In: James G. Wilson (ed.) *The Intertidal Ecosystem: The Value of Ireland's Shores*, 25–37. Dublin: Royal Irish Academy.

A CLASSIFICATION OF INSHORE MARINE BIOTOPES

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ABSTRACT

The greatest benefit of using habitat classifications is that the results from surveys of one or more sites can be directly compared with other studies. Such comparisons are difficult where *ad hoc* classifications peculiar to particular surveys or surveyors have been used. The development of a standard classification thus provides an invaluable standard where evaluation of the nature conservation importance or long term monitoring of sites is required.

The habitat classification developed as part of the BioMar project by the Joint Nature Conservation Committee in Britain, funded under the European Union LIFE Environment programme, is the first and only classification of all inshore littoral and sublittoral biotopes applicable to the north-east Atlantic.

This classification aims to provide a standard nomenclature and guide for describing and mapping marine biotopes. It covers all marine habitats from the high tide seaward, with the exception of salt marshes. Its development involved 12 meetings and 2 workshops with over 100 scientists from over 50 organisations throughout Europe to ensure the resulting structure would be widely applicable in the north-east Atlantic, and analysis of field data from about 1,600 sampling stations at 900 sites in Ireland, and over 10,000 sites in Britain to provide an empirical basis for the biotope descriptions.

This BioMar classification thus encompasses and complements related systems, including the European Union Habitats Directive, CORINE, European Palaearctic, Baltic HELCOM, French ZNIEFF-MER, and European Environment Agency EUNIS (European Nature Information System).

It has already been used in the identification of areas of nature conservation importance in Ireland and Britain. It has also been used in producing

Environmental Impact Statements and mapping areas of sensitivity during the SensMap project. It should also be used for mapping and inventorying areas of nature conservation importance (e.g. Natural Heritage Areas, Special Areas of Conservation, Special Protection Areas).

INTRODUCTION

Marine habitat classifications aim to provide a standard nomenclature and guide for describing and mapping marine biotopes (Costello 2000, 2001). The BioMar biotope classification (Connor *et al.* 1997a, b) covers all marine habitats from the high tide seaward, with the exception of salt marshes. Salt marshes are best characterised by terrestrial vascular plants and thus included in the terrestrial classifications.

Marine "habitats" by definition must be related to certain species. Benthic species habitats (e.g. boulders) vary on a scale of metres, whereas the habitats of pelagic and plankton species, and of marine birds and cetaceans, operate at larger areas, typically kilometres. These larger areas, here called seascapes, include bays, inlets, fjords, lagoons, estuaries, and harbours. Seascapes are the units used in environmental management, and are thus of practical importance. However, they contain a range of benthic marine habitats and biotopes that will vary from bay to bay. For this reason, seascapes were defined separately from biotopes and were excluded from the BioMar classification. If seascapes are to be classified, this requires an comparative analysis of the relationship of geo-morphological features to pelagic, plankton, and megafaunal species distributions. Different methods are used to map seascapes and biotopes. Mapping at a seascape level typically uses coastlines, bathymetric charts, and perhaps oceanographic, satellite or acoustic seabed data. In contrast, biotopes are usually identified by direct visual observation while walking on the seashore or scuba diving, or by sampling using video, still photography, grabs or cores. However, it is necessary to use biotopes to describe, map and evaluate the features of seascapes. Thus, the BioMar biotope classification complements any future developments of classifying seascapes.

The classification was developed as part of the BioMar project by the Joint Nature Conservation Committee in Britain, funded under the European Union LIFE Environment programme (Costello 1995, Picton & Costello 1998). It is the first and only classification of all inshore littoral and sublittoral biotopes applicable to the north-east Atlantic (see review by Hiscock 1991), and has been distributed to over 200 organisations in over 15 countries. Its development involved 12 meetings and two workshops with over 100 scientists from over 50 organisations throughout Europe to ensure the resulting structure would be widely applicable in the north-east Atlantic. An analysis of field data was made from about 1,600 sampling stations at 900 sites in Ireland, and over 10,000 sites in Britain to provide an empirical basis for the biotope descriptions. This BioMar classification thus encompasses and complements related systems, including the European Union Habitats Directive, CORINE (Commission of the European Communities 1991), European Palaearctic (Devilliers and Devilliers-Terschuren 1996), Baltic HELCOM, French ZNIEFF-MER (Dauvin *et al.* 1994), and

European Environment Agency EUNIS (European Nature Information System) (see Connor *et al.* 1997a, b for a more detailed linking of these systems). In this paper, we outline the benefits of using a marine biotope and habitat classification, describe the BioMar classification, and give some examples of the current and potential applications of this standardised ecological nomenclature and framework.

WHY USE THE MARINE BIOTOPE CLASSIFICATION?

The greatest benefit of using the BioMar classification is that the results from surveys of one or more sites can be directly compared with other studies (e.g. in Connor *et al.* 1997a, b). Such comparisons are difficult where *ad hoc* classifications peculiar to particular surveys or surveyors have been used. The classification is thus an invaluable standard where evaluation of the nature conservation importance or long term monitoring of sites is required. It has already been used in the identification of areas of nature conservation importance in Ireland and Britain. It is also being used in producing Environmental Impact Statements and mapping areas of nature conservation importance (e.g. Natural Heritage Areas, Special Areas of Conservation, Special Protection Areas).

Secondly, the classification can save time in the field and in data analysis. In the field, it is possible to rapidly label a sketch map of an area with the biotopes present. It is not necessary to map the distribution of each habitat and species and then subject this data to complex analyses in order to produce such maps. The classification can thus provide benefits in conducting surveys and interpreting their results. The upper levels (physical habitats) of the classification (Table 1) can generally be identified from existing information on marine charts. Thus a third use of the classification is that it can provide the basis of a methodology to predict the distribution of marine biotopes from existing data.

BIOTOPES

A biotope is the combination of the physical habitat (a place where animals and/or plants live) and its community of animals and plants. The three upper levels of the BioMar classification are listed in Table 1, and details of the 4th (biotopes) and 5th (sub-biotopes) are in Connor *et al.* (1997a, b). For the purpose of this classification, biotopes were only defined when they were recognisable in the field, and when the same combination of habitat and community was repeated in several different localities. The species used to characterise a biotope tend to be visually conspicuous by virtue of their size, lack of mobility, and/or dominant growth over the seabed. The presence of other species (not used to characterise biotope) will vary in a biotope over time, and between examples of a biotope in different places. Often, these will be species which are rare, inconspicuous, or need to be identified in the laboratory and/or by specialists. However, even characterising species will vary in abundance between areas. While a habitat and environmental conditions may not change, species abundance and occurrence will vary over time due to natural biological forces (e.g. grazing, predation, or disease). Biotopes can not be treated as a form of 'super-species' because their constituent species will

Table 1. Checklist of the upper three levels (major habitat, habitat complex, biotope complex) of the BioMar marine biotope classification of Connor *et al.* (1997a, b). Species on rock may also occur on other hard substrata (e.g. shells, piers, shipwrecks). Number of biotopes and sub-biotopes indicated in parentheses.

Littoral rock

- Lichens or algal crusts (9)
- Exposed (mussel/barnacle shores)
  - *Mytilus* (mussels) & barnacles (7)
  - Robust fucoids & red seaweeds (3)
- Moderately exposed (barnacle/fucoid shores)
  - Barnacles & fucoids (7)
  - Red seaweeds (5)
  - Ephemeral green or red seaweeds (freshwater or sand-influenced) (3)
  - *Mytilus* (mussels) & fucoids (3)
  - *Sabellaria* (honeycomb worm) reefs (1)
- Sheltered (fucoid shores)
  - Dense fucoids (stable rock) (10)
  - Fucoids, barnacles or ephemeral seaweeds (mixed substrata) (8)
  - *Mytilus* (mussel) beds (mixed substrata) (1)
- Rockpools (9)
- Overhangs & caves (3)

Littoral sediments

- Littoral gravels & sands
  - Shingle (pebble) & gravel shores (2)
  - Sand shores (7)
  - Estuarine coarse sediment shores (1)
- Littoral muddy sands
  - Muddy sand shores (4)
  - Littoral *Zostera* (seagrass) beds (1)
- Littoral muds
- Salt marsh (26 +)
- Sandy mud shores (4)
- Soft mud shores (3)
- Littoral mixed sediments (2)

Circalittoral rock

- Exposed
- Faunal crusts or short turfs (3)
  - *Alcyonium*-dominated communities (tide-swept/vertical) (4)
  - Barnacle, cushion sponge & *Tubularia* communities (very tide-swept/sheltered) (5)
  - Moderately exposed
  - Mixed faunal turfs (4)
  - Bryozoan/hydroid turfs (sand-influenced) (9)
  - Circalittoral *Sabellaria* reefs (1)
  - Mussel beds (open coast circalittoral rock/ mixed substrata) (3)
  - Brittlestar beds (2)
  - Grazed fauna (moderately exposed or sheltered rock) (2)
  - Ascidian communities (silt-influenced) (3)
  - Soft rock communities (2)
- Sheltered
  - Brachiopod & solitary ascidian communities (8)
  - Sheltered *Modiolus* (horse-mussel) beds (2)
  - Faunal turfs (deep vertical rock) (2)
  - Caves & overhangs (deep) (1)

Circalittoral offshore rock

- *Lophelia* (coral) reefs (1)

Sublittoral sediments

- Infralittoral gravels & sands
  - Maerl beds (open coast/clean sediments) (4)
  - Shallow gravel faunal communities (2)
  - Shallow sand faunal communities (5)
  - Estuarine sublittoral gravels & sands (3)
- Circalittoral gravels & sands (3)
- Infralittoral muddy sands

Table 1 (continued)

Infralittoral rock

Exposed

- Kelp with cushion fauna, foliose red seaweeds or coralline crusts (13)
- Robust faunal cushions & crusts (surge gullies & caves) (10)

Moderately exposed

- Kelp with red seaweeds (11)
- Grazed kelp with algal crusts (3)
- Sand or gravel-affected or disturbed kelp & seaweed communities (7)

Sheltered

- Silted kelp (stable rock) (14)
- Estuarine faunal communities (shallow rock/ mixed substrata) (3)
- Submerged fucoids, green & red seaweeds (lagoonal rock) (4)
- Other fauna & seaweeds (shallow vertical rock) (3)

Sublittoral sediments (continued)

- Seagrass beds (2)
- Shallow muddy sand faunal communities (4)

Circalittoral muddy sands (5)

Infralittoral muds

- Angiosperm communities (lagoons) (2)
- Shallow marine mud communities (4)
- Estuarine sublittoral muds (7)

Circalittoral muds (3)

Infralittoral mixed sediments

- *Laminaria saccharina* (sugar kelp) & filamentous seaweeds(4)
- Maerl beds (muddy mixed) (3)
- Oyster beds (1)
- Shallow mixed sediment faunal communities (3)

Estuarine sublittoral mixed sediments (3)

Circalittoral mixed sediments (3)

Circalittoral offshore sediments (3)

vary between and within an area over time. Areas of transition between recognisable biotopes (sometimes called ecotones) may be large in area, and contain a mixture of biotopes and species. Indeed, they may be richer in species than the more ‘typical’ biotopes. Such transitional areas are a natural feature of the environment and cannot be viewed as of greater or lesser importance than better known communities. Indeed, the presence of many species in the transitional area is probably dependent on colonisation from the adjacent biotopes. Making such decisions about whether a sampling station represents an already described biotope, is a transition between biotopes, or is a new biotope, requires a wide knowledge of marine community ecology and experience in using the classification.

The relationship between biotopes and the main habitat features can be illustrated in matrices (Figure 1). Many environmental factors influence the distribution and abundance of species, but only those recognisable on a single visit to a site have been used in the classification. However, the influence of other factors, such as temperature, salinity, siltation, turbidity, currents, human disturbance, pollution, and species interactions (e.g. predation, grazing, competition for space), may be indicated or inferred from observations at a site. In the classification, ‘exposure’ refers to both wave and current action. However, these forces can have significantly different effects on species distribution, but the former is generally the important factor in littoral biotopes and sublittorally on open coasts. Current exposure is more important in narrow channels and straits, and in offshore deep waters (> *c.* 100 m depth).

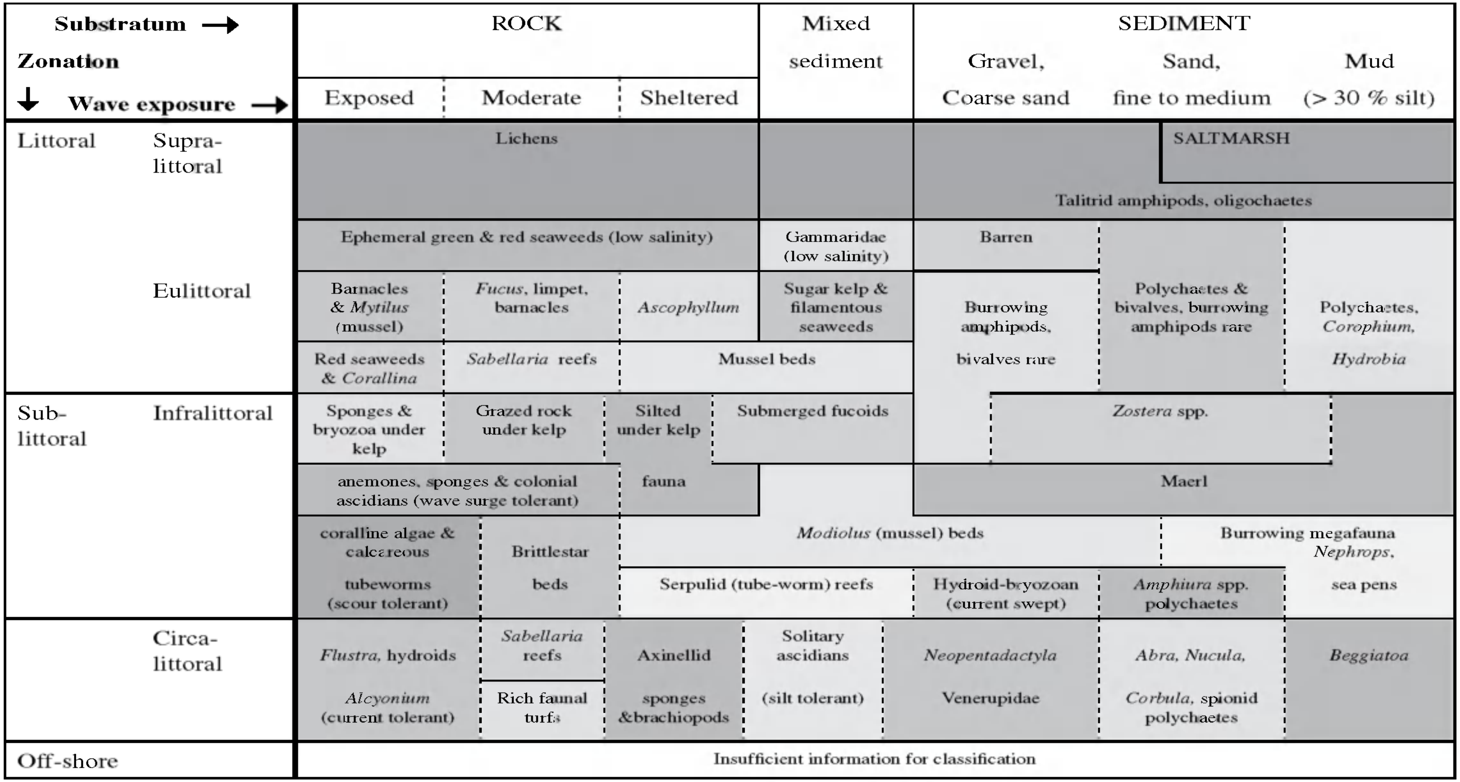

Figure 1. A matrix with the most important habitat features on the axes. This illustrates the relationship of shore height (littoral) and sea depth (sublittoral, offshore), with substratum (rock and grades of sediment), and the exposure of rocky habitats to wave action. These factors distinguish biotopes at the upper levels of the classification. Within the matrix the characteristic species of the communities occurring in the habitats are indicated (but see detailed classification for full definitions and details).

UPPER LEVELS OF THE CLASSIFICATION

The marine biotope classification firstly distinguishes seashores (littoral) from the seabed which is permanently submerged by the sea (sublittoral). Seashores are next divided into rock and sediments. The upper limit of the littoral (supralittoral) is the spray or splash zone on rocky shores, and the strandline on sediment shores. Many seashores may contain areas where boulders are associated with sand and mud, and such mixed sediments are a special category (Table 1 under Littoral sediments). The sublittoral is similarly divided on the basis of substratum being rock or sediment, but also on whether it is dominated by plants with animals (infralittoral) or only animals (circalittoral). The lower limit of the sublittoral is not defined, and offshore (including circalittoral) rock and sediment biotopes have not been sufficiently studied to be classified. However, a deep-sea coral reef biotope which occurs in Irish waters has been included because it is distinct and threatened by deep water trawling.

Littoral rock biotopes have been further divided on the basis of the well known distribution of species according to wave exposure. The uppermost biotopes are dominated by yellow (e.g. *Xanthoria*), grey (e.g. *Ramalina*) and black (e.g. *Verrucaria*) lichens on all rocky shores (Figure 1). The isopod *Ligia,* snails *Littorina saxatilis* and *Melarhaphe neritoides,* seaweeds (algae) *Enteromorpha, Porphyra, Prasiola, Ulothrix* are also common in this zone. The mid-shore (eulittoral) is dominated by either barnacles (*Semibalanus, Chthamalus* spp.), limpets, mussels and/or robust algae such as the coralline alga *Corallina* on wave exposed shores, to dense beds of fucoid algae such as *Ascophyllum* on wave sheltered shores. Moderately exposed shores contain beds of *Fucus* species, associated snails, mussels, amphipods, crabs, red algae, and many other species, and mixtures of species depending on the influences of local scale topography, freshwater, and sand scour. Features such as rock pools, crevices, overhangs (typically characterised by sponges and ascidians), and honeycomb worm (*Sabellaria*) reefs, may be large enough to map as distinct biotopes.

Littoral sediments are classified according to sediment size because this is a readily identifiable feature. It also reflects the wave exposure and water-holding properties on the sediment which influence species distributions. The upper shore, above, on and below the strandline, is characterised by several species of talitrid amphipods with differing microhabitats. In the eulittoral, the coarsest sediments (gravels) may have no species present. The fauna of coarse sand beaches is characterised by amphipod (e.g. *Pontocrates, Bathyporeia, Haustorius*) and isopod (*Eurydice pulchra*) crustaceans, often with certain polychaete worms (*Scolelepis, Nephthys, Lanice*) and the bivalve *Angulus tenuis,* which become progressively rarer in the more widespread muddy sand beaches. The muddy sand beaches are characterised by bivalve molluscs (e.g. *Macoma balthica,* cockle *Cerastoderma edule*), polychaete worms (e.g. *Arenicola, Lanice*), and shrimp *Crangon crangon.* A rich diversity of polychaete worms may occur on muddier beaches, and sea grass *Zostera* species may form beds which stabilise sediments and provide a surface of other species. Very muddy sand and sandy mud shores are dominated by polychaete worms (e.g. *Hediste diversicolor, Nephthys hombergii,* and *Pygospio elegans*), bivalves (e.g. *Macoma balthica, Abra tenuis, Cerastoderma edule, Scrobicularia plana*), snail *Hydrobia,* and amphipod *Corophium* species. Fine mud and muddy sands with a freshwater influence are characterised by oligochaete worms. Sediment shores may extend into salt marsh which is dominated by flowering plants (angiosperms), but will often have fucoid brown algae (e.g. *Pelvetia canaliculata, Fucus* spp.), and talitrid amphipods (e.g. *Orchestia* species) present. Because of the dominance of salt marshes by angiosperms their biotopes have already been classified in terrestrial phytosociological classifications (e.g. Commission of the European Communities 1991) and are not considered further in this marine classification.

Infralittoral rock is usually dominated by kelp species along the sublittoral fringe, ranging from *Alaria esculenta* in the most wave exposed, to *Laminaria digitata* in moderately exposed, and *Laminaria saccharina* in sheltered areas. Mixtures of these kelp species are common, and a rich under-storey of red algae, sponges, bryozoans and ascidians may occur. Immediately below these species the kelp *Laminaria hyperborea* may form a forest with a variety of associated fauna and flora forming a range of biotopes. The effects of sea urchin (e.g. *Echinus esculentus*) grazing may significantly impoverish the under-storey community.

Circalittoral rock is often characterised by some of the fauna which occurred under *L. hyperborea* forest, depending on the wave exposure, current, and sand scour conditions. The soft-coral *Alcyonium,* large sponges *Pachymatisma johnstonia* and *Cliona celata,* and hydroids (e.g. *Tubularia indivisa*), characterise vertical rock and tide swept biotopes. Wave exposed biotopes are characterised by the jewel anemone *Corynactis viridis,* cup coral *Caryophyllia smithii,* feather star *Antedon bifida,* and a range of bryozoans, anemones, sponges and hydroids. Current swept and sand scoured biotopes are usually characterised by hydroids (e.g. *Flustra foliacea, Sertularia* spp.), bryozoans, anemone *Urticina felina,* barnacles (e.g. *Balanus crenatus*), and calcareous tubeworms (e.g. *Pomatoceros triqueter*). Solitary ascidian species, brachiopods, and sponges characterise more wave and current sheltered conditions, such as occur in deeper waters. Some species may form particular biotopes, such as reefs of the honeycomb worm *Sabellaria spinulosa,* beds of mussels (i.e. *Mytilus edulis, Musculus discors, Modiolus modiolus*) and brittlestars (e.g. *Ophiothrix fragilis, Ophiocomina nigra*).

Sublittoral sediments represent an extension of the lower shore fauna into the sublittoral, with less distinct zonation of biotopes than occurs on rock. Beds of seagrass (*Zostera* species), *Ruppia maritima,* oysters *Ostrea edulis,* or maerl (e.g. *Phymatolithon calcareum, Lithophyllum* spp.), may occur on a range of sediments from coarse to very muddy sands. Other shallow sublittoral sand habitats may also be characterised by the urchin *Echinocardium cordatum* and razor shell (*Ensis*) species. Gravel with 'clean' and coarse sand habitats are characterised by bivalves (e.g. *Spisula elliptica*), anemones (e.g. *Halcampa, Edwardsia, Aureliania*), polychaetes (e.g. *Nephthys cirrosa, Lanice conchilega*) and amphipods (e.g. *Bathyporeia* spp.). In more stable and muddier sediments, anemones, seapens (*Virgularia mirabilis*), polychaetes, bivalves (e.g. *Pecten maximus, Fabulina fabula, Chamelea gallina*), characterise the biotopes. Very muddy sand biotopes are characterised by bivalves (e.g. *Abra* spp.), small brittlestars (e.g. *Amphiura* spp., *Ophiura* spp.), urchin *Brissopsis lyrifera,* Dublin Bay prawn *Nephrops norvegicus,* seapens (e.g. *Virgularia, Pennatula*) and polychaetes.

USING THE CLASSIFICATION OF MARINE BIOTOPES

The use of the marine biotope classification generally requires people with a first degree in an ecological science (e.g. botany, zoology, environmental science), some weeks field experience in sampling marine habitats, and skill in identifying species using specialist texts. Less skilled surveyors can limit their definition of biotopes to higher levels in the hierarchy (Table 1). More skilled surveyors, as would be required to assess the nature conservation importance of an area, would need to use the more detailed classification of over 200 biotopes published by Connor *et al.* (1997a, b), and identify more species than used to characterise biotopes. This detailed classification defines biotopes equivalent to the plant communities in the CORINE classification (Commission of the European Communities 1991). Connor *et al.* (1997a, b) also provide a biotope coding system based on abbreviations of the characterising habitat features and species. This is useful shorthand for use in map presentation and is linked to a colour code system for mapping. It should be noted that the classification is never final, and will be expanded as more information and results of analyses of existing data become available. For example, analysis of data from strandline habitats on seashores in Ireland showed that at least two biotopes could be characterised by common talitrid amphipod crustacean genera (Costello *et al.* 1999).

Biotopes less than 5 × 5 m in area, such as rockpools on the seashore, crevices in rock, or occasional stone on a sediment seabed, are not mapped but their presence is noted in the description of that biotope because such microhabitats can significantly increase the number of species in an area. The sampling of marine habitats is usually 'stratified' by limiting sampling to certain zones and/or biotopes. This greatly reduces the variation between replicate samples. The seashore is probably the most narrowly banded range of biotopes in the world due to the varying sensitivity of species to exposure to the air and submersion by the sea. Here biotopes may be only centimetres wide but kilometres long. Selected suites of biotopes can be combined for mapping purposes depending on the map scale, proposed readership, and data quality.

Field notes provide a standard indication of the abundance of species. This is helpful in biotope identification, desirable to compare the same biotopes in different areas, and essential to monitor change in a biotope over time. All conspicuous fauna and flora should be identified to species level and assigned to a semi-quantitative ($\log_{10}$) abundance scale following the methods described in Hiscock (1996). Where identification of species is uncertain or may be questioned later, representative specimens should be collected and/or photographed, and retained in a voucher collection. Where there are insufficient conspicuous species to identify a biotope, as usually is the case on mobile sediments (e.g. sandy beaches), then replicate sediment samples must be taken and the fauna identified microscopically. The naming of species should follow a standardised list (Costello *et al.* 2001, www.marbef.org/data/erms.php) unless otherwise stated, and of biotopes should follow Connor *et al.* (1997a, b). Ecological terminology should be used with care (Table 2).

Methods for biotope mapping have been developed in Ireland by the SensMap project (Emblow *et al.* 1998, Ecological Consultancy Services 2000, Davies *et al.* 2001). Field studies which mapped seabed habitats and communities in Wales were developed into an integrated methodology for mapping in the field, linking marine and terrestrial maps. This methodology was transferred to Ireland and adapted through collaborative fieldwork (Emblow *et al.* 1998). These methods and the biotope classification have already been used in producing Environmental Impact Statements. It should also be used for mapping and inventorying areas of nature conservation importance (e.g. Natural Heritage Areas, Special Areas of Conservation, Special Protection Areas).

The length of seashore occupied by the major habitats in the classification has been determined for each county of Ireland (Neilson and Costello 1999). This data could be used to consider how representative existing and candidate marine protected areas are of the habitats along the 7,500 km coastline, and could be expanded to aid prediction of the occurrence of biotopes and biodiversity (Neilson and Costello 1999).

The BioMar biotope classification provides a readily available (http://www.marlin.ac.uk/baski/baski_bio_home.htm), well-defined, ecological framework for use in environmental management, research and education. This standards-based system facilitates data management and exchange, and mapping at different spatial scales, such that comparisons of biodiversity between studies is possible. Future developments should include expanding the biotope classification beyond inshore waters and the North-East Atlantic, using it more as a management tool, and research into the potential of the classification to act as a surrogate for measures of biodiversity (e.g. species richness, complementarity, beta-diversity).

Table 2. A glossary of marine terminology used here. Some terms may be used slightly differently in other contexts. A useful dictionary of ecological terms is that by Lincoln *et al.* (1998).

Term	Definition	Alternative named
Biota	all living organisms, including fauna and flora	
Biotope	a habitat with a characteristic community	facies
Boulder	stones > 25 cm diameter	
Circalittoral	seabed dominated by animals, algae rare or absent, seasonally stratified, effect of wave action limited to storms	
Cobble	stones 64 to 256 mm diameter	
Community	group of different species which occur together	
Epibenthos	animals (epifauna) and plants (epiflora) living on the surface of the seabed or on other animals and plants	
Eulittoral	Between the supralittoral and sublittoral fringe	mediolittoral, hydrolittoral

Table 2 (continued)

Gravel	sediment grains 4 to 16 mm diameter	
Infauna	animals living within sediments	
Infralittoral	Rock dominated by algae, water column temperature and salinity variable,	Nearshore
Inshore	generally within 5 km of coastline and < 50 m depth	Coastal seas
Littoral	Between upper and lower tidemarks, exposed to air at the lowest tides	Intertidal
Mud	sediment grains < 0.063 mm diameter	silt, clay
Offshore	Stable water column characteristics (stenothermal, stenohaline), permanently stratified, beyond zone of freshwater influence, no benthic algae, generally > 5 km from the coastline	
Pebble	sediment grains 16–64 mm diameter	
Reefs	hard substrata raised from the seabed to provide cover for mobile fauna (e.g. fish, crustaceans). May be formed by rocks, coral, and tubeworms.	
Rock	with epibiota and infauna absent or rare	Hard substrata
Sand	sediment grains 0.063–4 mm diameter	
Sediment	with infauna, and usually some epibiota	Soft substrata
Spray zone	area of upper seashore not submerged at high tide but sprayed at high tide by seawater	Splash zone
Strandline	area of upper seashore where loose seaweed and other floating debris is deposited by the falling tide	
Sublittoral	Below the littoral, never exposed to air	Subtidal
Sublittoral fringe	Transition zone where littoral and sublittoral species occur	infralittoral fringe
Substrata	surfaces (plural) to which an organism grows on or amongst	
Substrate	substance used as a food source by organism or enzymes	
Substratum	surface (singular) to which an organism grows on or amongst	
Supralittoral	Uppermost part of shore affected by wave splash but not regularly submerged by the sea	Strandline, splash zone, spray zone, epilittoral, littoral fringe, supratidal
Zone	Horizontal area of vertical height above, and depth below, sea level which has characteristic fauna and flora	étage (French)

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