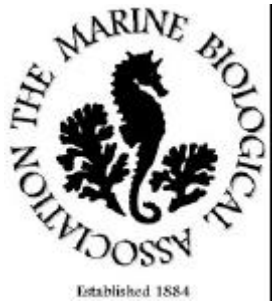

The Marine Life Information Network for Britain and Ireland (*MarLIN*)

Assessing seabed species and ecosystems sensitivities.

Existing approaches and development.

Keith Hiscock

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&

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February 1999

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PREFACE

THE MARINE LIFE INFORMATION NETWORK FOR BRITAIN & IRELAND

MarLIN

Information to support marine environmental management, protection and education.

Description of the programme.

The Marine Life Information Network for Britain and Ireland (MarLIN) is an initiative of the Marine Biological Association of the UK in collaboration with major holders and users of marine biological data and information.

***MarLIN*:**

- provides a structure for linking available data on marine life around Britain and Ireland;
- improves the access, display and interpretation of information in support of environmental management, protection and education, and
- is developing the most comprehensive, easily used source of information about marine habitats, communities and species around Britain and Ireland and their sensitivity to natural events and human activities.

***MarLIN* has a Core Network Team and three sub-programmes:**

1. **The Seabed Data Acquisition Sub-programme.** The major starting point for this sub-programme is the Marine Nature Conservation Review (MNCR) database which holds data from over 30,000 locations. Data sets from a wide variety of sources will be linked to the MNCR database, concentrating especially on offshore areas and the seas to the west of Britain. The data will be capable of interrogation to map species and biotope distributions as well as to interpret new data by identifying which biotopes they represent, displaying contextual information and accessing illustrations. This sub-programme contributes essential contextual information for National Biodiversity Network recording.
2. **The Biology and Sensitivity Key Information Sub-programme.** Biotopes and species pages will provide information about their biology and environmental preferences and to assist in identifying sensitivity and recoverability in relation to natural events and human activities. A graphical, web-based user interface enables the enquirer to identify areas of interest and ask whether any species known to be sensitive, of marine natural heritage importance etc. are present at a location. Hypertext links will access information describing statutes, directives, international conventions and key literature sources.
3. **The Biological Recording Centres and Education Sub-programme.** This sub-programme links especially to the National Biodiversity Network. It will develop marine biological recording through local recording centres and using volunteer recorders. It will realise the educational opportunities offered by access to images and descriptions of biology of communities and species together with their geographical distributions.

More information on *MarLIN* can be found on www.marlin.ac.uk

The Marine Life Information Network for Britain and Ireland (*MarLIN*)

Assessing seabed species and ecosystems sensitivities.

Existing approaches and development.

CONTENTS

The Marine Life Information Network for Britain and Ireland (*MarLIN*)

Assessing seabed species and ecosystems sensitivities.

Existing approaches and development.

Keith Hiscock

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&

Daniel Lear

1. Assessing 'sensitivity' – aims and approaches

The Biology and Sensitivity Key Information Sub-programme aims to:

> **Identify key information on the biology and sensitivity of seabed habitats, biotopes and species that can be applied in a practical way to environmental protection and management.**

Assessment of habitat, community or species 'sensitivity' includes the appraisal of the likely damage from an activity, the potential for recovery after damage and their importance from the point-of-view of maintaining marine natural heritage importance.

This work is being undertaken by the Marine Life Information Network (*MarLIN*) team at the Marine Biological Association of the UK. The Biology and Sensitivity Key Information Sub-programme will take account of existing schemes for assessing sensitivity and the results of workshops as well as trialing these different approaches. The approaches used will be developed in collaboration with the technical Sub-programme Management Group of *MarLIN*. The Objectives and Guiding Principles for the Biology and Sensitivity Key Information Sub-programme are given in Appendix 1.

Technical terms and jargon need to be minimised to provide a practical and user friendly approach. However, precision in the use of terms is essential, especially in gathering key information. All terms used within the programme will be clearly defined. A glossary of terms used presently is shown in Appendix 2 and acronyms listed in Appendix 3.

2. Review of recent approaches to assessing 'sensitivity'

All systems for assessing sensitivity of wildlife to human activities or identifying locations that are sensitive have their advantages and disadvantages. Most are tailored to the sort of information that is available for an area, habitat, species or activity at the time the system was devised. Appendix 4 presents an assessment of the strengths and weaknesses of the approaches that have been developed including systems that are used today in response to development proposals or accidents such as oil spills. Particular attention is drawn to the work of Holt *et al*. (1995, 1997) which thought through a lot of the concepts of sensitivity, vulnerability, recoverability and intolerance developed further here.

Although it is possible to define sensitivity in fairly precise terms, more pragmatic approaches have been used in preparing environmental assessments over the past twenty years or so. For the seashore and seabed, these approaches usually identify sensitive areas with particular shore types (because of links to self-cleaning following oil spills), with areas of landscape importance, with mariculture activities, with recreational activities and with sites scheduled as of nature conservation importance (but often not differentiating marine wildlife from other importance such as geological features or terrestrial only features).

One of the earliest attempts to assess sensitivity in an objective way was the 'oil spill vulnerability index' developed by Gundlach & Hayes (1978). The index has been an important starting point for preparing many sensitivity maps related to oil spills but is based mainly on likely persistence of oil in relation to shore type. Such 'surrogates' for sensitivity have been used for a long time as a 'shortcut' or 'best possible' approach. Even very recent electronic systems for identifying likely sensitivity of locations to prepare oil spill contingency plans use 'shore-type' mapping and the location (in Britain) of Sites of Special Scientific Interest as indicators of sensitivity. The system is probably best developed in the USA and there are several Web-sites describing and illustrating the approach (for instance, Michel & Dahlin1993 as updated in Research Planning Inc. 1998). These approaches are different to the ones being developed here which rely on information on the biology and structure of habitats, biotopes and species. This information will help to identify their fragility, susceptibility to contaminants or other factors and their ability to recover once damaged or lost.

Trying to 'adopt-and-adapt' from terrestrial approaches to identifying sensitivity and importance, whilst desirable for consistency, may not work in the sea. Criteria used to identify biotopes and species in terms of 'risk of extinction' (IUCN 1994) rely on quantitative information being available on recent population decline, on extent of occurrence in km² world-wide or on numbers of mature individuals known to be alive. Almost all marine species would fall into the IUCN Red List 'Data Deficient' category and so 'risk of extinction' is not a relevant category for seabed species. However, Von Nordheim, Anderson & Thissen (1996) have defined 'threat categories' for biotopes in the Wadden Sea area which use the sort of information resources which we have for at least some marine biotopes and species (Box 1). The categorisation of species or biotopes as extinct or threatened to various degrees is most useful in considering 'importance' for conservation of marine natural heritage rather than as an indication of sensitivity in the definition used here.

Box 1.

Threat categories developed for populations of taxa in the wild that are or have been reproducing regularly and whose populations are extinct, presumed extinct or have become endangered in a certain survey area within the past 10-100 years. From Von Nordheim, Anderson & Thissen (1996) for the Wadden Sea area.

EX – extinct or presumed extinct (disappeared from the area)

CR – Critical (Under immediate threat of extinction).

EN – Endangered

VU – Vulnerable

SU – Susceptible

* - Not Endangered

IR – International Responsibility

Whilst the threat of oil pollution has initiated much of the work on sensitivity, fisheries probably poses a much greater threat to marine habitats and species. Recognising that fisheries have a significant effect on marine ecosystems, the International Council for the Exploration of the Seas (ICES) undertook a series of workshops. Their conclusions provide a starting point to identify likely environmental factors or perturbations that will result from mobile bottom fishing gear (Box 2).

Since about 1994 in Britain and Europe, there has been considerable activity to develop more objective approaches to assessing sensitivity of marine habitats and species to human activities and natural events. The nature conservation agencies in Britain have commissioned several of the exercises shown in Appendix 4 (notably, Holt *et al.*1995, 1997; Anderson & Moore 1997) and have particularly addressed how the different elements determining likely impact of activities (for instance, frequency of the event, likelihood of the event, severity of the event) can be incorporated into a formula (MacDonald *et al* 1996; Cooke & McMath 1998). The opportunity

to develop some of the approaches to assessing sensitivity incorporating recoverability in relation to the importance of life cycles was taken at a meeting organised by the Marine Biological Association in 1997 (Hiscock, 1999) and several of the points made in that paper are included in the methods being developed here. The IMPACT working group of the Oslo & Paris Commissions (OSPAR) also initiated a significant workshop in the Netherlands in 1997 (OSPAR 1997) and the UK prepared reviews of literature on the role of different habitat types in the ecological functioning and the integrity of marine and coastal ecosystems for the IMPACT '98 meeting. Furthermore, literature reviews undertaken for the UK Marine SACs project (various authors) and the key information reviews prepared for some UK Biodiversity Action Plan species all itemise information on likely sensitivity and recoverability of biotopes and species. There are now reviews for 16 habitats (Jones *et al*. 1999) prepared to the style developed for OSPAR IMPACT and *MarLIN*.

Box 2.

Likely impact of mobile bottom fishing gear (ICES Working Group on the Ecosystem Effects of Fisheries 1994)

- Substratum removed to leave inhospitable habitat.
- Hard substrata having fragile slow growing species may be broken-up, abraded or overturned.
- Reefs of slow growing species providing a biological substratum for other species may be destroyed.
- Biological reefs or consolidated hard substrata overturned/destroyed but capable of rapid re-colonisation after disturbance ceases.
- Re-suspension of silt followed by sedimentation nearby or at a distance.
- Sediment compaction.
- Substratum structure and composition changed producing a 'new' habitat.

The various approaches described above and in Appendix 4 were taken into account in developing the sensitivity and recoverability scales trialled in this project. These scales are described in Section 9.

In all of the recent approaches, the main factors causing likelihood of an impact occurring and its probable importance for the destruction of or damage to habitats and species have been established. However, the system for assessing sensitivity and recoverability (which is a part of the project described here) and how to represent all of the elements that identify degree of impact into one ranking (which is not being considered in this project) are not generally agreed.

A popular way to summarise the impact of an activity on a community is to use some form of ordination analysis such as Multi-Dimensional-Scaling (MDS) (see Figure 1). Experience gained from monitoring the impact of accidents and from experimental studies should indicate the severity of the effect of the factors on the community and the timescale for recovery. However, if information from MDS analysis is to be used in the approach *MarLIN* is developing, the species 'driving' the change have to be identified.

3. Recent developments which assist sensitivity assessment

Assessing 'sensitivity', 'recoverability' and 'importance' requires the use of classification systems and rules. Only by having such structures and rules can we expect to begin to access information in an ordered way and understand a bewilderingly complicated world. The structures and rules which particularly help to assess sensitivity, recovery and importance are:

Directory of human activities likely to cause change. The JNCC Marine Information Team uses a list of keywords for activities. In addition, Cooke & McMath (1998) provides a catalogue of activities derived from the Marine Conservation Handbook (Eno 1991) which has been

developed by staff in the nature conservation agencies. The *MarLIN* programme has adopted a list of activities modified from the above sources (Box 3).

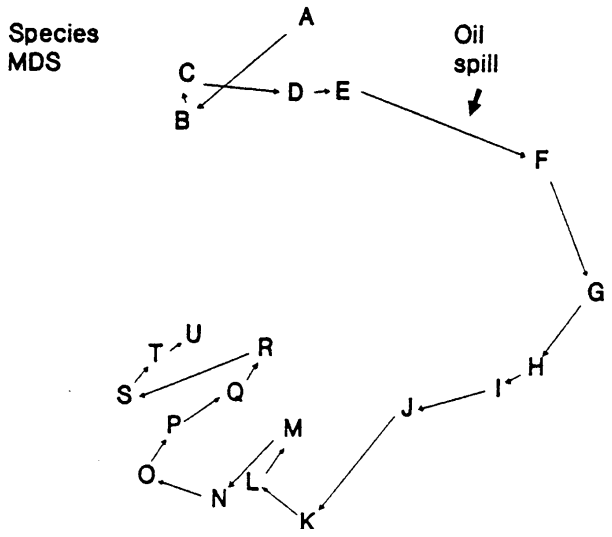


Figure 1. Effects of the Amoco Cadiz oil spill in the Bay of Morlaix, France on the whole community as expressed as MDS scores and changes towards a pre-spill community (recovery). MDS plot of quarterly samples of macrobenthic communities. A = April 1977; the oil spill was March 1978, U = February 1982. From Warwick & Clarke (1993).

Natural events likely to cause change. The literature on effects of natural events, particular extreme events, remains scattered and will be indexed as a part of this project.

Species directories. Catalogues exist for particular groups in various keys and guides and there is a marine species directory for Britain and Ireland (Howson & Picton 1997). A European Register of Marine Species (ERMS) is currently being compiled with the support of funds from the EC (project led by Dr Mark Costello, Ireland).

Biotope classification. In the past five years or so, significant progress has been made in identifying and classifying the biotopes (habitats and their associated communities) present on the seabed. Such classifications give us the ability to compare like-with-like in assessing features such as species richness and to gauge the extent and frequency of occurrence of the resource (for instance, to assess whether a biotope should be considered 'rare', 'scarce' or 'uncommon'). Deliberations within the ICES Benthos Working Group and now the ICES Marine Habitat Committee, as well as other fora, are being taken into consideration in developing the marine component of the European Union Nature Information System (EUNIS) classification. European marine biologists have already contributed significantly to developing the classification for inshore areas of Britain and Ireland under the EC Life-funded BioMar project (Connor *et al*. 1997 a&b). OSPAR will undertake development of a biotope classification for the NE Atlantic in the autumn of 1999 including work which is required to develop a biotope classification for deep water areas of the Britain and Ireland EEZ.

Indices of sensitivity and recoverability. Criteria and indices have been developed in studies commissioned by the nature conservation agencies and workshops held under the auspices of the ICES Benthos Working Group and OSPAR IMPACT. The character of these systems and their utility is reviewed in this report. Key terms and their definitions are shown in Box 4.

Criteria to assess the 'importance' of wildlife for the conservation of biodiversity. Protocols for assessing the relevant importance of sites have been developed by a wide range of organisations and are reviewed, for instance, by Hiscock (1997). Some of the main ones that are

practical to apply are listed in Section 6. Criteria for the identification of nationally rare and scarce species and biotopes have been developed by Sanderson (1996) and are described below.

Box 3.

Categories of human activity or natural events which may affect marine ecosystem (adapted from Cooke & McMath 1998; Eno 1991).

Aquaculture: algae
Aquaculture: fin-fish
Aquaculture: shellfish
Climate: current change
Climate: sea level change
Climate: temperature change
Climate: weather pattern change
Coastal defence: barrage
Coastal defence: dredging
Coastal defence: groynes
Coastal defence: sea walls
Collecting: algae/kelp harvesting
Collecting: bait digging
Collecting: curios
Collecting: eggs
Collecting: higher plants
Collecting: peelers (boulder turning)
Collecting: shellfish
Development (coastal/land): dock/port facilities
Development (coastal/land): land claim
Development (coastal/land): urban
Development (marine/offshore): artificial reefs
Development (marine/offshore): communications cables
Dredging: (navigational/maintenance)
Energy generation: (power stations)
Energy generation: (wind/wave/tide)
Extraction: maerl
Extraction: oil/gas
Extraction: rock/minerals (coastal quarrying)
Extraction: sand/gravel
Fishing: angling
Fishing: netting
Fishing: potting/creeling
Fishing: spear fishing
Fishing: suction dredging
Fishing: trawling
Predator control:
Recreation: dive site
Recreation: marina
Recreation: popular beach
Recreation: resort
Recreation: water sports
Removal of substratum:
Uses: animal sanctuaries
Uses: archaeology
Uses: boats/ships
Uses: coastal farming
Uses: coastal forestry
Uses: education/interpretation
Uses: military
Uses: mooring/beaching/launching
Uses: research
Waste: industrial effluent discharge
Waste: litter and debris
Waste: sewage discharge
Waste: spoil dumping
Water supply

Box 4.

Key definitions.

'Sensitivity' is the intolerance of a habitat, community or species to damage, or death, from an external factor (based on McLeod 1996). Sensitivity must be assessed relative to change in a specific environmental factor.

'Vulnerability' expresses the likelihood that a habitat, community or species will be exposed to an external factor to which it is sensitive. Degree of 'Vulnerability' therefore indicates the likely severity of damage should the factor occur at a defined intensity and/or frequency.

'Recoverability' is the ability of a habitat, community or species to return to a state close to that which existed before the development, activity or event. Recovery may occur through re-growth, re-colonisation by migration or larval settlement from undamaged populations or re-establishment of viability where, for instance, reproductive organs or propagules have been damaged by the event. Recovery can be partial or complete.

'Importance'. In the context of marine natural heritage: species or biotopes which are rare or very restricted in their distribution; species or biotopes that are in decline or have been; species or biotopes where a country has a high proportion of the regional or world population or extent; species that are keystone in a biotope by providing a habitat for other species; biotopes with a particularly high species richness; locations or biotopes that are particularly good or extensive representatives of their type. Species will also be 'important' if they are listed for protection on statutes, directives and conventions.

'Factor'. A component of the physical, chemical, ecological or human environment that may be influenced by natural events or anthropogenic activity.

'Activity' (maritime). An anthropogenic operation or activity which occurs in the marine or coastal environment (Cooke and McMath 1998).

4. What is 'sensitivity'?

In definitive terms, 'sensitivity' is the intolerance of a habitat, community or species to damage, or death, from an external factor. A habitat, community or species becomes 'vulnerable' to adverse effect(s) when the external factor is likely to happen. For instance, a crab might have a high sensitivity to physical impact but is only vulnerable if activities such as scallop dredging are being undertaken where it is present.

Sensitivity might be because of fragility in relation to physical impact, or might be because of intolerance to certain environmental conditions such as extremes of sunshine, temperature, turbidity or salinity or to dissolved contaminants or hypoxia. Identifying sensitivity of habitats and communities may be through the physical fragility of those habitats but is usually determined by assessing sensitivity of component species as adults.

As environmental impact studies are undertaken in relation to different activities and events, our knowledge base expands to facilitate the development of indices based on both sensitivity and potential for recovery. An early example of providing information which helps in assessing likely impact of events is the account of the effects of the very cold 1962-63 winter on marine fauna (Crisp 1964). More recently, the changes following oil spills have been studied in many areas although rarely disseminated in a way that helps assessment of sensitivity and recovery potential. One exception is the description by Dauvin (1991) of changes in sediment benthos off Brittany following the *Amoco Cadiz* oil spill (Figure 1).

Physical disturbance is another perturbation for which some systematic studies of recovery following an event have been undertaken. For instance, Kenny & Rees (1996) describe the temporal changes in benthic communities at dredged sites compared to reference sites nearby, and Kaiser & Spencer (1996) describe the impact of bottom trawls on benthos. An illustration of the effects of beam trawling is given in Figure 2. Progress has been made in recent years particularly in identifying and indexing sensitivity in relation to impact from mobile fishing gear, incidents of oil pollution and the wider activities occurring during oil exploration and development. A small number of species can be identified as highly sensitive and unlikely to recover from damage. However, work is still required on the concepts of sensitivity and bringing together the information required in order to assess sensitivity at particular locations.

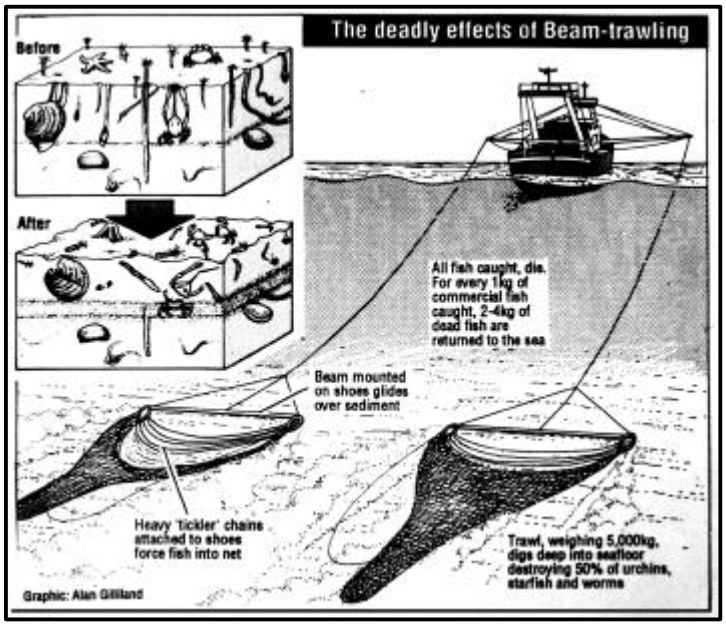


Figure 2. 'The deadly effects of beam trawling' – an artists impression.

5. What is 'recoverability'?

'Recoverability' is the ability of a habitat, community or species to return to a viable state which is at least close to that which existed before the development, activity or event. Recovery may be because of regrowth (in the case of damaged species capable of regrowing from remaining tissue), re-colonisation by migration or larval settlement from undamaged populations or re-establishment of viability where, for instance, reproductive organs or propagules have been damaged by the event. Recovery can be partial or complete.

There will be many habitats and species that will be adversely affected, even destroyed, by an activity or event. Such effects 'matter' to the continued survival of that feature if it does not have the potential to recover.

Von Nordheim, Anderson & Thissen (1996) have published scales for the assessment of regeneration ability in relation to the Red Lists of biotopes, flora and fauna of the Wadden Sea. These scales are: N regeneration impossible; K regeneration hardly possible (>150 years necessary); S regeneration difficult (15-150 years); B regeneration conditionally possible <15 years); X classification not meaningful. The scales being developed for work being undertaken in the *MarLIN* programme are based on outcomes of the OSPAR IMPACT workshop in February 1997 (OSPAR 1997).

6. What is 'importance'?

Habitats, communities and species are likely to be considered 'important' from a nature conservation point-of-view, if they are:

- Rare or very restricted in their distribution. For instance, the detached form of knotted wrack *Ascophyllum nodosum mackii* is an ecad (a growth form brought about by local environmental conditions) found in a few sheltered sea loch locations in western Scotland and Northern Ireland. *Leptopsammia pruvoti* is a cup coral known from only five locations in Great Britain. Clumps (small reefs) of the tube worm *Serpula vermicularis* are known only from Loch Creran in Scotland in Great Britain. Lagoon habitats are rare (although they can be locally common) and often hold species not present in marine inlets or on the open coast.
- In decline or have been. For instance, the fan mussel (*Atrina fragilis*), a nationally scarce species (as defined by Sanderson 1996) was once known from several marine inlets in south-west England but has only been found recently in the Helford River.
- A high proportion of the regional or world population or extent. For instance, Great Britain holds about 40% of the world population of Atlantic grey seals (*Halichoerus grypus*) and England has a high proportion of the European chalk coastline.
- Keystone in a biotope species by providing a habitat for other species (especially those which have been subject to decline over recent years). For instance, the horse mussel (*Modiolus modiolus*) attracts a wide range of epifaunal and cryptic species and horse mussel beds are a 'nursery' for young scallops. Beds have declined in extent in some areas where mobile bottom fishing gear has been used. The deep water coral *Lophelia pertusa* provides substantial reefs of hard substratum at the edge of the continental shelf where substrata are otherwise mainly sedimentary. *Lophelia* reefs are being damaged by deep-water demersal fishing gear.
- Biotopes with a particularly high species richness. Biotopes may have a particularly high species richness when they provide both sedimentary and hard substrata: for instance, well-developed beds of maerl (*Phymatolithon calcareum* and *Lithothamnium corallioides*); or when they provide shelter for a particular community (for instance amongst beds of sea grass *Zostera marina*). Some biotopes are rich for less certain reasons but which might be

associated with stable environmental conditions that allows colonisation by a large number of species.

- Particularly good or extensive representatives of their type (habitats or communities). For instance, the well developed and extensive areas (as length of coastline) of the sealoch biotope characterised by the brachiopod *Neocrania anomala* and the sea anemone *Protanthea simplex* present in Loch Duich, Scotland.

Progress has also been made in adapting criteria developed by terrestrial conservationists to marine ecosystems. The development of criteria to identify species that are rare or scarce has been undertaken by Sanderson (1996). For action in the UK under the Biodiversity Convention, criteria have recently been developed to identify marine habitats and species for biodiversity action plans (Box 5). Identification of species for action plans is especially weighted towards those that are vulnerable because of their low fecundity, high age of first maturity and/or inability to re-colonise an area after loss or removal (due to their particular developmental biology).

Box 5.

Selection criteria being used in the UK to identify habitats and species for Biodiversity Action Plans to be prepared to fulfil obligations under the Biodiversity Convention.

Habitats

- Habitats for which the UK has international obligations.
- Habitats at risk, such as those with a high rate of decline especially over the past 20 years.
- Habitats which are rare.
- Areas, particularly marine areas, which may be functionally critical for organisms inhabiting wider ecosystems.
- Marine habitats if 40% or more of the north-east Atlantic's occurrence of the habitat is located in the UK.
- Habitats which may be formed from a keystone species – one which hosts a characteristic community of other species.
- Areas important for rare species.

Species

- Threatened endemic and globally threatened species.
- Species where the UK has more than 25% of the world or appropriate biogeographical population.
- Species where number or range have declined by more than 25% in the last 25 years.
- Species found in fewer than 15 10x10 km squares in the UK.
- Species for which the UK has international obligations or which are protected under UK legislation.

Where there are sensitive features in an area, especially if they have low recovery potential, human activities that damage those features matter most if the features are 'important'. A 'decision tree' that illustrates how importance is addressed is shown in Figure 4. Whilst 'importance' might relate to commercial interests, recreation or other uses of the marine environment, the importance for the maintenance of biodiversity alone is considered in the approach shown in Figure 4.

There are well-developed criteria for the assessment of importance, aimed mainly at identifying potential marine protected areas (Hiscock 1997). The 'importance' of a site for nature conservation, for the past forty years or so, been based on the use criteria such as 'representativeness', 'rarity' and 'diversity' (see Hiscock

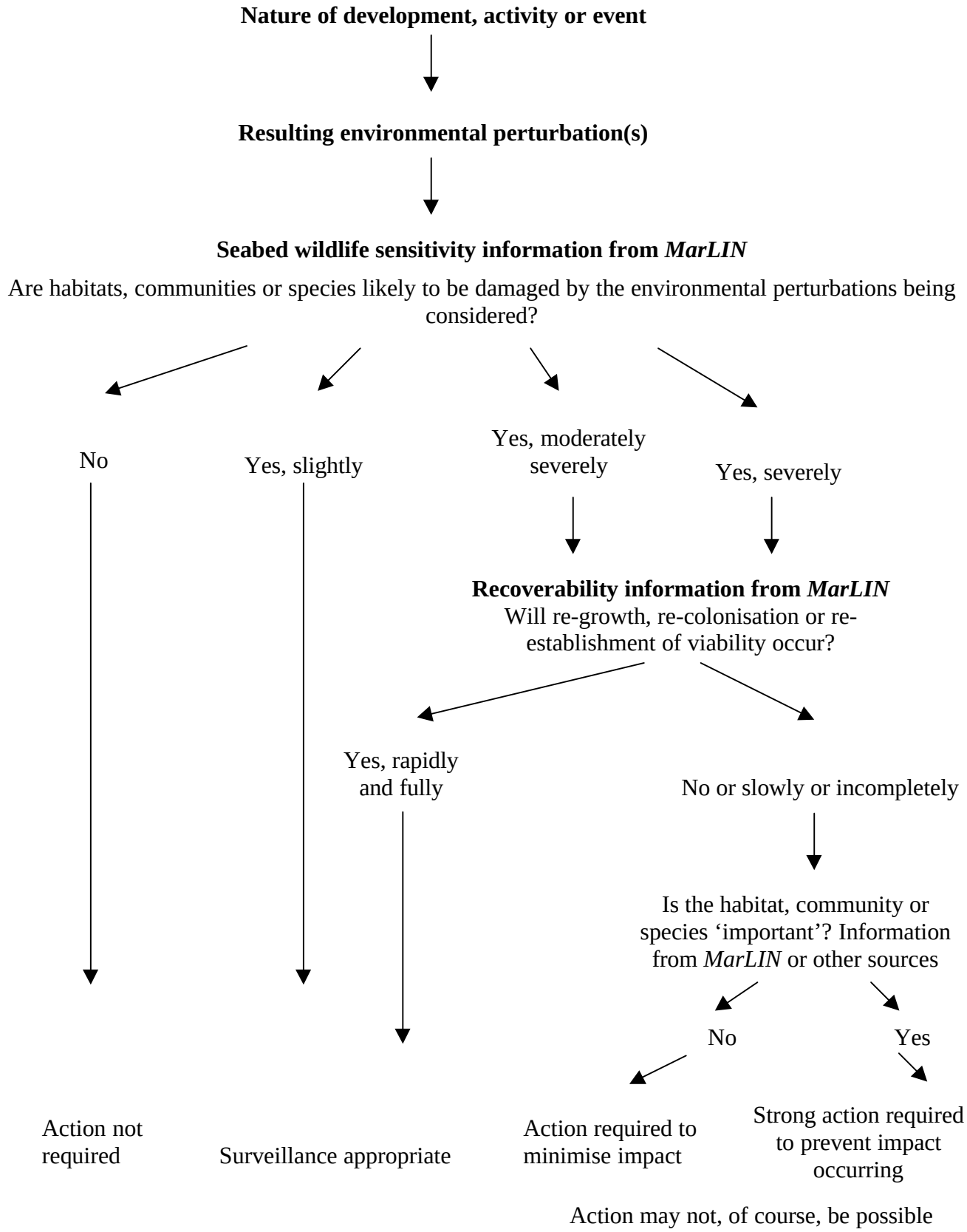


Figure 4. A 'decision tree' for environmental management incorporating concepts of sensitivity and importance (summarised from Hiscock 1999).

1997). Application of such criteria has resulted in the identification of protected areas but can also be used to identify the marine natural heritage importance of any location where there is sufficient information available.

Having 'contextual' information is very important to assessment of importance and there is now a very large resource of information available in Britain and Ireland mainly as a result of the work of the UK nature conservation agencies and, in Ireland, the results of the BioMar programme. Much more data exists and, with rapid access through networks, it will be possible to make much more effective use of that information. This is the 'Seabed data acquisition' Sub-programme within *MarLIN*.

In Britain, the nature conservation agencies, through their Marine Nature Conservation Review (MNCR) programme, have developed a protocol for site assessment based on seabed features. Each assessment is undertaken within physiographically and/or biogeographically distinct parts of the coast – there are 15 for Great Britain – or physiographically similar features; for instance, the Scottish fjordic sea lochs. Assessments are undertaken between defined *areas* using biotopes or biotope complexes (Connor *et al*. 1997 a&b) as the final comparative units. The MNCR is thus identifying specific locations (rather than certain biotopes) as of marine natural heritage importance so that their conclusions are not directly useful to this project but are of great significance for environmental sensitivity mapping.

The criteria used by Von Nordheim, Anderson & Thissen (1996) to define 'threat categories' for biotopes in the Wadden Sea area have been taken account of. These use the sort of information resources which we have for marine biotopes and species. Similarly, the criteria being developed in the UK to identify marine habitats (including biological habitats) and species for Biodiversity Action Plans, in order to fulfil obligations under the Biodiversity Convention, provide criteria to assess 'importance'. Selection criteria being used in the UK have been adjusted to take account of information resources for marine habitats and species. In particular, criteria for marine species are applied for species which are wide ranging and cannot be protected within a designated area and which are vulnerable because of their low fecundity, high age of first maturity and/or inability to re-colonise an area after loss or removal (due to particular developmental biology). The selection criteria, which are for terrestrial and marine features are given in the Box 5.

If a species or biotope is 'rare' or 'scarce', it immediately identifies itself as worthy of protection and 'rarity' is an internationally recognised and used criterion. Interpreting IUCN guidelines (IUCN 1994) in a Great Britain context, nationally 'rare' and 'scarce' species have been identified on the basis of their percentage occurrence in 10x10 km map squares. For inshore areas within the three nautical mile (c.5.5km) limit of territorial seas (which approximates to the zone under the influence of coastal processes), a 'nationally rare' species would occur in 8 or fewer squares, and a 'nationally scarce' species in 9 to 55 squares (Sanderson, 1996). There are significant problems in identifying 'rarity' especially in relation to availability of data but the value of this criterion demands pragmatic approaches. Applying such quantitative measures offshore requires further discussion and the development of international standards.

7. The Database

7.1. Development of the database

In order to store and interrogate the large amounts of data that are to be included within *MarLIN*'s activities it is necessary to utilise database software. Databases provide an excellent storage and retrieval system for the type of information being developed by *MarLIN* and allow the user to formulate 'queries' to extract the exact information they require from the system.

A scoping study was carried out to identify the software requirements of the programme, the available database software and approaches to develop a user-friendly interface (Lear 1999). Lear (1999) identified the following criteria. The software must:

- be 'relational' in its structure (i.e. links between fields, dynamically updateable data);
- be accessible through the Internet;
- permit data entry and manipulation through the Internet;
- allow complex query formation, based on existing data;
- be compatible with other data systems currently in development, such as those within JNCC and the countryside agencies;
- provide sufficient security for data held within it;
- allow data to be readily imported and exported from it;
- be flexible in its design and
- have sufficient capacity for all the data that will be accumulated.

Based on these criteria, Microsoft Access was chosen as the database to provide the backbone of the system. It is widely used within the scientific community and in Web development, and satisfies all the criteria specified above. In addition, it is extensively programmable which allows greater customisation and tailoring of the package to the exact needs of the sub-programme.

The construction of the species database is complete and has undergone rigorous testing. The development of the biotope database is well under way but cannot be completed until the data entry fields are finalised.

The scoping study (Lear1999) also concluded that:

- a Web interface would be used to disseminate and receive information;
- online glossaries would provide clarification of terms for non-specialist users;
- the user interface would utilise Active Server Pages (ASP) and Common Gateway Interface (CGI) technology.

7.2. Key information fields

7.2.1 Introduction

The 'key information' fields expected to be researched and summarised were initially discussed at the Newcastle species recording workshop in February 1998 (Foster-Smith 1998). They have since been used to produce key information reviews as a background to Species Action Plans (UK Biodiversity Action Plans) (an example is given as Appendix 5) and for the OSPAR IMPACT meeting in September 1998 (an example is given as Appendix 6). Some of the trialling and calibration of effort required had therefore already been carried out when project staff came into post.

Significant changes were made to the species key information fields following meetings of the Biology and Sensitivity Key Information Management Group of *MarLIN* in November 1998 and March 1999 and following a sensitivity workshop held in Bangor in January 1999. From extensive testing and experience of actual data entry, further slight modifications have been made in September 1999. The biotope key information fields are still in a draft form and have undergone considerable modification during October 1999.

Key information is entered to a Microsoft Access database which has a wide range of facilities for accessing scales and presenting information. The procedure for data entry is detailed in *MarLIN* Report No. 4 - Assessing seabed species and ecosystem sensitivities. Rationale and user guide (Tyler-Walters and Jackson 1999).

7.2.2 Species fields

With the species key information fields finalised and testing of the database complete no further changes to the database structure are anticipated. Data entry commenced in April 1999. At present, basic information has been entered for ninety species and completed for twenty-two species. An example of a data entry form used to populate the species database is shown in Figure 5. A complete list of the species key information fields is given in Appendix 7.

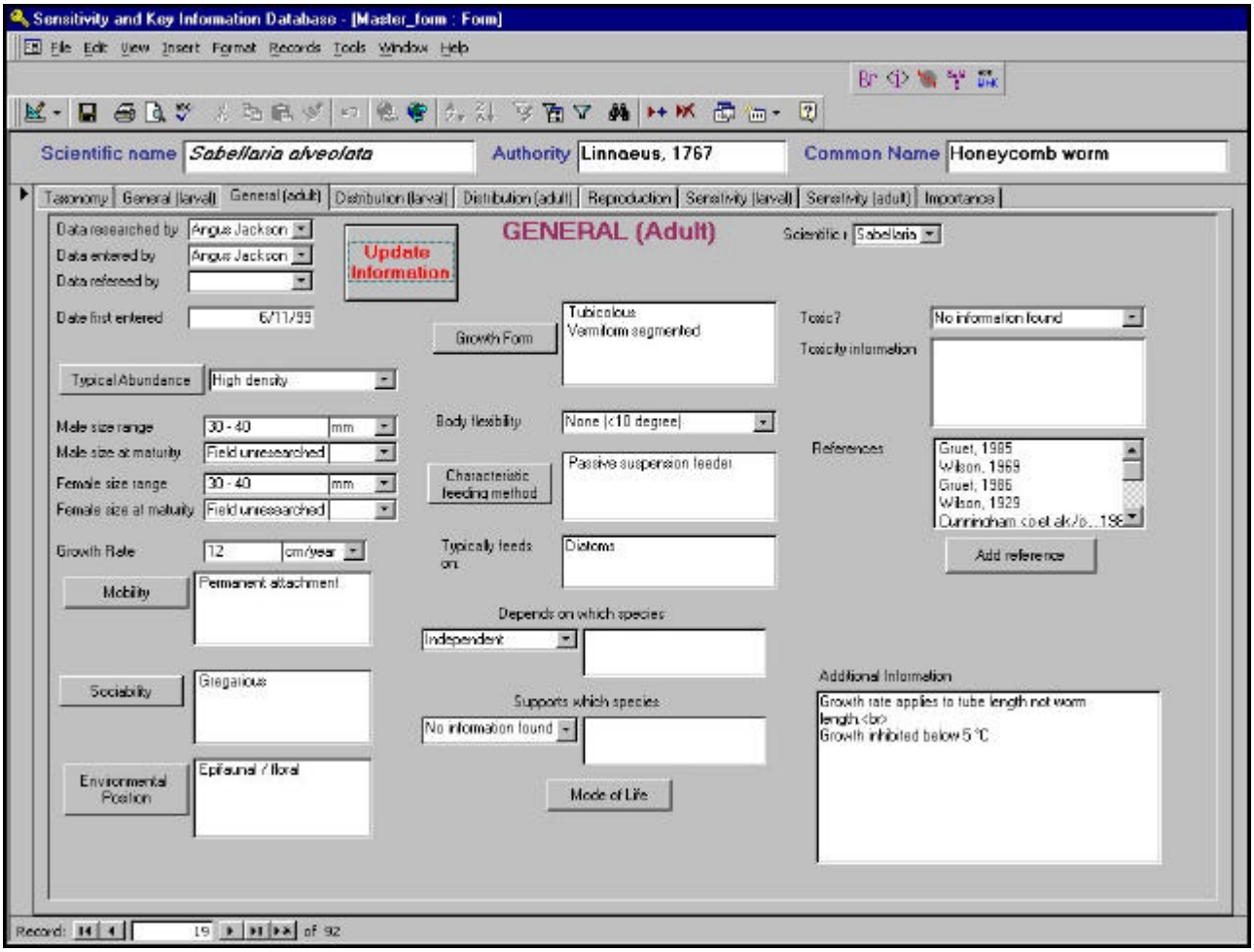


Figure 5. Data entry fields for the adult general biology of a species.

7.2.3 Habitat/biotope fields

The draft version of the key information fields for the biotope database has undergone considerable modification and is in the process of being finalised. An example of a data entry form that is used to populate the biotope database is shown in Figure 6. The draft key information fields for habitat / biotope biology and sensitivity assessment are given in Appendix 7.

7.2.4 Data entry.

Searching for the key information will rely to some extent on straightforward library and Internet searches but will be greatly aided by advice from relevant experts as to sources of academic data.

Completion of some fields in the database will be obligatory in order for basic information to be produced. This basic information can be entered relatively quickly. The remaining fields are prioritised for data entry. Those fields required to add value to biological information (sensitivity, recoverability and importance) along with others of general interest will be targeted first.

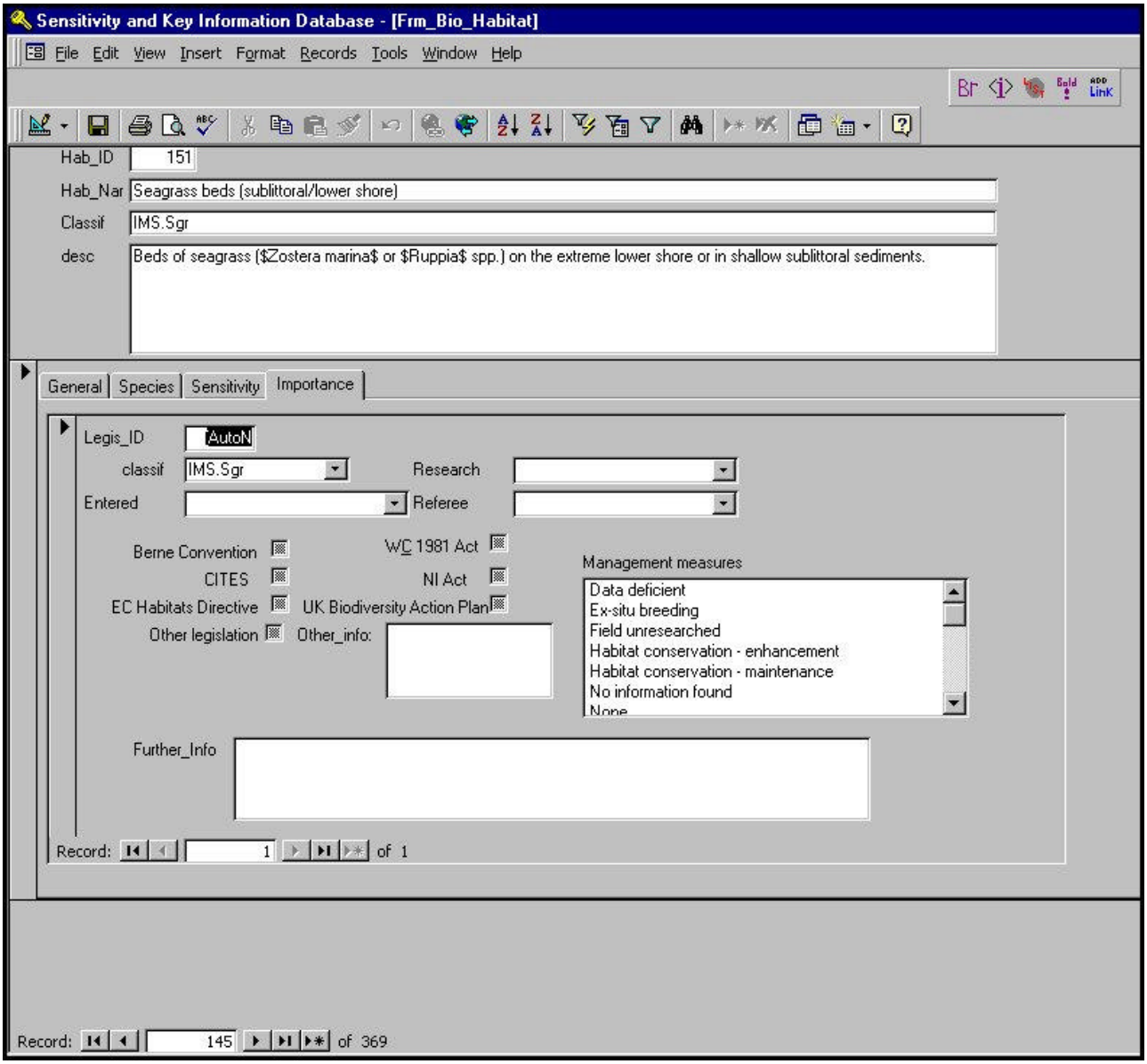


Figure 6. Data entry fields for the importance of a biotope

Some fields can be completed automatically from electronic resources already in existence. For example the electronic biotope classification (JNCC) and species dictionary (Ulster Museum/ Marine Conservation Society) will be used to fill in appropriate fields.

It will be possible to include images of species, biotopes, geographical distribution and even relationships or life cycles etc. However, the key information will not include identification keys or guides.

Quality assurance will be essential and it is proposed that relevant experts referee completed key information reviews. The species and biotope reviews will be published on the Internet so that feedback can be obtained from anyone who looks at them.

8. Sensitivity and recoverability assessments

8.1 Species and biotope sensitivity assessments

Numerous studies have considered the assessment of sensitivity in recent years. The most important or useful are reviewed in Appendix 4. The ICES Benthos Working Group workshops, held under the auspices of the OSPAR IMPACT group, studies commissioned or undertaken by the nature conservation agencies in the UK and subsequent development by *MarLIN* have all contributed to the scales shown in Tables 1 & 2.

Table 1. Species sensitivity scale developed for *MarLIN* and used after September 1999.

SPECIES SENSITIVITY The intolerance of a species population to damage, or death, from an external factor.	
If it is extremely unlikely for a factor to occur (e.g. emergence of a deep water species) then it will be assessed as not relevant.	
Rank	**Definition**
High	The species population is likely to be killed/destroyed by the factor under consideration.
Intermediate	Some individuals of a species population may be killed/destroyed by the factor under consideration and the viability of a species population will be reduced.
Low	A species population is unlikely to be killed/destroyed by the factor under consideration. However, the viability of a species population will be reduced.
Not sensitive	The factor does not have a detectable effect on survival or viability of a species population.
Not sensitive*	A species population may increase in abundance or biomass as a result of the factor.
Not relevant	This rating applies to species populations where the factor is not relevant because they are protected from the factor (for instance, through a burrowing habit), or can move away from the factor.

The present sensitivity scales take into account the need to separate sensitivity *sensu stricto* from frequency of occurrence, intensity and duration of the factor which are elements of vulnerability. The scale also incorporates sub-lethal damage and reproductive effects.

8.2. Benchmarks for sensitivity assessment

In order to be able to make valid comparisons between species, sensitivity to each factor needs to be assessed against a single fixed value or benchmark. Benchmarks are listed in *MarLIN* Report No. 4 (Tyler-Walters & Jackson 1999).

8.3. Species and biotope recoverability assessment

The scale developed by *MarLIN* for recoverability potential is given in Table 3. The same scale has been applied to both species and biotopes.

Table 2. Biotope sensitivity scale developed for *MarLIN* and used after September 1999.

BIOTOPE SENSITIVITY The intolerance of a habitat or community of species to damage, or death, from an external factor.	
Rank	**Definition (adapted from Hiscock, Jackson & Lear 1999)**
High	Keystone/dominant species in the biotope or habitat are likely to be killed/destroyed by the factor under consideration.
Intermediate	The population(s) of keystone/dominant species in a community may be reduced/degraded by the factor under consideration, the habitat may be partially destroyed or the viability of a species population, diversity and function of a community may be reduced.
Low	Keystone/dominant species in a community or the habitat being considered are unlikely to be killed/destroyed by the factor under consideration and the habitat is unlikely to be damaged. However, the viability of a species population or diversity / functionality in a community will be reduced.
Not sensitive	The factor does not have a detectable effect on structure and functioning of a biotope or the survival or viability of keystone/important species
Not sensitive*	The extent or species richness of a biotope may be increased or enhanced by the factor.
Not relevant	Sensitivity may be assessed as not relevant where communities and species are protected or physically removed from the factor (for instance circalittoral communities are unlikely to be effected by increased emergence regime).

8.4. Confidence

In line with the requirements for Quality Assessment of the information provided by the *MarLIN* Biology and Sensitivity Key Information Sub-programme, confidence levels are allocated to each assessment. Definitions for the various levels of confidence used by *MarLIN* are shown in Table 4.

9. Publication of information

Information from the database will be published on the Internet in the form of standardised web pages. Specific products, on CD or paper may be produced from time-to-time.

The data fields will be available through a Web interface, facilitating the distribution of the information through the Internet. This will be achieved by a combination of Active Server Pages (ASP) and custom made Visual Basic applications. This combined approach will give greater

flexibility to the system. Technical details of the Web interface under development are given in the software scoping study (*MarLIN* Report No. 2; Lear 1999).

Table 3. Recoverability potential.

RECOVERABILITY	DESCRIPTION
None	Recovery is not possible.
Very low	Partial recovery is only likely to occur after about ten years and full recovery may take over 25 years.
Low	Only partial recovery is likely within ten years and full recovery is likely to take up to 25 years.
Moderate	Only partial recovery is likely within five years and full recovery is likely to take up to ten years.
High	Full recovery will occur but will take many months (or more likely years) but should be complete within about five years.
Very high	Full recovery is likely within a few weeks or at most six months.
Immediate	Recovery immediate or within a few days

Table 4. Confidence levels for sensitivity and recoverability assessments.

CONFIDENCE A feeling of reliance or certainty	
Confidence level	**Definition**
High	Assessment has been derived from sources that specifically deal with sensitivity and recoverability to a particular factor. Experimental work has been done investigating the effects of such a factor.
Moderate	Assessment has been derived from sources that consider the likely effects of a particular factor.
Low	Assessment has been derived from sources that only cover aspects of the biology of the species or from a general understanding of the species. No information is present regarding the effects of factors.
Very low	Assessment derived by 'informed judgement' where very little information is present at all on the species.
Not relevant	The available information does not support an assessment, the data is deficient or no relevant information has been found.

It is important that the presentation of the information as a 'front end' is as user-friendly as possible. The information is targeted at a wide audience, including school children, amateur data recorders and professional researchers. The proposed layout of information from the species and biotopes sections of the database is shown in Figures 7 and 8.

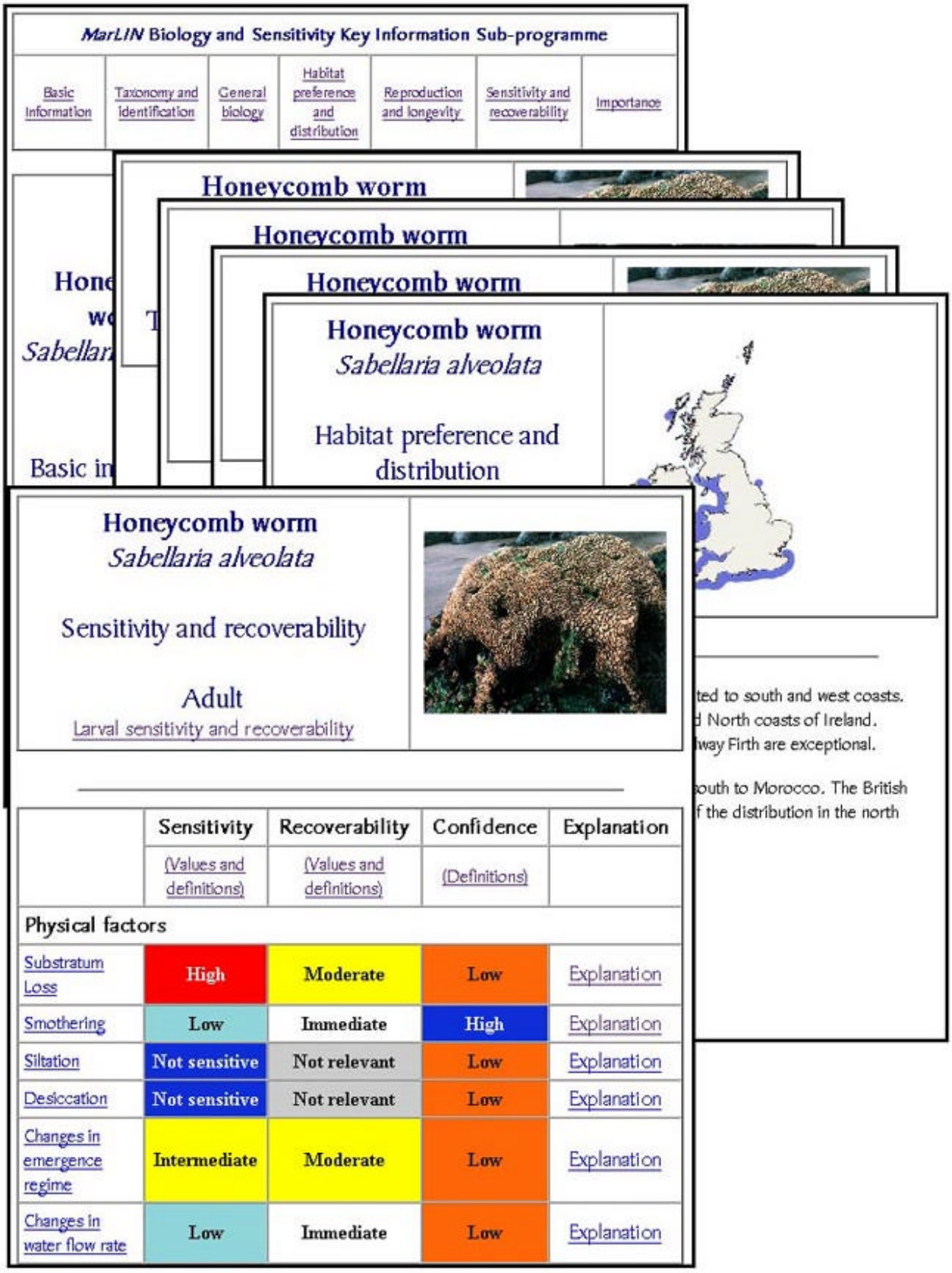
In addition to the information provided in the species and biotope pages, it will be possible to interrogate of the database directly. This will be able to be done in two ways:

- the selection of 'generic' frequently asked questions, for example "list all of the species in the database covered by Biodiversity Action Plans"; and
- creation of user-defined queries "on the fly", for example "list all of the species in the database that are highly sensitive to changes in oxygenation.

This 'layered' approach will ensure that the user can to select the information they require at the level of detail they require.

10. Acknowledgements

Much of the text in this report has been copied from reports and publications produced on the topic of sensitivity by Keith Hiscock. Harvey Tyler-Walters has contributed significantly to the October version.



	Sensitivity	Recoverability	Confidence	Explanation
	(Values and definitions)	(Values and definitions)	(Definitions)	
Physical factors				
Substratum Loss	High	Moderate	Low	Explanation
Smothering	Low	Immediate	High	Explanation
Siltation	Not sensitive	Not relevant	Low	Explanation
Desiccation	Not sensitive	Not relevant	Low	Explanation
Changes in emergence regime	Intermediate	Moderate	Low	Explanation
Changes in water flow rate	Low	Immediate	Low	Explanation

Figure 7. How various information pages for a species currently appear after interrogation of the database.

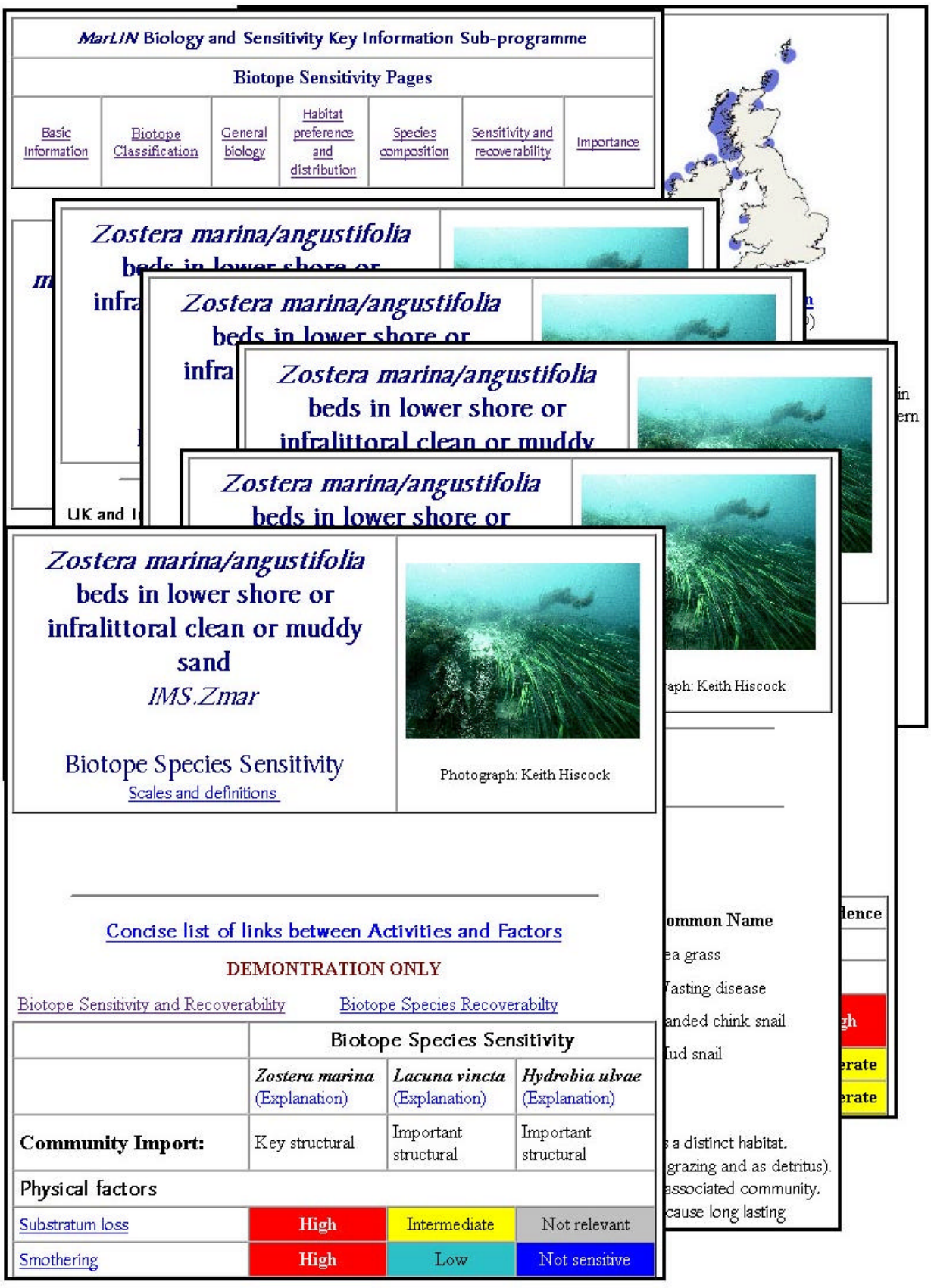


Figure 8. How various information pages for a biotope currently appear after interrogation of the database.

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Appendices

Appendix 1. *MarLIN* Objectives and Guiding Principles

MarLIN OBJECTIVES AND GUIDING PRINCIPLES

THE BIOLOGY AND SENSITIVITY KEY INFORMATION SUB-PROGRAMME

Objective 1

To provide the scientific information required by marine and coastal managers to better understand and describe the sensitivity of key seabed habitats, biotopes and species to natural events and human activities.

Guiding principles to Objective 1

1. The habitats, biotopes and species will be those which are commonly accepted: biotope complexes, biotopes and sub-biotopes from the MNCR biotopes classification (as amended) (Connor *et al.* 1997); species from the MCS/Ulster Museum Species Directory (Howson & Picton 1997) (supplemented for deep water areas within the EEZ.)
2. Any scale developed within *MarLIN* to indicate sensitivity of a habitat biotope or species must:
    1. take account of systems already developed to use their best features;
    2. be assessed against scales developed as a result of expert workshops;
    3. be assigned a confidence rating which also indicates 'lack of knowledge';
    4. be disseminated in a form capable of understanding by non-biologists.
3. Acknowledging that preparing full key information and sensitivity assessments for a habitat, biotope or species is a time consuming activity, to adopt an overall two-tiered approach to the development and implementation of the sensitivity work as follows:
    1. Initially, selective information will be entered to the database for all priority habitats, biotopes and species according to the criteria listed below.
    2. Subsequently, further information will be entered for high priority habitats, biotopes or species.

    Priority will be given to habitats, biotopes and species that:

    a. the UK Government has management responsibilities or obligations for under international conventions and directives including protected species and BAP listed species;

    b. have been identified in European workshops as threatened or requiring documentation;

    c. are subject to national regulations;

    d. contribute to national nature conservation initiatives;

    e. are surrogates for the condition of other habitats, biotopes or species;

    f. are indicators of threatening processes;

    g. are at high risk of impact due to their sensitivity or vulnerability;

    h. are nationally rare or scarce;

    i. are 'keystone' or characteristic species of a habitat or biotope.

4. Some habitats, biotopes and taxonomic groups that are well documented will also be researched/entered to the database to trial the development of the information fields and database.
5. As habitat, biotope and species pages are completed, they will be refereed by collaborators with experience in the relevant field.
6. Habitat, biotope and species pages will be available on the web and comments will be invited especially on the completed key information and to identify further information sources.

Objective 2

To develop a user-friendly computer-based system that will allow the information thus gathered to be interpreted and used by decision-makers applying the ecosystem approach to environmental management.

Guiding principles to objective 2

1. Demonstration material will be openly accessible on the Internet.
2. Full information will be available through the Internet and CD-ROMs or an Intranet as appropriate to partners / subscribers to *MarLIN*.
3. The system will operate by linking to geo-referenced data sources including MNCR data, accessed under the *MarLIN* seabed data access and acquisition sub-programme.
4. The information will be presented in a format and in a level of detail that will enable organisations or individuals with an interest or responsibility in the marine environment to undertake a preliminary assessment of the likely impact of a human activity or operation on marine habitats, biotopes or species.
5. The information will be accessed using a variety of approaches, including:
   - from an accepted list of potential threatening activities;
   - from the component factors of an activity;
   - from the species or biotope dictionaries.

   Threatening activities will be modified from the Marine Conservation Handbook and JNCC Marine Information Team keywords.

Appendix 2. Glossaries

General: Glossary of technical marine biological terms likely to be used in the Biology and Sensitivity Key Information Sub-programme. Compiled from McLeod (1996) with additions from Hiscock (1998) and various other references.

abiotic Devoid of life.

aboral Opposite the end/side on which the mouth is located (Kozloff 1996).

abundance scale A scale describing the relative abundance of organisms (as numbers of individuals per unit area or as % cover), with groupings in several broad categories. In the case of the MNCR's semi-logarithmic 'SACFOR' scale, the units are Superabundant; Abundant; Common; Frequent; Occasional; Rare. (Scale from Connor & Hiscock 1996).

accretion Build up or accumulation of sediment.

activity (maritime) An anthropogenic operation or activity which occurs in the marine or coastal environment (Cooke and McMath 1998)

aggregation Organisms (usually referring to of the same species) living closely together, but not physically connected (cf. 'colony').

algal mat A dense mass of green or other algae (e.g. *Enteromorpha* spp., *Ulva* spp.) which blankets the substratum in a littoral or shallow-water environment, often in areas of freshwater influence or where eutrophication occurs.

alien species A non-established introduced species (q.v.), which is incapable of establishing self-sustaining or self-propagating populations in the new area without human interference (cf. 'introduced species'; 'non-native').

anadromous (of fish) Upward-running: spending part of their life in the sea and migrating up rivers in order to breed (e.g. salmon) (cf. 'catadromous').

anaerobic An environment in which the partial pressure of oxygen is significantly below normal atmospheric levels; deoxygenated (Lincoln *et al.*1998).

annulated Where the external surface is divided into a chain of rings or 'annuli' by furrows giving the appearance of segments (Barnes *et al.*1993).

anoxic Devoid of oxygen.

anthropogenic Produced by human activity.

aquaculture The cultivation of aquatic organisms by human effort for commercial purposes. For the cultivation of marine organisms in seawater, the term 'mariculture' is also used. (Based on Baretta-Bekker *et al.* 1992.)

arborescent / arbuscular Having the shape or characteristics of a tree.

arctic Referring to a biogeographical region centred north of the British Isles and influencing the extreme north of the British Isles.

articulate Jointed, arthrous (Holmes 1979).

assessment **1)** The evaluation of marine natural heritage importance through an orderly process of gathering information about biotopes and species in an area and comparing their attributes by a standard protocol (as in 'conservation assessment'). **2)** The evaluation of the likely impact of a development on the environment (as in 'Environmental Impact Assessment').

association A term used by botanists to refer to an assemblage of plants with a definite floristic composition, considered by many workers to be synonymous or very similar to the zoological concept of 'community' (from Hiscock & Connor 1991).

attribute A characteristic of a habitat, biotope, community or population of a species which most economically provides an indication of the condition of the interest feature to which it applies. (CSMR.)

autecology The ecology of individual organisms or species (Lincoln *et al.*1998) (cf. 'synecology').

autotrophic Self-feeding, producing organic matter through photosynthesis (Prescott 1969).

azoic Devoid of animal life.

bathyal Pertaining to the sea floor between 200 m and 4000 m (Lincoln & Boxshall 1987).

bedrock Any stable hard substratum, not separated into boulders or smaller sediment units.

benthos Those organisms attached to, or living on, in or near, the seabed, including that part which is exposed by tides as the littoral zone (based on Lincoln & Boxshall 1987).

bioaccumulation The ability of organisms to retain and concentrate substances from their environment. The gradual build-up of substances in living tissue; usually used in referring to toxic substances; may result from direct absorption from the environment or through the food-chain. Cf. 'biomagnification'.

biocoenosis (biocenosis) A term used in continental Europe which can be considered roughly equivalent to 'community' as suggested by Cain (1939), i.e. "a term of convenience which is employed to designate sociological units to every degree from the simplest one-layered aggregation to the most complex phytocoenosis" (Hiscock & Connor 1991).

biodegradation Breakdown or decomposition by bacteria or other biological means.

biodiversity (biological diversity) "The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." (UN Convention on Biological Diversity 1992).

biogeography The branch of biology concerned with the geographical distribution of plants and animals, and the factors influencing that distribution.

biomagnification. (bioconcentration) Increasing concentration of a substance in successive trophic levels of a food chain (cf. 'bioaccumulation').

biomass The total quantity of living organisms in a given area, expressed in terms of living or dry weight or energy value per unit area.

biome A major ecological community, extending over a large area and usually characterised by a dominant vegetation (from Makins 1991).

biota The plant and animal life of a particular site, area, or period.

biotope 1) The physical 'habitat' with its biological 'community'; a term which refers to the combination of physical environment (habitat) and its distinctive assemblage of conspicuous species. MNCR uses the biotope concept to enable description and comparison. 2) The smallest geographical unit of the biosphere or of a habitat that can be delimited by convenient boundaries and is characterised by its biota (Lincoln *et al*.1998).

bioturbation The mixing of a sediment by the burrowing, feeding or other activity of living organisms (Lincoln *et al*.1998).

bivalved Characteristically a shell of two calcareous valves joined by a flexible ligament.

boreal 1) biogeographical Pertaining to cool or cold temperate regions of the northern hemisphere (Lincoln *et al*.1998). **2) Marine zoogeography** Ekman (1953) states that the centre of the boreal region lies in the North Sea. It is bounded by the subarctic transitional zone to the north between Shetland, the Faroe Islands and Iceland and in the south-west of Britain by a transitional zone with the Mediterranean-Atlantic lusitanian region.

boring Makes an excavation (through physical or chemical action) in which to live.

brackish Referring to mixtures of fresh and seawater. Usually regarded as between 0.5 ‰ and 30 ‰ salinity (q.v.) (based on McLusky 1993).

budding A form of asexual multiplication in which a new individual begins life as an outgrowth from the body of the parent. It may then separate to lead an independent existence or remain connected or otherwise associated to form a colonial organism (Barnes *et al*.1993).

bullate (saccate) Balloon or sac-like (Prescott 1969).

calcareous Containing calcium carbonate; chalky. (Of organisms): a species which accumulates calcium carbonate in its tissues.

capitate Enlarged or swollen at the apex, with a 'head', clubbed. (Prescott 1969).

carnivore A predator which feeds on animals.

catadromous (of fish) Downward-running: spending most of their life in rivers and migrating downstream to the sea in order to breed (e.g. eels) (cf. 'anadromous').

characteristic (species) Special to or especially abundant in a particular situation or biotope. Characteristic species should be immediately conspicuous and easily identified. (Based on Hiscock & Connor 1991.)

circalittoral The subzone of the rocky sublittoral below that dominated by algae (the infralittoral), and dominated by animals. No lower limit is defined, but species composition changes below about 40m to 80m depth, depending on depth of the seasonal thermocline. This subzone can be subdivided into the upper circalittoral where foliose algae are present and the lower circalittoral where they are not (see Hiscock 1985). The term is also used by Glémarec (1973) to refer to two étages of the sediment benthos below the infralittoral: a "coastal circalittoral category with a eurythermal environment of weak seasonal amplitude (less than 10°C) varying slowly" and a "circalittoral category of the open sea with a stenothermal environment". 1) lower The part of the circalittoral subzone on hard substrata below the maximum depth limit of foliose algae (based on Hiscock 1985). 2) upper The part of the circalittoral subzone on hard substrata distinguished by the presence of scattered foliose algae amongst the dominating animals; its lower limit is the maximum limit of depth for foliose algae (based on Hiscock 1985).

classification 1) taxonomy The placing of animals and plants in a series of increasingly specialised groups because of similarities in structure, origins etc., that indicate a common relationship (from Makins 1991). **2) biotopes** The process of identifying distinctive and recurrent groupings of species with their associated habitat and describing them within a structured framework.

clathrate Latticed (Holmes 1979).

clonal An assemblage of organisms derived by asexual or vegetative multiplication from a single original parent – generally assumed to be genetically identical. (From Lincoln *et al*.1998.)

coastal zone The space in which terrestrial environments influence marine (or lacustrine) environments and *vice versa*. The coastal zone is of variable width and may also change in time. Delimitation of zonal boundaries is not normally possible; more often such limits are marked by an environmental gradient or transition. At any one locality the coastal zone may be characterised according to physical, biological or cultural criteria, which need not, and rarely do, coincide. (Based on Carter 1988.)

colonial Descriptive of organisms produced asexually which remain associated with each other; in many animals, retaining tissue contact with other polyps or zooids as a result of incomplete budding (Barnes *et al*. 1996).

colonisation The process of establishing populations of one or more species in an area or environment where the species involved were not present before (from Baretta-Bekker *et al.* 1992).

colony 1) A group of organisms of the same species living connected together in a common mass (Fitter & Manuel 1986.) (cf. 'aggregation'). **2)** A group of organisms connected by behavioural or sociological factors (e.g. seabird colony, seal colony).

commensalism Symbiosis (q.v.) in which one species derives benefit from a common food supply, whilst the other species is not adversely affected (Lincoln *et al*.1998).

community A group of organisms occurring in a particular environment, presumably interacting with each other and with the environment, and identifiable by means of ecological survey from other groups (from Mills 1969; see Hiscock & Connor 1991 for discussion.)

confidence A feeling of reliance or certainty (Thompson 1995).

conservation (nature) "The regulation of human use of the global ecosystem to sustain its diversity of content indefinitely" (Nature Conservancy Council 1984).

constancy 1) The frequency of occurrence of a species in samples from the same community (based on Makins 1991). **2)** The continued presence of a species or community at a particular location. (Cf. 'persistence', 'resilience', 'stability').

contamination "An increase of background concentration of a chemical or radionuclide" (from Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection - GESAMP - 1995).

coralline Relating to, or resembling, coral, especially any calcareous red alga impregnated with calcium carbonate.

cosmopolitan Of worldwide distribution (Brusca 1980).

critically endangered (IUCN Red List categories) A taxon is Critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future (International Union for the Conservation of Nature and Natural Resources 1994) (cf. 'Extinct', 'Endangered', 'Vulnerable').

crustose Forming or resembling a crust (Thompson 1995).

cryptic (cryptozoic) 1) An animal which lives in hidden places, such as crevices, caves or beneath stones. **2)** An organism whose appearance or coloration makes it difficult to see or recognise.

cylindrical With straight sides and a circular section (Thompson 1995).

decomposers Organisms which feed by breaking down dead organic matter (from Lincoln *et al.*1998).

demersal Living at or near the bottom of a sea or lake, but having the capacity for active swimming (from Lincoln *et al.*1998).

dendroid Branching irregularly – similar to that of a root system (Prescott 1969).

dependency (conservation assessment) The reliance (of a species, community or ecological process) on a particular location (for instance, a feeding, breeding, sheltering area or a migration corridor) or structure (for instance, a kelp forest, a sea grass bed, a maerl bed) for survival.

deposit-feeders Any organisms which feed on fragmented particulate organic matter in or on the substratum; detritivores (from Lincoln *et al.*1998).

desiccation Removal of water; the process of drying. (Lincoln *et al.*1998)

detritus Fragmented particulate organic matter, derived from the decomposition of plant and animal remains.

diel Daily, pertaining to a 24 hour period (Lincoln *et al.*1998).

digitate Having parts arranged like fingers on a hand (Holmes 1979).

dimorphic Occurring in two distinct forms (usually morphological forms) (Barnes *et al.*1993).

direct development Development without a larval stage (cf. indirect development)(Barnes *et al.*1993).

disturbance "A chemical or physical process caused by humans that may or may not lead to a response in a biological system within an organism or at the level of whole organisms or assemblages. Disturbance includes stresses". (from Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection - GESAMP - 1995).

diversity The state or quality of being different or varied (from Makins 1991). In relation to species, the degree to which the total number of individual organisms in a given ecosystem, area, community or trophic level is divided evenly over different species, i.e. measure of heterogeneity. Species diversity can be expressed by diversity indices, most of which take account of both the number of species and number of individuals per species (Based on Baretta-Bekker *et al.* 1992). Cf. 'evenness'; 'richness'.

diversity (conservation assessment) An assessment of the richness of different types in a location (which can be large or small) including the number of different biotopes and numbers of species. The number of species present in an example of a particular biotope.

ecad A plant or animal form produced in response to particular habitat factors, the characteristic adaptations not being heritable; a habitat form (from Lincoln *et al*.1998).

ecology The study of the inter-relationships between living organisms and their environment (from Lincoln *et al*.1998).

Ecological Quality (EcoQ) An expression of the structure and function of the ecological system taking into account natural physiographic, geographic and climatic factors as well as biological, physical and chemical conditions including those resulting from human activities (from a draft of the EC Ecological Quality of Water Directive)

Ecological Quality Objective (EcoQO) The desired level of the EcoQ relative to a reference level.

ecosystem A community of organisms and their physical environment interacting as an ecological unit (from Lincoln *et al*.1998). Usage can include reference to large units such as the North Sea down to much smaller units such as kelp holdfasts as "an ecosystem".

ecotone The zone of transition between two major ecological communities.

endangered (IUCN Red List categories) A taxon is considered Endangered when it is not Critically endangered (q.v.) but is facing a very high risk of extinction in the wild in the near future (International Union for the Conservation of Nature and Natural Resources 1994) (cf. 'Extinct', 'Critically endangered', 'Vulnerable').

endemic Referring to organisms that are confined to a particular area or geographical location (Prescott 1969).

environment The complex of biotic climatic, edaphic and other conditions which comprise the immediate habitat of an organism; the physical, chemical and biological surroundings of an organism at any given time. (cf. 'habitat')(from Lincoln *et al*.1998).

Environmental Assessment (EA) Environmental Impact Assessment (EIA) A process of predicting and evaluating an action's impacts on the environment, from which the conclusions are used as a tool in decision-making. It aims to minimise environmental degradation by giving decision-makers better information about the consequences which development actions could have on the environment, although it cannot, in itself, achieve that protection (based on Pritchard 1993). An Environmental Assessment can be used to produce an Environmental Statement (ES). Cf. 'Environmental Statement' 'Strategic Environmental Assessment'

Environmental Statement (ES) A statement intended to provide all of the information needed to evaluate the likely environmental implications of a proposed development. (Adapted from Treweek 1996). Cf. 'Environmental Assessment (EA)'.

epibenthos All organisms living on the surface of the seabed.

epifauna Animals living on the surface of the seabed.

epilithic Growing on the surface of rock.

epiphytic Growing on the surface of a living plant (but not parasitic upon it).

epizoic Growing or living on the exterior of a living animal (but not parasitic upon it).

euhaline Fully saline seawater > 30 ‰ salinity.

eulittoral The main part of the littoral zone characterised by limpets, barnacles, mussels, fucoid algae (other than those characteristic of the littoral fringe), with red algae often abundant on the lower part. It lies above the main population of Laminariales. Zonation within the eulittoral is variable, with two to four (commonly three) belts often clearly discernible. 1) (lower) The lower belt of the eulittoral subzone, bordering the sublittoral fringe, and generally dominated by *Fucus serratus* and red algae. 2) (mid) The broad middle belt of the eulittoral subzone, usually characterised by limpets and barnacles or *Mytilus* and filamentous red algae in exposed situations, or dominated by fucoids, often with clumps of large mussels present, in shelter. 3) (upper) The narrow upper belt of the eulittoral subzone, often very variable in character. (from Hiscock 1990).

euryhaline Of or relating to the capability of an organism to live in environments of variable salinity (from Charton & Tietjen 1989).

eurythermal Of or relating to the capacity of some organisms to survive in a wide range of temperatures (from Charton & Tietjen 1989).

eutrophication The over-enrichment of an aquatic environment with inorganic nutrients, especially nitrates and phosphates, often anthropogenic (e.g. sewage, fertiliser run-off), which may result in stimulation of growth of algae and bacteria, and can reduce the oxygen content of the water.

exposed (wave exposure) 1) Coasts which face the prevailing wind but which have a degree of shelter because of extensive shallow areas offshore, offshore obstructions, or a restricted (less than 90°) window to open water. These sites are not generally exposed to large waves or regular swell. **2)** Open coasts facing away from prevailing winds but with a long fetch, and where strong winds are frequent (from Hiscock 1990).

exposure The degree of wave action on an open shore, governed by the distance of open sea over which the wind may blow to generate waves (the fetch) and the strength and incidence of the winds (Hawkins & Jones 1992). Expressed as a descriptive scale for MNCR recording. Cf. 'exposed', 'extremely exposed', 'sheltered', 'ultra-sheltered', 'very exposed', 'very sheltered'.

extent (conservation assessment) In identifying sites for protection, preference will be given to sites with larger examples of highly rated or rarer biotopes. It is also necessary to consider the size of site required to ensure that the unit to be managed is 'viable'.

extinct (IUCN Red List categories) A taxon is 'extinct' when there is no reasonable doubt that the last individual has died (International Union for the Conservation of Nature and Natural Resources 1994). The term can be applied on a local or national basis as well as world-wide and is also used to refer to situations where it no longer exists from a particular point of view (for instance: 'functionally extinct'; 'commercially extinct'). Cf. 'Critically endangered', 'Endangered', 'Vulnerable'.

extremely exposed (wave exposure) Open coastlines which face into the prevailing wind and receive both wind-driven waves and oceanic swell without any offshore obstructions such as islands or shallows for several thousand kilometres and where deep water is close to the shore (50 m depth contour within about 300 m) (from Hiscock 1990).

extremely sheltered (wave exposure) Fully enclosed coasts with a fetch of no more than about 3 km (from Hiscock 1990).

facies (biological) A geographical variant of a marine community, or a variant which includes a conspicuous or abundant species not present in the main community (based on Hiscock & Connor 1991, from Cotton 1912).

factor (environmental) A component of the physical, chemical, ecological or human environment that may be influenced by natural events or anthropogenic activity (Tyler-Walters & Jackson 1999).

fauna 1) The animal life of a given region, habitat or geological period; **2)** A descriptive catalogue of the above (from Lincoln *et al.*1998).

fecundity The potential reproductive capacity of an organism or population, measured by the number of gametes (eggs) or asexual propagules.

filiform Filamentous slender and thread-like (Kozloff 1996).

filter-feeder (see 'suspension-feeder')

fission Form of asexual multiplication involving division of the body into two or more parts each or all of which can grow into new individuals (Barnes *et al.*1993).

flabellate Shaped like a fan, fanlike (Brusca 1980).

flaccid Soft, limp, flabby (Brusca 1980).

flora 1) The plants or plant life of a particular region, habitat or geological period. **2)** A descriptive catalogue of the above. (from Lincoln *et al.*1998).

foliose Bearing leaves or leaf-like structures; having the appearance of a leaf.

fragility (conservation assessment) The degree of sensitivity of habitats, communities and species to environmental change (Ratcliffe 1977) (cf. sensitivity).

funnel shaped In the shape of a funnel.

globose Spherical / ovoid / globular (Brusca 1980).

gonochoristic Having separate sexes (cf. hermaphroditic) (Barnes *et al.*1993).

grazers 1) Animals which: rasp benthic algae (or sessile animals, such as bryozoan crusts) from the substratum, or **2)** animals which ingest phytoplankton from the water column by suspension-feeding (q.v.).

gregarious Living in groups or communities, growing in clusters.

growth form The physical appearance and structure of an organism (cf. life form).

habitat The place in which a plant or animal lives. It is defined for the marine environment according to geographical location, physiographic features and the physical and chemical environment (including salinity, wave exposure, strength of tidal streams, geology, biological zone, substratum, 'features' (e.g. crevices, overhangs, rockpools) and 'modifiers' (e.g. sand-scour, wave-surge, substratum mobility). (Cf. 'environment').

Habitats Directive The abbreviated term for *Council Directive 92/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora* (Commission of the European Communities 1992). Known until about autumn 1994 informally as the "Habitats and Species Directive".

haline Another term for saline (q.v.).

halocline A horizontal boundary layer in the water-column, at which salinity changes sharply with depth.

heavy metal A generic term for a range of metals with a moderate to high atomic weight, for example cadmium, mercury, lead. Although many are essential for life in trace quantities, in elevated concentrations most are toxic and bioaccumulate, and so are important pollutants.

herbivores Organisms which feed on plants, including phytoplankton.

hermaphroditic Capable of producing both ova and spermatozoa either at the same time (permanent) or sequentially (cf. protandry, protogyny, gonochoristic) (Barnes *et al.*1993).

holeuryhaline A term used for organisms that freely inhabit fresh water, seawater and brackish water, or which establish populations in all these environments (from Lincoln *et al.*1998).

holoplankton Plankton with a completely pelagic life cycle (cf. meroplankton) (from Baretta-Bekker *et al.* 1992).

hydrocarbons Organic compounds containing mainly hydrogen and carbon; the basic constituents of fossil fuels.

importance In the context of marine natural heritage: species or biotopes which are rare or very restricted in their distribution; species or biotopes that are in decline or have been; species or biotopes where a country has a high proportion of the regional or world population or extent; species that are keystone in a biotope by providing a habitat for other species; biotopes with a particularly high species richness; locations or biotopes that are particularly good or extensive representatives of their type. Species will also be 'important' if they are listed for protection on statutes, directives and conventions.

imposex An abnormality of the reproductive system in female gastropod molluscs, by which male characteristics are superimposed onto female individuals (Smith 1980), resulting in sterility or, in extreme cases, death. This may be caused by hormonal change in response to pollution from organotin antifoulants, even at low concentrations. See 'organotin'.

indicator organisms or species An organism whose characteristics (e.g. presence or absence, population density, dispersion, reproductive success) are used as an index of attributes too difficult, inconvenient, or expensive to measure for other species, or environmental conditions of interest (Landres, Verner & Thomas 1988). Such characteristics may be used to indicate the degree of pollution or other environmental conditions at a particular locality. See Rowell (1994) and GESAMP (1995) for a discussion.

infauna Benthic animals which live within the seabed.

infralittoral A subzone of the sublittoral in which upward-facing rocks are dominated by erect algae, typically kelps; it can be further subdivided into the upper and lower infralittoral (based on Hiscock 1985). The term is also used by Glémarec (1973) to refer to areas (étages) with a eurythermal environment of great seasonal and also daily and tidal amplitude. **1) lower** The part of the infralittoral subzone which, on hard substrata, supports scattered kelp plants (a kelp park) or from which kelps are absent altogether and the seabed is dominated by foliose red and brown algae. It may be difficult to distinguish the lower infralittoral where grazing pressure prevents the establishment of foliose algae. **2)** upper The part of the infralittoral subzone which, on hard substrata, is dominated by Laminariales forming a dense canopy, or kelp forest (based on Hiscock 1985).

inquilinism A symbiotic association in which one symbiont lives in close association with another, generally in the tube or burrow or actually within a body chamber of the host (Brusca 1980).

international importance 1) biotopes or areas (conservation assessment) Biotopes or areas which are highly rated in a coastal sector (q.v.) are considered of international importance if they are one of the best examples or only examples present in the north-east Atlantic (North Cape, Norway to Gibraltar). This was, until 1995, defined for communities as being: "Communities which are outstandingly good examples of their type in the north-east Atlantic. Communities recorded at only a very few locations in the north-east Atlantic" (Hiscock & Mitchell 1989). Cf. 'international importance: species', 'local importance', 'national importance', 'regional importance' (biotopes or areas and species). **2) species** (conservation assessment) Species which are recorded at only a very few locations in the north-eastern Atlantic. Species recorded in higher abundance in the area under consideration than anywhere else in the north-eastern Atlantic, or where the area is one of only a few locations where large quantities are recorded (Davies *et al.* 1990, based on Hiscock & Mitchell 1989). Cf. 'international importance: biotopes or areas', 'local importance', 'national importance', 'regional importance' (biotopes or areas and species).

interstitial Relating to the system of cavities and channels formed by the spaces between grains in a sediment (interstitial space).

intertidal The zone between the highest and lowest tides (from Lincoln *et al*.1998).

introduced species Any species which has been introduced directly or indirectly by human agency (deliberate or otherwise), to an area where it has not occurred in historical times and which is separate from and lies outside the area where natural range extension could be expected (i.e. outside its natural geographical range (q.v.)). The term includes non-established introductions ('aliens' (q.v.)) and established non-natives (q.v.), but excludes hybrid taxa derived from introductions ('derivatives').

irreplaceability (conservation assessment) Not capable of replacement if destroyed in some way. Applied to habitat features, biotopes and species.

iteroparous Breeding several times per lifetime (cf. semelparous) (Barnes *et al.*1993).

keystone species A species which, through its predatory activities (for instance, grazing by sea urchins) or by mediating competition between prey species (for instance, by eating sea urchins), maintains community composition and structure. Removal of a keystone species leads to rapid, cascading changes in the structure they support (based on Raffaelli & Hawkins 1996). The term is also applied here to species which provide a distinctive habitat (for instance a bed of the horse mussel *Modiolus modiolus*, or kelp plants *Laminaria hyperborea*) and whose loss would therefore lead to the disappearance of the associated community.

k-strategy A life strategy optimally geared to living in a stable habitat with a high level of interspecific competition. Parental care is facilitated by low fecundity (small litters of large size offspring), by longevity and size. K-strategists are unlikely to be well adapted to recover from population densities significantly below their equilibrium level and may become extinct if depressed to such low levels. (From Baretta-Bekker *et al.* 1992). Cf. r-strategy.

lanceolate Lance shaped and usually elongate (Brusca 1980).

larva A juvenile phase differing markedly in morphology and ecology from the adult (Barnes *et al.*1993).

lecithotrophic Development at the expense of internal resources (i.e. yolk) provided by the female (cf. planktotrophic) (Barnes *et al.*1993).

life form Structural types of organisms or growth forms that dominate or are most conspicuous in certain environmental conditions. (based on Richards, Bunker & Foster-Smith 1995) (cf. growth form).

littoral The area of the shore that is occupied by marine organisms which are adapted to or need alternating exposure to air and wetting by submersion, splash or spray. On rocky shores, the upper limit is marked by the top of the *Littorina*/*Verrucaria* belt and the lower limit by the top of the laminarian zone (Lewis 1964). It is divided into separate subzones, particularly marked on hard substrata. Cf. ‘intertidal’.

littoral fringe The upper subzone of the littoral zone, bordering the supralittoral. It is characterised by marine lichens, littoral molluscs and algae tolerant of exposure to air for long periods; its lower boundary is characteristically the upper limit of dense barnacles. This subzone can be further subdivided into the upper and lower littoral fringes. (From Hiscock 1990.)

local importance (conservation assessment) Biotopes or locations which are among the best examples or the only examples within a particular physiographic feature or area of coast but occur widely elsewhere in the coastal sector (q.v.). This was, until 1995, defined as being: "communities or areas which are widespread in similar situations but for which the one mentioned is a good example in the coastal sector under consideration". (Based on Hiscock & Mitchell 1989.) Cf. ‘international importance: species’, ‘national importance’, ‘regional importance’ (biotopes or areas and species).

Lowest Astronomical Tide The lowest tidal level which can be predicted to occur under average meteorological conditions and any combination of astronomical conditions (from Ministry of Defence 1987).

lusitanian (biogeographical) Referring to a biogeographical region centred to the south of the British Isles and influencing the extreme south-west of the British Isles.

macrobenthos The larger organisms of the benthos, exceeding 1 mm in length (from Lincoln & Boxshall 1987); often applied to organisms >0.5mm. Cf. ‘meiobenthos’, ‘microbenthos’.

macrofauna Animals exceeding 1 mm in length (Lincoln & Boxshall 1987) or retained on a 1 mm or 0.5mm sieve; often applied to organisms >0.5mm. Cf. ‘meiofauna’, ‘microfauna’.

macroscopic Large enough to be visible to the naked eye, typically exceeding 1mm in length.

maerl Twig-like unattached (free-living) calcareous red algae, often a mixture of species and including species which form a spiky cover on loose small stones - ‘hedgehog stones’.

mariculture The cultivation, under appropriate environmental conditions, of marine organisms in seawater by human effort for commercial purposes (based on Baretta-Bekker *et al.* 1992 and Charton & Tietjen 1989). (See also 'aquaculture'.)

marine protected area "Any area of intertidal or subtidal terrain, including geological and geomorphological features, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment." (IUCN definition, as modified by the Marine Protected Area Group, a working group of Wildlife Link's Joint Marine Group).

Marine Nature Reserve (MNR) A statutory marine protected area declared in Great Britain by the Nature Conservancy Council and its successor agencies under the Wildlife and Countryside Act 1981 for the purpose of conserving marine flora or fauna or geological or physiographical features in the area and providing opportunities for study and research (from Anon. 1994). Voluntary MNRs are non-statutory protected areas agreed by local sea-users and other interested parties.

massive Bulky (Homes 1979).

Mediterranean (biogeographical) An extension of the Atlantic Ocean between Europe and Africa (Charton & Tietjen 1989) often used to describe a biogeographic region but which, according to Ekman (1953), is not a distinct faunal unit but enters into a greater one which includes the neighbouring parts of the Atlantic.

medusoid / medusiform Disk, bell or umbrella shaped and often gelatinous (Barnes *et al.*1993).

meiobenthos Small benthic organisms which pass through a 1 mm mesh sieve, but are retained by a 0.1 mm mesh (from Lincoln & Boxshall 1987). Typically, they inhabit interstitial space in sediments. Cf. 'macrobenthos', 'microbenthos'.

meiofauna Small interstitial animals which pass through a 1 mm mesh sieve but are retained by a 0.1 mm mesh (from Lincoln & Boxshall 1987). Cf. 'macrofauna', 'microfauna'.

meroplankton Temporary plankton consisting of pelagic stages of organisms which also have benthic stages. Mainly the larvae of sedentary organisms. (From Baretta-Bekker *et al.* 1992). Cf. holoplankton.

mesohaline Pertaining to brackish water between 5 ‰ and 18 ‰ salinity (from McLusky 1993).

metagamic Pertaining to reproductive cycles that alternate between sexual and asexual phases (Lincoln, Boxshall and Clark 1998).

microbenthos Microscopic benthic organisms less than 0.1 mm in length (Lincoln & Boxshall 1987). Cf. 'macrobenthos', 'meiobenthos'.

microfauna Small animals less than 0.1 mm length, not visible to the naked eye (cf. 'macrofauna', 'meiofauna').

microhabitat A small part of the habitat which has distinct physical conditions, e.g. rock crevice.

microscopic Any organism which cannot be observed without the use of a microscope.

migratory Of organisms that move from one habitat or location to another; typically periodically or seasonally and of relatively long distance (from Lincoln *et al*. 1998)

mobile Capable of spontaneous movement, able to move freely.

moderately exposed (wave exposure) Generally coasts facing away from prevailing winds and without a long fetch, but where strong winds can be frequent (from Hiscock 1990).

modifier A physical or biological feature or occurrence affecting a site which changes the characteristics of a habitat, e.g. sand-scour, wave surge, substratum mobility, freshwater run-off, grazing, or pollution.

monitoring The process of repetitive observation, for defined purposes, of one or more elements of the environment, according to prearranged schedules in space and time and using comparable methods for environmental sensing and data collection. Monitoring provides factual information concerning the present state and past trends in environmental behaviour (Based on UNEP definition). The term is also applied to compliance monitoring against accepted standards to ensure that agreed or required measures are followed. (Cf. 'surveillance').

mutualism A symbiosis in which both organisms benefit, frequently a relationship of complete dependence. (Lincoln *et al*. 1998) (cf. symbiosis, commensalism, parasite)

national importance 1) biotopes and areas (conservation assessment) Biotopes or areas which are highly rated in the coastal sector will be described as of national importance if they are one of the best examples or only examples known in Great Britain. This was, until 1995, defined for communities as being, "outstandingly good examples of their type in Britain". National importance can apply to biotopes which are, or are likely to be, widely occurring in other similar physiographic situations in the north-eastern Atlantic. (Based on Hiscock & Mitchell 1989). Cf. 'national importance: species', 'international importance', 'local importance', 'regional importance' (biotopes or areas and species). **2) species (conservation assessment)** Considered to be those benthic species which are nationally rare or nationally scarce (q.v.). Until 1995, defined as: "Species which are recorded at only a few locations in Britain but are more widespread in other parts of the north-east Atlantic. Species recorded in higher numbers at locations under consideration than elsewhere in Britain or where the site is one of a very few locations where large quantities are recorded in Britain." (Based on Hiscock & Mitchell 1989.) A species may also be nationally important where a high proportion of the world population occurs in Britain, even though the species might be widespread in Britain. A nationally important species could be one whose numbers are declining rapidly. Cf. 'national importance: biotopes and areas', 'international importance', 'local importance', 'regional importance' (biotopes or areas and species).

nationally rare (species) For marine conservation purposes, these are regarded as species of limited national occurrence (q.v. rarity). By analogy with the approach adopted in British Red Data Books (for instance, Bratton 1991) but referring to sea areas within the three-mile limit of territorial seas, they are defined as those species known to occur in 0.5% or less (eight or fewer) of the 10 x 10 km squares containing sea within the three-mile limit of territorial seas for Great Britain (Sanderson 1996). Cf. 'nationally scarce'.

nationally scarce (species) For marine conservation purposes, these are regarded as species of limited national occurrence (q.v. rarity). By analogy with the approach adopted in British Red Data Books (for instance, Bratton 1991) but referring to sea areas within the three-mile limit of territorial seas, they are defined as those species known to occur in 0.5 to 3.5% (nine to 55) of the 10 x 10 km squares containing sea within the three-mile limit of territorial seas for Great Britain (Sanderson 1996). Cf. 'nationally rare'.

natural habitat As defined by the Habitats Directive (q.v.) "natural habitats means terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or semi-natural." (Commission of the European Communities 1992).

naturalness (conservation assessment) The extent to which a location and its associated biotopes is unaffected by anthropogenic activities

natural range The geographical range of a species in recent times (since about 5,000 BP) but excluding any changes to that range as a result of human agency.

nature conservation The regulation of human use of the global ecosystem to sustain its diversity of content indefinitely (Nature Conservancy Council 1984).

nekton Actively swimming pelagic organisms able to move independently of water currents; typically within the size range 20 mm to 20 m (from Lincoln & Boxshall 1987).

neritic Referring to coastal waters overlying the continental shelf (0 m to 200 m below chart datum) (based on Baretta-Bekker *et al.* 1992).

neuston 1) Organisms similar to plankton, that inhabit the surface film of open water. **2)** The ecosystem of the surface film of open water.

niche The ecological resource occupied by a species in a community or ecosystem.

non-native (species) A species which has been introduced directly or indirectly by human agency (deliberate or otherwise), to an area where it has not occurred in recent times (about 5,000 years BP) and which is separate from and lies outside the area where natural range extension could be expected (i.e. outside its natural geographical range (q.v.)). The species has become established in the wild and has self-maintaining populations; the term also includes hybrid taxa derived from such introductions ('derivatives'). (Cf. 'alien species'; 'introduced species'; 'recent colonist'; 'reintroduction'; 'translocation').

oceanodromous Used of organisms that migrate only within the oceanic province (Lincoln *et al.*1998).

oligohaline Pertaining to brackish water between 0.5 ‰ and 5 ‰ salinity (based on Carriker 1967, in McLusky 1993).

oligotrophic Having low primary productivity; used of water bodies or substrata low in nutrients.

omnivores Animals which feed on a mixed diet including plant and animal material (from Lincoln *et al.*1998).

ontogenetic migration The occupation by and animal of different habitats at different stages of development (Lincoln *et al.*1998).

organochlorine chlorinated hydrocarbon A synthetic organic compound containing chlorine, highly toxic and the base for many pesticides. Includes PCBs (polychlorinated biphenyls).

organotin, tributyltin (TBT), triphenyltin A synthetic organic compound containing tin, used as a pesticide particularly to prevent the establishment of fouling organisms, but known to be toxic to certain species even at low concentrations. See 'imposex'.

oviparous A type of reproduction in animals in which the fertilised eggs are laid or spawned by the mother.

ovoviviparous A type of reproduction in animals in which the embryo(s) develop in persistent membranes and hatch within the maternal body. No nutrition is derived from the mother.

oxycline A horizontal boundary layer in the water column, at which dissolved oxygen content changes sharply with depth.

paralytic shellfish poisoning (PSP) A serious illness affecting organisms with higher nervous systems (vertebrates) caused by eating shellfish which have themselves consumed toxin-producing micro-organisms (usually certain phytoplankton species) and have bioaccumulated the toxins.

parameter Quantity constant in case considered, but varying in different cases (Thompson 1995). An arbitrary constant, as distinguished from a fixed or absolute constant. Any desired numerical value can be given to a parameter. The term is also used to describe a definable characteristic of an item, device or system (Considine 1976). A variable in terms of which it is convenient to express other interrelated variables which may then be regarded as being dependent upon the parameter (Chambers & Chambers 1971).

parasite An organism that lives in or on another living organism (the host), from which it obtains food and other requirements. The host does not benefit from the association and is usually harmed by it. (cf. commensalism, mutualism, symbiosis).

parthenogenesis A form of asexual multiplication in which the ovum develops into a new individual without fertilisation (Barnes *et al.*1993).

Particularly Sensitive Sea Area An area that needs special protection through action by IMO because of its significance for recognised ecological or socio-economic or scientific reasons and which may be vulnerable to environmental damage by maritime traffic (International Maritime Organisation 1991).

pedunculate With the body borne on a stalk (Nichols *et al.* 1971).

pelagic zone The open sea and ocean, excluding the sea bottom. Pelagic organisms inhabit such open waters.

penicillate Brush like (Prescott 1969).

persistence The continued presence of species or communities at a location (usually inferring in spite of disturbance or change in conditions) (cf. 'constancy', 'stability', 'resilience').

photophilous Thriving in conditions of strong light (cf. 'sciophilous').

photosynthesis The biochemical process that utilises radiant energy from sunlight to synthesise carbohydrates from carbon dioxide and water in the presence of chlorophyll and other photopigments (based on Lincoln *et al.*1998).

phylum (pl. phyla) A major taxonomic division containing one or more classes.

phyto- (as prefix, e.g. phytobenthos, phytoplankton) Pertaining to plants.

phytoplankton Planktonic plant life: typically comprising suspended or motile microscopic algal cells such as diatoms, dinoflagellates and desmids (based on Lincoln & Boxshall 1987).

pinnate Branching like a feather – an elongate main axis with lateral branches or lobes (Prescott 1969).

pisciform In the shape of a fish.

plankton Organisms which drift in the water column and have limited powers of locomotion in comparison with the horizontal water movements. Many benthic animals have planktonic larvae which act as a dispersive phase. (See also holoplankton, meroplankton). (Based on Hawkins & Jones 1992.) (Cf. 'nekton').

planktotrophic Feeding at least in part on materials captured from the plankton (cf. lecithotrophic) (Barnes *et al.*1993).

pleuston Buoyant organisms subject to wind drift. (Baretta-Bekker *et al.* 1992).

poikilohaline A term used of organisms having body fluids that conform to external changes in salinity (from Lincoln *et al.*1998).

pollution (marine) "The introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of seawater and reduction of amenities." (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection - GESAMP - 1995).

polyhaline Pertaining to brackish water having a salinity between 18 ‰ and 30 ‰ (from McLusky 1993).

polymorphic Occurrence of different forms (usually morphological) of individuals of the same species.

population All individuals of one species occupying a defined area and usually isolated to some degree from other similar groups (from Lincoln & Boxshall 1987).

precautionary principle A principle underlying the concept of sustainable use of resources, which implies that:

a) Prudent action be taken in the absence of scientific certainty;

b) The balance of the burden of proof between the requirement to prove significant damage and the requirement to show no irreversible harm be encouraged;

c) Environmental well-being be given legitimate status and best-practice techniques be developed.

(From WWF *Marine Update* No. 14, April 1994).

protandrous A condition of hermaphroditism in plants and animals where male gametes mature and are shed before female gametes mature (Holmes 1979).

protists Any organism belonging to the kingdom Protista, including bacteria, protozoans, unicellular algae and fungi, regarded as distinct from plants and animals (from Makins 1991).

protogyny A condition of hermaphroditism in plants and animals where female gametes mature and are shed before male gametes mature (Holmes 1979).

pycnocline A horizontal boundary layer in the water column at which water density changes sharply with depth, as a result of either a halocline or a thermocline, or both acting together. See 'stratification'.

radial Symmetrical about any plane passed perpendicular to the oral/aboral axis (Barnes *et al.*1993).

rarity (conservation assessment) Seldom found or occurring. 'Rarity' needs to take account of the type of distribution and abundance which would be expected of a particular habitat, community, taxonomic group or species and any historical information about past numbers.

rarity (species) "The current status of an organism which, by any combination of biological or physical factors, is restricted either in numbers or area to a level that is demonstrably less than the majority of other organisms of comparable taxonomic entities" (Gaston 1994). (See also 'nationally rare', 'nationally scarce'.)

recent colonist A species which, without any human intervention, has extended its natural geographical range (q.v.) in recent times and which has established new self-maintaining and self-regenerating populations in the wild (cf. 'non-native'; 'vagrant').

recoverability The ability of a habitat, community or individual (or individual colony) of species to redress damage sustained as a result of an external factor.

recruitment (population biology) Term used for the arrival of young in a given population per unit of time (based on Baretta-Bekker *et al.* 1992).

Red Data Book species A species listed in catalogues published by the IUCN or by national agencies, listing species which are rare, endangered or vulnerable to extinction globally or nationally.

Red list species A species identified as 'Extinct', 'Extinct in the wild', 'Critically endangered', 'Endangered', 'Vulnerable', 'Lower risk', 'Data deficient' or 'Not evaluated' according to criteria laid down in the *IUCN Red List Categories* (International Union for the Conservation of Nature and Natural Resources 1994).

refugium (pl. refugia) Geographical area which has remained isolated from, or unaltered by, climatic or other changes affecting surrounding regions, and that therefore provides a haven for relict (q.v.) species or populations.

regeneration Replacement by compensatory growth and differentiation of lost parts of an organism (Barnes *et al.*1993).

regional importance biotopes and areas (conservation assessment) Biotopes or areas which are widespread in similar situations but for which this is a good example in the coastal sector (q.v.) under consideration. Regional importance was, until 1995, defined for communities as being "Communities which are present in similar physiographic situations in Britain but which are outstandingly good examples of their type in the location under consideration, or are as good as examples of similar communities present elsewhere in Britain. Communities recorded at only a few locations in the same biogeographic region." (Davies *et al.* 1990, based on Hiscock & Mitchell 1989). (Cf. 'regional importance: species', 'international importance', 'local importance', 'national importance' (biotopes or areas and species)).

regional importance (species conservation assessment) Species which are unrecorded or recorded at only a few locations in similar physiographic situations in other parts of Britain. Species recorded in higher abundance in the site under consideration than in any other part of the region. Species which are at the geographical limits of their distribution might be included in this category. (Davies *et al.* 1990, based on Hiscock & Mitchell 1989). Cf. 'regional importance: biotopes or areas' 'international importance', 'local importance', 'national importance' (biotopes or areas and species).

reintroduction A species which has been reintroduced by human agency, deliberate or otherwise, to an area within its natural geographical range (q.v.) but where it had became extinct in historical times.

relict (species) A species believed to have been previously more widely distributed but now restricted to a limited number of locations where populations are probably self-sustaining, for example, *Thyasira gouldi*, *Leptopsammia pruvoti*.

representativeness (conservation assessment) Typical of a feature, habitat or assemblage of species. Representative examples are identified from the range of natural or semi-natural habitats and associated communities (biotopes) within a biogeographically distinct area or the boundaries of a national territory.

resident A permanent inhabitant, non-migratory

resilience The ability of an ecosystem to return to its original state after being disturbed (from Makins 1991) (cf. 'constancy', 'persistence', 'stability').

resistance The degree to which a variable is changed following perturbation (Pimm 1984). The tendency to withstand being perturbed from the equilibrium (Connell & Sousa 1983). (cf. 'Stability'; 'adjustment stability'.)

reticulate In the form of a mesh or net (Prescott 1969).

richness (species) The number of species in a community, habitat or sample (cf. 'diversity'; 'evenness').

risk assessment An evaluation of the possibility of undesired events and the probability of harm being caused.

RoxAnn An acoustic ground discrimination system, based on sonar, which provides information on seabed relief and features.

r-strategy A life strategy which allows a species to deal with the vicissitudes of climate and food supply by responding to suitable conditions with a high rate of reproduction. R-strategists are continually colonising habitats of a temporary nature. (From Baretta-Bekker *et al.* 1992). Cf. 'k-strategy'.

salinity Measure of the concentration of dissolved salts in seawater, normally expressed as parts per thousand (‰). Freshwater is regarded as < 0.5 ‰ (limnetic), seawater as > 30 ‰ (euhaline), and brackish water as intermediate, including oligohaline, mesohaline and polyhaline waters. (Based on McLusky 1993.)

saltmarsh Areas of alluvial or peat deposits, colonised by herbaceous and small shrubby terrestrial vascular plants, almost permanently wet and frequently inundated with saline waters (from Long & Mason 1983).

scavenger Any organism that feeds on dead organic material.

sciophilous Thriving in shaded situations, or in habitats of low light intensity (from Lincoln *et al.*1998) (cf. 'cryptic', 'photophilous').

scour The effect of abrasion, usually by sand or gravel, on the seabed.

seasonal Showing periodicity related to the seasons (Lincoln *et al.* 1998).

sedentary Attached to a substratum but capable of movement across (or through) it (cf. 'sessile').

segment A semi-independent, serially repeated unit of the body (Barnes *et al.*1993).

semelparous Breeding only once then dying (cf. iteroparous) (Barnes *et al.*1993).

semi-quantitative Measurement based on estimates or rough counts of relative quantity (density, cover) - e.g. abundance scales (cf. 'quantitative').

sensitivity (conservation assessment) The intolerance of a habitat, community or individual (or individual colony) of a species to damage, or death, from an external factor. See 'fragility', 'vulnerability'.

sessile Permanently attached to a substratum (cf. 'sedentary').

sheltered (wave exposure) Coasts with a restricted fetch and/or open water window. Coasts can face prevailing winds but with a short fetch (< 20km) or extensive shallow area offshore, or may face away from prevailing winds (from Hiscock 1990).

shore backing The terrestrial habitat immediately behind the shore.

Site of Special Scientific Interest (SSSI) An area of land or water notified by the Nature Conservancy Council or its successor agencies under the Wildlife and Countryside Act 1981 as being of special nature (can include geological) conservation importance.

solitary Living alone, not gregarious.

Special Area of Conservation (SAC) A site of [European] Community importance designated by the [EU] Member States through a statutory, administrative and/or contractual act where the necessary conservation measures are applied for the maintenance or restoration, at a favourable conservation status, of the natural habitats and/or the populations of the species for which the site is designated (Commission of the European Communities 1992). (This status is achieved by sites adopted by the European Commission.)

Special Protection Area (SPA) A site of European Community importance designated under the Wild Birds Directive (Commission of the European Communities Council Directive 79/409/EEC of 2 April 1979 on the Conservation of Wild Birds).

stability The ability of an ecosystem to resist change (from Makins 1991) (cf. 'constancy', **'**persistence', 'resilience').

stellate Arranged like a star.

stenohaline Tolerance of only a narrow range of salinities (from Lincoln & Boxshall 1987).

stenothermal Tolerance of a narrow range of temperatures.

stochastic (statistics) Of a random variable. Having a probability of distribution, usually with finite variance.

straplike Ribbonlike, in the form of a strap or ribbon.

Strategic Environmental Assessment (SEA) The formalised, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan or programme and its alternatives, including the preparation of a report on the evaluation and the use of the findings in publicly-accountable decision-making (Pritchard 1993) (cf. 'Environmental Assessment').

stratum (ecological) (pl. strata) A horizontal layer of vegetation within a stratified plant community (from Lincoln & Boxshall 1987).

stress "A chemical or physical process that leads to a response within an organism, or at the levels of whole organisms or assemblages" (from Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection - GESAMP - 1995).

sublittoral The zone exposed to air only at its upper limit by the lowest spring tides, although almost continuous wave action on extremely exposed coasts may extend the upper limit high into the intertidal region. The sublittoral extends from the upper limit of the large kelps and includes, for practical purposes in nearshore areas, all depths below the littoral. Various subzones are recognised. (Based on Hiscock 1985.) (Cf. 'subtidal').

sublittoral fringe The upper part of the sublittoral zone which is uncovered by the tide. On hard substrata, the zone is characterised by the kelps *Laminaria digitata* and *Alaria esculenta*. The lower limit of this zone is marked by the upper limit of the truly sublittoral kelp *Laminaria hyperborea*. This species assemblage does not occur on all British coasts. (Based on Lewis 1964.)

substratum (pl. substrata) Material available for colonisation by plants and animals; a more correct term in this context than 'substrate'.

succession Sequential development of plant or animal communities through time.

supralittoral The lower terrestrial zone, characteristically dominated by orange and white-to-grey lichens on hard substrata with scattered salt-tolerant higher plants and mosses (from Hiscock 1990).

surrogate species Species which are likely to change if the whole community is changing and therefore respond to change on behalf of the community.

surveillance A procedure by which a series of surveys is conducted in a sufficiently rigorous manner for changes in the attributes of a site (or species) to be detected over a period of time. Surveillance is often conducted to identify normal background variation ('noise') in order that abnormal changes can be identified by a monitoring programme. (From Marine Conservation Monitoring Workshop, January 1993.) The term is also applied to compliance surveillance to ensure that agreed or required measures are followed. (See also 'survey'. Cf. 'monitoring').

survey An inventory of the attributes of a site, area or region in terms of habitat and associated organisms (or of the distribution and/or autecological characteristics of selected species), usually by means of a standardised procedure. (Based on Marine Conservation Monitoring Workshop, January 1993.)

suspension feeders Suspensivores, filter-feeders, any organisms which feed on particulate organic matter, including plankton, suspended in the water column (from Lincoln *et al.*1998).

sustainability (environmental) Maintaining the environment's natural qualities and characteristics and its capacity to fulfil its full range of functions, including maintenance of biodiversity (from English Nature, Planning for environmental sustainability, June 1994).

sustainable development "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987 (Brundtland Report)).

symbiosis The living together in a constant and definite relationship of two different organisms (cf. commensalism, mutualism, parasite) (Brusca 1980).

synecology The study of the ecology of groupings of organisms, populations, communities or systems; ecological sociology (based on Lincoln *et al.*1998) (cf. 'autecology').

taxon (pl. taxa) A taxonomic group of any rank, including all its subordinate groups; may be a single species or a group of related species, e.g. genus, class, order, etc., considered to be sufficiently distinct from other such groups to be treated as a separate unit (based on Lincoln & Boxshall 1987 and Fitter & Manuel 1986).

taxonomy The branch of biology concerned with the classification of organisms into groups (taxa) based on similarities of structure, origin, etc.

terrestrial Living on, or referring to, land.

tidal stream The alternating horizontal movement of water associated with the rise and fall of the tide (from Lincoln & Boxshall 1987) (cf. 'current').

tide The periodic vertical movement of water level with respect to some point on land. See 'astronomical tide'.

toxicology The branch of science concerned with poisons, their nature, effects and antidotes (from Makins 1991). 'Ecotoxicology' is the application of toxicology to the natural environment.

tributyl tin (TBT) (See 'organotin').

tubicolous Tube dwelling (Barnes *et al.*1993).

turbinate Whorled (Brusca 1980).

turf The lowest stratum of erect branching or filiform species.

typicalness (conservation assessment) See 'Representativeness'.

ultra-sheltered (wave exposure) Fully enclosed coasts with a fetch measured in tens or at most a few hundred metres (from Hiscock 1990).

understorey, undergrowth layer Organisms occurring under the main canopy of algae, especially of kelps (from Hawkins & Jones 1992).

vagile Wandering; freely motile, mobile. (cf. 'sessile').

vagility The tendency of an organism or population to change its location or distribution with time; mobility.

vagrant (species) Individuals of a species which, by natural means, move from one geographical region to another outside their usual range, or away from usual migratory routes, and which do not establish a self-maintaining, self-regenerating population in the new region (cf. 'alien species'; 'recent colonist').

vermiform Wormlike, long and lender like a worm (Brusca 1980).

very exposed (wave exposure) **1)** Open coasts which face into prevailing winds and which receive wind-driven waves and oceanic swell without any offshore obstructions for several hundred kilometres, but where deep water is not close to the shore (50m depth contour further than about 300m).

2) Open coasts adjacent to extremely exposed sites but which face away from prevailing winds. (From Hiscock 1990.)

very sheltered (wave exposure) Coasts with a fetch less than about 3 km where they face prevailing winds or about 20 km where they face away from prevailing winds, or which have offshore obstructions such as reefs or a narrow (<30°) open water window (based on Hiscock 1990.)

viviparous A type of reproduction in animals in which the embryo(s) develop within and derive nourishment from the maternal body.

vulnerability The likelihood that a habitat, community or individual (or individual colony) of a species will be exposed to an external factor to which it is sensitive. See 'Sensitivity'.

vulnerable (IUCN Red List categories) A taxon which is not 'Critically endangered' (q.v.) or 'Endangered' (q.v.) but is facing a high risk of extinction in the wild in the medium term future (International Union for the Conservation of Nature and Natural Resources 1994) (cf. 'Extinct', 'Critically endangered', 'Endangered').

water quality **1)** The nature of a body of water in terms of its physical (for instance, suspended sediment load) and chemical (for instance, salinity) characteristics.

2) The degree of contamination of water. See 'classification (water quality)'.

whiplike In the form of a whip.

zooid One of the individual animals connected together in a common mass constituting a colony (based on Fitter & Manuel 1986).

zooplankton The animal component of the plankton (Lincoln *et al*.1998).

Typical abundance of a species in Britain and Ireland:

Term	Definition
High	Species that are found in high numbers in their appropriate habitats. Equivalent to Superabundant and Abundant on the MNCR SACFOR abundance scale
Moderate	Species that are found in moderate numbers in their appropriate habitats. Equivalent to Common and Frequent on the MNCR SACFOR abundance scale
Low	Species that are found in low numbers in their appropriate habitats. Equivalent to Occasional and Rare on the MNCR SACFOR abundance scale
Very low	Less than rare on the MNCR SACFOR abundance scale

Mobility and attachment type:

Term	Definition	
Mobile	**Swimmer**	An organism that moves through the water column via movements of its fins, legs or appendages, via undulatory movements of the body or via jet propulsion (e.g.*Gadus*, *Loligo*).
	Crawler	An organism that moves along on the substratum via movements of its legs, appendages or muscles (e.g. *Carcinus*).
	Burrower	An organism that lives or moves in a burrow (e.g. *Arenicola*).
	Drifter	An organism whose movement is dependent on wind or water currents (e.g. *Aurelia*).
Fixed	**Permanent attachment**	Non-motile; permanently attached at the base (Lincoln, Boxshall and Clark 1998)(e.g.*Caryophyllia*)
	Temporary attachment	Temporary / sporadic attachment. Attached to a substratum but capable of movement across (or through) it (e.g. *Actinia*)

Sociability:

Term	Definition
Solitary	Living alone, not gregarious (Thompson 1995).
Gregarious	Living in groups or communities, growing in clusters (Thompson 1995).
Colonial	Descriptive of organisms produced asexually which remain associated with each other; in many animals, retaining tissue contact with other polyps or zooids as a result of incomplete budding (Barnes *et al*. 1996).

Environmental position:

Term	Definition
Epifauna / flora	Animals / plants living on the surface of the seabed.
Infauna	Benthic animals which live within the seabed.
Interstitial	Relating to the system of cavities and channels formed by the spaces between grains in a sediment (interstitial space).
Demersal	Living at or near the bottom of a sea or lake, but having the capacity for active swimming (from Lincoln, Boxshall & Clark 1982).
Pelagic	Inhabiting the open waters of the sea or ocean, excluding the bottom layers.

Growth forms:

Term	Definition
Boring	Makes an excavation (through physical or chemical action) in which to live.
Crustose	Forming or resembling a crust (Thompson 1995).
Flaccid	Soft, limp, flabby (Brusca 1980).
Massive	Bulky (Homes 1979).
Cushion	A mass or pillow of soft material.
Turf	The lowest stratum of erect branching or filiform species.
Foliose	Bearing leaves or leaf-like structures; having the appearance of a leaf.
Shrub	Having a very short stem with branches near the ground (Thompson 1995).
Arborescent / Arbuscular	Having the shape or characteristics of a tree.
Forest	A large number or dense mass of vertical objects (Thompson 1995).
Accretion	Build up or accumulation of sediment.
Radial	Symmetrical about any plane passed perpendicular to the oral/aboral axis (Barnes, Calow and Olive 1988).
Stellate	Arranged like a star.
Whiplike	In the form of a whip.
Straplike / Ribbonlike	In the form of a strap or ribbon.
Filiform / Filamentous	Slender and thread-like (Kozloff 1996).
Vermiform	Wormlike, long and slender like a worm (Brusca 1980).

Growth forms (continued)

Term	Definition
Digitate	Having parts arranged like fingers on a hand (Holmes 1979).
Penicillate	Brush like (Prescott 1969).
Pinnate	Branching like a feather – an elongate main axis with lateral branches or lobes (Prescott 1969).
Capitate / Clubbed	Enlarged or swollen at the apex, with a 'head', clubbed. (Prescott 1969).
Clathrate	Latticed (Holmes 1979).
Reticulate	In the form of a mesh or net (Prescott 1969).
Funnel shaped	In the shape of a funnel.
Dendroid	Branching irregularly – similar to that of a root system (Prescott 1969).
Flabellate	Shaped like a fan, fanlike (Brusca 1980).
Tubicolous	Tube dwelling (Barnes, Calow and Olive 1988).
Medusiform / Medusoid	Disk, bell or umbrella shaped and often gelatinous (Barnes, Calow and Olive 1988).
Cylindrical	With straight sides and a circular section (Thompson 1995).
Globose	Spherical / ovoid / globular (Brusca 1980).
Bullate / Saccate	Balloon or sac-like (Prescott 1969).
Articulate	Jointed, arthrous (Holmes 1979).
Bivalved	Characteristically a shell of two calcareous valves joined by a flexible ligament.
Turbinate	Whorled (Brusca 1980).
Pisciform	Fishlike.

Feeding method:

<table>
<tr><td>Autotroph</td><td colspan="3">Primary producer, an organism that synthesises complex organic substances from simple inorganic substrates using energy from sunlight (e.g. Seaweeds).</td></tr>
<tr><td rowspan="2">Suspension Feeder
Any organism which feeds on particulate organic matter, including plankton, suspended in the water column (from Lincoln, Boxshall & Clark 1982).</td><td>Active</td><td colspan="2">Catching food on a filter from water by actively sweeping (e.g. Porcellana platychelyes) or pumping (e.g. sea squirts, many bivalve molluscs).</td></tr>
<tr><td>Passive</td><td colspan="2">Catching food on a filter held into flowing water (e.g. hydroids, sea fans, sea pens), or collecting the ‘rain’ of detritus on sticky apparatus other than a filter (e.g. Cucumaria frondosa).</td></tr>
<tr><td rowspan="2">Deposit Feeder
Any organism which feeds on fragmented particulate organic matter from the substratum; detritivores (from Lincoln, Boxshall & Clark 1982)</td><td>Surface</td><td colspan="2">Obtaining food from the surface of the substratum (e.g. Corophium volutator).</td></tr>
<tr><td>Sub-surface</td><td colspan="2">Obtaining food from within the substratum (e.g. Echinocardium cordatum).</td></tr>
<tr><td rowspan="5">Predator
An organism that feeds by preying on other organisms, killing them for food (from Lincoln, Boxshall & Clark 1982).</td><td rowspan="2">Carnivore
Feeding on animals</td><td>Active</td><td>Catching live animal food through active searching or ambushing.</td></tr>
<tr><td>Passive</td><td>Catching live animal food that happens to make contact with a trap mechanism.</td></tr>
<tr><td rowspan="2">Omnivore
Animal which feeds on a mixed diet including plant and animal material (from Lincoln, Boxshall & Clark 1982).</td><td>Active</td><td>Consuming live animal or plant food through active searching or ambushing.</td></tr>
<tr><td>Passive</td><td>Consuming live animal or plant food that happens to make contact with a trap mechanism.</td></tr>
<tr><td>Herbivore
An organism which feeds on plants, including phytoplankton.</td><td></td><td>Grazing on seaweeds, diatoms or bacterial films (e.g. limpets, Hydrobia ulva).</td></tr>
<tr><td>Saprophage / scavenger</td><td colspan="3">Any organism that actively feeds on dead organic material (e.g. crabs, whelks).</td></tr>
<tr><td>Symbiont contribution</td><td colspan="3">Where some dietary component(s) are provided by symbiotic organisms (e.g. Anemonia with zooxanthellae)</td></tr>
<tr><td>Parasite</td><td colspan="3">An organism that lives in or on another living organism (the host), from which it obtains food and other requirements (e.g. Leeches).</td></tr>
</table>

Mode of life:

Term	Definition
Independent	Any organism not relying on another for food (except as prey), environment or livelihood.
Parasite	An organism that lives in or on another living organism (the host), from which it obtains food and other requirements. The host does not benefit from the association and is usually harmed by it.
Mutualist	A partner in a symbiosis where both organisms benefit, frequently a relationship of complete dependence. (Lincoln, Boxshall and Clarke 1982)
Inquilinist	A partner in a symbiotic association which lives in close association with another, generally in the tube or burrow or actually within a body chamber of the host (Brusca 1980).
Commensal	A partner in a symbiosis in where one species derives benefit from a common food supply, whilst the other species is not adversely affected (Lincoln, Boxshall & Clark 1982).
Host	An animal or plant with a parasitic, commensal, mutualist or inquilinist dependent on it (from Fowler and Fowler 1995).

Physiographic type: (from Hiscock 1996)

Term	Definition
Open Coast	Any part of the coast not within a marine inlet, strait or lagoon, including offshore rocks and small islands. This includes MNCR types; Linear coast, Islands / Rocks and Semi-enclosed coast.
Offshore seabed	Seabed beyond three miles (5km) from the shore.
Strait/Sound	Channels between the mainland and an island or between two islands which are open at both ends to the open coast (it does not refer to similar features or narrows within marine inlets).
Sealoch	Glacially formed inlets (fjords, fjards) of western Scotland and Ireland; typically elongate and deepened by glacial action with little freshwater influence. Often with narrows and sills dividing the loch into a series of basins.
Ria/Voe	Drowned river valleys of south-west Britain (ria) and Shetland (voe). Often with a greater presence of rock and more marine in character than estuaries.
Estuary	Downstream part of a river where it widens to enter the sea; often with significant freshwater influence and predominantly comprising sediment habitats.
Isolated Saline Water (Lagoon)	Enclosed bodies of water, separated or partially separated from the sea by shingle, sand or sometimes rock and with a restricted exchange of water with the sea, yielding varying salinity regimes.
Enclosed Coast / Embayment	Any other sort of enclosed coast not covered by the definitions above such as harbours or marinas.

Biological Zones: (from Hiscock 1990)

Term	Definition
Supralittoral	The lower terrestrial zone, characteristically dominated by orange and white-to-grey lichens on hard substrata with scattered salt-tolerant higher plants and mosses.
Upper Littoral Fringe	This is colonised by *Verrucaria maura* with *Littorina saxatilis* and *Littorina neritoides* often present. May include saltmarsh species on shale/pebbles in shelter.
Lower Littoral Fringe	The *Pelvetia/Porphyra* belt with patchy *Verrucaria maura* and *Fucus spiralis* (on sheltered shores). *Fucus disticus* and *Fucus spiralis nana* occurs on extremely exposed shores in the NE. *Verrucaria. mucosa* present above the main barnacle population. May also include saltmarsh species on shale/pebbles in shelter.
Upper Eulittoral	Barnacles and limpets present in quantity with *Fucus vesiculosus* and *Ascophyllum* although often this belt has only sparse algal cover compared with the lower eulittoral.
Mid Eulittoral	Barnacle - limpet dominated, sometimes mussels, with *Fucus vesiculosus* and *Ascophyllum nodosum*. *Mastocarpus stellatus* and *Palmaria palmata* patchy in lower part. Usually quite a wide belt.
Lower Eulittoral	*Fucus serratus*, *Mastocarpus stellatus*, *Himanthalia elongata* and *Palmaria palmata* present; sparse barnacles. Patchy *Alaria*.
Sublittoral Fringe	Dominated by *Alaria esculenta*, *Laminaria digitata* or *L. saccharina* with sparse barnacles and encrusting Rhodophycota.
Upper Infralittoral	Kelp forest.
Lower Infralittoral	Sparse or no kelp , dominated by foliose algae except where grazed.
Upper Circalittoral	Dominated by animals with sparse foliose algae except where grazed.
Lower Circalittoral	Dominated by animals with no foliose algae but encrusting Rhodophycota patchy in grazed areas.

Substratum:

The substratum types defined below are categories which may support distinctive biotopes or that certain species favour or are characteristic of. These categories are modified from the Wentworth and Folk classifications. Distinctive habitats which are not directly linkable to substratum, but which hold or may hold distinctive biotopes or particular species, are included. The habitats listed are based in part on the descriptive term used for the names of biotopes in the MNCR biotopes classification.

Term	Definition
Bedrock	Any stable hard substratum, not separated into boulders or smaller sediment units. Includes soft rock-types such as chalk, peat and clay
Large to very large boulders	>512 mm. Likely to be stable
Small boulders	256 - 512 mm. May be unstable.
Cobbles	64-256 mm. May be rounded to flat. Substrata that are predominantly cobbles.
Pebbles	16-64 mm. May be rounded to flat. Substrata which are predominantly pebbles.
Gravel / shingle	4-16 mm Clean stone or shell gravel including dead maerl.
Maerl	Live maerl. *Phymatolithon calcareum* and *Lithothamnion corallioides* in Britain and Ireland.
Muddy gravel	10 - 80 % gravel, 20 - 90 % mud.
Coarse clean sand	0.5 - 4 mm. > 90 % sand.
Fine clean sand	0.063 - 0.5 mm. >90 % sand.
Sandy mud	50 - 90 % sand, 10 - 50 % mud.
Muddy sand	50 - 90 % mud, 10 - 50 % sand.
Mud	<0.063 mm (silt / clay fraction).
Mixed	Mixtures of a variety of sediment types. Pebble / gravel / sand / mud.
Algae	E.g. *Laminaria*
Biogenic reef	An elevated structure on the seabed built by calcareous or other concretion-forming organisms, or by chemical precipitation (Hiscock 1996) For example by *Modiolus* or *Sabellaria*.
Artificial	E.g. wood, metal or concrete
Water column	The vertical column of water in a sea or lake extending from the surface to the bottom (Lincoln *et al*. 1998).
Salt marsh	A flat, poorly drained coastal swamp inundated by most high tides. (Lincoln *et al*. 1998).
Strandline	A line on the shore composing debris deposited by a receding tide; commonly used to denote the line of debris at the level of extreme high water (Lincoln *et al*. 1998).
Seagrass	Habitat associated with seagrass bed communities.

Substratum (continued):

Term	Definition
Under boulders	Habitat associated with the underside of boulders.
Crevices / fissures	Narrow openings (Thompson 1995).
Rockpools	A pool of water among rocks left behind by an ebbing tide.
Caves	A large hollow in the side of a vertical rock face or cliff.
Overhangs	An overhanging part of a rock formation (Thompson 1995).
No preference	

Wave exposure: (from Hiscock 1990).

Term	Definition
Extremely exposed	Open coastlines which face into the prevailing wind and receive both wind-driven waves and swell without any offshore obstructions such as islands or shallows for several thousand kilometres and where deep water is close to the shore (50 m depth contour within about 300 m).
Very exposed	1) Open coasts which face into prevailing winds and which receive wind-driven waves and oceanic swell without any offshore obstructions for several hundred kilometres, but where deep water is not close to the shore (50 m depth contour further than about 300 m) 2) Open coasts adjacent to extremely exposed sites but which face away from prevailing winds.
Exposed	1) Coasts which face the prevailing wind but which have a degree of shelter because of extensive shallow areas offshore, offshore obstructions, or a restricted (less than 90°) window to open water. These sites are not generally exposed to large waves or regular swell. 2) Open coasts facing away from prevailing winds but with a long fetch, and where strong winds are frequent.
Moderately exposed	Generally coasts facing away from prevailing winds and without a long fetch, but where strong winds can be frequent (from Hiscock 1990).
Sheltered	Coasts with a restricted fetch and/or open water window. Coasts can face prevailing winds but with a short fetch (< 20 km) or extensive shallow area offshore, or may face away from prevailing winds.
Very sheltered	Coasts with a fetch less than about 3 km where they face prevailing winds or about 20 km where face away from prevailing winds, or which have offshore obstructions such as reefs or a narrow (< 30° open water window.
Extremely sheltered	Fully enclosed coasts with a fetch of no more than about 3 km.
Ultra sheltered	Fully enclosed coasts with a fetch measured in tens or at most a few hundred metres.

Tidal stream exposure:

Term	Definition
Very strong	> 6 knots
Strong	3 to 6 knots
Moderately strong	1 to 3knots
Weak	< 1 knot
Very weak	Negligible

Salinity:

Term	Definition
Full salinity	30-40 ppt
Variable salinity	18-40 ppt
Reduced salinity	18-30 ppt
Low salinity	<18 ppt
Unknown Salinity	?

Migration:

Term	Definition
Resident / Non-migratory	Remaining within the same area (from Lincoln *et al*. 1998).
Seasonal (feeding)	A seasonal migration for the purpose of following or moving to suitable feeding grounds.
Seasonal (reproduction)	A seasonal migration in order to reproduce.
Seasonal (environment)	A seasonal migration in order to remain with suitable environmental conditions.
Diel	Daily, pertaining to a 24 hour period.
Passive	A migration undertaken through the effects of tide, current or wind.
Active	A migration undertaken by active movement across the substratum or through the water column.

Reproductive type / life history:

Term	Definition
Budding	A form of asexual multiplication in which a new individual begins life as an outgrowth from the body of the parent. It may then separate to lead an independent existence or remain connected or otherwise associated to form a colonial organism (Barnes, Calow and Olive 1988).
Parthenogenesis	A form of asexual multiplication in which the ovum develops into a new individual without fertilisation (Barnes, Calow and Olive 1988).
Fission	Form of asexual multiplication involving division of the body into two or more parts each or all of which can grow into new individuals (Barnes, Calow and Olive 1988).
Permanent hermaphrodite	Capable of producing both ova and spermatozoa either at the same time (Barnes, Calow and Olive 1988).
Protandrous hermaphrodite	A condition of hermaphroditism in plants and animals where male gametes mature and are shed before female gametes mature (Holmes 1979).
Protogynous hermaphrodite	A condition of hermaphroditism in plants and animals where female gametes mature and are shed before male gametes mature (Holmes 1979).
Gonochoristic	Having separate sexes (Barnes, Calow and Olive 1988).

Frequency of reproduction:

Term	Definition
Semelparous	Breeding only once then dying (Barnes, Calow and Olive 1988).
< Biannual	Breeds less frequently than every two years.
Biannual episodic	Breeds every second year but in one or more discrete periods initiated by some trigger (for example a lunar cycle).
Biannual protracted	Breeds once every two years over an extended or drawn out period.
Annual episodic	Breeds every year but in one or more discrete periods initiated by some trigger (for example a lunar cycle).
Annual protracted	Breeds every year over an extended or drawn out period.

Developmental mechanism:

Term	Definition
Oviparous	A type of reproduction in animals in which the fertilised eggs are laid or spawned by the mother.
Planktotrophic	Feeding at least in part on materials captured from the plankton (Barnes, Calow and Olive 1988).
Lecithotrophic	Development at the expense of internal resources (i.e. yolk) provided by the female (Barnes, Calow and Olive 1988).
Direct development	Development without a larval stage (Barnes, Calow and Olive 1988).
Ovovivparous	A type of reproduction in animals in which the embryo(s) develop in persistent membranes and hatch within the maternal body. No nutrition is derived from the mother.
Viviparous	A type of reproduction in animals in which the embryo(s) develop within and derive nourishment from the maternal body.

Management regime:

Regime	Definition
Quota or take limited by numbers	Restrictions based on limits to the numbers of individuals taken. For example the 'Total Allowable Catch' system applied to fisheries in the EU
Quota or take limited by effort	Restrictions based on limits to the numbers of individuals/boats/nets etc doing the collecting or the amount of time spent collecting.
Restriction of movements of this species	Limiting the movements / transportation of a species in order to prevent its spread/ colonisation etc. where it may be undesirable
Restriction of movements of likely hosts of this species	Limiting the spread/ colonisation etc. of a species to where it may be undesirable by restricting the movements / transportation of its host(s)
Technical restriction in methods of collection	Restrictions such as limiting the size of individuals taken, for example mesh size of nets.
Habitat conservation - maintenance	Efforts to preserve the habitat or environment in its current state.
Habitat conservation - enhancement	Efforts to improve the condition of the habitat or environment, restoration to its original state.
Re-introduction	Deliberate re-introduction by human intervention of a species to an area within its natural geographical range but where it has become extinct in historical times.
Ex-situ breeding	Safeguarding the existence of a population through breeding programmes outside of its natural habitat e.g. captive breeding programmes.

Appendix 3. Key to acronyms

Acronyms likely to be used in relation to studies of sensitivity and identification of marine natural heritage importance of areas are given below.

Terms are briefly explained where they are not referenced in the glossary above and are unclear. The inclusion here of environmental consultants and other commercial organisations merely represents some of the many contractors who have been involved with work on sensitivity and whose names are regularly abbreviated in reports. The inclusion or exclusion of any such organisation is not intended as an endorsement or otherwise of their work.

ACME	Advisory Committee on the Marine Environment (an ICES committee)
AONB	Area of Outstanding Natural Beauty
AOS	Area of Search (in relation to SSSI selection)
ASMO	ASsessment and MOnitoring group (of the Oslo and Paris Conventions)
ASP	Active Server Pages. Active Server Pages is a compile-free application environment for Microsoft's Web Server. ASP scripts can be embedded in an HTML document and are parsed before being sent to the client web browser. Active Server Pages provide a method to create dynamic or database driven web pages. Active Server Pages have native support for both VBScript and Jscript and can also embed ActiveX server components.
ASSI	Area of Special Scientific Interest (Northern Ireland)
ATBA	Areas To Be Avoided (by shipping)
BEDMAN	BEnthic Data MANagement. (A database developed at the Dutch National Institute for Coastal and Marine Management and the Netherlands Institute of Ecology to hold survey data on macro- and meiobenthic fauna from the North Sea.)
BGS	British Geological Survey
BioMar	(Not an acronym) Marine coastal zone management: Identification, description and mapping of biotopes (an EU LIFE-funded project). (Not to be confused with the USA biodiversity and systematics research programme BioMar: BIOlogical diversity in MARine systems).
BOD	biochemical oxygen demand
BODC	British Oceanographic Data Centre
BRC	Biological Records Centre
CA	country agency - one of the statutory national nature conservation bodies, the Countryside Council for Wales, English Nature or Scottish Natural Heritage
CAMEO	Computer-Aided Management of Emergency Operations
CANOCO	CANOnical Community Ordination (a multivariate analytical programme)
CCMS	Centre for Coastal and Marine Sciences (of NERC)
CCW	Countryside Council for Wales
CGI	Common Gateway Interface. A way of interfacing computer programs with HTTP or WWW servers, so that a server can offer interactive sites instead of just static text and images.
CEC	1) Commission of the European Communities; the European Commission; 2) Council of the European Communities; 3) Critical Environmental Capital; 4) Crown Estates Commissioners.
CITES	Convention on International Trade in Endangered Species
CORINE	Co-ORdination of INformation on the Environment (an EU biotopes classification initiative)
COST	COoperation européene dans la domaine de la recherché Scientifique et Technique (an EU forum for European scientific research co-operation.)

CZM	Coastal Zone Management
DANI	Department of Agriculture for Northern Ireland
DETR	Department of Environment Transport and the Regions (DoE until mid 1997)
DML	1) Dove Marine Laboratory, Cullercoats 2) Dunstaffnage Marine Laboratory, Oban
DoE	Department of the Environment (DETR after mid 1997)
DoE(NI)	Department of the Environment for Northern Ireland
DTI	Department of Trade and Industry
EA	1) Environmental Assessment 2) Environment Agency
EC	1) European Commission; the Commission of the European Communities; 2) European Community (now referred to as the European Union)
EcoQ	Ecological Quality
EEA	European Environment Agency
EIA	Environmental Impact Assessment or Analysis
EIR	Environmental Information Regulations
EIS	Environmental Impact Statement
EMS	European Marine Site
EN	English Nature
ENSIS	English Nature SSSI Information System
ERA	Environmental Risk Assessment
ES	Environmental Statement
ESA	Environmentally Sensitive Area
ESI	Environmental Sensitivity Index
EcoQO	Ecological Quality Objective
EQO	Environmental Quality Objective
EU	European Union
EUCC	European Union for Coastal Conservation
FSC	Field Studies Council
FSCRC	Field Studies Council Research Centre
GB	Great Britain
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine environmental Protection (until about 1991, the Joint Group of Experts on the Scientific Aspects of Marine Pollution) (an advisory body to the Heads of eight organisations of the United Nations System)
GIS	Geographical Information System
GOOS	Global Ocean Observing System
IAMW	Important Area for Marine Wildlife
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management
IFREMER	Institut Français de Recherché pour l'Exploitation de la Mer
IMA	Important Marine Area
IMO	International Maritime Organisation
IOE	Institute of Offshore Engineering (Heriot Watt University, Edinburgh)
IUCN	International Union for the Conservation of Nature and Natural Resources
JAMP	Joint Assessment and Monitoring Programme (OSPAR)
JNCC	Joint Nature Conservation Committee
LIFE	L'Instrument Financier pour l'Environment [Financial Instrument for the Environment]
LME	Large Marine Ecosystem

LNR	Local Nature Reserve
MarLIN	Marine Life Information Network
MAFF	Ministry of Agriculture, Fisheries and Food
MBA	Marine Biological Association of the United Kingdom
MNA	Maritime Natural Area
MARPOL	International Convention for the Prevention of Pollution of the Sea from Ships
MARS	Network of European Marine Research Stations
MBA	Marine Biological Association of the United Kingdom
MCA	1) Marine Consultation Area, or 2) (generally prefixed 'Voluntary') Marine Conservation Area
MCS	Marine Conservation Society
MEHRA	Marine Environmental High-Risk Area
MNCR	Marine Nature Conservation Review
MNR	Marine Nature Reserve
MPA	Marine Protected Area (generic term)
NCC	Nature Conservancy Council
NCCE	Nature Conservancy Council for England (English Nature; NCCE remains the formal legal title)
NERC	Natural Environment Research Council
NGO	non-governmental organisation
NHM	The Natural History Museum, London
NMMP	National Marine Monitoring Plan (UK)
NNR	National Nature Reserve
NP	National Park (England and Wales)
NRA	National Rivers Authority (now the Environment agency)
NRSC	National Remote Sensing Centre
NSQSR	North Sea Quality Status Report
NSTF	North Sea Task Force
NT	National Trust
NTS	National Trust for Scotland
NVZ	Nitrate Vulnerable Zone
OLD	Operations Likely to Damage (English Nature term)
OPRU	Oil Pollution Research Unit
OSIS	Oil Spill Information System
OSPAR	OSlo/PARis Convention (short title for the 1992 International Convention for the Protection of the Marine Environment of the North-East Atlantic)
OSPARCOM	OSlo and PARis COMmissions
PCBs	poly-chlorinated biphenyls
PCoA	Principal Co-ordinates Analysis
PDA	potentially damaging activity (generally used in context of marine protected areas)
PDO	potentially damaging operation (generally used in context of notified SSSIs)
PML	Plymouth Marine Laboratory (of NERC)
PPG	Planning Policy Guidance note
ppt	parts per thousand (measurement of salinity, normally expressed as ‰)
PRIMER	Plymouth Routines In Multi-variate Ecological Research (a multivariate analytical programme)
PSP	paralytic shellfish poisoning
PSSA	Particularly Sensitive Sea Area
QSR	Quality Status Report

QUASIMEME	QUality ASsurance of Information for Marine Environmental Monitoring in Europe
RDB	Red Data Book
redox	REDuction-OXidation
RoxAnn	Reputedly a derivation from "rocks and sand"; see glossary of terms
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SACFOR	An abundance scale used by MNCR for recording benthic marine organisms (see Hiscock 1996): Superabundant; Abundant; Common; Frequent; Occasional; Rare
SAMS	Scottish Association for Marine Science
SAST	Seabirds at Sea Team (a project within JNCC's Seabirds and Cetaceans Branch)
SCOPAC	Standing Conference on Problems Associated with the Coastline
SCR	Seabird Colony Register (JNCC)
Seasearch	A JNCC & MCS Phase 1 sublittoral habitat survey
SEPA	Scottish Environment Protection Agency
SERCON	System for Evaluating Rivers for CONservation
SMA	Sensitive Marine Area
SMBA	Scottish Marine Biological Association (now Scottish Association for Marine Science)
SNH	Scottish Natural Heritage
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
SPA	Special Protection Area (a site designation under the 1979 EC Directive on the Conservation of Wild Birds)
SQM	Site Quality Monitoring
SSSI	Site of Special Scientific Interest
SWQO	Statutory Water Quality Objective
SWT	Scottish Wildlife Trust
TBT	tri-butyl tin (organotin)
TWINSPAN	Two-Way INdicator SPecies ANalysis (a multivariate analytical programme)
UCNW	University College of North Wales (now known as University of Wales, Bangor)
UK	United Kingdom
UKDMAP	United Kingdom Digital Marine Atlas Project
UKOOA	United Kingdom Offshore Operators' Association
UNCED	United Nations Conference on Environment and Development (the 1992 'Rio' conference)
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
VCO	Voluntary Conservation Organisation
VSA	Very Sensitive Area (normally used in context of fish-farming)
WA	(as suffix, e.g. SWWA) Water Authority
WWF	World-Wide Fund for Nature (formerly World Wildlife Fund)
ZNIEFF	Zones Naturelles d'Intérêt Écologique, Faunistique et Floristique [Natural Zones of Ecological, Faunistic or Floristic Interest] (A French initiative to identify sites of interest and classify biotopes.)

Appendix 4. Catalogue of recent or current methods of identifying and/or quantifying sensitivity and an assessment of their strengths and weaknesses.

Description of system and references	Strengths	Weaknesses	Notes
Anderson, S. and Moore, J. 1997. *Guidance on assessment of seabed wildlife sensitivity for marine oil and gas exploration.* A report to JNCC from OPRU, Neyland, UK. Report No. OPRU/18/96. A scale of 1-4 is applied on a matrix of habitats against potential consequences (effects) of oil exploration. For each consequence, a total score is produced and multiplied by a weighting factor of 5, 2 or 1 depending on the likelihood of the consequence occurring to give an overall weighted score.	The approach takes account of likelihood of a factor occurring. Practical experience of likely effects of a wide range of factors likely to occur during oil exploration was used including some workshop material. The matrix is simple to understand.	A key to the 4-point scale could not be found so that it is very subjective. By using a '1' as the lowest score (which presumably means no or little effect likely), summing a column of 1's and then multiplying by 5 (if the factor is highly likely to occur), a very high score is achieved even though impact is likely to be negligible or nil.	Based partly on the methodology from Holt *et al*. (1995) but only in relation to effects of oil and gas exploration.
Carter, I.C., Williams, J.M., Webb, A. and Tasker, M.L. 1993. Seabird concentrations in the North Sea: An atlas of vulnerability to surface pollutants. Use an 'offshore vulnerability index': ovi = 2a + 2b + c + d Where a= % of time spent on the water; b=population size, c=recoverability and d=reliance on marine environment.	Used successfully in mapping vulnerability of seabirds through time. Takes account relative importance of the sea to bird species and recoverability potential of a population.	Not strictly a measure of sensitivity – more of vulnerability. Recoverability is integral component.	Each component scored on a 1-5 scale.
Cooke, A. and McMath, M. 1998. SENSMAP: Development of a protocol for assessing and mapping the sensitivity of marine species and benthos to maritime activities. CCW Marine Report:98/6/1 Development of the method used by MacDonald *et al.*	Can deal with non-linear effects and effects of multiple factors. Includes confidence values. Refers to 'Species intolerance' as a measure of the inability of a species to endure damage caused by an external	Recoverability is integral to sensitivity. Vulnerability not yet included. Even though the system uses an objective formula, allocating scores in the first place is subjective. Use of a formula may mean that oversimplification of	Intolerance is ranked on a scale of 0-10. Recoverability is assessed using three categories scored on 1-4 scale. Intolerance measured by % of population killed or

(1996). Use a formula of $S = I \times R^2$. Where S = sensitivity, I= intolerance and R = recoverability Recoverability and intolerance values will exist on a database and then when species and effect information are put in the resulting sensitivity will be the output.	factor. Use of simple, modifiable formula to define sensitivity value.	definitions occurs.	damaged. Matrix table constructed using formula and resulting values placed in five bands. Lack of discrimination may be improved by using a scale that starts at zero.
Dicks, B. and Wright, R. 1989. *Coastal sensitivity mapping for oil spills.* In: Ecological impacts of the oil industry. John Wiley and Sons.			Doesn't actually outline a scoring mechanism but does give guidelines that sensitivity mapping projects should follow.
Gundlach, E.R. and Hayes, M.O. 1978. Classification of coastal environments in terms of potential vulnerability to oil spill damage. *Marine Technical Society Journal, 12 (4)*: 18-27. A simple 1-10 scale primarily depending on physical characteristics of the shoreline	Simple index – easy to understand. Easy definition of shoreline type. Recoverability is incorporated in the sensitivity scale.	Only useful for the effects of oil spills. Restricted to the shoreline. Only very broad categories. Only begins to take biological characteristics into account.	
Hiscock, K., Connor, D., & Hill, T. 1998. *Recovery of seabed wildlife from natural change and human activity – assessing sensitivity and importance.* ICES CM 1998/V:13. Hiscock, K. 1998 Sensitivity of seabed habitats – assessment and protection (Summary of the presentation). *UK Oceanography '98. University of Southampton. 7-11 September 1998.* (Unpublished.) 6 point scales used.	Recoverability assessed separately to sensitivity. Scores relate to particular effects. Descriptive scales (0-5). Only involves two values (sensitivity and Recoverability). Attempts to deal with multiple species, multiple events and multiple factors (in a descriptive way). Provides stages in an assessment protocol for deciding on importance.	Sensitivity assessment does only specifies factor intensity, frequency or duration descriptively. No clear indication of what variables constitute recoverability or sensitivity. Each is derived from just one value hence somewhat intuitive allocation of scores.	

Holt, T.J., Jones, D. R., Hawkins, S.J. & Hartnoll, R.G. (1995, 1997). The sensitivity of marine communities to man-induced change. (1995 Report No. 65 for CCW, 1997 Irish Sea Forum) Holt *et al.* used four criteria (longevity, fragility, stability and intolerance) to assess 'damage', while recoverability was assessed separately.	Scoring of life forms provides a compromise between resolution and practicality. 'Damage' and recoverability treated separately. Allows variable weighting. Very useful as a source of information on effect of impacts such as oil, general chemicals and temperature. Also identifies factors most important to habitat types and biotope complexes.	Compromised by a requirement to assess sensitivity against 'life forms' and, partly because of the coarseness of such a classification, they found that none of the life forms was particularly sensitive. 'Life forms' not readily applied to many situations. No inclusion of vulnerability. Over-simplification of definitions used in scoring inevitable. Problems reconciling inter-relationships between categories –Provides only an all-round sensitivity rating. No discussion of the importance of individual species in determining sensitivity within life forms or communities.	Lack of discrimination may be improved by using a scale that starts at zero. Could be applied to a variety of detrimental effects.
MacDonald , D.S., Little, N., Eno, C., & Hiscock, K. 1996. Disturbance of benthic species by fishing activities: a sensitivity index. *Aquatic Conservation, 6*: 257-268. Developed a sensitivity index for seabed species in relation to mobile bottom fishing gear. 'Recoverability' was especially weighted in their formula because it was such an important factor. Their index of sensitivity (*S*) was: $S = (F \times I)\, e^{R}$ where *R* is *recovery* (scored on a scale of 1 to 4, equivalent to short, moderate, long and very long recovery period or no recovery likely), *F* is *fragility* (scored on a scale of 1 to 3, equivalent to not very fragile, moderately fragile, and very fragile and	The approach provides a structured integration of the main factors determining likely sensitivity and is an improvement on complete subjectivity. Convenient single score for comparisons. Quite good for the effects of fishing which can be easily categorised.	The three variables in the equation are subjective and different scores might be given by different workers. Also, raising the recoverability score to the power of *e* is a crude way of weighting. Based on the assumption that the disturbance has a linear effect on sensitivity. Doesn't separate sensitivity and recoverability – fixed weighting for recoverability. Limited to single species, single factor, single event. Use of formula may mean that oversimplification of definitions occurs.	MacDonald *et al*. (1996) were able to identify a small number of species likely to be highly sensitive to certain types of fishing gear.

I is the *intensity of the impact* (scored on an arbitrary scale of 1 to 3, equivalent to low, moderate and high intensity).			
OSPAR Workshop on species and habitats. Texel. February 24-28 1997. Identified example habitats and species and their 'importance' in terms of 'Ecological value' and 'Status' including sensitivity/ poor recoverability which was scored as 'Local effect', 'sensitive', 'Very sensitive'.	Expert European group.	Sensitivity/ recoverability was a small part of the work of the group. The scoring system for sensitivity was restricted in extent..	'Very sensitive' = if adversely affected by human activities will only recover over a long period (.25 years). 'Sensitive' species = will only recover in 5-25 years.
Michel, J., & Dahlin, J. 1993. Guidelines for developing digital environmental sensitivity index atlases and databases. **Research Planning Inc. 1998. Environmental Sensitivity Index (ESI).** Http://www.Researchplanning.com/esi/esi.htm Http://www.Nos.noaa.gov.hazmap/oiltour/esi1.htm1 Designed for the impact of oil spills. Sensitivity ranking is based on: • Relative exposure to wave and tidal energy. • Shoreline slope. • Substrate type. • Biological productivity and sensitivity. The ESI scale is 1 (Exposed impermeable vertical substrates) to 10 (vegetated wetlands).	Widely used in the USA and the approach is used world-wide. Therefore must be considered practical and authoritative. Includes some subtidal aspects. The map-based approach is easily used and rapidly available in the event of an accident.	Restricted to oil spill effects on the shore, sea surface and shallow subtidal (although 'interest' features are relevant to any adverse activity). Likelihood of damage to biological resources and potential for recovery potential not obvious from material inspected. No clear scoring system for sensitivity or recoverability of any individual biotopes or species.	A more comprehensive inclusion of biological characteristics than (Gundlach and Hayes 1978) but still only using broad categories. Maps show shoreline types and locations where sea mammals and seabirds congregate and/or breed and areas used for recreation, management (for conservation), resource extraction, aquaculture, and archaeological or other cultural use. Similar approach to the UK Oil spill sensitivity atlas.

Weslawski, J.M., Wiktor, J., Zajaczkowski, M., Futsaeter, G. and Moe, K.A. 1997. Vulnerability assessment of Svalbard intertidal zone for oil spills. *Estuarine, Coastal and Shelf Science*. 44 (Supplement A) 33-41. Provides a system for estimating a coasts vulnerability to oil spills. Considers both physical and biological parameters. Up to 19 factors considered.	Simple, easy allocation of scores to both biological and physical factors. Clear descriptions of factors. Worst case scenario approach used for squares with special features. Capacity to deal with varied habitats within a square.	Only deals with 5x5 Km squares. Problems associated with transforming point data into 25km^2 If different habitats occur within a square then a compromise has to be reached as to the score allocated. Biological and physical vulnerabilities scored independently. No seasonal aspect. Scoring bands for physical and biological vulnerability are different. Only deals with intertidal effects.	Factors ranked by importance (principal, important and secondary). For each factor three vulnerabilities were identified; low (1) medium (2) and high (3) To calculate a score the factor was multiplied by the vulnerability value. Factors were weighted as follows principal (6), important (3) and secondary (1).The mean values for each factor category are summed. Scores are divided into four bands

Appendix 5. Key information review as a background to Species Action Plans (UK Biodiversity Action Plans)

KEY INFORMATION ON: *Eunicella verrucosa*

[This example uses a previous 5-level scale for sensitivity assessment]

AUTHOR: Keith Hiscock

1. Information from the Species Directory (with added common names):

Phylum:	Cnidaria
Class:	Hexacorallia
Subclass:	
Order:	Gorgonacea
Family:	Plexauridae
Genus:	*Eunicella*
Species & authority:	*verrucosa* (Pallas 1766)
Subspecies / variety / form:	
Recent synonyms:	
Common name(s):	Pink sea fan

2. Key identification features:

Colonies are profusely branching usually in one plane creating a fan-shaped colony. The colonies may be up to 30 cm high and/or broad. The polyps are close-set and irregularly arranged on the branches giving a knobbly appearance. The colour is almost always salmon pink in British colonies but white becomes the predominant colour with increasing distance south along the coast of continental Europe. Irish colonies are also white. The living coenencycme coats a black or dark brown axis. Microscopic inspection of the spicules may be needed to confirm identification. (Based on Manuel 1988.)

3. Recorded distribution

Britain & Ireland: Extending eastwards to Lyme Bay and probably to Portland Bill in the English Channel but recorded almost to the Thames Estuary at Margate in historical times (Manual 1988). To the north and east, recorded eastwards in the Bristol Channel from North Devon near Ilfracombe where it was present in the 1970's (K. Hiscock, own observations) but on the north shores of the Bristol Channel known only from the entrance at Skomer. The northwards distribution in the Irish Sea is to at least to north Pembrokeshire but specimens have been reported to have been caught by fishermen off Bardsey (R. Holt, pers. comm.). Occurs all along the west coast of Ireland to Northern Ireland and may occur in Scotland (Manual 1988).

NE Atlantic: Recorded south to north-west Africa including sparse records from the Canary Isles and extensively present in the Mediterranean (Carpine & Grasshoff 1975).

World: Western basin of the Mediterranean, north-west Africa and mainland coast of the north-east Atlantic north to south-west Britain.

4. Biotopes found in (* = characteristic of the biotope): *Alcyonium digitatum* with massive sponges (*Cliona celata* and *Pachymatisma johnstonia*) and *Nemertesia antennina* on moderately tide-swept exposed circalittoral rock (ECR.AlcMaS) (usually in local shelter); *Phakellia ventilabrum* and axinellid sponges on deep exposed circalittoral rock (MCR.PhaAxi); Erect sponges, *Eunicella verrucosa* and *Pentapora foliacea* on slightly tide-swept moderately exposed circalittoral rock (MCR.ErSEun)*; Cushion sponges (*Polymastia boletiformis, Tethya*), branching sponges, *Nemertesia* spp. and *Pentapora foliacea* on moderately exposed circalittoral rock (MCR.ErSPbolSH).

5. Other information (complete from initial review then opportunistically): Studies at Ilfracombe, Lundy and Skomer have shown that the branches of colonies grow at irregular rates but an approximate mean of 10 mm a year. This suggests that the larger colonies are 30 or more years old. Recruitment

appears to be irregular but sufficiently frequent to maintain dense populations at some locations. The axis has annual growth rings which suggest slower growth in cold years (K. Hiscock, unpublished).

Photographs: [source and reference number]

Habitat found in:

Physiographic	Open coast
Substratum	Bedrock or stable boulders
Wave exposure	Very exposed to Sheltered.
Tidal stream strength	Moderately strong to weak.
Height/Depth (as zone)	Lower Infralittoral, Circalittoral.
Salinity	Full.
Other	On upward facing rock.

Description of habitat preferences: Present on upward facing rock in the lower infralittoral but especially the circalittoral where it may form forests in favourable conditions. Present to 200m depth (Manuel 1988). Thrives most on exposed coasts but below the zone of multidirectional water movement (below about 25m on coasts exposed to prevailing winds and oceanic swell) and where there are moderately strong tidal streams.

Origin (non-native species): n/a

Date of arrival in UK (non-native species): n/a

Sensitivity (of adults) [Score as: 5 = minor impact/concentration/variation from normal in a single brief event would cause mortality; 4 = minor impact/concentration/variation from normal in a prolonged or multiple event would cause mortality; 3 = considerable force/concentration/variation from normal or prolonged or several events required to cause mortality; 2 = force of impact would have to be 'crushing' or prolonged/concentration high and long-term/variation from normal would be required to cause long-term to cause mortality; 1 = resilient, most likely because of ability to avoid the potentially damaging event (migration, close-up, bury) at least in the short term (hours or a few days); 0 = no damage likely even from major physical force or concentrated contaminant over a sustained period (several days) - either extremely tough or able to remain out of the impacting activity - for instance, by being buried or swimming away].

Physical impact (fragility) =	3
Physical disturbance (displacement) =	5
Siltation =	2
Turbidity =	3
Deoxygenation =	4
Salinity change =	4
Temperature change =	3
Oil pollution =	3
Chemical contaminants =	3
Eutrophication =	2
Other (name) =	

Recovery potential (in relation to a single event causing mortality) [Score as 5=Very poor, even partial recovery unlikely at the location for at least 25 years; 4=Poor, partial recovery likely within 10 years, full recovery likely to take up to 25 years; 3=Moderate, partial recovery likely within 5 years, full recovery likely to take up to 10 years; 2=High, full recovery will occur but will take at least several months; 1=Very high, full recovery likely within a few weeks or at most 6 months; 0=recovery immediate or within a few days).]

= 4

Feeding type: Carnivore

Life-span: [Score as: 5=possibly over 100 years; 4=several decades; 3=<10 years; 2=<5 years; 1=annual or <1 year]

= 4

Reproduction:

Asexual (budding, splitting)	
Planktonic larva - long	
Planktonic larva - short	
Benthic larva	X
live-bearer - parental care	
live-bearer - no parental care	
egg-layer -parental care	
egg-layer - no parental care	

Time of year reproduction occurs: Not known.

Frequency of reproduction: Not known but lack of small individuals in most years suggests that reproduction and settlement may occur only every few years.

Age at which sexual maturity reached: Not known.

Growth rate: About 1 cm in branch length per year. Likely to be more in south-west England and less at the eastern and northern limits of distribution.

Key references:

Taxonomy	Manuel (1988), Carpine & Grasshoff (1975).
Biology	Carpine & Grasshoff (1975).
Effects of human activities	Eno *et al.* (1996).
Fluctuations in abundance	

Historical information (eg past losses/gains, changes in distribution): May once have occurred as far east in the English Channel as Margate (Manuel 1988).

Parasite on/in: n/a

Symbiont on/in: n/a

Inquilinist on/in: n/a

Host for: The sea anemone *Amphianthus dohrnii*; the sea slug *Tritonia nilsohdneri*; the prosobranch *Simnia patula*. Other species attach to branches especially ephemeral algae (in shallow depths) and branching bryozoans. Squid attach their eggs to branches.

Considered key-stone? Yes

Why keystone?:

Feeds on others (population control)	
Fed on by others (food chain link)	The sea slug *Tritonia nilsodneri*; the prosobranch *Simnia patula*.
Habitat for community	

Keystone species in which biotopes: ECR.AlcMaS, MCR.PhaAxi, MCR.ErSEun, MCR.ErSPbolSH.

Applications / use:

Trade	no
Aquaculture	no
Harvest	no
Curiosity / charisma (tourism)	minor
Research	minor
Culinary	no

Protected status or relevance under Conventions and Directives:

Berne	no
CITES	no
EC Habitats Directive	no
W&C 1981 Act	yes
NI ACT	no
UK Biodiversity Action Plans	yes
Other (name)	

Appendix 6. Key information review as background to the OSPAR IMPACT meeting in September 1998

Compiled by: Keith Hiscock, English Nature, Northminster House, Peterborough PE1 1UA. UK.

[This example uses a previous 5-level scale for sensitivity assessment]

Derived, in part, from: the UK marine biotope classification (Connor *et al*. 1997(b)) and a review undertaken for the UK Marine SACs Project (Davison 1998).

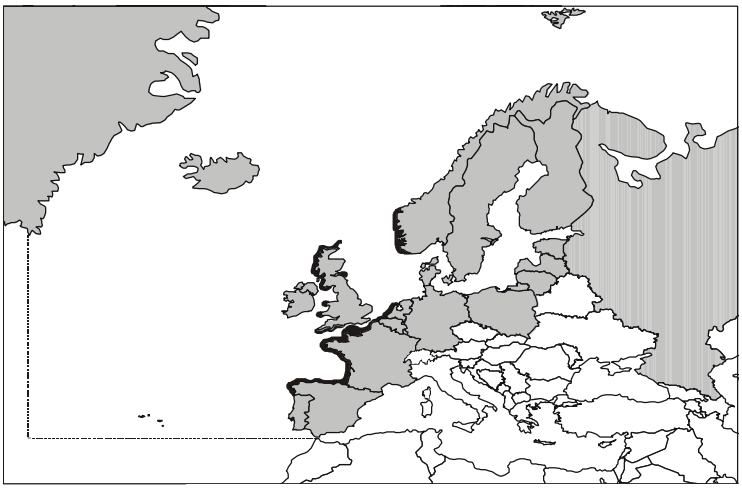
Classification

Classification	*Code*	*Biotope(s)*
Wadden Sea (1996)	03.02.05	Benthic zone of the shallow coastal waters with muddy and sandy bottom, rich in macrophytes
UK (MNCR BioMar – 97.06)	IMS.Zmar	*Zostera marina*/*angustifolia* beds in lower shore or infralittoral clean or muddy sand
France (ZNIEFF-MER)	II.3.3	Herbiers de *Zostera marina, Zostera noltii* (= *Z. nana pro parte*) du médiolittoral inférieur
	III.3.4	Herbiers de *Zostera marina*

Description

IMS.Zmar. Expanses of clean or muddy fine sand in shallow water and on the lower shore (typically to about 5 m depth) can have dense stands of *Zostera marina/angustifolia* [Note: the taxonomic status of *Z. angustifolia* is currently under consideration but is most likely a dwarf form of *Zostera marina*]. In IMS.Zmar the community composition may be dominated by these *Zostera* species and therefore characterised by the associated biota. Other biota present can be closely related to that of areas of sediment not containing *Zostera marina*, for example, *Laminaria saccharina*, *Chorda filum* and infaunal species such as *Ensis* spp. and *Echinocardium cordatum* (e.g. Bamber 1993) and other bivalves listed below. It should be noted that sparse beds of *Zostera marina* may be more readily characterised by their infaunal community. Beds of this biotope in the south-west of Britain may contain conspicuous and distinctive assemblages of Lusitanian fauna such as *Laomedea angulata*, *Hippocampus* spp. and Stauromedusae. Some examples of *Zostera marina* beds have markedly anoxic sediments associated with them. (from Connor *et al.* 1997(b))

Distribution



Habitat requirements

Habitat factor	*Range of conditions*
Salinity	Fully marine; Variable; Reduced; Low. McRoy (1966) suggests optimum salinities of 10 to 39‰, den Hartog (1970) reports tolerances as low as 5‰ in the Baltic. Laboratory studies indicate that maximum germination occurs at 30ºC and 1‰ salinity (Hootsmans *et al.* 1987). Field studies indicate that germination occurs over a wide range of temperatures and salinities (Churchill 1983, Hootsmans *et al.* 1987). In brackish waters along the Atlantic coast, *Zostera marina* behaves as an annual plant, shedding its leaves in winter (Jacobs 1982). Low salinities may encourage production of reproductive shoots and stimulate leaf production. *Zostera marina* beds survived disease especially in low salinity conditions in the eastern United States (Muehlstein, Porter & Short 1988).
Wave exposure	Sheltered, Very sheltered, Extremely sheltered, Ultra sheltered
Tidal streams	Weak, very weak
Substratum	Clean sand, muddy fine sand, mud
Zone	Lower shore, Upper infralittoral
Depth range	0-5 m
Temperature	Optimum temperature range for *Zostera marina* appears to be between 5 and 30 ºC (Marsh *et al.* 1986, Bulthius 1987). Seasonal growth is closely associated with temperature. Yonge (1949) suggested that growth ceases below 10 ºC and that flowers could only open and seeds form when the temperature exceeded 15 ºC. *Zostera marina* beds which occur intertidally may be damaged by frost although the rhizomes most likely survive (Covey & Hocking 1987).
Water quality	*Zostera marina* requires high light levels. It most commonly occurs shallower than 2m below chart datum, exceptionally to 5m and the deepest recorded depth it has been found in Britain and Ireland is 13m below chart datum off south-west Ireland (Cullinane *et al.* 1985). Harrison (1987) describes how the extent of a *Zostera marina* bed expanded after construction of a causeway blocked the flow of silty water.
Nutrients	It seems most likely that nitrogen is the limiting nutrient. In carbonate-based sediments, phosphates may be limiting due to adsorption onto sediment particles (Short 1987). Mild nutrient enrichment of sediments may stimulate growth of *Zostera marina* shoots (Roberts *et al.* 1984).

(from Connor *et al*. (1997b), unless otherwise stated)

Species composition and biodiversity
Characterising species

For IMS.Zmar in the UK	*% Frequency*	*Faithfulness*	*Typical abundance*
Anemonia viridis	••	••	**Frequent**
Arenicola marina	••	•	**Occasional**
Lanice conchilega	••	•	**Occasional**
Pagurus bernhardus	••	•	**Occasional**
Carcinus maenas	•••	•	**Occasional**
Gibbula cineraria	••	•	**Occasional**
Hinia reticulata	••	••	**Occasional**
Chorda filum	••	••	**Frequent**
Laminaria saccharina	••	•	**Occasional**
***Ulva* sp.**	••	•	**Frequent**
Zostera marina	•••••	•••	Abundant

(from Connor *et al*. 1997b)

Species found uniquely in biotope

The hydroid *Laomedia angulata* and the algae *Rhodophysema georgii, Halothrix lumbricalis, Leblondiella densa, Myrionema magnusii, Cladosiphon zosterae* and *Punctaria crispata* have only been recorded attached to seagrass leaves. The endophytic green alga *Entocladia perforans* is also host specific to *Zostera marina*.

Number of species recorded in biotope

Ecological relationships

Zostera marina provides a habitat for a wide range of species to find shelter or a suitable substratum on which to live. Fish occur amongst the seagrass and include the wrasse and goby species also found in kelp. The green wrasse (*Labrus turdus*) is normally associated with seagrass beds in the Mediterranean and may be present in Isles of Scilly *Zostera marina* beds (Fowler 1992). Especially found in sea grass beds are pipe fish *Syngnathus typhle* and *Entelurus aequoraeus* and, rarely, sea horses *Hippocampus ramulosus*. Cuttlefish, *Sepia officinalis*, are also found and lay their eggs amongst seagrass. Small prosobranchs, especially *Rissoa* sp(p) and *Lacuna vincta* graze on the leaves. The mud snail *Hydrobia ulvae* is found on leaves in estuarine conditions. At open coast sites, stauromedusae (stalked jellyfish), *Haliclystus auricula* and *Lucernariopsis campanulata*, may be present on leaves. The hydroid *Laomedia angulata* and the algae *Rhodophysema georgii, Halothrix lumbricalis, Leblondiella densa, Myrionema magnusii, Cladosiphon zosterae* and *Punctaria crispata* have only been recorded attached to seagrass leaves. The endophytic green alga *Entocladia perforans* is also host specific to *Zostera marina*. Seagrass rhizomes help to stabilise sediments and may thereby increase species diversity. Sea anemones (*Cereus pedunculatus, Cerianthus lloydii*) and the prosobranch *Nassarius reticulatus* are often common in the sediment. In the Isles of Scilly, the sea anemone *Anthopleura ballii* is unusually present.

Habitat complexity

Seagrasses provide shelter and hiding places. The leaves and rhizomes provide substrata for the settlement of epibenthic species which in-turn may be grazed upon by other species.

Recruitment processes

Zostera marina provides refuges for many species of fish and nursery areas for some.

Sediment stabilisation

The slowing of water movement by leaves encourages accumulation of sediments whilst the dense rhizome and root system stabilises the sediment preventing or reducing sediment loss. The consolidation of the sediments enables the development of richer infaunal communities with higher densities of individuals than those in adjacent bare sediments (reviewed most recently in Boström & Bonsdorff (1997).

Productivity

Sea grasses have high rates of primary production and are an important source of organic matter whose decomposition provides a starting-point for detritus-based food chains. They also provide a substratum for other plant species.

Keystone (structuring) species

Zostera marina, Labrynthula macrocystis

Importance of biotope for other species

Intertidal and probably shallow subtidal *Zostera marina* beds provide a source of food for a variety of wildfowl, although not to the extent that intertidal *Zostera noltii* do. Studies of feeding on *Zostera* rarely differentiate which species is being referred to. Tubbs & Tubbs (1983) reported that brent geese grazing contributed to the cover of *Zostera marina* and *Zostera noltii* being reduced from between 60-100% cover in September to between 5-10% cover between mid-October and mid-January. The observation (den Hartog 1977) that the decline in *Zostera marina* during the wasting disease of the 1930's was followed by very heavy losses of the Brent goose and the Canada goose suggests that they rely on *Zostera marina* for a

large proportion of their food. However, it remains unclear and seems unlikely that subtidal *Zostera marina* beds are affected by wildfowl grazing.

Although much referred to as a nursery area for fish, there is little evidence to support the assertion that beds of *Zostera marina* provide such a facility.

Temporal changes

Zostera marina beds are naturally dynamic, at least in open coastal areas. In the Isles of Scilly, beds have 'advancing' and 'receding' edges. The fungus *Labrynthula macrocystis* caused the loss of over 90% of *Zostera marina* beds in the 1920's and 1930's and a full recovery has not yet occurred (Vergeer *et al.* 1995 for a recent review). *Zostera marina* beds may show marked annual changes. In brackish conditions, there is die-back of the leaves in the autumn and regrowth in the spring and early summer (Jacobs 1982, Dyrynda 1997). This die-back has been observed to be almost complete in The Fleet in Dorset, UK (Dyrynda 1997) and resulted in sediment destabilisation as well as loss of cover for fish and substratum for invertebrates.

Time for community to reach maturity

Zostera marina beds most likely do not seed and establish rapidly. There has been little recovery of *Zostera marina* beds following the wasting disease in the 1930's. Olesen & Sand-Jensen (1994) reported that, in Danish waters, new *Zostera marina* beds could take at least five years to become established and stable with small patches (<32 shoots) showing high mortalities. However, these observations are near to established beds and seeding over a distance particularly between isolated water bodies is likely to be slow. An extensive series of experiments has been undertaken to try to re-establish beds (see, for instance, Fonesca *et al.* 1994).

Sensitivity to human activities

Sensitivity to:	***Human activity***	***Score***	***Comments***
Physical impact (fragility)	Mobile (bottom) fishing gear Shipping – anchoring	2	Seagrass is flexible and likely to be resilient to impact
Physical disturbance (displacement)	Dredging (navigation channel maintenance) Aggregate dredging Maerl gravel and shell sand dredging	3	Displacement may happen as a result of anchors being dragged through a seagrass bed or over-vigorous foraging by wildfowl. The most frequent and probably severe effect is from storms. Severe or prolonged storm events may cause significant losses. Floods in estuarine situations may also increase water flows sufficiently to wash-out seagrasses or sediments (for instance, Wyre *et al.* 1977, DenHartog 1987).
Siltation	Land claim	2	Siltation following normal events (for instance sediment taken into suspension by high river flows) is likely to be transitory and result in negligible impact.
Turbidity	Spoil dumping Land drainage	4	Prolonged increases in turbidity would reduce light penetration and prevent adequate photosynthesis by deeper populations of *Zostera marina*. Geisen *et al.* (1990) suggest that turbidity caused by eutrophication, deposit extraction and dredging activities were major factors in the decline of *Zostera* in the Wadden Sea.
Deoxygenation	Salmonid fish farming	4	No evidence of effects found in the literature but de-oxygenation would be likely to adversely affect plants.

Salinity change	Estuarine barrages	2	*Zostera marina* seems to be highly tolerant of changes in salinity. However a severe event such as replacement of seawater by a layer of freshwater after prolonged rain may have an effect.
Temperature change	Global warming		Den Hartog (1970) suggested that *Zostera marina* generally tolerates temperatures up to 20ºC without showing signs of stress. There is likely to be damage through frost to beds exposed at low water (denHartog 1987).
Oil Pollution	Oil spills	3	Apparently healthy *Zostera marina* beds are known to exist in areas subject to low level chronic hydrocarbon contamination (see, for instance, Howard, Baker & Hiscock 1989). Smothering by stranded oil is likely to occur on lower shore populations but little is known of effects [check Amoco Cadiz]
Contaminants	Inorganic mine and particulate wastes Pesticides Shipping (anti-fouling paints)	?	Terrestrial herbicides have been found to inhibit growth and cause decline in *Zostera marina* (Delistraty & Hershner 1984) Some effects may be indirect. For instance, *Zostera marina* readily uptakes heavy metals and TBT (Williams *et al.* 1994). Whilst plants appeared unaffected, any loss of grazing prosobranchs due to TBT contamination in the leaves or externally would result in excessive algal fouling of leaves and poor productivity and possible smothering. Lead accumulation (from shotgun pellets) in sediments may stress *Zostera* plants.
Eutrophication	Sewage discharge	3	High nitrate concentrations have been implicated in the decline of *Zostera marina* by Burkholder *et al.* (1993). Such eutrophication may increase the cover of epiphytic algae and prevent photosynthesis of sea grass plants. Eutrophication may increase abundance of *Labrynthula macrocystis* (see below). However, nutrient enrichment may stimulate growth of *Zostera marina* (Fonesca *et al.* 1994)
Other (name)		4	**Wasting disease.** An infection by the fungus *Labrynthula macrocystis* which decimated *Zostera marina* in the 1920's to the mid 1930's. Continuously present at low levels; reason for epidemics unclear but stress including pollution incidents suggested (see, for instance, Rasmussen 1977, Short *et al.* 1988, Vergeer *et al.* 1995).
		2	**Wildfowl grazing**
		2	**Smothering by algae.** Smothering by algae may be linked to eutrophication. *Zostera marina / angustifolia* plants were overwhelmed by *Enteromorpha* in Langstone Harbour but their final demise may have been due to grazing by brent geese (denHartog 1994).
	Mariculture Shipping (As main causes of the importation of non-native species)	?2	**Exclusion by non-native species (esp. *Sargassum muticum*)**. *Sargassum* seems to colonise seagrass beds without displacing the seagrass. (For instance, Critchley 1983, Covey & Hocking 1987). Future non-native species may be more 'aggressive' and have a greater affect.

Recovery potential

In relation to a single event causing mortality = 3

(Beds affected by chronic wasting disease could take longer.)

Assessment of regeneration ability in the Wadden Sea: B – Regeneration conditionally possible (less than 15 years) (Von Nordheim, Anderson & Thissen 1996)

Conservation, protection and management

Conservation status

Region	*Status*
OSPAR area	Not known
Wadden Sea	1 – Threatened by complete destruction (Von Nordheim, Anderson & Thissen 1996)
UK	TBA
Other sub-regions	Not known

Protected status

Protection mechanism	*Habitat*
EC Habitats Directive	A named component of *Lagoons* (a priority habitat*) and Shallow sandbanks slightly covered by seawater all of the time.* Also a characteristic feature *of Large shallow inlets and bays* and *Estuaries* and occurs on the lower shore in *Mudflats and sandflats not covered by the tide at low water.*
UK Biodiversity Action Plan	Seagrass beds

Management measures

To maintain biotope in natural state: Avoid activities which result in increased levels of turbidity in the long term. Prevent excessive nutrification of water bodies.

To restore biotope to natural state: Remove or reduce sources of contaminants which may adversely affect associated grazing species. Minimise anchoring and prohibit the use of mooring chains, which drag the seabed in *Zostera marina* beds.

Appendix 7. Biology and sensitivity key information *pro formas*

Species Biology and Sensitivity Key Information Data Entry Fields

Revised Draft 2 September 1999

Scientific name (Authority and Date)
Common name(s)

TAXONOMY

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**
5. **MCS / Ulster Museum species code**
6. **Taxonomic classification**
   - **Phylum**
   - **Subphylum**
   - **Superclass**
   - **Class**
   - **Subclass**
   - **Order**
   - **Suborder**
   - **Family**
   - **Subfamily**
   - **Genus**
   - **Species**
   - **Subspecies / variety / form**
7. **English equivalent for Phylum**
8. **Recent synonyms (since 1950) with authorities and dates**
9. **General description**
10. **Key identification features**
11. **Images** [with description, holder and photographer]
12. **Additional information**
13. **Key references**

GENERAL BIOLOGY (Larval)

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**
5. **Typical abundance in Britain** — High / Moderate / Low / Very low densities / Field not researched / No information found / Data deficient / Not relevant.
6. **Typical body size range (units)**
7. **Mobility / Attachment** — Swimmer / Crawler / Burrower / Drifter / Temporary attachment / Permanent Attachment / Field not researched / No information found / Data deficient / Not relevant.
8. **Sociability** — Solitary / Gregarious / Colonial / Field not researched / No information found / Data deficient / Not relevant.
9. **Environmental position** — Epifaunal/floral / Infaunal / Interstitial / Demersal / Pelagic /

Field not researched / No information found / Data deficient / Not relevant.

10. Growth form See Appendix *MarLIN* report No.1.

11. Body flexibility High (>45º) / Low (10 – 45º) / None (<10º)

12. Feeding method Autotroph, Active/passive suspension, Surface/subsurface deposit, active /passive carnivore, active/passive omnivore, herbivore, scavenger, symbiont contribution, parasite, Field not researched / No information found / Data deficient / Not relevant.

13. Typically feeds on?

14. Is the species toxic? Yes / No / Field not researched / No information found / Data deficient / Not relevant.

15. Further toxicity information

16. Mode of life – Dependent on Independent, Parasite on/in, Mutualist on/in/with, Inquilinist on/in/with, Commensal on/in/with, Field not researched, No information found, Data deficient, Not relevant.

Mode of life – Supports Host for / Field not researched / No information found / Data deficient / Not relevant

17. Additional Information.

18. Key references

GENERAL BIOLOGY (Adult)

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**
5. **Typical abundance in Britain** High / Moderate / Low / Very low densities / Field not researched / No information found / Data deficient / Not relevant.
6. **Typical male and female body size range (units)**
7. **Male and female size at maturity (units)**
8. **Growth rate (units)**
9. **Mobility / Attachment** Swimmer / Crawler / Burrower / Drifter / Temporary attachment / Permanent Attachment / Field not researched / No information found / Data deficient / Not relevant.
10. **Sociability** Solitary / Gregarious / Colonial / Field not researched / No information found / Data deficient / Not relevant.
11. **Environmental position** Epifaunal/floral / Infaunal / Interstitial / Demersal / Pelagic / Field not researched / No information found / Data deficient / Not relevant
12. **Growth form** See Appendix *MarLIN* Report No. 1
13. **Body flexibility** High (>45º) / Low (10 – 45º) / None (<10º)
14. **Feeding method** Autotroph, Active/passive suspension, Surface/subsurface deposit, active/passive carnivore, active/passive omnivore, herbivore, scavenger, symbiont contribution, parasite, Field not researched, No information found, Data deficient, Not relevant.
15. **Typically feeds on?**
16. **Is the species toxic?** Yes / No / Field not researched / No information found / Data deficient / Not relevant.
17. **Further toxicity information**
18. **Mode of life – Dependent on** Independent, Parasite on/in, Mutualist on/in/with, Inquilinist on/in/with; Commensal on/in/with; Field not researched / No

information found / Data deficient / Not relevant.

Mode of life – Supports Host for; Field not researched / No information found / Data deficient / Not relevant.

19. Additional Information.

20. Key references

GEOGRAPHICAL DISTRIBUTION AND HABITAT PREFERENCES (larval)

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**
5. **Geographical Distribution** Map and text description
6. **Global distribution** Map and text description
7. **Habitat preferences**
   - **Major**
     - **Physiographic**
     - **Biological zone**
   - **Component**
     - **Substratum**
     - **Wave exposure**
     - **Tidal stream strength**
     - **Depth range in metres**
     - **Salinity**
     - **Other**

8. **Resident / Migratory** Resident /non migratory, Seasonal feeding, Seasonal reproduction, Seasonal environmental, Diel, Passive, Active, Field not researched / No information found / Data deficient / Not relevant.
9. **Additional information**
10. **Key references**

GEOGRAPHICAL DISTRIBUTION AND HABITAT PREFERENCES (Adult)

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**
5. **Geographical distribution** Map and text description
6. **Global distribution** Map and text description
7. **Habitat preferences**
   - **Major**
     - **Physiographic**
     - **Biological zone**
   - **Component**
     - **Substratum**
     - **Wave exposure**
     - **Tidal stream strength**
     - **Depth range in metres**
     - **Salinity**
     - **Other**
8. **General habitat information**
9. **Resident / Migratory** Resident /non migratory, Seasonal feeding, Seasonal reproduction,

Seasonal environmental, Diel, Passive, Active, Field not researched / No information found / Data deficient / Not relevant.

10. Native species Yes / No / Field not researched / No information found / Data deficient / Not relevant.

11. Origin if not native

12. Date of arrival if known

13. Additional information

14. Key references

REPRODUCTION

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**
5. **Life-span (units):** <1 / 1-2 years / 2-5 years / 5-10 years / 10-20 years / 20-100 years /100+ years / Field not researched / No information found / Data deficient / Not relevant.
6. **Age at maturity (units)**
7. **Generation time (units)**
8. **Reproductive type** Budding, parthenogenesis, fission, Permanent hermaphrodite, Protandrous hermaphrodite, Protogynous hermaphrodite, Gonochoristic, Metagamic / Field not researched / No information found / Data deficient / Not relevant.
9. **Frequency of reproduction** Semelparous, <biannual, biannual episodic, biannual protracted, annual episodic, annual protracted.
10. **Fecundity (no. of eggs / young)** 1 / 2-10 / 11-100 / 100 – 1,000 / 1,000 – 10,000 / 10,000 – 100,000 / 100,000 – 1,000,000 / 1,000,000+ / Field not researched / No information found / Data deficient / Not relevant.
11. **Developmental mechanism** Planktotrophic / Lecithotrophic / Direct Development / Ovoviviparous / Viviparous (Parental Care) / Viviparous (No Care) / Field not researched / No information found / Data deficient / Not relevant.
12. **Larval settling time** <1 day / 1 day / 2-10 days / 11-30 days / >30 days / Field not researched / No information found / Data deficient / Not relevant.
13. **Dispersal potential** <10m / 10-100m / 100-1000m / >1000m / Field not researched / No information found / Data deficient / Not relevant.
14. **Time of first gamete release**
15. **Time of last gamete release**
16. **Additional information**
17. **Key references**

SENSITIVITY (Larval)

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**

5. **Sensitivity to factors:**

Physical factors	Substratum loss
	Smothering
	Siltation
	Desiccation
	Changes in emergence regime
	Changes in water flow rate
	Changes in temperature
	Changes in turbidity
	Changes in wave exposure
	Noise
	Visual presence
Chemical factors	Synthetic compounds
	Heavy metals
	Hydrocarbons
	Radionuclides
	Changes in nutrient levels
	Changes in salinity
	Changes in oxygenation
Biological factors	Abrasion / Impact causing damage to the organism
	Displacement of the organism
	Introduction of microbial pathogens
	Introduction of non-native species and translocation
	Selective extraction of this species
	Selective extraction of other species
Other	

6. **Confidence** High, Moderate, low, very low, not relevant
7. **Additional information**
8. **Key references**

SENSITIVITY (Adult)

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**
5. **Sensitivity to factors** See table above for factors
6. **Recoverability following removal of factor** See table above for factors
7. **Confidence**
8. **Additional information**
9. **Key references**

IMPORTANCE

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date first entered**

Marine Natural Heritage Importance

5. **Legislation**

Protected status or relevance under directives and conventions

Berne
CITES
EC Habitats Directive
W&C 1981 Act
NI Act
UK Biodiversity Action Plans
IUCN categories
Other

6. Rarity Is the species nationally rare or scarce?

Biotope or Ecosystem Importance

7. Does the species create space in assemblage?	Little / Moderate / Lots / No / Field not researched / No information found / Data deficient / Not relevant.
8. Does the species occupy space and exclude?	Little / Moderate / Lots / No / Field not researched / No information found / Data deficient / Not relevant.
9. Does the species provide structure without which the biotope would not exist?	Substratum / Crevices / Shelter / No / Field not researched / No information found / Data deficient / Not relevant.
10. Does the species provide a unique food source?	Yes / No / Field not researched / No information found / Data deficient / Not relevant.

11. For What?

Commercial Importance

12. Utilisation

Medicinal use	Yes / No / Field not researched / No information found / Data deficient / Not relevant.
Trade use	
Aquaculture use	
Harvested (targeted)	
Harvested (by-catch)	
Curio use	
Research use	
Culinary use	
Other	

13. Management measures None, Quota or take limited by numbers, Quota or take limited by effort, Restriction of movement of this species, Restriction of movement of host species, technical restriction in methods of collection, habitat maintenance, habitat enhancement, reintroduction, ex-situ breeding, culling.

14. Additional Information

15. Key references

Biotope Biology and Sensitivity Key Information Data Entry Fields
Revised Draft 3 October 1999

(MERMAID) = Linked data from MIT Mermaid pages)

BASIC INFORMATION

Biotope / Habitat name
MNCR Biotope code
Description

BIOTOPE CLASSIFICATION

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date of last edit**

UK and Ireland Classification

5. **MNCR Habitat Complex**
6. **MNCR Biotope Complex**
7. **MNCR Biotope**
8. **Similar Biotopes** Other biotopes that could be confused with this biotope or characterized by the same species

Other Classification

9. **Habitat Directive Annex I habitat:**
10. **Additional Information** Other classifications (for example, ZNIEFF-MER, Wadden Sea, Helcon.
11. **Key references**

GENERAL BIOLOGY

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date of last edit**
5. **Ecological Relationships**
6. **Habitat Complexity**
7. **Productivity**
8. **Temporal Changes**
9. **Recruitment processes**
10. **Time for the community to reach maturity**
11. **Biotope importance for other species**
12. **Additional Information**
13. **Key references**

HABITAT PREFERENCES AND DISTRIBUTION

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date of last edit**
5. **British and Irish Distribution**

6. **Global distribution**
7. **Habitat preferences**
    - **Substratum (MERMAID)**
    - **Zone (MERMAID)**
    - **Depth range (MERMAID)**
    - **Wave exposure (MERMAID)**
    - **Tidal streams (MERMAID)**
    - **Salinity (MERMAID)**
    - **Temperature range preference**
    - **Water quality preference** High/Low turbidity; Presence/Absence of suspended sediment
    - **Limiting nutrients** E.g., Nitrogen, Phosphates, Calcium
    - **Other preferences**
8. **Additional Information**
9. **Key references**

SPECIES COMPOSITION

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date of last edit**
5. **Characterizing species (MERMAID)** Species name, abundance, frequency, faithfulness
6. **Species characteristic of sensitivity** Key structural/functional, characteristic, important structural/function
7. **Species richness** Very rich/Rich/Moderate/Poor/Very Poor
8. **Species found uniquely in the biotope**
9. **Nationally rare or scarce species associated with biotope**
10. **Additional information**
11. **Key references**

BIOTOPE SENSITIVITY

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date of last edit**
5. **Sensitivity to factors (ranked against the factors below)**

Physical factors	Substratum loss
	Smothering
	Siltation
	Abrasion
	Selective extraction
	Displacement
	Changes in emergence regime
	Changes in water flow rate
	Changes in temperature
	Changes in turbidity
	Changes in wave exposure
	Noise
	Visual presence
Chemical factors	Synthetic compounds
	Heavy metals
	Hydrocarbons
	Radionuclides
	Changes in nutrient levels
	Changes in salinity
	Changes in oxygenation
Biological factors	Introduction of microbial pathogens
	Introduction of non-native species and translocation
	Selective extraction of this species
	Selective extraction of other species
Other	

6. **Recoverability (ranked against the above factors)**
7. **Likely change in species richness** Major decline/decline/minor decline/no change/ rise/ not relevant.
8. **Confidence**
9. **Biotope Species Sensitivity and Recoverability**
   - *Presentation of sensitivity assessments for species that characterize biotope sensitivity*
   - *Presentation of recoverability assessments for species that characterize biotope sensitivity*
10. **Additional information**
11. **Key references**

IMPORTANCE

1. **Information researched by**
2. **Information entered by**
3. **Information refereed by**
4. **Date of last edit**

Marine Natural Heritage Importance

5. **Legislation**

Protected status or relevance under directives and conventions

Berne Convention
CITES
EC Habitats Directive
Wildlife & Countryside Act (W&C) 1981.
NI Act

UK Biodiversity Action Plans
UK Biodiversity Action Plan habitat
Other

6. **Nationally Rare or Scarce** Is the biotope nationally rare or scarce?

Commercial Importance

7. **Aquaculture use**
8. **Harvested use**
9. **Research use**
10. **Other**

Habitat Management

11. **Management measures** None / Quota / Culled / Habitat conservation – enhancement Habitat conservation – maintenance
12. **Management** Description of measures
13. **Additional Information**
14. **Key references**