* populations but generally below flowering plants.
Upper littoral fringe	This is the splash zone above High Water of Spring Tides with a dense band of the black lichen by *Verrucaria maura*. *Littorina saxatilis* and *Littorina neritoides* often present. May include saltmarsh species on shale/pebbles in shelter.
Lower littoral fringe	The *Pelvetia* (in shelter) or *Porphyra* (exposed) belt. With patchy *Verrucaria maura*, *Verrucaria mucosa* and *Lichina pygmaea* present above the main barnacle population. May also include saltmarsh species on shale/pebbles in shelter.
Upper eulittoral	Barnacles and limpets present in quantity or with dense *Fucus spiralis* in sheltered locations.
Mid eulittoral	Barnacle-limpet dominated, sometimes mussels or dominated by *Fucus vesiculosus* and *Ascophyllum nodosum* in sheltered locations. *Mastocarpus stellatus* and *Palmaria palmata* patchy in lower part. Usually quite a wide belt.
Lower eulittoral	*Fucus serratus*, *Mastocarpus stellatus*, *Himanthalia elongata* or *Palmaria palmata* variously dominant; barnacles sparse.

Sublittoral fringe	Dominated by *Alaria esculenta* (very exposed), *Laminaria digitata* (exposed to sheltered) or *Laminaria saccharina* (very sheltered) with encrusting coralline algae; barnacles sparse.
Upper infralittoral	Dense forest of kelp.
Lower infralittoral	Sparse kelp park, dominated by foliose algae except where grazed. May lack kelp.
Upper circalittoral	Dominated by animals, lacking kelp but with sparse foliose algae except where grazed.
Lower circalittoral	Dominated by animals with no foliose algae but encrusting coralline algae.

Substratum

Bedrock	Includes very soft rock-types such as chalk, peat and clay.
Boulders	Very large (>1024 mm), large (512-1024 mm), small (256-512 mm)
Cobbles	64-256 mm
Pebbles	16-64 mm
Gravel	4-16 mm
Coarse sand	1-4 mm
Medium sand	0.25-1 mm
Fine sand	0.063 - 0.25 mm
Mud	<0.063 mm (the silt/clay fraction)

Each division of sediment type above represents two divisions on the Wentworth scale (Wentworth 1922).

In the habitat classification, bedrock, stable boulders, cobbles or pebbles and habitats of mixed boulder, cobble, pebble and sediment (***mixed substrata***) as well as artificial substrata (concrete, wood, metal) are collectively referred to as ***rock***. Highly mobile cobbles and pebbles (shingle), together with gravel and coarse sand are collectively referred to as ***coarse sediments***. ***Mixed sediment*** consists of heterogeneous mixtures of gravel, sand and mud and may often have shells and stones also.

MNCR SACFOR abundance scales

The MNCR cover/density scales adopted from 1990 provide a unified system for recording the abundance of marine benthic flora and fauna in biological surveys (Connor & Hiscock 1996). The scales are given below and should be used in conjunction with the following notes:

1. Whenever an attached species covers the substratum and percentage cover can be estimated, that scale should be used in preference to the density scale.
2. Use the *massive/turf* percentage cover scale for all species, excepting those given under *crust/meadow*.
3. Where two or more layers exist, for instance foliose algae overgrowing crustose algae, total percentage cover can be over 100% and abundance grades will reflect this.
4. Percentage cover of littoral species, particularly the fucoid algae, must be estimated when the tide is out.
5. Use quadrats as reference frames for counting, particularly when density is borderline between two of the scale.
6. Some extrapolation of the scales may be necessary to estimate abundance for restricted habitats such as rockpools.
7. The species (as listed over) take precedence over their actual size in deciding which scale to use.
8. When species (such as those associated with algae, hydroid and bryozoan turf or on rocks and shells) are incidentally collected (i.e. collected with other species that were specifically collected for identification) and no meaningful abundance can be assigned to them, they should be noted as present (P).

MNCR SACFOR abundance scales

S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare

GROWTH FORM			SIZE OF INDIVIDUALS / COLONIES					
% COVER	**CRUST / MEADOW**	**MASSIVE / TURF**	**<1 cm**	**1-3 cm**	**3-15 cm**	**>15 cm**	**DENSITY**	
>80%	S		S				>1 / 0.0001 m^2 (1x1 cm)	>10,000/ m^2
40-79%	A	S	A	S			1-9 / 0.001 m^2 (3.16x3.16 cm)	1000-9999 / m^2
20-39%	C	A	C	A	S		1-9 / 0.01 m^2 (10x10 cm)	100-999 / m^2
10-19%	F	C	F	C	A	S	1-9 / 0.1 m^2	10-99 / m^2
5-9%	O	F	O	F	C	A	1-9 / m^2	
1-5% or density	R	O	R	O	F	C	1-9 / 10 m^2 (3.16x3.16 m)	
<1% or density		R		R	O	F	1-9 / 100 m^2 (10x10 m)	
					R	O	1-9 / 1000 m^2 (31.6x31.6 m)	
						R	>1 / 10,000 m^2 (100x100 m)	<1 / 1000 m^2

PORIFERA	Crusts *Halichondria*	Massive spp. *Pachymatisma*		Small solitary *Grantia*	Large solitary *Stelligera*	
HYDROZOA		Turf species *Tubularia* *Abietinaria*		Small clumps *Sarsia* *Aglaophenia*	Solitary *Corymorpha* *Nemertesia*	
ANTHOZOA	*Corynactis*	*Alcyonium*		Small solitary *Epizoanthus* *Caryophyllia*	Med. Solitary *Virgularia* *Cerianthus* *Urticina*	Large solitary *Eunicella* *Funiculina* *Pachycerianthus*
ANNELIDA	*Sabellaria spinulosa*	*Sabellaria alveolata*	*Spirorbis*	Scale worms *Nephtys* *Pomatoceros*	*Chaetopterus* *Arenicola* *Sabella*	
CRUSTACEA	Barnacles Tubiculous amphipods		*Semibalanus* Amphipods	*B. balanus* *Anapagurus* *Pisidia*	*Pagurus* *Galathea* Small crabs	*Homarus* *Nephrops* *Hyas araneus*
MOLLUSCA	*Mytilus* *Modiolus*		Small gastropod *L. neritoides* Small bivalves *Nucula*	Chitons Med. gastropod *L. littorea* *Patella* Med. bivalves *Mytilus* *Pododesmus*	Large gastropod *Buccinum* Lge bivalves *Mya, Pecten* *Arctica*	
BRACHIOPODA				*Neocrania*		
BRYOZOA	Crusts	*Pentapora* *Bugula Flustra*			*Alcyonidium* *Porella*	
ECHINO-DERMATA				*Echinocyamus* *Ocnus*	*Antedon* Small starfish Brittlestars *Echinocardium* *Aslia, Thyone*	Large starfish *Echinus* *Holothuria*
ASCIDIACEA	Colonial *Dendrodoa*			Small solitary *Dendrodoa*	Large solitary *Ascidia, Ciona*	*Diazona*
PISCES					Gobies Blennies	Dog fish Wrasse
PLANTS	Crusts, Maerl *Audouinella* Fucoids, Kelp *Desmarestia*	Foliose Filamentous			*Zostera*	Kelp *Halidrys* *Chorda* *Himanthalia*

Examples of groups or species for each category

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