Collecting and using data for management of marine and coastal biotopes.

Final report of the BioMar project.

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Section 1.

Non Technical Summary

For effective management of coastal ecosystems an understanding of the nature of the seabed and the marine life that inhabits it, together with a knowledge of the communities which occur and where they are to be found, is of prime importance. In addition such information helps to identify areas of high species diversity. The aims of the BioMar project were to improve on the information available for marine fauna and flora, in particular the collection, storage, handling and dissemination of data. The objectives also incorporated a review of the current status of conservation of the marine in Europe, which provided an inventory of marine protected areas. Finally, the project set out to gather more detailed and comprehensive information about coastal/marine sites of importance in Britain and Ireland. The partners in the BioMar project were the National Parks and Wildlife Service (Ireland). Trinity College Dublin (Ireland), the Joint Nature Conservation Committee (UK), the University of Newcastle (UK) and AIDEnvironment (Netherlands).

By field surveys in inshore waters (from high water to a max. of 50m in depth and usually < 5m from shore), information was collected on intertidal and subtidal biotopes. BioMar surveyed over 1000 sites in Britain and over 900 sites in Ireland. The field information was used to:

(a) develop and demonstrate standardised methods for survey of marine sites,

(b) develop a classification system for marine biotopes which exist in Britain and/or Ireland,

(c) identify marine sites of conservation importance in Britain and Ireland.

Irish coastal lands of conservation importance incorporating marine biotopes were also surveyed. For Ireland, the project has provided two lists of candidate SACs, one being of coastal sites which include maritime biotopes, the other being a list of sites of marine biotopes.

The Marine Biotope Classification System developed during the project formed the basis for describing, naming, mapping and comparing the conservation value of inshore marine areas. To ensure the classification system could be widely used along the Atlantic coasts of Europe, meetings and workshops were held with European specialists in marine ecology and management (including CORINE, ZNIEFF-Mer, OSPAR). At these meetings the developing classification system was discussed. The classification system was subsequently modified to take the outcome of these discussions into account.

The use of remote sensing methods for rapidly surveying both littoral (using aerial photography) and sublittoral (using acoustic and video techniques) areas, in conjunction with the detailed point-source data derived from diving surveys and other sampling methods was explored, as a potential mechanism for interpreting more extended lengths of coastline. Coupling these techniques in this way demonstrated that stretches of coast can be rapidly covered to produce maps of their predicted biotopes. Thirty nine surveys were carried out, covering a range of marine areas in Britain and Ireland, and in collaboration between BioMar partners and a number of government agencies and authorities. The comparability of the maps produced from these surveys, and the ability to integrate them with Geographic Information Systems (GIS), demonstrated the potentially wide application of the methods. Both the methodology developed and the maps are making a significant contribution to the elaboration of management plans for marine SACs in Britain. The use of GIS in (a) developing a wave exposure index and (b) calculating the length of cliff, rock, gravel, sand, mud and salt-marsh in the Irish coastline was shown.

A database which had previously been developed for marine data storage and analysis was further improved. The database currently stores environmental information on over 21,000 sampling stations, derived from more than 10,000 sites around Britain and Ireland, compiled from BioMar and previous studies.

A systematic survey of marine ecological literature relevant to British and Irish waters was conducted. To date, some 2700 references relating to Ireland have been summarised and published on diskette, and in book form. Due to the large size and complexity of the database, the more accessible forms of electronic publication (diskettes, Compact Disk, and World Wide Web) were employed for its dissemination. BioMar produced (in collaboration with the Irish Marine Data Centre) BioMarLit, a bibliography of the marine related papers published in the Irish Naturalist's Journal. This product was published on diskette. A compact disc, the BioMar Biotope Viewer, has been used to publish the marine survey data collected in Ireland. This CD also contains the Marine Biotope Classification System.

There has been considerable effort put into disseminating information about the BioMar project. The partners have made over 75 presentations on the project, embracing 22 international and 28 national meetings. In addition, 46 publications (including 6 books, 2 diskettes, 1 compact disc) have arisen from BioMar to date, and more are in preparation.

Resumé

Comprendre le caractère du fond de la mer et de la vie marine qui s'y trouve, avec la connaissance des communautés qui existent et des lieux qu'elles occupent, sont d'importance fondamentale en ce qui concerne la gestion efficace des écosystèmes littoraux. De plus, ce type d'information facilite l'identification des sites de haute biodiversité. Les buts du projet BioMar étaient d'améliorer l'information sur la faune et la flore marine; en particulier l'acquisition, le classement, le traitement et la dissémination des données. Le projet s'occupe également d'une revue de l'état actuel de la protection des biotopes marines en Europe, y compris un inventaire des sites marines protégés. Enfin, il avait pour objectif de fournir des informations plus détaillées et plus complètes sur les sites marins/littoraux d'importance en Grande Bretagne et en Irlande. Les participants associés du projet BioMar étaient The National Parks and Wildlife Service (Irlande), Trinity College Dublin (Irlande), The Joint Nature Conservation Committee (Grande Bretagne), The University of Newcastle (Grande Bretagne) et AIDEnvironment (Pays-Bas).

En faisant des études de terrain dans des zones littorales (de la limite des marées hautes jusqu'à 50m de profondeur, et d'habitude < 5m de la côte) des données concernant les biotopes infra-littoraux et marins ont été assemblées. BioMar a échantillonné plus de 1000 sites en Grande Bretagne et plus de 900 sites en Irlande. Ces échantillons ont été utilisés dans

a) le développement et le teste de méthodes standardisées de récolte de données.
b) le développement d'un système de classification des biotopes marins qui existent en Grande Bretagne et/ou en Irlande.
c) l'identification de sites d'importance pour la protection de la nature, en Grande Bretagne et/ou en Irlande.

Quelques sites cotiers irlandais en partie terrestres, d'importance pour la protection de la nature, ont aussi été échantillonnés. Pour l'Irlande ce projet a fourni deux listes de SACs proposés, une liste comprenant des sites littoraux d'intérêt maritime, l'autre étant une liste de sites de biotopes marins.

Le Système de Classification des Biotopes Marins développé pendant ce projet a formé la base pour décrire, identifier et délimiter sur les cartes la disposition des biotopes et pour comparer la valeur des sites.

Pour assurer que le système de classification soit utilisé pour les côtes atlantiques de l'Europe, des réunions et des ateliers ont eu lieu avec des spécialistes Européens en écologie et gestion marines (CORINE, ZNIEFF-Mer, OSPAR). Lors de ces réunions le système de classification en développement a été discuté. Subséquemment, ce système a été modifié pour tenir compte des résultats de ces discussions.

L'application des techniques de photographie aérienne pour la surveillance rapide des endroits littoraux, et des techniques acoustiques et de video pour des sites sous-marins, conjointement avec des résultats detaillés produits par l'échantillonnage localisé par des plongeurs, a été recherchée comme méthode potentielle d'interprétation de plus longues sections côtières. Avec l'utilisation de ces techniques en parallèle, on a démontré que le

traitement rapide de sections de côtes pour produire des cartes de biotopes prédits, est bien possible. Trente neuf études de terrain ont été exécutées, comprenant une gamme de sites marines en Grande Bretagne et en Irlande, dans une collaboration entre les partenaires BioMar et diverses agences gouvernementales, universitaires etc. La comparabilité des cartes produites par ces études, et le pouvoir de les intégrer dans le Système d'Information Géographique (SIG), ont démontré la possibilité d'application extensive de ces méthodes. La méthodologie développée et les cartes contribuent toutes les deux, significativement, à l'élaboration des plans de gestion des sites marins protégés en Grande Bretagne. Sur la côte Irlandaise, l'utilité de SIG pour le développement d'un indice d'exposition vagues et pour le calcul de la longeur de differents types de côtes (falaises, rochers, graviers, sables, vase et marais salées) a été démontrée.

Une base de données, développée auparavant pour le traitement et l'analyse d'information marine a encore été ameliorée. Actuellement, cette base de données contient de l'information concernant plus de 21000 stations d'échantillonnage, venant de plus de 10000 sites situés autour de la Grande Bretagne et de l'Irlande, et provennant du projet BioMar et d'autres études.

Une revue systématique de littérature sur l'écologie marine, concernant la Grande Bretagne et l'Irlande, a été mise en place. Jusqu'à présent, 2700 références traitant de l'Irlande ont été résumées et cette bibliographie a été publiée sous forme de disquette et de livre. A cause de la taille et de la complexité de la base de données, les formes les plus accessibles de publication électronique (disquette, CD et Internet) ont été utilisées pour sa dissémination. Egalement, BioMar a produit (en collaboration avec The Irish Marine Data Centre) BioMarLit, une bibliographie des articles d'écologie marine, publiés dans The Irish Naturalists Journal. Ce produit a été publié sur disquette. BioMar Biotope Viewer, un CD, a été utilisé dans la publication des données venant des sites marins irlandais. Ce CD contient le Système de Classification des Biotopes Marins.

Un effort considérable a eu lieu pour disséminer de l'information àpropos du projet BioMar. Les associés ont produit plus de 75 présentations concernant le projet pendant 22 réunions internationales et 28 nationales. De plus, 46 publications (6 livres, 2 disquettes et 1 CD inclus) ont été issues du projet BioMar, et d'autres sont en préparation.

Introduction

BioMar

Laying the foundation for marine coastal zone management

To effectively manage our coastal ecosystems we must have, amongst other things, an understanding of the nature of the sea bed and the marine life that inhabits it. A sound knowledge of the character of our sea bed habitats and their communities (referred to here as biotopes), and their distribution around our coasts, leads to effective decision making about their sustainable use. Such knowledge also helps to identify those marine biodiversity hot spots that, through protection and management, can be conserved for generations to come. With this in mind the BioMar project set out to significantly improve upon certain key aspects of marine biological information and data collection:

The aims of the BioMar project were to:

- **Develop an inshore marine biotope classification system.** There was no marine biotope classification system equivalent to the European CORINE habitats classification system.
- **Survey marine biotopes in Ireland.** No broad survey of marine habitats using the same methods had taken place and the distribution of biotopes was unknown.
- **Assess remote sensing methods for seabed mapping.** Effective conservation management of marine and maritime biotopes requires broad scale mapping of their extent, for which remote mapping technology represents the only potentially available tool, at present.
- **Develop computerised data storage, analysis and dissemination systems.** These are necessary for the effective use of data collected, e.g. assisting the development of the biotope classification system. In addition, specialist data need to be both readily available and presented in a form that can be interpreted by conservation managers.
- **Develop criteria for the selection of marine SACs.** The explanation and justification of the selection of particular sites requires the use of transparent criteria.
- **Provide an indicative list of potential marine and maritime SACs for Ireland.** Prior to the BioMar Irish survey there was insufficient information upon which to base the selection of potential SACs.
- **Provide an inventory of marine protected areas in Europe.** Knowledge of the present state of marine conservation in Europe highlights where steps must be taken to improve the effectiveness of the European marine conservation effort.

Development of a marine biotopes classification system.
The selection of marine and maritime areas for nature conservation, the management of areas for nature conservation, monitoring and environmental assessment must be underpinned by a knowledge of the communities of organisms present. Marine biotopes are as diverse as terrestrial systems. However, our knowledge of the character and

distribution of marine biotopes is poor in comparison and their protection through designated sites extremely limited compared with terrestrial biotopes. There is no habitat classification of seabed communities for Britain and Ireland equivalent to the European CORINE habitat classification system or the UK National Vegetation Classification. This is evident from the EU Habitats Directive (Council Directive 92/42/EEC), where only a handful of marine habitats are listed in Annex I, for which sites should be designated as Special Areas of Conservation (SACs). The lack of a detailed classification system for the marine environment is largely because of the difficulty of surveying, particularly where the substrate is rock and traditional grab sampling techniques are unsuitable. This classification gap has been addressed for Britain and Ireland by BioMar, through the development of a detailed Marine Nature Conservation Review (MNCR) BioMar Biotope Classification system for Britain and Ireland. The classification system then provides a basis for mapping seabed habitats and for making judgements about the quality of those habitats (e.g., species diversity or very rare examples) to inshore management and protection of our coastal biodiversity.

Data collection, storage and analysis.

Central to the development of the biotope classification system has been the computerised storage and analysis of detailed data collected in the field, or available in published form or from other sources. As there was very limited information available in Ireland to aid in the selection of marine sites as potential candidate SACs, an in-depth survey of the variety of habitats around the coast of Ireland was incorporated into this operation.

The extensive data collection activities carried out in both Britain and Ireland have led to (1) the development of a database for storing and analysing the data and (2) a protocol for survey methods. Within the database data records are easily accessed and data sets readily analysed using the statistical packages TWINSPAN, DECORANA and PRIMER and are linked to a literature module, a species directory and a mapping routine. In this report the protocol for survey methods in outlined and details of the survey methods used have been published in Hiscock (1996). The database development is described by MacDonald and Mills (1996).

The initial MNCR Biotope Classification system was based on information available in the literature and has been further developed and refined from data collected during the course of the project The classification system is hierarchical in structure. Substrate type, exposure to wave action and height above or below sea level (zonation) form the upper level classification units. Within this structure the defined biotopes have been grouped at several levels so it can be used at a broad scale by non specialists, for broad scale mapping and by conservation managers, but also at a more detailed level for SAC selection and by specialists. It has been developed through extensive international and national consultations and thoroughly tested. It has also been designed so that it can be extended to other parts of Europe's coastline. The system both classifies and describes 200 biotopes, with a list of their characterising species and their distribution.

Seabed mapping.

The data collected by divers give details of the site, the variety of habitats present, the species present in each habitat and an indication of their abundance. As diver collected information is generally derived from only a small area it is considered point data. Diver surveys are rarely intensive enough to give any idea of the physical extent of a community, due to poor visibility under water. However, remote sensing technology using acoustics is now available. The BioMar project has assessed the interpretability of data generated from this source and demonstrated that this technique, used in conjunction with underwater videos, traditional grab sampling of sediments and diver information, allows broadscale mapping of biotopes over sizeable areas within a 1-2 week period. The use of aerial photography in mapping intertidal areas has also been demonstrated by this project which has further shown its, importance in both structuring future survey work and conservation management. Central to the mapping of biotopes is the structure of the Biotope Classification System, which allows for the mapping of both defined biotope complexes and individual biotopes.

Data dissemination

Data held in large and sophisticated databases are generally not available to conservation managers and the wider public and are of little use to non specialists. To disseminate this information to a wider and non specialist audience a multi media programme, which includes the Irish field data collected during the project and the marine biotope classification system, called the BioMar Biotope Viewer, has been produced on CD ROM, and runs using Microsoft Windows 95. This interactive programme gives the user a choice of starting by looking at sites for which data are available, information on different species, their distribution and details about the biology of selected species and the biotope classification system. There are over 400 photographs to illustrate the species and biotopes thus giving the observer an overview of the marine communities without getting wet! It is anticipated that this CD will be of considerable use to conservation managers and managers of the coastal zone.

Other relevant products of the project include a computerised bibliography of Irish Naturalist's Journal papers, as a demonstration model, a wide variety of publications including two books, numerous papers and reports. In addition the project has been publicised through conferences and workshops at national and international level.

The selection of marine and maritime SACs

The selection of potential marine SACs has been made possible by using the biotope classification system in conjunction with detailed species lists from the biotopes observed on-site. These data enable mapping of the distribution of similar biotopes, comparison of the species diversity within biotopes, assessment of the variety of biotopes present in an area and the presence of rare or notable species within biotopes to be indicated. The criteria used for the selection of marine candidate SACs in Ireland and the UK, as outlined in this report, illustrate two different approaches, which take into account the different data sets. An indicative list of potential marine SACs in Ireland, based on the Irish survey work, is presented.

Sites with maritime communities in Ireland were identified through the re-assessment of Areas of Scientific Interest and the mapping of the boundaries of these sites.

The status of marine conservation in Europe

To assess the status of marine conservation in Europe an inventory of the marine protected areas and the legislation covering these areas was compiled and published. This has highlighted areas where there is little protection and poor legislation.

The future

The results of the BioMar project will serve as a guide to those wishing to commission or undertake marine survey work and use the results of that work for conservation management and monitoring. Broad scale mapping of marine biotopes using a variety of remote sensing techniques is likely to become a standard tool for the management of areas of conservation interest, because the maps produced can then be overlaid with sensitivity maps. Maps of this nature will be important not just to managers of nature conservation sites but to Coastal Zone Management as a whole.

The data from the field and literature surveys are an important contribution to knowledge of marine biodiversity and the biodiversity of lagoons and machairs in Ireland.

The BioMar project has already provided the basis for initiatives at a European level, originating variously within the European Environment Agency, the European Topic Centre for Nature Conservation and the Oslo and Paris Commissions for marine pollution. The MNCR Marine Biotope Classification System has already played a significant role in determining the structure of the marine element of the Pan European Biotope Classification System, known as the European Nature Information System (EUNIS), currently being developed.

The BioMar Biotope Viewer, although not yet widely known or publicised, is already recognised as being a powerful tool for conservation managers and there is an initiative to further develop it.

The roles of the BioMar Partners

National Parks and Wildlife Service (NPWS)
Department of Arts Culture and the Gealteacht

Administrative co-ordination.
The NPWS was responsible for the administrative co-ordination of the project and for any liaison with the EC in relation to BioMar.

Mapping maritime biotopes
The NPWS revisited the Areas of Scientific Interest with a maritime component to determine if they should be proposed as Natural Heritage Areas. The boundaries of the sites were mapped and selected sites were proposed as candidate SACs.

Within the National Parks and Wildlife Service Mr M. Canny had overall responsibility for the BioMar project.

Trinity College Dublin (TCD)

The survey of marine habitats and communities in Ireland
A team of four marine ecologists surveyed and described a wide variety of marine habitats and their communities on the sea bed and around the shores of Ireland. The method of data collection used was that developed by MNCR and all the data were entered into a copy of the MNCR database in TCD. In addition a bibliography of all relevant literature was compiled.

The identification of marine sites as potential Special Areas of Conservation
The marine survey data were analysed and biotopes were identified. A set of criteria was developed and used to select sites of nature conservation interest. A list of sites was forwarded to the NPWS with the recommendation that they be considered as candidate SACs for inclusion in the Natura 200 Network.

Data Dissemination
The BioMar Biotope Viewer is an electronic publication on CD. It demonstrates how scientific data can be made generally available and interpreted by non specialists, in particular those involved in nature conservation and management of the coastal zone. In addition, a computerised bibliography of marine related papers from the Irish Naturalist's Journal was compiled and published on diskette. The use of the World Wide Web for disseminating information on the marine environment was explored.

Scientific Co-ordination
Dr. M. Costello co-ordinated the scientific element of the BioMar project.

Dr M. Costello lead the TCD team.

Marine Nature Conservation Review (MNCR)
Joint Nature Conservation Committee (JNCC)

Field surveys and database development
Surveys of the marine habitats and their communities were carried out in England, Scotland and Wales. The MNCR data base was further developed for the storage, and analysis of the data collected.

Development of a marine biotope classification system
The development of a marine biotope classification system for Britain and Ireland was the responsibility of the MNCR within the JNCC. This was achieved by using field data collected by the BioMar project in Britain and Ireland, together with field data collected in Britain since 1987. Considerable consultation took place, both nationally and internationally, during the development of the classification system and the product was tested by a variety of end users.

Dr K. Hiscock and Mr D. Connor were responsible for the co-ordination of the role of the JNCC in BioMar project.

University of Newcastle (UN)

Seabed mapping using remote sensing techniques
The University of Newcastle was responsible for both the assessment and development of methods for the use of remote sensing techniques and mapping of marine biotopes on the seabed using underwater sonar, video photography, charts and aerial photography. The team demonstrated the importance of these tools for the management of nature conservation and their widespread applications.

The team was led by Dr R. Foster-Smith and Dr J. Davies.

AIDEnvironment
(of the Netherlands)

Marine Conservation and Legislation in Europe
AIDEnvironment were responsible for gathering detailed information on designated and protected marine sites in Europe and the national and international legalisation covering these areas. From this information recommendations were made with respect to EC policies for the protection of marine areas and the implementation of the EU Habitats Directive and the Natura 2000 programme.

The collection of this data and the production of the report were the responsibility of Mr G. Peet and Dr H. Nijkamp.

TASK 1 Project Management and Co-ordination

LEAD PARTNERS **National Parks and Wildlife Service (administrative). Trinity College Dublin (scientific).**

OBJECTIVE

- Co-ordinate activities between partners and monitor progress of all project tasks so as to ensure the efficient execution of the project. The project tasks are listed below with the lead partner

	TASK	LEAD PARTNER
1	**Management and co-ordination**	**NPWS (with TCD)**
2	**Develop a marine biotopes classification**	**JNCC**
3	**Survey marine biotopes in Ireland**	**TCD**
4	**Assess remote survey methods**	**Newcastle**
5	**Survey maritime biotopes in Ireland**	**NPWS**
		All partners
6	**Develop computerised data storage, analysis, and dissemination systems.**	**TCD (with JNCC)**
7	**Inventory of marine protected areas in Europe**	**AIDEnvironment**
8	**Dissemination**	**All partners**

The timetable for meeting of the project steering committee (representatives of each partner) technical meetings (all partners and other technical participants) and meeting between project managers, EcoTEC, ERM and the Commission are give in Appendix 1 along with work schedules for Trinity College, Marine Nature Conservation Review and the University of Newcastle. No timetable is given for AidEnvironment as their task was complete in early 1994.

Project management proceeded well although some minor difficulties were experienced at very end of the project. A new Technical Annex was agreed in 1994 and became the basis for the completion of the project.

Section 2

TASK 2 Develop a marine biotopes classification

LEAD PARTNER **Joint Nature Conservation Committee, (Marine Nature Conservation Review), UK.**

OBJECTIVE

- To develop a clearly defined and robust marine habitat and community classification system suitable for application in the cold temperate north-east Atlantic.

Introduction

A European habitat classification system, CORINE (Commission of the European Communities 1991), was developed in the 1980's and used as a basis for deriving the Annex I habitats listed in the EC Habitats Directive, for which SACs are now being designated. It has recently been updated as the Palaearctic classification (Devilliers and Devilliers-Terschuren 1996). For marine habitats both CORINE and the Palaearctic classification comprise very broad and general marine habitats. It has been widely recognised that, as the marine environment is as diverse as the terrestrial environment, there was a need for a marine classification to be developed which was comparable in detail to existing terrestrial classifications. Such a classification would enhance both the conservation of marine habitats and their management and should contribute significantly to the European EUNIS classification currently being developed by the European Environment Agency (EEA).

Background

A classification of benthic marine biotopes (i.e. seashore and seabed habitats and their associated communities) for Britain and Ireland has been developed by the UK Joint Nature Conservation Committee's ***Marine Nature Conservation Review (MNCR)*** as part of the **BioMar** project.

The classification is intended as a tool to:

- aid the conservation of marine habitats, and
- aid the management of marine habitats

The classification has been developed by analysing empirical data sets, reviewing the literature and other classifications, and through collaborating with a wide range of marine scientists and conservation managers. It is supported by field survey data collected throughout Britain and Ireland and by an extensive database. To ensure the classification is capable of expansion to offshore habitats and to other parts of the north-east Atlantic, and is a widely-acceptable scheme of classification, the MNCR has consulted widely with relevant institutes and marine habitat specialists throughout Europe.

The **biotope classification** described here provides a description of the currently defined biotopes of the littoral (intertidal) and near-shore sublittoral (subtidal) zones. The full classification is given in Connor *et al.* 1997a and 1997b. An electronic form of the classification is included in the ***BioMar Biotope Viewer***, which is described in more detail in Section 6. Further details about the structure and approach to development of the classification are given in Hiscock & Connor (1991) and Connor *et al.* (1995).

The terms biotope, habitat and community

A ***biotope*** is defined as the ***habitat*** (i.e. the environment's physical and chemical characteristics) together with its recurring associated ***community*** of species, operating together at a particular scale. The ***habitat*** is taken to encompass the substratum (rock, sediment or biotic reefs such as mussels) and the particular conditions of wave exposure, salinity, tidal streams and other factors which contribute to the overall nature of the location.

The term ***community*** is used here to signify a similar association of species which regularly recurs in widely-separated geographical locations; the degree of similarity will vary, depending on the scale considered.

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

Classification Development

Considerations underlying the classification

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

- its intended application by a variety of users and at various scales (environmental managers, marine scientists and field surveyors working at local, national and international levels).
- the variety of intended applications listed on page 26.
- the variation in the scale of physical and biological features (recognising that marine ecosystems operate at a wide variety of scales, e.g. whole estuaries, individual mussel beds);
- the different levels of detail in available data.
- the different skill levels of future users and their different methods of survey.

To achieve the points above it was considered essential to develop a hierarchical classification in which the broader higher units in the classification could be more finely divided to support more detailed use.

To underpin management and conservation of the marine environment, the classification needed to:

- be scientifically sound, adopting a logical structure in which the categories are clearly defined, avoiding overlap in their definition, duplication of categories in different parts of the system and ensuring that ecologically-similar biotopes are placed near to each other and at the appropriate hierarchical level within the classification;
- be practical in format and clear in its presentation;
- include sufficient detail to be of practical use for conservation managers and field surveyors but be sufficiently broad (through a hierarchical structure) to enable summary habitat information to be presented at national and international level. The lower end of the system should be comparable in detail to that of terrestrial classifications, such as the UK National Vegetation Classification and the lower end units of the CORINE/ Palaearctic classifications.
- be sufficiently flexible to enable modification resulting from the addition of new information, but stable enough to support ongoing uses. Changes should be clearly documented to enable reference back to previous versions.

To this end the classification would be ecologically lead and based on actual field data from a wide range of sites.

Scope of the classification

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

- **Marine, estuarine and brackish-water (lagoon) habitats** - it also includes reference to saltmarsh habitats described in the National Vegetation Classification (NVC) (Rodwell In prep.; Doody, Johnston & Smith 1993) as these are regularly covered by the sea, and NVC types which occur in brackish lagoons (Rodwell 1995).
- **Rock and sediment habitats**
- **Upper shore to coastal waters** - From the supralittoral or splash zone and strand-line on the shore out to the near-shore subtidal zone (out to about the 3 mile/5 km limit). However, many of the subtidal biotopes described are also found much further offshore. An initial selection of deep-water biotopes are also defined.
- **Plant and animal communities, including epibiota and infauna** - Biotopes are defined using both their fauna and flora. Most benthic marine habitats include sedentary animals and small mobile animals which are an integral part of the community. In many habitats, especially in deeper water, there are no macroflora to characterise the habitats.
- Sediment biotopes are defined both by their epibiota (surface-dwelling animals and plants) and their infauna (animals living in the sediment).

- In rocky habitats the micro-habitat features, such as under-boulder and crevice biota, are treated within the overall habitat in which they occur.
- **Britain and Ireland** - It covers all habitats around Britain and Ireland and, through a widely accepted broad framework, is readily expandable to include offshore continental shelf habitats and other areas in the north-east Atlantic, Mediterranean and Baltic Seas.

Classification strategy

It is possible to classify the marine environment in two principal ways:

1. by using physiographic features (such as estuaries and lagoons) which encompass an often disparate range of biotopes but which in many cases are at an appropriate scale for management and site designation;
2. on a habitat basis (e.g. sublittoral sediment, kelp forests, mussel beds) which in hierarchical form, even at the coarsest level of detail, have similarities in both habitat characteristics and their species composition.

Both approaches have their advantages, depending on the end use of the classification, and both have been employed, often inconsistently mixed together, by various existing classifications (e.g. Annex I types in the EC Habitats Directive, habitats in the UK Biodiversity Action Plan, the CORINE and Palaearctic European classifications).

One of the key aims of the present classification was to develop a system that could be used at a variety of scales from international through to local requirements. As there is considerable overlap in the biotope composition between the physiographic features, it was not possible to use such physiographic features as the upper-end units in a fully hierarchical classification without inducing enormous duplication of the finer biotope units at the lower end of the system. It is, however, possible to have parallel physiographic and habitat-based classifications which can be inter-related; such an approach is adopted here (see Connor *et al.* 1997a, b regarding the inter-relationship of the two approaches).

Development of the classification

Development of the classification has been through the integration of a variety of aspects:

Classification review - A review of existing classifications was undertaken (Hiscock & Connor 1991). With a view to future use in a European context and a compatible approach, the European CORINE (Commission of the European Communities 1991) and French ZNIEFF-MER (Dauvin *et al.* 1994) classifications were examined. The review pointed to both the best features of the existing classifications and their weaknesses, in particular of the CORINE classification.

Literature review - An initial list of biotopes forming the basis of the classification was derived from an extensive review of the literature describing marine habitats. The scientific literature was of considerable help for sediment habitats but relatively poor for rocky habitats. These initial lists of biotopes were then refined on the basis of new dedicated field surveys, data analyses and further field trials.

Field surveys and other data acquisition - The collection of data suitable to develop the classification was through field surveys throughout Britain since 1987 by MNCR and as part of the BioMar project since 1993 (Appendix 3) and by the BioMar project in Ireland since 1993. Data were acquired also from the published literature and through collaboration with a wide variety of academic, government and other organisations. The programme and survey methods are fully described in Connor & Hiscock (1996).

Database development - A database was developed by the MNCR (MacDonald & Mills 1996) to store and analyse all the field survey data and, where appropriate, data from published literature. Data for over 11, 000 sites (each comprising one or more habitat records) around Britain and Ireland have been collated and entered on the MNCR database. Incorporated in the database is a literature module and a module which holds definitions of each classification type, linked to a dictionary of species and to the field survey data.

Data analysis - Data analyses, using clustering and ordination techniques such as TWINSPAN, DECORANA and PRIMER, were employed to help define the biotopes. The analytical processes adopted are described in Mills (1994). To date over 15,500 habitat records (58% of current database records) have been analysed and assigned to the classification.

Applicability for mapping - A national standard colour scheme was developed to represent the higher level units in the classification and to promote consistency in the display of mapped biotope information.

Dissemination of working versions of the classification - To stimulate use and comment on both the classification's general structure and the biotopes identified within it, four interim working versions of the classification were released. Consultation version 96.7 of the classification was distributed to over 170 institutes and individuals in fourteen countries. Feedback has been very important to help improve all aspects of the classification for end-users.

Testing of the classification - The classification has been tested in three key areas:

- **Use by field surveyors** - Field testing, particularly the intertidal biotopes, has been undertaken by a variety of groups, of differing skill levels and using various techniques (e.g. rapid shore surveys, detailed shore and diving surveys, remotely-operated video camera surveys). Field trials took place in 19 areas in the UK ranging from the Orkneys to the Isles of Scilly and in Ireland. The trials were under taken by Entec, the University of Hull, Scottish Natural Heritage, English Nature, Countryside Council for Wales, MNCR / JNCC and in Ireland by BioMar, Trinity College.

- **Mapping trials** - Biotope distribution maps have been constructed for large areas of coast in south-east Scotland/north-east England (Brazier *et al.*, in prep.), the inlets in eastern England (Hill, Emblow & Northen 1996), Liverpool Bay and the Solway Firth (Covey, in prep.) and lagoons in Scotland. Biotopes maps have also been produced for six candidate Special Areas of Conservation (SACs) for English Nature (Posford-Duvivier Environment 1997).
- **Quality assessment of sites** - The biotope classification has been used to undertake a comparative site assessment to aid the identification of locations of high natural heritage importance (as outlined in Hiscock *ed.* 1996). The assessments have been undertaken for large stretches of coast, marine inlets, estuaries and lagoons and to assist the interpretation of data to select possible SACs for the EC Habitats Directive.

Consultation - Consultation with a wide variety of academic, government, international and other organisations and individuals has been undertaken to seek input into all aspects of the classification. The consultations have included:

International consultations with:

CORINE representatives at the Institute of Terrestrial Ecology (ITE), Monks Wood, UK.
ZNIEFF-MER at the National Museum of Natural History, Paris, France.
Helsinki Commission (HELCOM) EC Nature.
International Council for the Exploration of the Sea (ICES) Benthic Ecology Working Group.
MNCR/BioMar European Workshops in Cambridge (1994) and Dublin (1995).

Presentations to:

Representatives of the EC DGXI, Brussels
European Topic Centre for Nature Conservation, Paris (ETCNC).
European Environment Agency (EEA).
Oslo and Paris conventions on Marine Pollution (OSPAR).

Consultations within UK and Ireland

Lagoon specialists.
UK Country Nature Conservation Agencies: Scottish Natural Heritage, English Nature and the Countryside Council for Wales.
BioMar partners.
Consulting companies and research institutes.

Publicity - The classification has been widely publicised to a variety of audiences at national and international conferences, through papers and workshops and through the JNCC/country agency *Marine Scene* newsletter. Presentations have been made to audiences in Belgium, Denmark, the Faroe Islands, France, Germany, Greece, Ireland, the Netherlands, Sweden and the UK.

Structure of the Classification

Habitat influence on marine communities

In the marine environment, there is a strong relationship between the physical and chemical nature of the habitat and the biological composition of the community. Most communities appear to occur within a recognisable suite of environmental parameters, although some occur within a more tightly-defined set of parameters (habitat), than do others. Community structure is also modified by biological factors such as recruitment, predation, grazing and inter-species competition.

The habitat attributes which appear to influence community composition are given below (the factors that influence community structure most strongly are in bold):

Factor	*Gradient/range*
Substratum	Rock (including bedrock, boulders, mixed cobbles and pebbles; biological reefs e.g. mussels) - coarse gravels, sands, muds and mixed sediments.
Zonation (height or depth)	From the ***littoral*** zone (including the supralittoral or splash zone/strandline and the eulittoral or true intertidal zone), through to the shallow ***sublittoral*** zone dominated by kelps and seaweeds or with wave-disturbed sediment communities (***infralittoral***) to those in deeper water characterised by animals (***circalittoral***). ***Offshore circalittoral*** communities develop in stable conditions below about 60-80 m.
Exposure to wave action	Very exposed coasts (e.g. Shetland and St Kilda) - extremely sheltered coasts (sealochs and lagoons).
Strength of tidal currents	Very strong currents of 8 to 10 knots (4 to 5 m per second) or more in tidal rapids - negligible currents in some sealochs.
Salinity	Fully marine on the open coast, through variable salinities in estuaries - stable brackish conditions in lagoons.
Temperature (biogeographic)	National differences in water temperature give more species-rich communities in the south and west and poorer communities in the north and east. Some regional variation in species composition is noted within biotope descriptions.
Topography	Rocky habitat topography has a marked influence on the variety of communities which may occur.
Geology	The rock type affects overall topography and the surface texture affects colonisation.
Pollution	Severe pollution may reduce species richness, effect densities of some species and alter community structure.
Oxygenation	Fine sediments in more sheltered areas tend to become anoxic below the surface, giving a distinct black layer. Severe deoxygenation significantly reduces species richness.

Wave surge	Gullies subject to wave surge have distinct animal-dominated communities. Wave surge on vertical rock tends to give communities typical of more exposed sites.
Sand scour, turbidity and siltation	Sand scour and sediment in suspension can influence the species composition of the community e.g., encourage growth of ephemeral algae and sometimes mussels (*Mytilus*) and tube-worms (*Sabellaria*). Siltation on rock in sheltered areas often restricts the growth of seaweeds.
Shading	Shaded faces encourage the growth of species intolerant of desiccation on the shore and species tolerant of low light conditions in the sublittoral.

The approach to using habitat parameters to aid the definition of biotopes was discussed in the BioMar European workshops (Hiscock *ed.* 1995, Brazier & Connor 1995, Connor *ed.* 1997) to help derive a framework for the classification which was both scientifically sound and also had wide applicability in the north-east Atlantic (and elsewhere).

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

The framework for the classification - the primary habitat matrix

The upper end of the classification is based on substratum and vertical gradient or zonation as these factors play a highly significant role in all communities. They are also the most easily and reliably recorded attributes in the field and are readily mapped.

Placement of the biological entities within such a habitat framework has a number of benefits:

- It helps to display the relationship of each biotope to other closely related types and to clarify the habitat parameters which contribute to its structure. These relationships are less clear in conventional listings of types.
- It enables the identification of dissimilar communities within apparently similar physical environments. Here, although there may be subtle physical factors which drive such differences in biological composition, other factors such as seasonal change, chance recruitment, grazing pressures or pollution effects may account for the differences and allow such communities to be linked within the classification.

- It also provides a structure for undertaking new ecological survey, by enabling the full range of habitats in an area to be identified and sampled.

The primary matrix is set out in full in Table 2.1. A coding system has been devised which gives each biotope a unique code. The letters in capitals reflect the upper levels of the hierarchy. The letters that follow the first period are determined by the characterising species. The position of the various components of the matrix within the overall classification is described below.

Presentation through a hierarchical classification

The classification adopts a hierarchical approach to the differentiation of types, related to their degree of biological distinction, to the ability to discriminate types by various methods of remote and *in situ* sampling, to the ease of recognition by workers with differing skill levels and to the end use of the classification for conservation management at various scales.

Five levels in the hierarchy have been developed:

1. **Major habitats** - These are extremely broad divisions of national and international application for which Habitats Directive Annex I habitats (e.g. reefs, mudflats and sandflats not covered by seawater at low tide) are the approximately equivalent. These are the units bounded by bold lines in Table 2.1.

2. **Habitat complexes** - These serve to provide very broad divisions of national and international application which reflect major differences in biological character. They are equivalent to the intertidal SSSI selection units (for the designation of shores in the UK) and can be used as national mapping units. These are the individual blocks in Table 2.1.

3. **Biotope complexes** - These are groups of biotopes with similar overall character, suitable for local mapping where biotopes consistently occur together and are relatively restricted in their extent. This is especially applicable to rocky shores and very nearshore subtidal rocky habitats, giving better units for management and for assessing sensitivity than the individual biotopes. They are relatively easy to identify, either by non-specialists or by coarser methods of survey (such as video or rapid shore surveys), thereby offering opportunities for data collection by a wide range of people and without recourse to specialist species identification skills.

4. **Biotopes** - These are typically distinguished by their different dominant species or suites of conspicuous species; most should be readily recognised by workers with a basic knowledge of marine species, although sampling may be necessary in some sediment types. The vast majority of available data are attributable to this level (or the sub-biotope level), which is equivalent to the communities defined in terrestrial classifications such as the National Vegetation Classification and the lower-end CORINE/Palaearctic units.

Table 2.1 Framework for the MNCR BioMar biotope classification - the primary matrix (letters in [ ] are codes used in the coding system)

SUBSTRATUM / ZONE		ROCK [R] (epibiota)			SEDIMENT [S] (infauna + epibiota)			
		Exposed rock [E] (high energy - wave exposed or very tide-swept)	**Moderately exposed rock [M]** (moderate energy - moderately wave-exposed or tide-swept)	**Sheltered rock [S]** (low energy - wave sheltered and weak tidal streams)	**Gravels & sands [GS]**	**Muddy sands [MS]** (10-30% silt/clay)	**Muds [MU]** (30-100% silt/clay)	**Mixed sediment [MX]** (gravel, sand and mud)
Littoral [L] (splash zone, strandline & intertidal)	(lichens; green algae; fucoid, barnacle & mussel communities; intertidal sediments)	Exposed littoral rock [ELR]	Moderately exposed littoral rock [MLR]	Sheltered littoral rock [SLR]	Littoral gravels & sands [LGS]	Littoral muddy sands [LMS]	Littoral muds [LMU]	Littoral mixed sediment [LMX]
Infralittoral [I] (shallow subtidal)	(kelp & other algal communities; wave-disturbed animal communities)	Exposed infralittoral rock [EIR]	Moderately exposed infralittoral rock [MIR]	Sheltered infralittoral rock [SIR]	Infralittoral gravels & sands [IGS]	Infralittoral muddy sands [IMS]	Infralittoral muds [IMU]	Infralittoral mixed sediment [IMX]
Circalittoral [C] (nearshore deeper subtidal)	(animal-dominated communities in semi-stable conditions)	Exposed circalittoral rock [ECR]	Moderately exposed circalittoral rock [MCR]	Sheltered circalittoral rock [SCR]	Circalittoral gravels & sands [CGS]	Circalittoral muddy sands [CMS]	Circalittoral muds [CMU]	Circalittoral mixed sediment [CMX]
Circalittoral offshore [CO] (offshore deep subtidal)	(animal communities in stable conditions)	Circalittoral offshore rock [COR]			Circalittoral offshore sediment [COS]			

Intertidal and subtidal sediment biotopes may cover very extensive areas of shore or seabed.

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

The levels in the hierarchy, together with their main roles, their definition, an example of each and the number of types at each level, are summarised in Table 2.2.

Where the biotopes cannot be grouped into higher units that offer an advantage over their habitat complex group (e.g. some sediment types) no biotope complex has been defined. Also to assist the interpretation of the classification by non-specialists, certain key biotopes (mainly those easy to recognise because they are characterised by single dominant species, e.g. mussel beds) have been raised to the biotope complex level although they comprise only a single biotope. Whilst every effort has been made to ensure equivalence of types at each level of the hierarchy, the position of a unit in the hierarchy is a balance between the various definitions and roles outlined above (and in Table 2.2) rather than a strict application of specified criteria.

Table 2.3 gives the full list of the elements in the MNCR BioMar classification for levels 1 to 3. Table 2.3 gives, for each of the seven major habitats in level 1, the names of the relevant types at levels 2 and 3. To illustrate the details of the hierarchical layout a full list of biotopes is given for littoral rock in Table 2.4.

Identification of biotopes

To ensure consistency across the classification in how types were defined, a working definition of a biotope, enabling its distinction from closely related types, was developed. The following criteria were applied:

1. The entity could be distinguished on the basis of a consistent difference in species composition (based on different dominant species, the co-occurrence of several species characteristic of the particular habitat conditions or the presence of taxa unique to or primarily found in the community), using a combination of both the presence and abundance of the most 'obvious' species in a community. Sub-biotopes were often defined using less conspicuous species.
2. It occurred in a recognizably different habitat (but acknowledging that distinct communities may develop in the same habitat through change with time). Sub-biotopes were often defined on the basis of more subtle habitat differences.
3. It was a recognisable entity in the field - i.e. it was not an artifact of data analysis.

Table 2.2 Outline structure of the classification hierarchy and number of types defined.

Level	1	2	3	4	5
Term	**Major habitat**	**Habitat complex**	**Biotope complex**	**Biotope**	**Sub biotope**
Example 1	Littoral rock	Sheltered littoral rock	Dense fucoids (stable rock)	*Ascophyllum nodosum* on very sheltered mid eulittoral rock	*Ascophyllum nodosum*, sponges and ascidians on tide-swept mid eulittoral rock
Code	LR	SLR	F	Asc	Asc.T
Example 2	Sublittoral sediments	Infralittoral gravels and sands	Maerl beds (open coast/clean sediments)	*Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand	*Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand
Code	SS	IGS	Mrl	Phy	Phy.R
Role	Approximate to Habitats Directive Annex I types	SSSI selection units National mapping units	Local mapping units (particularly for intertidal and subtidal rocky habitats) Rapid/broad scale survey	Sample data Important habitat/species variation MNCR conservation assessment units	Sample data Minor habitat/species variation Temporal variation Disturbed & polluted habitats
Typical survey techniques	Desk study of charts	Sublittoral acoustic	Phase 1 - Non-specialist recorders or subtidal video	Phase 2 - species identification (main species) *in situ* (or from samples)	Phase 2 - species identification *in situ* (or from samples)
Definition	Gross habitat features	Major differences in species/ community form Large habitat differences	Broad biology or habitat features	Dominant species/taxa linked to distinctive habitat characteristics Biogeographic variation	Sub-dominant species (or dominant species for disturbed/ polluted biotopes) Minor biogeographic variation
Number of types defined	7	21	60	196 (excludes 28 NVC types)	80

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

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

6. It is a single entity in the field, although there may be some spatial variation or patchiness from one square metre to the next. Therefore each area identified in the field should by capable of correlation with a single biotope as defined in classification (a 1:1 relationship of field units to classification units). The surface species characteristics of sediment habitats (their epibiota) are described in association with the sediment infauna as a single entity, rather than treated as separate communities (however the nature of available data has restricted the clear association of these two aspects in the classification as they are typically derived from differing survey techniques).

For each of the 196 individual biotopes defined, a biotope description has been drawn up which sets out the typical habitat characteristics, describes the biotope, lists the characterising species and gives the known distribution, together with other relevant information. An example of such a biotope description is given in Table 2.5.

Applications Of The Classification

The classification has been developed to underpin management and conservation of marine ecosystems by providing a better basis for the evaluation of their scientific and nature conservation interest and for determining their management requirements. In doing this it will:

1. provide a common language for describing the biological character of the marine environment;
2. facilitate mapping of the distribution, frequency of occurrence and extent of biotopes at local, national and international levels;
3. provide a framework in which to place the results of ecological survey;
4. enable a more consistent assessment of site quality through the comparison of biotope composition, quality and rarity at different sites, thus supporting the designation of marine protected areas;

5. facilitate the identification of rare or vulnerable habitats which may require specific protection measures, e.g. under the Habitats Directive or the UK Biodiversity Action Plan;
6. by conserving representative examples of habitats, facilitate the conservation of biodiversity (the majority of marine species being small and sedentary or mobile bit associated with the seabed);
7. help structure the future collection and interpretation of survey results (an important factor in helping to achieve standard approaches to environmental assessments and other types of ecological survey);
8. provide a basis for predicting the biological character of an area based on its physical environment (although the degree of confidence will vary according to particular habitats);
9. aid site monitoring through the placement of individual sites, and their temporal change in character or quality, within the framework of a wider national perspective;
10. facilitate the assessment of sensitivity of marine habitats and species to a range of impacts, uses and developments, enabling sensitivity maps to be developed;
11. improve the sustainable management of the marine environment through enhanced understanding of marine ecosystems and more objective scientifically-based decisions on use and development within the marine environment;
12. aid the management of rare species by placing them in the context of their associated biotopes;
13. contribute to international (European) classifications, through the methodology, structure and definition of types developed for Britain and Ireland.

The European perspective

The classification will contribute significantly to existing classifications for Europe, that are being refined through current initiatives promoted by the European Commission (EC).

With the establishment of the European Environment Agency, further consideration has been given to habitat classification requirements at a European level and, in particular, to the restructuring and rationalisation of the Palaearctic system (Moss & Davis 1997). Work is consequently underway, through the European Topic Centre for Nature Conservation (ETCNC) to develop a new EUNIS (European Nature Information System) classification. This will be derived largely from the Palaearctic classification, and will link to an associated database on sites, habitats and species. For marine habitats, the MNCR BioMar classification, now widely known throughout Europe, is likely to contribute significantly to the proposed EUNIS classification and MNCR is working closely with those developing EUNIS. Further work is required to integrate existing marine classifications, to ensure a satisfactory pan-European marine classification is developed.

North Sea Ministerial Declaration and OSPAR

The June 1995 North Sea Ministerial Declaration included (under *I. The protection of species and habitats in coastal and offshore areas*):

> "6. the Ministers INVITE the European Commission and the European Environment Agency to further develop and agree on a classification system for marine biotopes in the North Sea, compatible with the classification system used in the Habitats Directive, to be used as a basis for the identification of marine habitats and species that need special protection measures"

OSPAR, in consideration of this and other aspects in the North Sea Declaration, as well as requirements at a wider north-east Atlantic level to feed into their Quality Status Reports, considered the need for a marine classification at an OSPAR workshop on habitats and species (Texel, Netherlands in February 1997). The workshop strongly recommended that a north-east Atlantic classification be developed following a similar structure and level of detail as the MNCR BioMar Classification and, if approved further within OSPAR, that it should be developed in collaboration with the EEA to ensure full compatibility with the EUNIS classification (Oslo and Paris Conventions 1997).

Future requirements

To meet the needs of both OSPAR and the EEA for European marine habitat classifications, consideration needs to be given to amalgamation of existing classifications, e.g. those currently developed for the Baltic (HELCOM), Scandinavia (Nordic Council), the Wadden Sea (Common Wadden Sea Secretariat), Britain and Ireland (MNCR BioMar), France (ZNIEFF-MER), Mediterranean systems and others.

Table 2.3 MNCR BioMar biotope classification - main types (levels 1 to 3)

LITTORAL ROCK (and other hard substrata)

Lichens or algal crusts

EXPOSED LITTORAL ROCK (mussel/barnacle shores)

Mytilus (mussels) and barnacles

Robust fucoids and red seaweeds

MODERATELY EXPOSED LITTORAL ROCK (barnacle/fucoid shores)

Barnacles and fucoids

Red seaweeds (moderately exposed shores)

Ephemeral green or red seaweeds (freshwater or sand-influenced)

Mytilus (mussels) and fucoids (moderately exposed shores)

Littoral *Sabellaria* (honeycomb worm) reefs

SHELTERED LITTORAL ROCK (fucoid shores)

Dense fucoids (stable rock)

Fucoids, barnacles or ephemeral seaweeds (mixed substrata)

Mytilus (mussel) beds (mixed substrata)

Rockpools

Overhangs and caves

LITTORAL SEDIMENTS

LITTORAL GRAVELS AND SANDS

Shingle (pebble) and gravel shores

Sand shores

Estuarine coarse sediment shores

LITTORAL MUDDY SANDS

Muddy sand shores

Littoral *Zostera* (seagrass) beds

LITTORAL MUDS

Saltmarsh

Sandy mud shores

Soft mud shores

LITTORAL MIXED SEDIMENTS

INFRALITTORAL ROCK (and other hard substrata)

EXPOSED INFRALITTORAL ROCK

Kelp with cushion fauna, foliose red seaweeds or coralline crusts (wave-exposed rock

Robust faunal cushions and crusts (surge gullies & caves)

MODERATELY EXPOSED INFRALITTORAL ROCK

Kelp with red seaweeds (moderately exposed rock)

Grazed kelp with algal crusts

Sand or gravel-affected or disturbed kelp and seaweed communities

SHELTERED INFRALITTORAL ROCK

Silted kelp (stable rock)

Estuarine faunal communities (shallow rock/mixed substrata)

Submerged fucoids, green and red seaweeds (lagoonal rock)

Fauna and seaweeds (shallow vertical rock)

CIRCALITTORAL ROCK (and other hard substrata)

EXPOSED CIRCALITTORAL ROCK

- Faunal crusts or short turfs (wave-exposed rock)
- *Alcyonium*-dominated communities (tide-swept/vertical)
- Barnacle, cushion sponge and *Tubularia* communities (very tide-swept/wave-sheltered)

MODERATELY EXPOSED CIRCALITTORAL ROCK

- Mixed faunal turfs (moderately exposed rock)
- Bryozoan/hydroid turfs (sand-influenced)
- Circalittoral *Sabellaria* reefs
- Mussel beds (open coast circalittoral rock/mixed substrata)
- Brittlestar beds
- Grazed fauna (moderately exposed or sheltered rock)
- Ascidian communities (silt-influenced)
- Soft rock communities

SHELTERED CIRCALITTORAL ROCK

- Brachiopod and solitary ascidian communities (sheltered rock)
- Sheltered *Modiolus* (horse-mussel) beds

- Faunal turfs (deep vertical rock)
- Caves and overhangs (deep)

CIRCALITTORAL OFFSHORE ROCK (and other hard substrata)

- *Lophelia* reefs

SUBLITTORAL SEDIMENTS

INFRALITTORAL GRAVELS AND SANDS

- Maerl beds (open coast/clean sediments)
- Shallow gravel faunal communities
- Shallow sand faunal communities
- Estuarine sublittoral gravels and sands

CIRCALITTORAL GRAVELS AND SANDS

INFRALITTORAL MUDDY SANDS

- Seagrass beds (shallow sublittoral/lower shore)
- Shallow muddy sand faunal communities

CIRCALITTORAL MUDDY SANDS

INFRALITTORAL MUDS

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

CIRCALITTORAL MUDS

INFRALITTORAL MIXED SEDIMENTS

- *Laminaria saccharina* (sugar kelp) and filamentous seaweeds (mixed sediment)
- Maerl beds (muddy mixed sediments)
- Oyster beds
- Shallow mixed sediment faunal communities
- Estuarine sublittoral mixed sediments

CIRCALITTORAL MIXED SEDIMENTS

CIRCALITTORAL OFFSHORE SEDIMENTS

Table 2.4. An extract from the full list of biotopes to illustrate the hierarchical layout and levels 1-4 in the classification system.

Higher and biotope code		Biotope
LR		LITTORAL ROCK (and other hard substrata)
LR.L		**Lichens or algal crusts**
LR.L	YG	Yellow and grey lichens on supralittoral rock
LR.L	Pra	*Prasiola stipitata* on nitrate-enriched supralittoral and littoral fringe rock
LR.L	Ver	*Verrucaria maura* on littoral friuge rock
LR.L	Ver.Por	*Verrucaria maura* and *Porphyra umbilicalis* on very exposed littoral fringe rock
LR.L	Ver.B	*Verrucaria maura* and sparse barnacles on exposed littoral fringe rock
LR.L	Ver.Ver	*Verrucaria maura* on moderately exposed to very sheltered upper littoral fringe rock
LR.L	Bli	*Blidingia* spp. on vertical littoral fringe soft rock
LR.L	UloUro	*Ulothrix flacca* & *Urospora* spp. on freshwater-influenced vertical littoral fringe soft ro
ELR		EXPOSED LITTORAL ROCK (MUSSEL/BARNACLE SHORES)
ELR.MB		***Mytilus*** **(mussels) and barnacles**
ELR.MB	MytB	*Mytilus edulis* and barnacles on very exposed eulittoral rock
ELR.MB	BPat	Barnacles and *Patella* species on exposed to moderately exposed, or vertical sheltered, eulittoral rock
ELR.MB	BPat.Cht	*Chthamalus* spp. on exposed upper eulittoral rock
ELR.MB	BPat.Lic	Barnacles and *Lichina pygmaea* on steep exposed upper eulittoral rock
ELR.MB	BPat.Cat	*Catenella caespitosa* on overhangiug or shaded vertical upper eulittoral rock
ELR.MB	BPat.Fvesl	Barnacles, *Patella species* and *Fucus vesiculosus* f. *linearis* on exposed eulittoral rock
ELR.MB	BPat.Sem	*Semibalanus balanoides* on exposed to moderately exposed, or vertical sheltered, eulittoral rock
ELR.FR		**Robust fucoids and red seaweeds**
ELR.FR	Fdis	*Fucus distichus* subsp. *anceps* and *Fucus spiralis* f. *nana* on extremely exposed upper eulittoral rock
ELR.FR	Coff	*Corallina officinalis* on very exposed lower eulittoral rock
ELR.FR	Him	*Himanthalia elongata* and red seaweeds on exposed lower eulittoral rock See also MLR.Pal & MLR.Mas
MLR		MODERATELY EXPOSED LITTORAL ROCK (FUCOID/BARNACLE SHORES)
MLR.BF		**Barnacles and fucoids**
MLR.BF	PelB	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock
MLR.BF	FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
MLR.BF	Fser	*Fucus serratus* on moderately exposed lower eulittoral rock
MLR.BF	Fser.R	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
MLR.BF	Fser.Fser	Dense *Fucus serratus* on moderately exposed to sheltered lower eulittoral rock
MLR.BF	Fser.Fser.Bo	*Fucus serratus* and under-boulder fauna on lower eulittoral boulders
MLR.BF	Fser.Pid	*Fucus serratus* and piddocks on lower eulittoral soft rock See also ELR.BPat and SLR.Fspi
MLR.R		**Red seaweeds (moderately exposed shores)**
MLR.R	XR	**Mixed red seaweeds on moderately exposed lower eulittoral rock**
MLR.R	Pal	*Palmaria palmata* on very to moderately exposed lower eulittoral rock
MLR.R	Mas	*Mastocarpus stellatus* and *Chondrus crispus* on very to moderately exposed lower eulittoral rock
MLR.R	Osm	*Osmundea (Laurencia) pinnatifida* and *Gelidium pusillum* on moderately exposed mid eulittoral rock
MLR.R	RPid	*Ceramium* sp. and piddocks on eulittoral fossilised peat
MLR.Eph		**Ephemeral green or red seaweeds (freshwater or sand-influenced)**
MLR.Eph	Ent	*Enteromorpha* spp. on freshwater-influenced or unstable upper eulittoral rock

MLR.Eph	EntPor	*Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid to lower eulittoral rock
MLR.Eph	Aud	*Audouinella floridula* on sand-scoured lower eulittoral rock
MLR.MF		***Mytilus* (mussels) and fucoids (moderately exposed shores)**
MLR.MF	MytFves	*Mytilus edulis* and *Fucus vesiculosus* on moderately exposed mid eulittoral rock
MLR.MF	MytFserR	*Mytilus edulis, Fucus serratus,* red seaweeds on moderately exposed lower eulittoral ro
MLR.MF	MytPid	*Mytilus edulis* and piddocks on eulittoral firm clay
MLR.LSab		**Littoral *Sabellaria* (honeycomb worm) reefs**
MLR.LSab	Salv	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock

Table 2 5. Example biotope description

Mrl Maerl beds (open coast/clean sediments)

IGS.Phy *Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand

Habitat classification

Salinity:	Full
Wave exposure:	Moderately exposed
Tidal streams:	Moderately strong, Weak
Substratum:	Maerl gravel and coarse sand
Zone:	Infralittoral
Depth band:	0-5 m, 5-10m, 10-20m, 20-30m

Biotope description

Maerl beds characterised by *Phymatolithon calcareum* in gravels and sands. Associated epiphytes include red algae such as *Cryptopleura ramosa, Brongniartella byssoides* and *Plocamium cartilagineum* with *Desmarestia* spp. and *Dictyota dichotoma* also very often present. Algal species may be anchored to the maerl or to dead bivalve shells amongst the maerl. Polychaetes, such as *Chaetopterus variopedatus*, and the gastropods *Gibbula magus* and *Gibbula cineraria* may be present. *Liocarcinus depurator* and *Liocarcinus corrugatus* are often present, although they may be under-recorded; it would seem likely that robust infaunal bivalves such as *Circomphalus casina, Mya truncata* and *Dosinia exoleta* are more widespread than available data currently suggests. IGS.Phy contains two distinct entities depending on depth: a shallower type with red seaweeds (IGS.Phy.R) and a lower infralittoral entity with notably less epiphytic seaweeds (IGS.Phy.HEc). It seems likely that stable wave-sheltered maerl beds with low currents may be separable from IGS.Phy; having a generally thinner layer of maerl overlying a sandy /muddy substratum with a diverse cover of epiphytes (e.g. Bosence 1976; Blunden *et al.* 1977; 1981; Davies & Hall-Spencer 1996) but insufficient data currently exists on a national scale. Wave and current-exposed maerl beds, where thicker depths of maerl accumulate, frequently occur as waves and ridge / furrows arrangements (see Bosence 1976; Blunden *et al.* 1977; 1981; Irvine & Chamberlain 1994). At some sites where IGS.Phy occurs, there may be significant patches of maerl gravel containing the rare burrowing anemone *Halcampoides elongatus*; this may be a separate biotope, but insufficient data exists at present. Northern maerl beds in the UK do not appear to contain *L. corallioides* but in south-west England and Ireland *L. corallioides* may occur to some extent in IGS.Phy as well as IMX.Lcor, where it dominates.

Similar biotopes

CGS.Ven.Neo	*Neopentadactyla mixta* may occur in IGS.Phy, but deeper dead maerl can give rise to the CGS.Ven.Neo biotope

Characterising species

	% Frequency	*Faithfulness*	*Typical abundance*
Chaetopterus variopedatus	••	•	Occasional
Lanice conchilega	••	•	Occasional
Galathea intermedia	••	••	Occasional
Gibbula magus	••	••	Occasional
Gibbula cineraria	••	•	Occasional
Ensis arcuatus	••	•	Occasional
Circomphalus casina	••	••	Occasional
Dosinia exoleta	••	••	Occasional
Neopentadactyla mixta	••	••	Frequent
Lithothamnion corallioides	•	•••	Common
Phymatolithon calcareum	•••••	•••	Common
Plocamium cartilagineum	••	•	Frequent
Cryptopleura ramosa	••	•	Occasional

Brongniartella byssoides	••	•	Occasional
Dictyota dichotoma	•••	•	Occasional
Desmarestia aculeata	••	•	Occasional
Desmarestia viridis	••	•	Occasional
Laminaria saccharina	•••	•	Occasional

Distribution

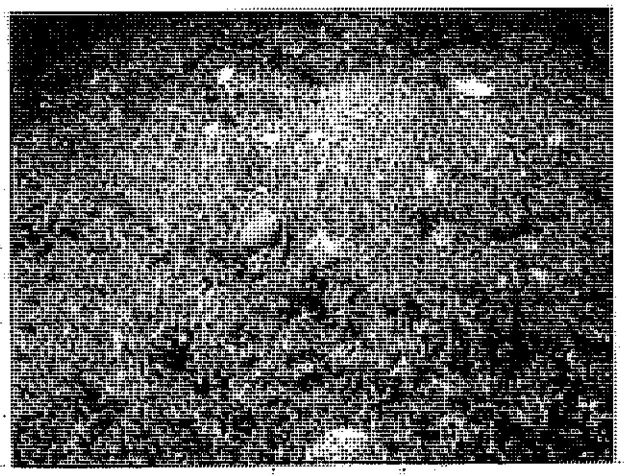
Sector	*Area*	*Source*	*Section/page*	*Equivalence*
R1	Shetland	Pearson, Coates & Duncan 1994	SH2	
R1	Shetland	Tittley *et al.* 1985		
R1	Shetland	Howson 1988	Habitat 41	
R2	Hoy, Wyre, Rousay and Shapinsay Sounds and Wide Firth		R2-4.Phy	
R8	Fal/Helford	Moore In prep	SWI.77	
R8	Falmouth	Davies & Sotheran 1995	p8	
R9	Milford Haven	Moore In prep	SWI.77	
R12	Clyde sealochs	Howson, Connor & Holt 1994	SL71	
R13	Jura/Mull	Howson, Connor & Holt 1994	SL71	
R14	Lochs Tarbet/ Uiskevagh/ Skipport/ Boisdale	Howson, Connor & Holt 1994	SL71	
R15	Summer Isles	Dipper 1981b	p11	
R15	Central/Skye/North-west sealochs	Howson, Connor & Holt 1994	SL71	
IR2	N. Ireland	Erwin *et al.* 1990	p37	
IR6	Galway Bay	Sides *et al.* 1994	KA24	

Frequency of occurrence

In Britain: Uncommon

Features of conservation interest

Phymatolithon calcareum and *Lithothamnion corallioides* are listed on the EC Habitats Directive Annex Vb. Recent studies have revealed infaunal species new to science (Davies & Hall-Spencer 1996).



IGS.Phy.HEc: Maerl *Phymatolithon calcareum* bed with sparse red seaweeds and the octopus *Eledone cirrhosa* (Loch Gairloch, Highland; S. Fowler)

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Section 3

TASK 3 Survey of marine biotopes in Ireland

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OBJECTIVES

- to survey marine biotopes of Ireland.
- to test the methods developed for collecting (through field survey and review of existing data) marine data for conservation management.
- to contribute to the development of the classification of marine biotopes
- to identify marine areas of nature conservation importance in Ireland.

Despite the ever increasing amount of relevant marine information available, it is often insufficient for coastal and marine management. The most basic sources of marine information for Ireland are the Ordnance Survey land maps and Admiralty sea charts. The charts include information on tidal current, seabed types, bathymetry and coastal topography. With additional information from published sources, or the experience of scientists in the region, general predictions as to which communities and species may be present are possible. However, these predictions are too general for use in marine nature conservation management. They must be confirmed with direct field observations by experts, because maps may not show important physical features (e.g. rock-pools), and may contain errors. It is the unexpected presence or absence of certain species that can make a site of more or less interest for nature conservation. Field observations are essential for any management decisions about the importance of an area for nature conservation, or which developments would be unlikely to harm the long-term viability of the local biodiversity.

A national survey of marine biotopes had never been undertaken in the Republic of Ireland. A four year littoral and sublittoral survey was completed in Northern Ireland in 1986 (Fuller *et al.*, 1987, 1991; Erwin *et al.*, 1990).

Literature reviews

Considerable published and unpublished information exists on marine fauna, flora and ecology. Although individual studies may be limited in geographic, taxonomic and other scope, they can be invaluable in planning new work and interpreting results. The TCD team compiled a bibliography of 2672 publications relevant to the marine ecology of Ireland, from 17 Irish and 4 British journals. The authors, year of publication, title, journal or book reference, geographical location (latitude, longitude, national grid reference), keywords, a summary, project coastal sectors, and location of the document (e.g. library) were entered into a copy of the MNCR database in TCD. The bibliography has been published in book format (Kelly *et al.*, 1997) and allows cross referencing using authors, key words and taxonomic groups. In addition an analysis of the papers showed geographic and taxonomic gaps in past studies, and trends in effort in Ireland over the past two centuries (Kelly and Costello 1995, 1996, Kelly *et al.* 1997).

Unpublished reports, and discussions with others, including scientists, naturalists, sports divers, and local officials, also provided useful information on the biodiversity and human activities in the Irish coastal zone.

Adoption of a Protocol for Survey of Marine Inshore Biotopes

Following its testing by the BioMar TCD survey team, a protocol for survey of inshore marine biotopes developed by JNCC was adopted for use in the project, with minor adjustment (see Appendix 2). That protocol has since been published by the JNCC (Hiscock, 1996) and can be recommended as a standard technique for use elsewhere on Europe's coasts. In any such survey work, maintenance of data quality is of considerable importance and some comments, incorporating the TCD experience and procedures outlined in Hiscock (1996) are given in Appendix 2.

Field Surveys

The aim of the field surveys was to sample as wide a variety of marine habitats and their communities as possible, to obtain an indication of the marine biodiversity of Ireland. This variety was predicted on the basis of biogeography, coastline topography, bathymetry and substrata. The areas to be surveyed were initially selected to provide a wide geographic coverage in Ireland. Secondly, a study of available data, particularly marine charts, but also land maps and results of previous surveys, suggested site locations. The assessment of the nature conservation importance of areas and the development of the marine biotopes classification system both required species level identification from known habitats sampled. Three approaches to surveying marine seabed biotopes were used; 1) direct observation by ecologists, for the rapid collection of information: 2) remote sampling techniques (e.g. grabs and dredges) when depth and/or currents prevented scuba diving, and in some sediment habitats where too few species were identifiable in the field and 3) remote sensing. The team at TCD carried out a national survey of marine biotopes in Ireland from May 1993 to September 1996 (See Appendix 2).

All seashores were sampled on foot, and most sublittoral sites using scuba, by ecologists working in pairs (for reasons of safety). Hand held, or boat mounted, Geographical Positioning Systems (GPS) with an accuracy to within 100 m, were used in conjunction with maps to record the position of sampling sites. In general, sites were only visited once. The fauna and flora were recorded on standard forms (Appendix 2) from readily identifiable habitats observed during a dive, or along a transect from the upper to lower shore. Habitats were distinguished by marked changes in substratum and species present. In addition, on seashores at least the strandline or lichen zone, middle shore, and lower shore, were recorded as separate habitats. Similarly, divers recorded infralittoral (zone with algae) and circalittoral (below alga zone) rock zones as separate habitats. Where additional habitats were recognised in any zone (e.g. due to change in substratum or community present) and greater than 5 m^2 in area, they were also described. Shore heights were determined taking the strandline (sediment shores) or lower limit of the lichen (rocky shores) zones as the high tide mark. Depth was recorded from electronic divers depth gauges and corrected for tidal height. Most recording was of species which were identifiable in the field without magnification. The abundance or cover of the species in each habitat was recorded using the MNCR abundance scale (Hiscock, 1996). Photographs were taken of habitats and species at almost all sites. Specimens were collected for a voucher collection and when species identification needed to be confirmed. A sketch of the site, its habitats, and location of dominant species were also made on the recording forms. The data were entered into a copy of the MNCR database held at Trinity College. The forms were then archived as a long term record of the survey.

On most sand and mud sediments four cores, 11 cm diameter and 20 cm deep, were taken by hand in the middle and lower parts of beaches and mudflats, and on some sublittoral sediment habitats which had few epifauna. The cores were sieved through a 1 mm sieve. A 1 m^2 area of sediment was dug to 20 cm depth in at least the middle and lower parts of beaches and mudflats to record and collect fauna. In areas too deep or too current-swept for scuba diving, samples were taken using a dredge or grab.

Survey Results
From 1993 until 1996, over 1900 stations in 908 sites were surveyed (Fig. 3.1). This included 692 sublittoral (439 on rock, 253 on sediment) and 216 littoral (93 rock, 123 sediment) sites. These comprised about 730 sublittoral rock and 260 sediment, and 600 littoral rock and 315 sediment stations. In some surveys few replicates of the same habitat were found, which limits the understanding of variation in a biotope, but more importantly indicates the area has a diverse range of biotopes and warrants further sampling. However, the geographic extent of the survey was critical in determining the diversity of biotopes and the overall biodiversity of the area. Descriptions of each site and the habitats recorded and the species lists for each habitat have been published in the BioMar Biotope Viewer on CD.

Data analysis. A total of 1405 species or higher taxa were recorded during the survey. For detailed analysis this voluminous data set was split into the following categories, littoral rock, littoral sediment, infralittoral rock, circalittoral rock and sublittoral sediments. Each set of data was analysed using the statistical tools incorporated into the database, such as TWINSPAN and DECORANA. Biotopes were identified or newly described, and the records for each biotope tagged in the database. A summary of the number of biotopes for each biological zone is given in Table 3.1. Once this detailed analysis was complete, the number of different biotopes in each survey area and the national distribution of the biotopes were determined, using the mapping facility in the database. By examining the species matrices for the biotopes it was possible to determine the range of species diversity within a biotope and the presence of rare or notable species.

Infaunal sediment sampling
As part of this project, special studies were undertaken by TCD (Hunt 1995) and the MNCR (Brazier 1996) to evaluate the sampling methods available for infauna in sediments. Infaunal species vary in distribution from being widely dispersed to clumped and it was felt that the methods currently in use were inadequate.

Both studies found that for most sites four cores did not adequately sample the range of species present. Furthermore, because many species were represented by only one or

Figure 3.1. The sites surveyed by BioMar TCD in Ireland.

two specimens per sample, the variation between samples in the same habitat could often be 50-100 % and the merits of scaling up such counts to numbers per metre squared was doubtful. Reflecting these issues, the MNCR now recommends that, for infaunal studies, eight cores, each 10.3 cm in diameter, per sampling station are taken and combined (Hiscock, 1996). Brazier (1996) found the same biotopes were identified following either 0.5 mm and 1.0 mm sieving of samples from eight cores. However, the smaller mesh collected 13 - 53 % more species. Thus the mesh used in sieving sediments will affect species richness and correlated factors such as the likelihood of occurrence of rare species. These differences illustrate the need for caution in comparing species lists and measures of biodiversity derived from different sampling methods. Hunt (1995) demonstrated the importance of digging over a 1 m^2 of sediment to a depth of 20 cm when sampling sediments.

Table 3.1. A summary of the number of biotopes identified from the Irish BioMar survey.

Biological zone	Number of biotopes
Littoral rock	36
Infralittoral rock	27
Circalittoral rock	15
Littoral sediment	6
Sublittoral sediments	24
Total	108

Voucher Collections

A collection of representative specimens identified in the survey was established. The Irish faunal material has been lodged in the National Museum of Ireland (accession number NMI 31.1993) and flora in the herbarium of the Department of Botany, TCD, where they are available for study. A catalogue of the specimens has been produced (Morrow *et al.*, 1997). The photographs taken during the survey have been catalogued in the database.

The Identification of Areas of Conservation Interest.

To protect biodiversity there is a need to include as many species as possible in protected areas. To fulfil this, sites with the most (i.e. species rich), and with rare (i.e. they occur in few other areas so options for site selection are limited), species are a priority for protection. To encompass biogeographic variation (at species and genetic level) it is necessary to protect sites in different geographic regions of the coast. A check list of the principle actions in identifying marine areas of nature conservation importance is given in Table 3.2. The aim of a site selection process is thus to identify a network of areas which will encompass the variety of biotopes, and as many species as possible, within the national territory.

Supplementary or supporting criteria may be added to promote the selection of certain areas for conservation, such as its value for research, education, history, tourism (scenic beauty) and/or a refuge for fish stocks (Hiscock 1996). However, such criteria were not used in BioMar. This study does not consider the protection of large mobile species such as fish, birds, seals and whales.

Table 3.2. A checklist of the principle actions in identifying marine areas of nature conservation importance.

- review existing information on an area
- collect field data on presence fauna and flora by standard techniques using expert ecologists
- define biotope for each sampling station
- rank biotopes according to species richness
- note presence of notable (rare, threatened or otherwise of conservation interest) biotopes
- examine species lists for each sampling station and area
- note presence of notable (rare, threatened or otherwise of conservation interest) species
- synthesise above biotope and species data to define area within which many species, and notable species occur
- consider geographic network of areas which would include as many of the species known from the country as possible

The data used in selecting areas of nature conservation importance in Ireland was that collected by the TCD team. This data was collected in a comparable manner which facilitates a standard and balanced analysis.

Criteria used to select areas of nature conservation importance

1. Biotope richness of an area
2. Species richness of an area
3. Biotope rarity
4. Species rarity

The distribution and species richness of biotopes were the two most important factors in identifying areas of nature conservation importance. The species composition of all stations was also studied. The distribution of species which were rare in Ireland or Europe, or had already been identified as being of nature conservation interest, were categorised as notable and also used in prioritising areas for protection. Several species were previously unknown from Ireland or coastal waters (Table 3.3), and some new species of sponge were also discovered during the course of survey work (Morrow, unpubl.).

'Naturalness' was not used as a criterion in the analysis of marine areas by TCD as no significantly impacted areas (e.g. harbours) were surveyed. 'Representativeness' is sometimes used as a secondary criterion in conservation assessment. A representative site may be expected to be the 'best (i.e. richest) example' of a certain biotope. In TCD, representativeness was not used as a site selection criterion because it could not be applied to all biotopes. It was felt difficult to justify the prioritisation of 'average' examples of biotopes, where few examples of a biotope were recorded, or where the sample recorded contained several, or was transitional between, biotopes. Assessment of biotope species richness cannot be made with certainty with 5 or fewer examples (Connor & Hill, 1997).

Table 3.2 Examples of notable marine species recorded in Ireland.

Species	BioMar finding	Previous knowledge
SPONGES		
Plakortis simplex Schulze, 1880.	Common in Gurraig Sound, Kilkieran Bay, Co. Galway on tideswept boulders and bedrock at 10-30 m depth; and at Glannafeen Cliff, Lough Hyne, Co. Cork on sheltered bedrock at 15m depth	Only previous Irish record was from 50 miles west-north-west of Eagle Island, Co. Mayo, at 388 fathoms depth (Stephens, 1915).
Quasillina brevis (Bowerbank, 1866)	At Kerry Head Shoals, Co Kerry on exposed circalittoral bedrock between 40 - 50 m depth	Only previous Irish record was from 50 miles W.N.W. of Eagle Island in 388 fms (Stephens, 1915).
Tricheurypon viride (Topsent, 1889)	In Salt Lake, Connemara at 6 m depth, and Roskeada Bay, Kilkieran Bay, Co. Galway at 10 m depth	Stephens (1921) reported specimens from 388, 468 and 37 fm.
Halicnemia verticillata (Bowerbank, 1862)	At 30 m depth south-west of Doonguddle, Co. Galway.	Only previous Irish records were from 336 fm, 550 fm, and between 627 and 728 fm (Stephens, 1921).
Hexadella racovitzai Topsent, 1896	From south of East Brannock Island and west of Bentlevemore, Inishmore, Aran Islands, Co. Galway, and Kerry Head Shoals, Co. Kerry at 40 - 50 m depth	First record in Ireland, and not recorded in Britain
SEA-ANEMONE		
Cataphellia brodricii (Gosse, 1859)	Frequent at the Saltee Islands, and common at one site on the east coast, south of Rosslare, Co Wexford.	Only one previous Irish record from Gascanane Sound, West Cork
Edwarsia delapiae Carlgren & Stephenson, 1928	A small population growing in shallow mud (approximately 5 m BCD) in Portmagee Channel, Valencia Island.	Only record since it was first described from *Zostera* beds on the shore at Valencia Island, Co. Kerry.
ASCIDIANS		
Sidnyum elegans (Giard, 1872)	Several sites around the Saltee Islands on lower circalittoral, tide-swept boulders at 20 - 30 m depths	First Irish record
Stolonica socialis Hartmeyer, 1903	Common at several sites around the Saltee Islands, and at Sheephaven and the entrance to Mulroy Bay, North Donegal	Only previous Irish record from north-west coast (Picton 1985). In Britain limited to south-west coast and English channel
Phallusia mammillata (Cuvier, 1815).	Common in Bantry Bay, Co. Kerry	Only Irish record, although a large and conspicuous species.
AMPHIPOD CRUSTACEAN		
Talorchestia brito Stebbing, 1891.	Only found on strandline at Raven Point beach in Co. Wexford	First and only Irish record although a well sampled habitat in Ireland

It should be noted that the TCD surveys did not map the spatial extent of biotopes. Mapping of biotopes is considered the next step in developing management plans for areas of conservation interest.

The outcome of the site analysis has been to identify 20 areas (Fig. 3.2) as being of sufficient importance to marine nature conservation that they be proposed as candidate SACs (Costello & Emblow, 1997). The exact boundaries proposed for these areas and their further prioritisation will be finalised by NPWS, in the context of management issues, such as their relationship to other coastal areas of conservation interest.

Limitations of the survey and site assessment

There are gaps in the data due to events such as poor weather condition, damage to equipment, constraints imposed by diving safety etc., and further sampling may be necessary before management plans can be put together for marine areas. In addition, the survey methodology was based on the collection of semi-quantative data due to time constraints and more quantitative techniques may be necessary for monitoring biodiversity. The diving survey did not sample or record small species that could not be identified *in situ* (i.e. those generally less than 1 cm in length). Similarly, seabed meiofauna (i.e. that passing through 1 mm sieve, e.g. nematodes, copepods) and meioflora (e.g. single celled algae, fungi) were not sampled, although these can be extremely diverse and important in natural ecosystems. The site assessment of areas of nature conservation importance has been constrained by the data set, in particular the very limited number of examples of some biotopes and the fact that the analysis was only carried out at a national level as the data set was too small for a more regional approach as suggested by Hiscock (1996).

Contribution to the Biotope Classification System

The team at TCD played a role during the development of the biotope classification system by using the Irish data and their expertise to comment on drafts of the classification structure and categories and by contributing to a number of classification workshops (See Section 2). Both teams had access to the data collected in Britain and Ireland through regular updates of their respective databases. During the process of analysing the Irish data, to reveal which biotope types were represented, there was close co-operation between the TCD and MNCR, leading to identification of sites with rare biotopes, recognition of regional variants of already-defined biotopes and new biotopes that should be included in the classification system.

Use of GIS an aid to the prediction of biotopes

GIS is powerful and widely used tool but most environmental studies using GIS have employed it for management of detailed data at the local scale. Studies to assist coastal management planning (Clark *et al.* 1990), manage natural resources (Welch *et al.* 1992),

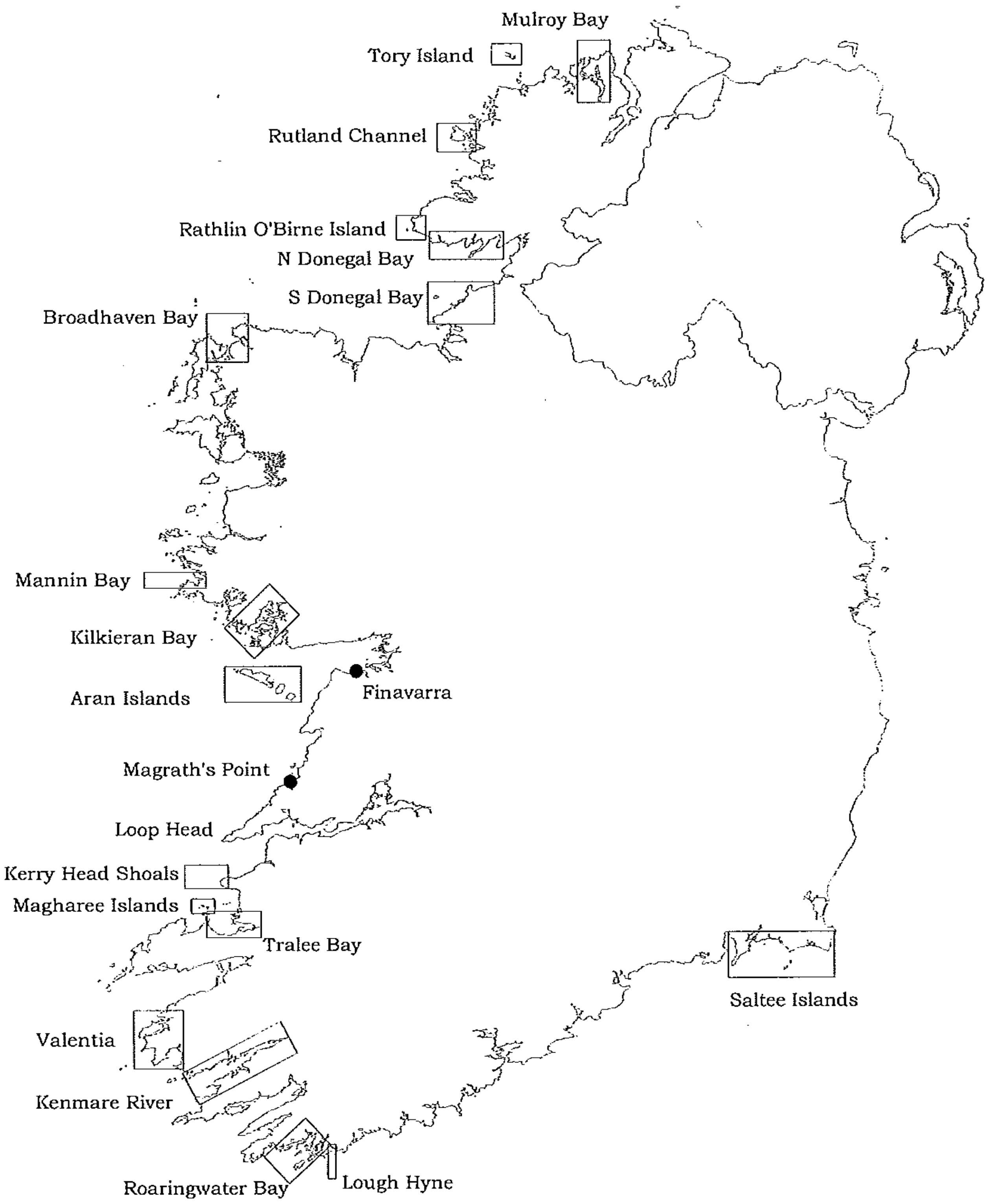

Figure 3.2. A map of Ireland showing the 20 areas of nature conservation interest identified by the BioMar survey. The boxes are not the actual boundaries but are only indicative of the areas to be considered by the National Parks and Wildlife Service as candidate Special Areas of Conservation. ● indicates two shore areas.

store and handle marine navigational data (Wardle 1992), model factors involved in eutrophication of a lagoon (Riunca *et al.* 1996), and develop indices of coastal erosion (O'Riain, 1996), have used GIS on coastal data. Analysis of the BioMar field data and European workshops identified seabed substratum and wave exposure as two of the most important physical variables in determining species distributions. GIS has the potential for taking standardised physical data at a national level, and analysing it to predict the distribution of biotopes and species. However, as this is a novel use of GIS the technical problems and resources to apply the technology remained uncertain.

The BioMar project chose two approaches to test the application of GIS in synthesising physical environmental data, as an aid in prediction of biotope and species occurrence. In the first, an existing model for calculating the exposure of coasts to wave action was programmed into a GIS and its reliability tested (Crean *et al.* 1995).

The wave exposure index

The wave exposure index (Crean *et al.* 1995) was based on that published by Thomas (1986). This was developed, over a two year period, into an automated model within a GIS and tested on parts of the coast of Donegal, Kenmare River, and the east coast of County Wexford. The model only calculated the index correctly for the Donegal area on which it was originally developed. The model could not cope accurately with the different spatial scales of the maps for the other areas. The main weakness of the GIS model used was that it was bounded by the size of the box around the piece of coastline, whereas the fetch should have been allowed to extend up to 100 nautical miles. Thus the use of different map scales altered the apparent fetch and the resulting index values. The great variation in scales of marine charts makes the calculation of integrated (or compound) indices which can be universally applied very difficult. The study demonstrated the complexities of coastal GIS modelling.

The lengths of littoral substrata for the Irish coastline

The second approach, over a seven month period, labelled the coastline of Ireland with the substrata recorded on Admiralty charts, and calculated the relative lengths of each substratum for defined sections of coast (Neilsen and Costello, unpublished). The Irish coastline was calculated to be 7524 Km of which 41% is rock, 34% sand and 11% mud.

The significance of this study is that it gives an accurate calculation of coastline length and allows different types of coastline to be compared on a national basis. The counties with the longest coastlines were Cork, Mayo, Donegal, Galway, Kerry, and Clare (Table 3.3). They have the most mud, sand, gravel, rocks, cliff and salt-marsh respectively. Comparisons can also be made at a broader geographic scale. The Atlantic to North Sea coast of France (3830 Km) is 30 % rock, 40 % sand, and 30 % salt-marsh and mud, while the Mediterranean coast of France (1703 Km) is 65 %, 25 % and 10 % respectively (Richard and Dauvin 1997). The Irish coast is thus 26 % longer than that of France, but has a shorter length of salt-marsh and mud shores. The Mediterranean coast of France is twice as rocky as its Atlantic coast, but together those coasts have less rocky coast than Ireland. These facts provide a perspective which should be considered in European coastal zone management. They suggest that, all other things being equal (e.g. natural quality of habitats), Ireland should have more rocky coast, but less salt-marsh and mud shores, protected from human impacts than France.

Repeating this study in other coastal areas, to produce standardised coastal data which could be combined in even larger databases, would aid management at larger as well as local spatial scales. It would form a baseline on which other data sets such as natural resources and communities of conservation importance could be overlaid and could be extended to cover the sublittoral. It would aid EU Member States to determine the frequency of occurrence of different habitat types at national level, which is of relevance to implementation of the Habitats Directive (92/43/EEC).

Table 3.3. The lengths of the dominant littoral substrata for the coastline (mainland plus islands) of each county in Ireland.

COUNTRY	SUBSTRATA TYPES (km)							TOTAL	
	Cliff	Rock	Stone	Sand	Mud	Saltings & marsh	No intertidal	km	%
Antrim	47.3	32.7	6.6	70.4	0.0	0.0	48.3	205.3	2.7
Clare	26.1	147.8	61.6	45.0	67.1	9.6	19.4	376.5	5.0
Cork	63.3	605.1	82.2	125.2	236.3	2.5	83.9	1198.5	15.9
Derry	0.0	5.7	0.0	67.9	0.0	0.0	1.7	75.4	1.0
Donegal	32.5	426.7	112.9	444.8	45.3	1.9	41.7	1105.8	14.7
Down	0.0	83.1	65.2	117.9	94.7	0.0	2.8	363.7	4.8
Dublin	5.3	29.0	5.2	110.5	0.0	0.0	19.3	169.4	2.3
Galway	7.7	750.8	80.6	127.8	80.1	0.0	38.9	1085.8	14.4
Kerry	93.9	338.2	85.8	249.5	63.4	3.0	51.9	885.7	11.8
Kilkenny	0.0	0.0	0.0	0.0	13.4	1.4	8.9	23.7	0.3
Leitrim	0.0	2.7	2.0	0.0	0.0	0.0	0.0	4.7	0.1
Limerick	0.0	0.0	16.7	0.0	24.6	3.3	0.0	44.6	0.6
Louth	0.0	4.6	17.2	81.3	0.0	0.0	0.0	103.1	1.4
Mayo	61.4	270.3	77.8	593.6	70.0	0.9	35.1	1109.0	14.7
Meath	0.0	0.0	0.0	16.5	0.0	0.0	0.0	16.5	0.2
Sligo	0.0	75.8	21.2	107.7	5.4	0.0	20.4	230.5	3.1
Waterford	0.0	88.1	5.7	56.5	24.5	1.0	13.6	189.3	2.5
Wexford	12.2	41.6	2.9	149.4	35.6	0.0	31.0	272.7	3.6
Wicklow	8.6	11.8	3.0	18.2	0.0	0.0	22.3	63.8	0.8
Ireland	358.3	2914.0	646.6	2382.1	760.2	23.7	439.1	7523.9	100.0

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Section 4

TASK 4 Assessment of remote survey methods

LEAD PARTNER **University of Newcastle**

OBJECTIVE

- To develop methodologies for mapping intertidal and subtidal marine biotopes on a broad geographic scale, and evaluate the use of sonar, remote video, and other technology for gathering data on these biotopes.

- To conduct pilot studies with this methodology in collaboration with potential end-users, to demonstrate applications in coastal management.

Introduction

Effective environmental management of an area requires a knowledge of the biological communities present and their extent. Ease of viewing of terrestrial biotopes makes the process of description and mapping relatively straightforward through the use of Ordnance Survey maps, aerial photography and vantage points. Littoral environments are similarly accessible, although the very narrow zonation of biotopes often presents problems for survey. Sublittoral marine habitats, by contrast, can only be inspected using specialised equipment and even then it is difficult to get a comprehensive coverage of large geographic areas. This lack of vista means that an overview of the sea floor must be pieced together from information obtained using survey techniques that are available since there are no techniques that allows us to 'see' biotopes directly. At the beginning of the project echo sounder acoustic ground discrimination systems (AGDs) had just been developed for mapping substrata for the seabed. The idea of using acoustically generated data to map sublittoral biological communities was a novel one but the potential for and importance of broadscale mapping was apparent. Techniques and methodologies for both littoral and sublittoral biotope mapping were investigated by Newcastle University.

The following points were considered important to the design of a broad scale mapping methodology:-

1. Broad scale mapping should use techniques which are relatively rapid, inexpensive and commercially available.
2. The survey techniques and the data produced should be widely understood.
3. The data should be accessible in a versatile format so that managers can extract appropriate statistics and manipulate the data for optimal presentation.
4. The maps produced by broadscale surveys could form the 'front-end' of a geographical query system with access to a variety of databases.

Definition of broad scale mapping
The issue of scale is central to mapping: Broad scale implies that large areas are mapped at a low level of resolution, although the actual scale ratios will vary depending upon the nature and minimum size of the basic mapping unit on one hand and the size of the geographic feature being mapped

Littoral Mapping
Broadscale mapping of littoral biotopes was carried out using both topographic maps and aerial photographs. Aerial photography was the only remote method used. Photographs of the coast were analysed to show boundaries between areas of similar habitat and biotope composition as well as conspicuous linear features. Characteristics of the original photographs such as colour, hue, grain and patchiness and position relative to the lower shore were all used to identify homogenous areas and boundaries. The analysis was done both by eye and use of the more sophisticated image processing techniques to identify areas of uniform spectral characteristics. Where field recorders ground truthed selected sites, the correlation between biotope and spectral characteristics were used to extrapolate to the whole image to derive the biotope coverage (Sotheran *et al.,* 1997). However this gave only limited discrimination between biotopes. The confidence and detail of the maps derived from aerial photographs was improved by increasing the intensity of ground truthing. Comprehensive ground truthing to check the integrity of uniform areas on the photographs was found to be the best compromise between time taken for survey work and the detail/accuracy achieved.

Littoral mapping using the following basic technique proved to be fairly rapid. Two surveyors working as one team covered between 1 km and 3 km of coastline over a single low tide period. Laminated aerial photographs were used as field base maps and boundaries between biotopes were marked directly onto them (Fig.4.1). The boundaries were directly digitised into a GIS and the attributes entered into a linked database and a map of the biotopes of the area generated (Fig. 4.2). Quite detailed habitat and biological community data was recorded and this data can be manipulated and displayed flexibly within a GIS. High quality, detailed maps can be produced as scales of 1:5,000 and 1:25,000. Above this scale reinterpretation of the detail is required to summarise suites of biotopes that compose the shore.

A methodology for broadscale (Phase 1) littoral mapping has been produced (Foster-Smith and Bunker, 1997) and the Newcastle team contributed to a broadscale mapping manual produced by the Countryside Council for Wales (Richards *et al.,* 1995).

Sublittoral mapping.
Three types of acoustic instruments were considered for adoption for sublittoral broad scale mapping, echo-sounders, sidescan sonar and swath sounders. In 1993 sidescan sonar and swath sounders were sophisticated and expensive technologies while echo sounders were the simplest. In contrast the principal of the echo sounder acoustic ground discrimination systems (AGDS) was a new and a relatively low cost technology developed for mapping different sediment types on the seafloor. For this reason the

Figure 4.1 An aerial photograph showing biotope boundaries marked by field surveyors.

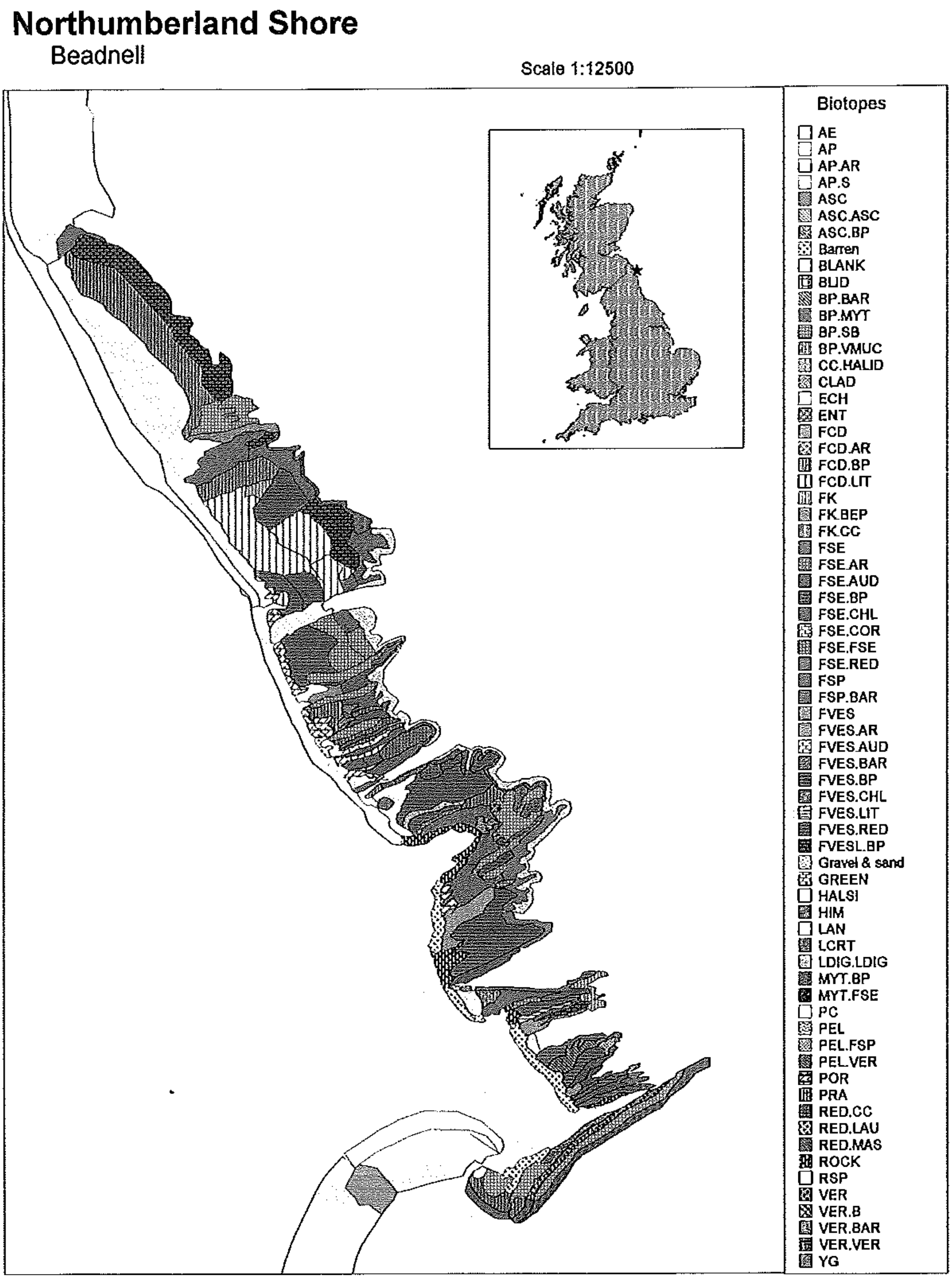


Figure 4.2 Biotopes (life forms) attributed to the different parts of coast by field surveyors using the aerial photograph in Fig 4.1 as the base map.

system was selected to determine if it could be used for the broadscale mapping of biological communities. One proprietary system RoxAnn™ was used and a non technical summary of the method is outlined below. The methods are a generic and equally apply to other systems.

The RoxAnn™ AGDS and differential GPS were linked to a laptop computer for datalogging and the transducer was mounted on a pole so that the complete system was compact and portable (Fig. 4.3). The RoxAnn AGDS processes the return signal from the sea floor and two values are extracted that provide information on ground hardness (E1) and roughness (E2) respectively (Chivers *et al., 1990)*: depth is also recorded. As AGDS records from only limited area under the vessel it is necessary to record a series of tracks (Fig. 4.4) to build up an acoustic image of an area. The data from the hardness, roughness and depth for adjacent tracts are processed separately to create three images (Fig. 4.5) which are then analysed to produce a map representing the acoustic ground types (Fig. 4.5). As these acoustic images have no directly interpretable biological meaning it is therefore essential to obtain ground validation of the data. The image was used to plan for ground validation points. Most samples were collected using a towed video recorder. Supplementary grab samples were taken in sedimentary habitats to describe infaunal communities. In some cases diver collected observations and samples were also used. The ground samples (Fig. 4.6) were analysed for their characteristic flora and fauna and classified according to the UK national classification of marine biotopes (defined as the physical habitat and the associated biological community). For mapping purposes, these biotopes were grouped according to their dominant life form, for instance kelp forest, faunal turf, algal crust. These sample stations were overlain onto the acoustic images to generate an acoustic signature for each life form A new map (Fig. 4.7) was then generated which may be interpreted as a life form map or marine benthic resource map. There are a number of ways in which this method can be refined to give more accurate and detailed information on the biotopes present.

While the methodology may sound simple considerable effort was needed to refine the analysis techniques such that for every day in the field several days were required for data analysis to produce the final maps. A methodology for the use of echo sounder ground discrimination systems for biotope mapping has been devised (Foster-Smith and Davies, in press).

BioMar contribution to the development of acoustic mapping
One of the factors in determining the choice of equipment used was that it should be commercially available and not in the developmental stage. The emphasis was more on the use of available hardware and software for the novel application of biotope mapping. Nevertheless, the development of a portable AGDS was novel and the project explored the use of dual frequency AGDS and this has been instrumental in the development of commercial portable and dual frequency RoxAnn units. A second dual frequency ADGS was developed in collaboration with Irish Hydrodata (Cork) which proved to be promising, but not sufficiently reliable to justify its use in routine survey work. This system is still being developed as a simple echo sounder logger system by Irish Hydrodata.

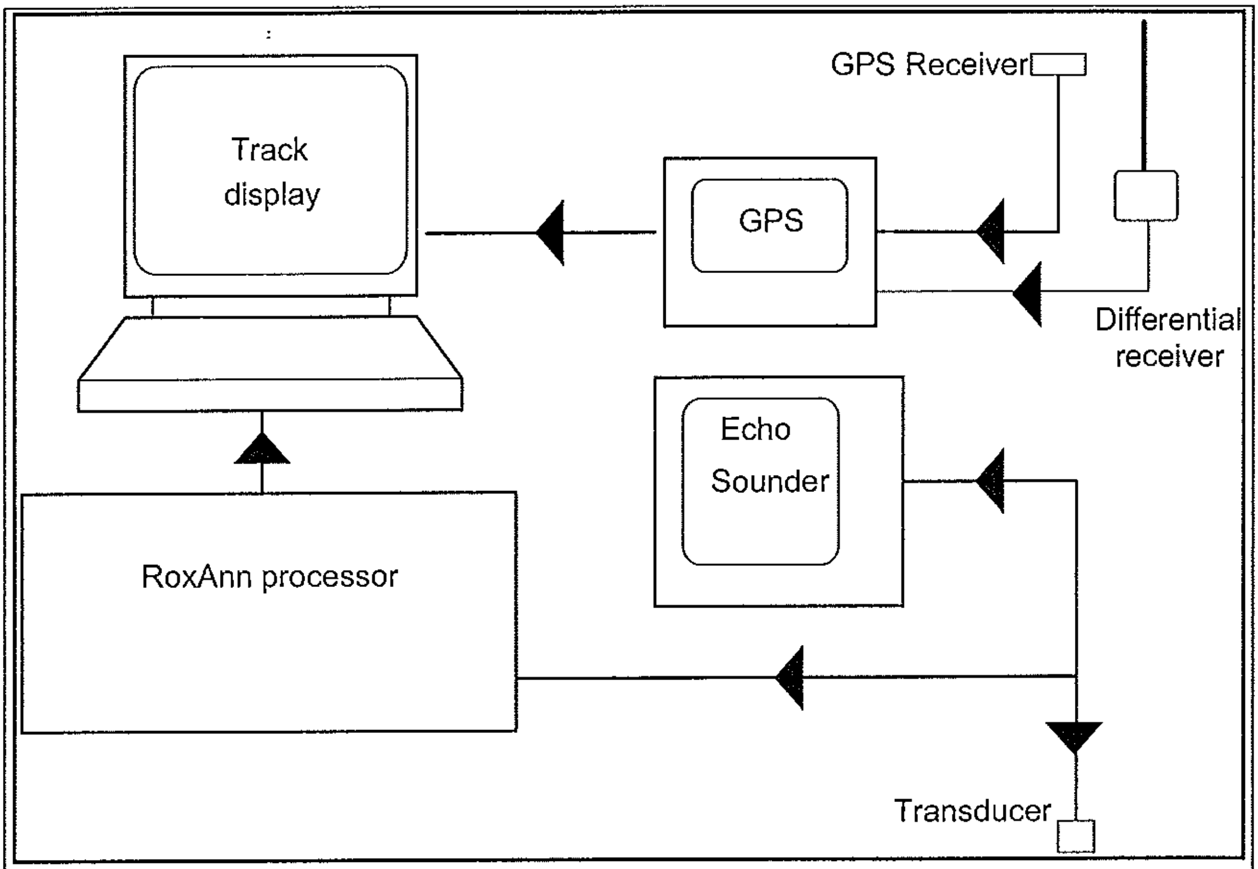


Figure 4.3 A schematic diagram of the RoxAnn acoustic ground discrimination system

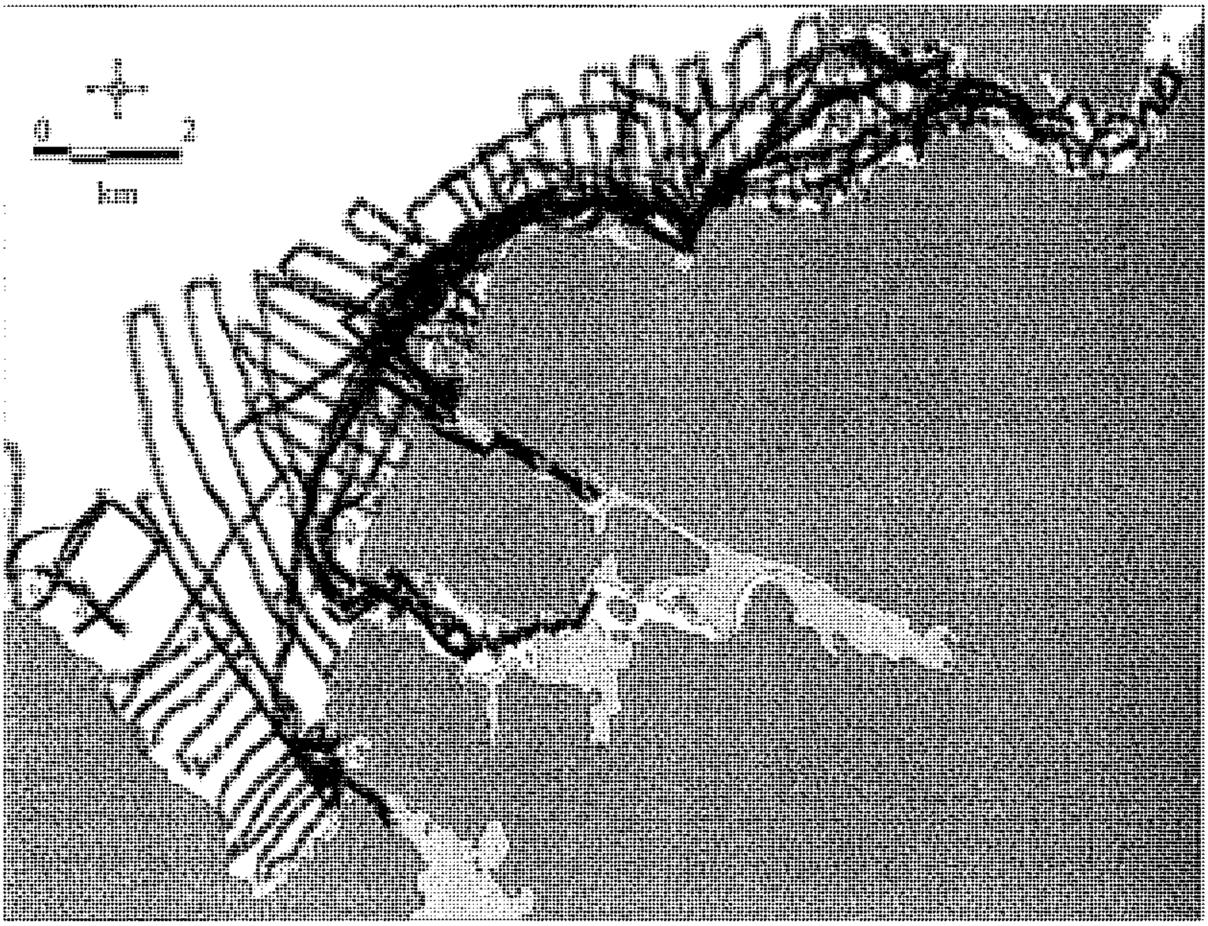


Figure 4.4 Location of acoustic survey tracks

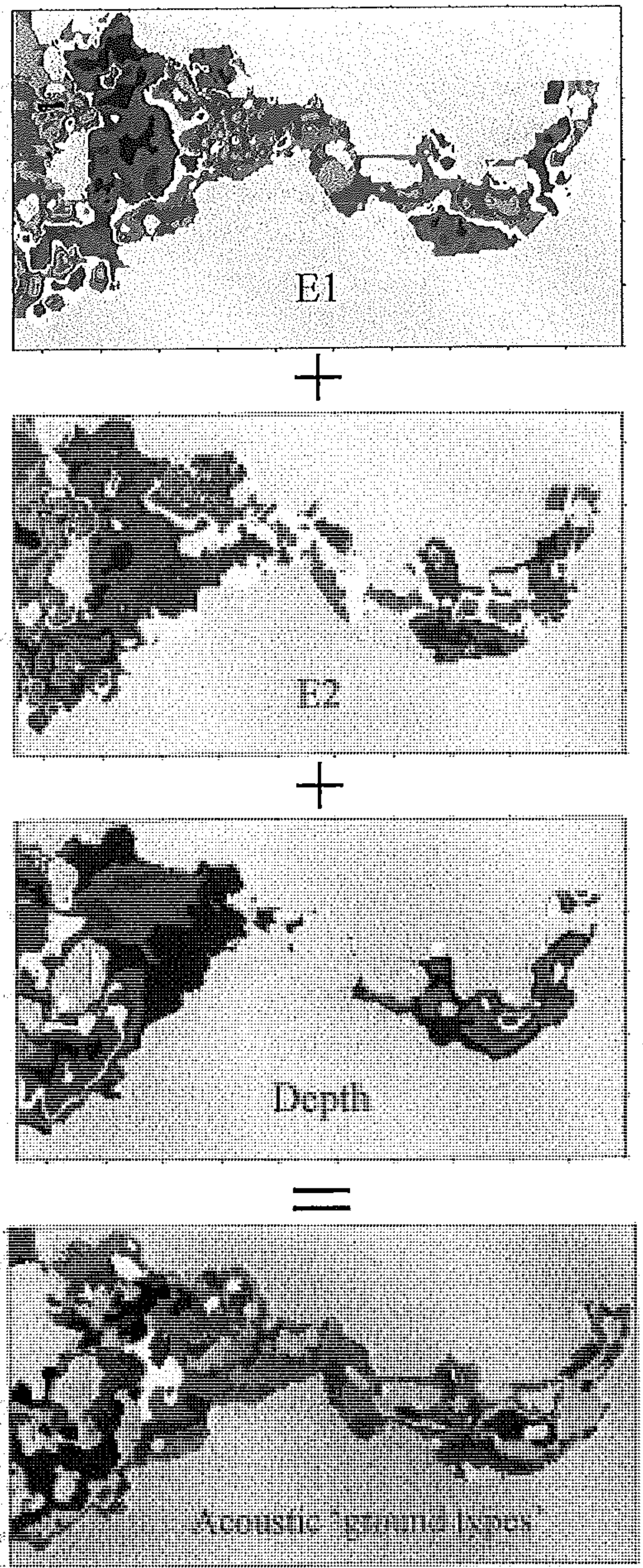


Figure 4.5 Images of E1, E2 & depth analysed by unsupervised classification to give a map of 'acoustic ground types'.

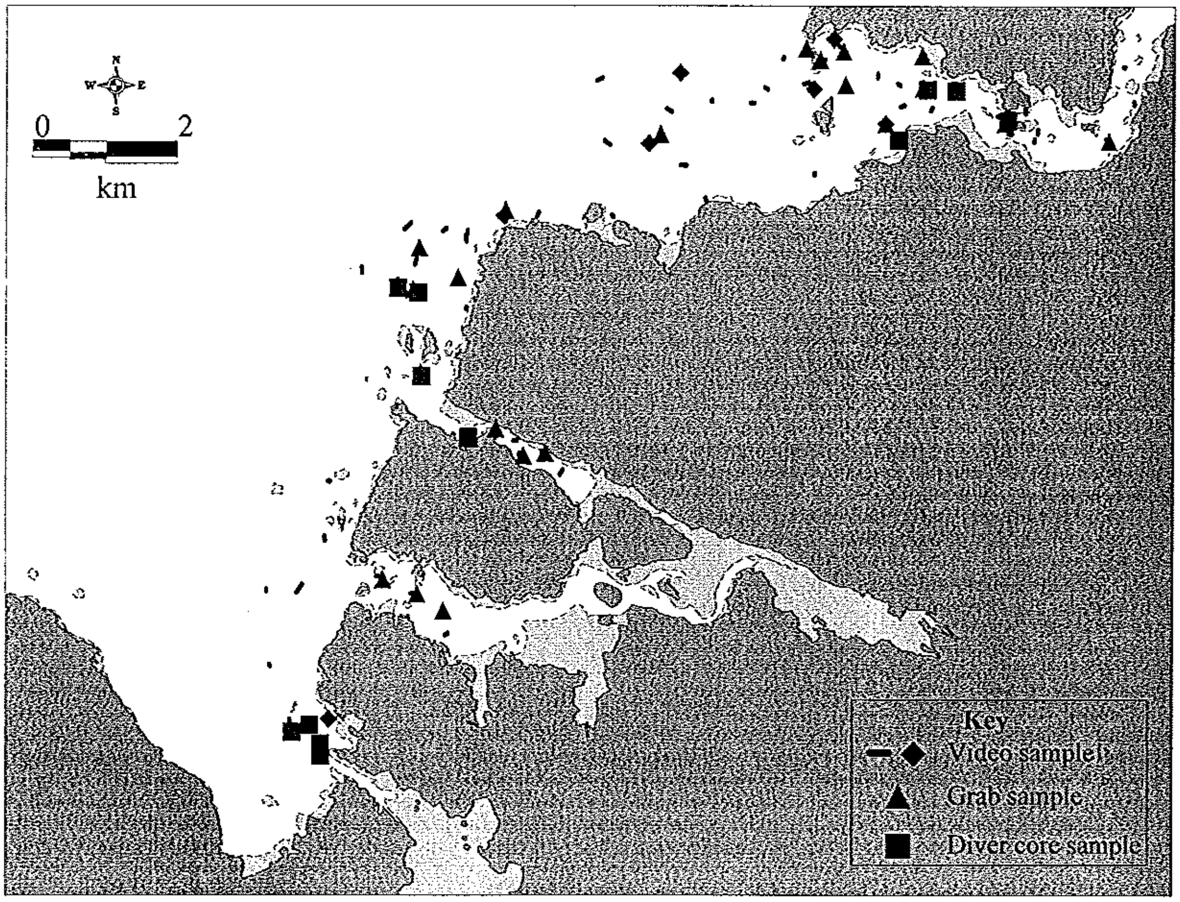
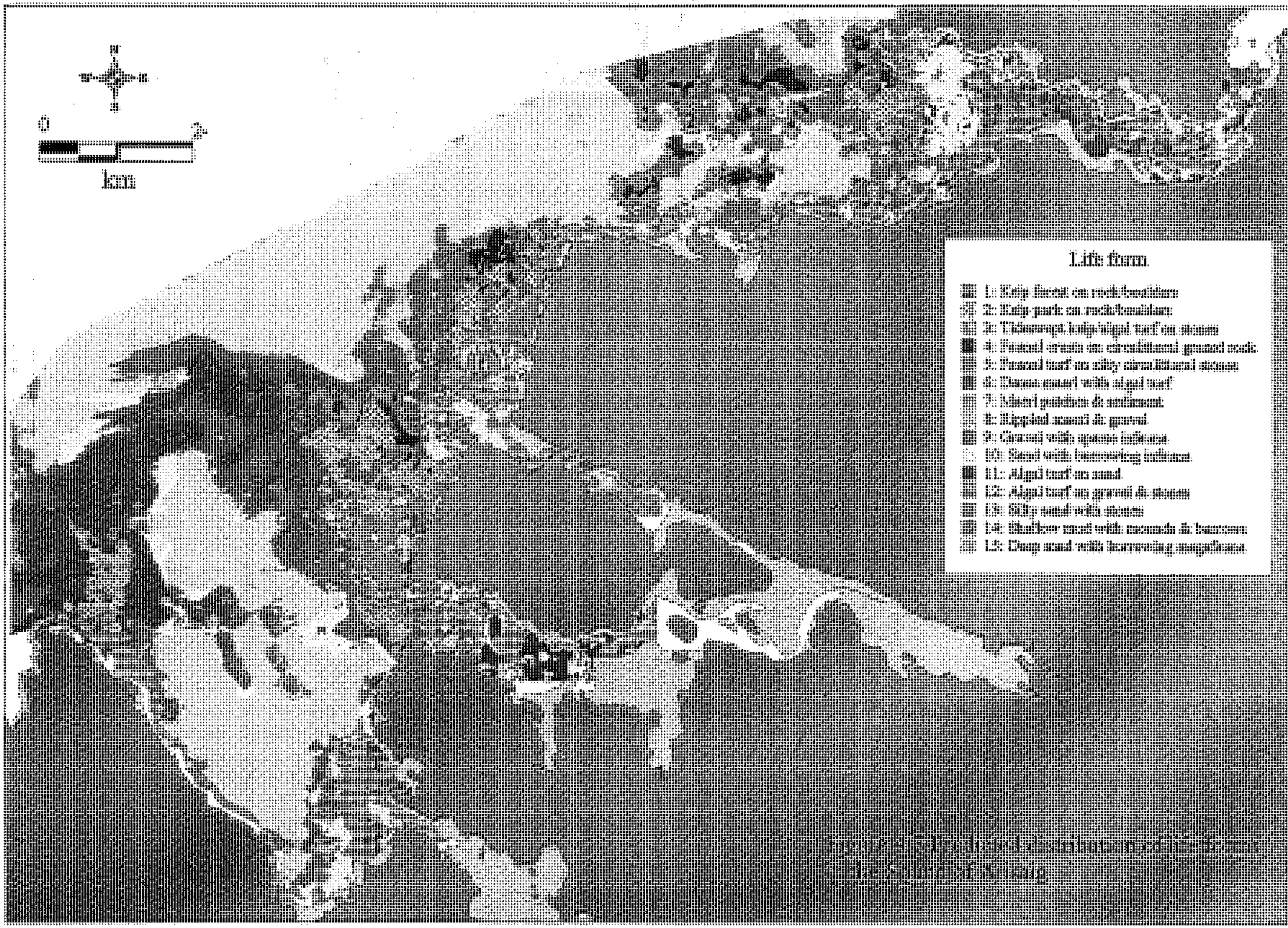


Figure 4.6 Location of ground validations stations


0
2
km
Life form
1: Kelp forest on rock/boulders
2: Kelp park on rock/boulders
3: Tide-swept kelp/algal turf on stones
4: Faunal crusts on circalittoral grazed rock
5: Faunal turf on silty circalittoral stones
6: Dense maerl with algal turf
7: Maerl patches & sediment
8: Rippled sand & gravel
9: Gravel with sparse infauna
10: Sand with burrowing infauna
11: Algal turf on sand
12: Algal turf on gravel & stones
13: Silty sand with stones
14: Shallow mud with mounds & burrows
15: Deep mud with burrowing megafauna

The use of image processing programmes for data produced by AGDS was novel and has since been adopted by many other research groups. Although software used was commercially available, transferring files between different software modules meant that problems of file compatibility needed to be addressed before a complete suite of programmes for processing could be used (Foster-Smith and Davies, 1997).

Mapping techniques

Life Forms - these are biological units that could be easily recognised by non specialists and are broad units of biotopes suitable for mapping e.g. kelp forests. A demand by the end users for these broad based units has led to the MNCR biotopes being grouped so that they are suitable units for mapping and with a standard colour format to allow an easy comparison of maps.

GIS a) Analysis of acoustic data within GIS.

The techniques for analysis of the sublittoral acoustic data are now well established. The data are converted into a continuous cover through interpolation (e.g. using Surfer software) and this is then imported into GIS for analysis and correlation with ground truth data (including existing data and BioMar and MNCR records. Considerable experience has been accumulated in analysis within GIS and has been incorporated into a manual for the interpretation of acoustic data.

b) Use of GIS to display and link with management decision support systems.

Littoral data is more directly interpretable and boundaries are drawn directly into GIS and the information associated with each polygon are entered. The Newcastle team contracted James Perrin (Wales) to create a MapInfo / Microsoft Access Graphic User Interface (GUI) to link data stored in a database directly to a GIS for spatial analysis and display. Whilst this has been specifically developed for littoral mapping such links should also benefit sublittoral mapping. Data can be treated and displayed in a versatile way within GIS and be linked to a management decision support system. The team worked with the Environment Agency, English Nature and the National Trust on the Northumberland coast when developing the littoral GIS/Database as they have a need to incorporate many different data sets and overlay the data onto a base map such as a biotope map.

Errors produced in the mapping process

The errors produced in the mapping process which can result in different interpretation of the distribution of biotopes have been examined. The sensitivity of the interpreted maps to varying data treatments, map confidences and appropriate cartographic methods for display were investigated and are discussed in the methodology manual for acoustic surveys (Foster-Smith and Davies, 1997).

Limitations of broadscale mapping using remote acoustic sensing

The RoxAnn system has proved itself useful in providing a broad scale image of acoustic ground types indicating hardness/roughness. The accuracy of the boundaries between different ground types is limited by track spacing. Accuracy is also limited by the accuracy of the global positioning system (GPS). Biotopes maps are an interpretation of the acoustic map based on ground truthing at selected sites. Comprehensive ground truthing is required for successful interpretation of the acoustic image to produce a biotope distribution map although there will always be a degree of uncertainty about biotope distribution. Thus, biotope maps are predictive for both the biotopes present and the position of the boundaries between the biotopes and should be integrated into a more comprehensive survey strategy where confidence is tested by further sampling. Extrapolation of results from one area to another to avoid the necessity of further ground truthing does not result in a map with an acceptable level of confidence. The limitations to discrimination between biotopes using AGDS often means that only broad biotope categories can be mapped and a system based on overall biological appearance (life forms) was devised to provide suitable mapping units. A more detailed discussion of the accuracy of biotope maps and the limitations of remote sensing are given in Appendix 2.

Surveys in Britain and Ireland

A total of 40 surveys (Appendix 3) have been conducted in collaboration with the Countryside Council for Wales (CCW), English Nature (EN) Entech Ltd., Environment Agency, The National Trust for England and Wales, Scottish Natural Heritage, Trinity College Dublin, Northumberland County Council and North Tyneside Metropolitan Borough Council (MCB). They include both littoral and sublittoral surveys. These surveys tested, demonstrated and directed the development of remote mapping techniques for marine biotopes. The high degree of collaboration with outside organisations was invaluable in the level of feedback from the end user into the mapping survey strategy. A clear demand for maps illustrating seabed biotopes has been demonstrated. The reports that resulted from these surveys are listed in the references at the end of this section and each survey resulted in a biotope map, similar to Fig. 4.7 being produced.

SEASEARCH

SEASEARCH is a project for volunteer divers and others to make useful and accurate observation of underwater habitats and the life they support. It is run on behalf of the UK country Agencies and the JNCC by the Marine Conservation Society. The BioMar project became closely involved in this project by writing a guide to biotope descriptions and recording (Foster-Smith, 1995) and collaboration with specific SEASEARCH projects by providing base maps of ground types for diver sampling surveys. The primary SEASEARCH projects were in Cardigan Bay (Wales) and in Susses (England).

Application to Environmental Management

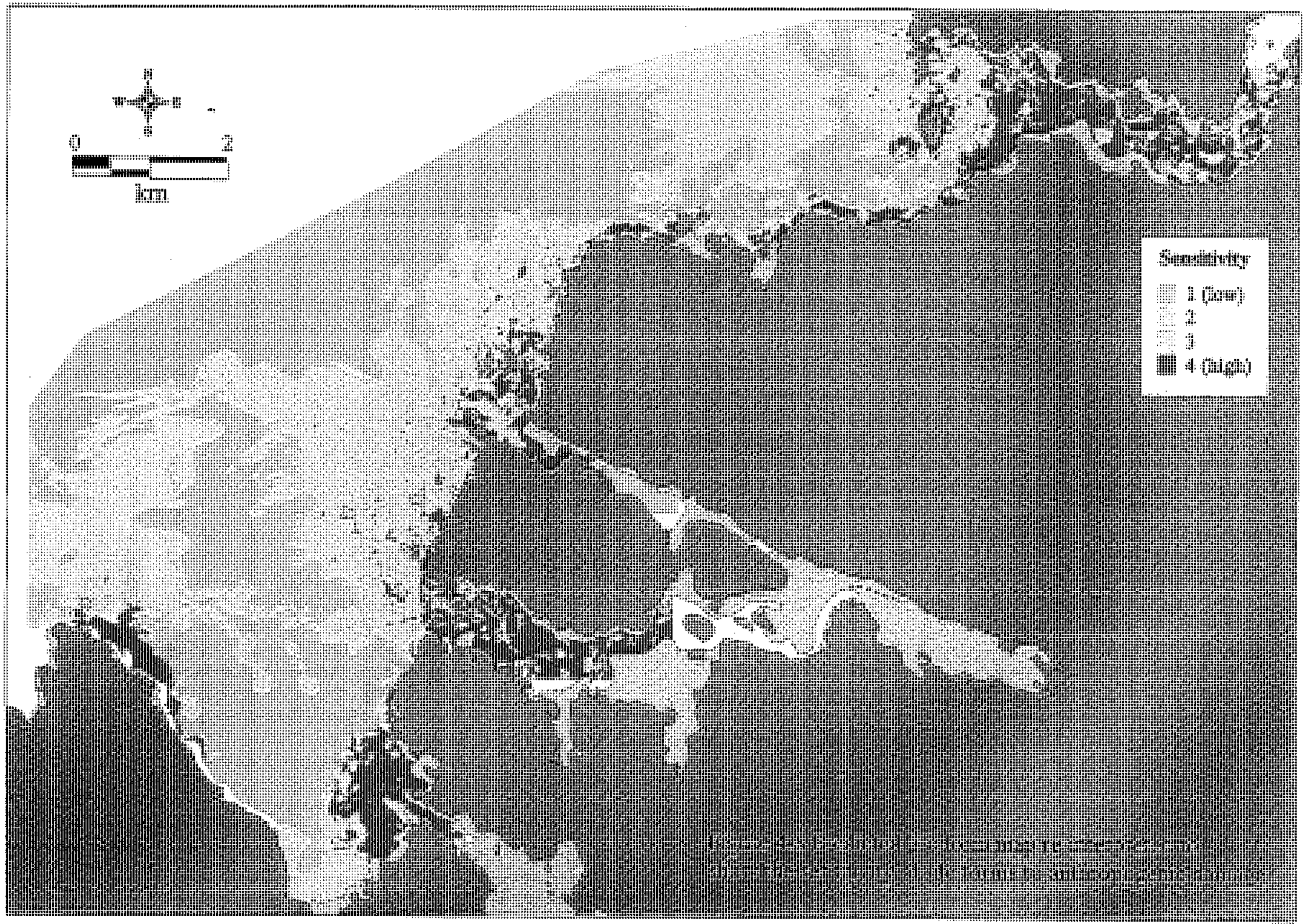
For each candidate Special Area of Conservation Article 4.4 of the Council Directive 92/43/EEC states that once a site is designated Member States will establish

'....priorities in the light of the importance of the site for the maintenance or restoration, at a favourable conservation status....' and Article 6.1. states that '....Member States shall establish the necessary conservation measures, involving, if needs be, appropriate management plans specifically designated for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites.'
Thus conservation objectives need to be set for every site and incorporated into management plans. This highlights the advantages of knowing the extent of different biotopes which can be determined by broadscale mapping and which can form the basis for other aspects of site management. For example data collected during a study for Scottish Natural Heritage (SNH) were transferred to their GIS in electronic format. SNH then used their GIS to reinterpret the benthic resource map in terms of sensitivity of each life form to anthropogenic damage (Fig. 4.8). Mapping the sensitivities may assist the development of conservation objectives for this site and will be of importance in the management of the site particularly when other data sets can be overlaid within a GIS system.

Broadscale mapping provides a limited amount of information on biological communities i.e. broadscale marine community maps but does not give the detailed information on species present and their abundance that results from diver surveys. Where little is known about an area broadscale mapping prior to a diver survey will help to structure the more detailed survey by showing both variety of communities present and the likely boundaries between biotopes and thus should make diver surveys more efficient.

This project has demonstrated the ease at which the biological communities can be mapped using remote acoustic technique, the importance of these maps for in environmental and conservation management and their use is structuring diver surveys for the collection of more detailed point source data. There is now a demand for biotope maps generated by acoustic surveys. The importance of biotope maps applies to all potential marine SACs within the European Union and to marine conservation in general in the north east Atlantic.

Since the completion of the BioMar project the team at Newcastle are being funded by English Nature, the Countryside Council for Wales, Scottish Natural Heritage and the Crown Estates, as part of the Life funded UK Marine SACs project, to accoustically map areas of nature conservation importance. In addition the team is involved in an EU funded project on the Effects on Large Industrial Fisheries on Non Target Species (ELIFONTS) in collaboration with the Danish Institute of Fisheries, Fisheries Research Services, the Institure of Terrestrial Ecology and the Sea mammal Research Unit. The acoustic techniques being used are single and dual frequaency RoxAnn units and sidescan sonar.


0
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km
Sensitivity
1 (low)
2
3
4 (high)

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Section 5

TASK 5 Survey maritime biotopes in Ireland

LEAD PARTNER National Parks and Wildlife Service, Dublin.

Objective

- Identify and map the areas with maritime biotopes of nature conservation interest.
- Provide a candidate list of Irish maritime conservation areas for Natura 2000.

Natural Heritage Area Survey of Maritime Biotopes

Under the Natural Heritage Area (NHA) Survey the former Areas of Scientific Interest (An Foras Forbartha, 1981) in Ireland were resurveyed. The survey of coastal sites funded by Life-BioMar was part of a country-wide NHA survey conducted between 1993 and 1995. The survey work was carried out by National Parks and Wildlife rangers and by ecologists on contract to the National Parks and Wildlife Service. The survey had three main objectives:

- Re-assess the Areas of Scientific Interest.
- Map the boundaries of each area to be included as a proposed NHA.
- Assess the quality of the site to determine if it should be delisted.

When resurveying the Areas of Scientific Interest it was important to determine both which community types were present and whether their quality was still sufficiently high to warrant inclusion in an NHA. For each site the data collected included land use, a list of habitats present and photographs (including vertical and/or oblique photographs). Field survey notes and boundaries were drawn on 1:10560 maps (the 6 inch map series). The methodology followed for the survey work was that of the wider NHA survey funded by EU-Acnet programme and described in Lockhart *et al.*, (1993). Considerable effort was put into defining the precise boundaries of these sites because this information was not available from the An Foras Forbartha (1981) survey data. The site boundaries are of considerable importance, as much of the land is in private ownership and the designation of privately owned land has consequences for both the landowner and the implementation of conservation management measures. The survey resulted in 1200 sites being proposed as NHAs (Fig. 5.1), which, after public consultation, may be designated when the Wildlife Act (1976) is amended. A total of 295 of these sites have a coastal component.

Lagoons

Lagoons are listed as priority habitat in Annex 1 of the Habitats Directive (92/43/EEC) and as only five Irish lagoons had previously been surveyed in detail, a more comprehensive study of lagoons was carried out. The objectives of the survey were as follows:

- to identify all coastal lagoons and lagoon like habitats in Ireland and briefly describe them.
- to classify those according to the geomorphological type, hydrological regime and biotic communities.
- to provide descriptions of the selected sites and assess their conservation value on the basis of their geomorphology, vegetation, aquatic macro-invertebrate fauna and ecotonal coleoptera.

Possible sites were identified from maps (Ordnance Survey Discovery Series where available) aided by aerial photographs and data from NPWS staff. A total of 147 potential sites was identified. After an initial screening process, ninety nine sites were surveyed in varying degrees of detail and 56 sites (Fig. 5.2) were sampled for flora and fauna using a standardised sampling regime and notes were made on both the hydrology and the threats to the sites. Twenty sites were selected for further intensive study.

The survey showed that there are distinct regional differences in the frequency and types of lagoon occurring in Ireland (Table 5.1). A total of 484 taxa were recognised, of which 451 were identified to species. Species occurring in marginal vegetation were not included. Only 18 of the 38 lagoon specialist species listed for the British Isles were recorded, 12 of them faunal and 6 floral (including algae and charaphytes and *Ruppia cirrhosa,* which was not listed by Davidson *et al.,* 1991). Among the ecotonal Coleoptera, 16 were recognised as indicator species i.e., with specialised habitat requirements, comprising 8% of Carabidae and 8% Staphylinidae. Of the 20 lagoons selected for intensive survey the majority were 2-5 m in depth and only two (Furnace and Drongawn) reached depths of 18 m or more. The information brought together by this survey is being prepared for publication as a special supplement to the Bulletin of the Irish Biogeographical Society.

Table 5.1. The distribution of the four main lagoon types (sedimentary lagoon, rock lagoon, natural saline lake and artificial lake) of the 56 sites visited in the six regions of the coastline.

	Lagoon		Saline lake		
	Sedimentary	Rock	Natural	Artificial	Total
Dublin-Wexford	2	0	0	4	6
Cork	5	0	0	11	16
Kerry	1	0	1	0	2
Clare	3	2	0	1	6
Galway	3	1	8	1	13
Mayo	4	0	1	1	6
Donegal	1	0	4	2	7
TOTAL	19	3	14	20	56

Figure 5.2. A map of Ireland showing the distribution of the four lagoon types of the 56 lagoons sampled.

From the 20 sites that were intensively studied 16 were recommended as being worthy of consideration as candidate SACs. These recommendations have been accepted by the NPWS. Ten of these lagoons are among sites now under public consultation. The remaining sites will be included in future phases. The major threat to lagoons was identified as eutrophication originating from farming practices.

Machair

Machair is one of the maritime Annex I habitats of the Habitats Directive (92/43/EEC) for which Ireland has special responsibility, as it occurs only in Ireland and Scotland. It is listed as a priority habitat in Ireland only. This habitat had not previously been intensively surveyed with the exception of one site. The survey was confined to a short list of potential candidate SACs, which covered a wide variety of machair types over a large geographical area, already under consideration as candidate SACs. The survey did not cover all machair sites in Ireland due to time constraints.

The survey had the following objectives:

- To survey 27 machair sites.
- Record the Annex I habitats.
- Record the Annex II plant species present at each site.
- Map the vegetation types.
- Describe and map the geomorphological characteristics of each site.
- Determine current land use.
- Make recommendations for future management.

Machairs are known to be concentrated on the west coast of Ireland and based on existing information 27 locations were selected for the survey, 6 in Co. Donegal, 1 in Co. Sligo, 9 in Co. Mayo and 11 in Co. Galway. The location of the machairs surveyed is shown in Fig. 5.3.

The results of this project have provided a wealth of data on the vegetation, geomorphology and current management of each site. Fifteen different types of Annex 1 habitat of the Directive (92/43/EEC) were recorded at the sites, although the quality of the habitat did not always warrant the site being designated as an SAC for that habitat. Of the 27 sites surveyed, 24 were recommended for designation as SACs on the basis of the machair community present and have been included in the sites now under public consultation. Some machairs that were not examined in this survey have also been selected as candidate SACs, on the basis of other data. The identified threats to machairs were the fencing of small areas, stocking levels of sheep and cattle and use of artificial fertilisers.

The identification of threats to both the lagoons and machairs proposed as SACs is important to the protection and management of these sites. This information will be used by the Life-Nature project being carried out by the NPWS for the development of management plans for candidate SACs.

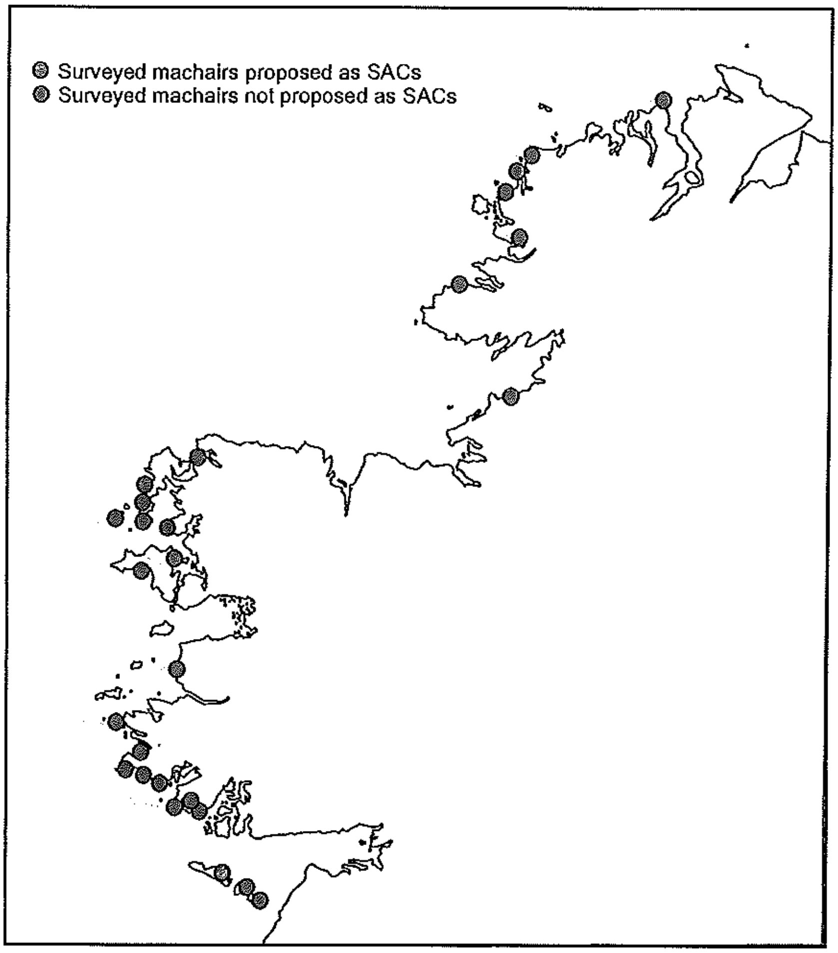


Fig. 5.3 A map showing the location of the machairs surveyed in west and north-west Ireland.

Littoral mudflats

Estuaries, mudflats and sandflats not covered by sea water at low tide are two of the eight habitats listed under open sea and tidal areas for which SACs should be designated under the EU Habitats directive (92/43/EEC). As the BioMar TCD team were concentrating on the open coast it was important to ensure that both estuaries and sand/mud flats were sampled. The survey objective was

- To survey mudflats/ sandflats to determine which sites would qualify as SACs

Seventeen bays and estuaries were selected for the survey. The criteria used for selection of the areas were that they should be geographical spread, little or no pre-existing data for them and they were known to be important to birds. The methods followed were those used by the TCD BioMar team and described in the Rationale and Methods by Hiscock (1996). Because of the considerable extent of the shores i.e. the distance from high water to low water was frequently 1-2 km, 4 rather than 3 stations were sampled on a transect and additional samples were taken between upper and low shore if the surface features suggested the presence of additional biotopes. The organic content of the granulometric samples was determined by the percentage loss on ignition.

Within most of the bays and estuaries an area was examined at both the inner and outer part of the inlet and this resulted in 34 transect areas being sampled (Fig. 5.4). Seventy five infaunal species were recorded and the results showed the importance of both coring and digging the sediment over a larger area to determine which species were present. The data were entered into the MNCR database and analysed to determine the biotopes present in each area.

The criteria used to assess the conservation value of the sites were richness of species and biotopes and rarity of species and biotopes. Twelve sites were considered to be of high conservation value on the basis of these criteria. Where a bay had one of the sites of high conservation value the whole bay must be considered to be of importance because a bay is a unit with respect to the dynamics of coastal processes. Seven of the sites have been included in the proposed SAC list and the remaining five are within proposed SAC but mudflats have not been listed as a habitat for which the area is being designated. Fifteen of the biotopes found in survey are included in the 12 sites.

It must be pointed out that ranking sites on such limited sampling of large areas should be treated with caution and all sampled sites were considered to have some conservation importance. However, the difference in conservation status of the different parts of a bay will be important when considering the management of the site. In addition the data needs to be re-examined along with the TDC BioMar data and other existing data to determine the overall frequency of both the biotopes and species as those considered rare in this limited study may not be uncommon.

Sandbanks

Many of the Irish sandbanks which are slightly covered by water at all times occur in areas with currents and poor visibility that make diving difficult, or are more than 5 km off shore. A desk top study (Kearns-Mills 1996) was carried out to map the location of

Figure 5.4. The 34 sandflat / mudflat areas sampled.

sandbanks using data from admiralty charts, British Geological Survey maps, published reports and unpublished data from the Geological Survey of Ireland. This report draws together all the broad scale information on the sediments around the Irish coast. The different sediment types have been drawn on a series of eight Admiralty Charts for the coast. This report showed that sandbanks are concentrated on the east and south-east coast of Ireland and one large sandbank off Wexford has been selected as a candidate SAC. The report shows that in addition to sand banks on the east coast there are a number of gravel banks, a habitat not listed in Annex I of the Habitats Directive.

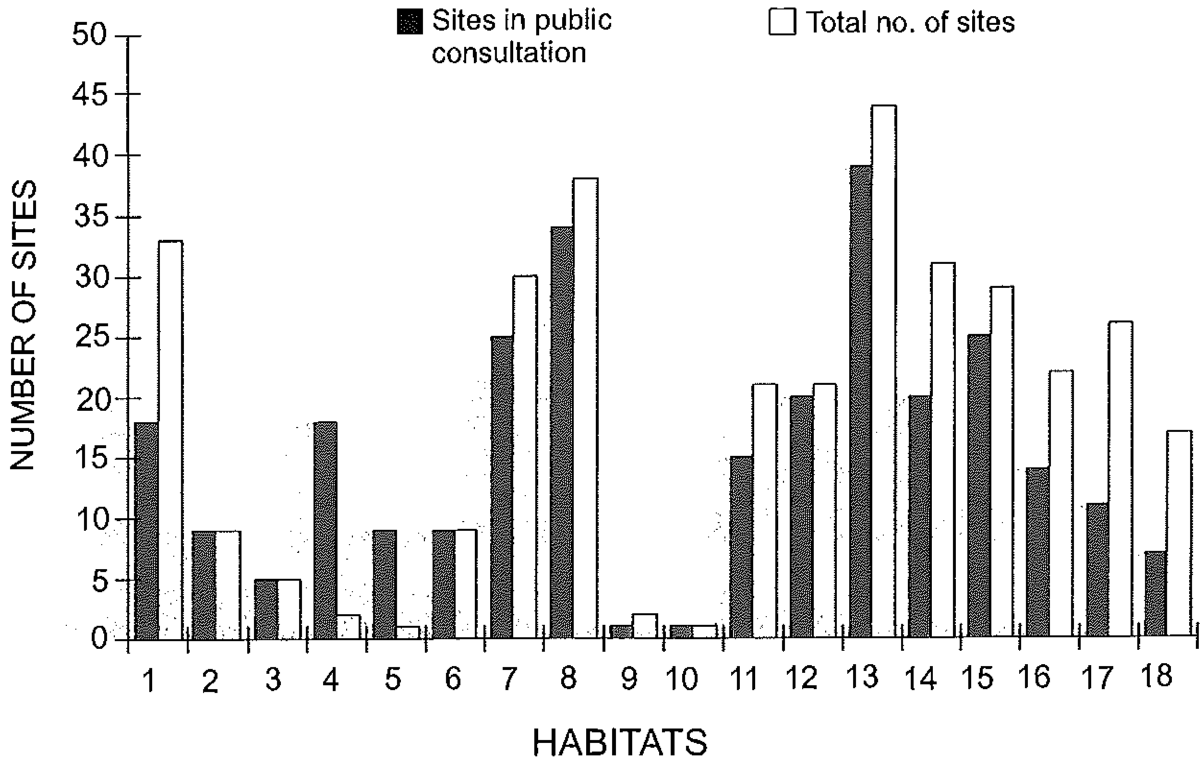
The Selection of Candidate Special Areas of Conservation with Maritime and Marine components

The majority of the terrestrial and maritime sites proposed for designation as Special Areas of Conservation have been selected from the proposed NHAs and using the data from the lagoon survey (Healy *et al.*, 1997), and the machair survey (Crawford *et al.*, 1997). At present 116 sites have been selected as proposed SACs with a coastal element. Relatively few of these have fully marine communities (Table 5.2). When the additional marine sites from the TCD BioMar survey are added, the total number of sites with coastal and marine communities proposed as SACs is in the region of 150. The number of sites with each maritime habitat type (excluding marine habitats) is shown in Fig. 5.5. The sites will be advanced for public consultation in three phases and the first tranche of 207 proposed SACs has been publicised (Fig. 5.6), of which 63 have a coastal element (Table 5.3). A list of sites and their maritime components is given in Table 5.4. Land owners have been notified if their land is included in a proposed designation. The second phase is expected in late 1997 and the third phase, which will contain the majority of the marine sites, in early 1998.

Table 2. A summary of Annex I marine habitats in proposed SACs currently under public consultation.

Habitat	No of proposed SACs under public consultation
Estuaries	10
Large shallow inlets and Bays	8
Marine caves	2
Sandbanks covered with water at all times	0
Reefs	8
Tidal sand and mudflats	17

Central to the designation of marine habitats and the maintenance of their favourable conservation status is an understanding of the impacts and conflicts of use in the coastal zone. At a more immediate level NPWS recognised a need to assess the ecological impacts of mariculture in relation to potential SACs, because mariculture is a rapidly growing industry in shallow bays and mud flats uncovered at low water. To this end NPWS commissioned a report on the ecological impacts of mariculture (Heffernan,



Key to Habitat numbers
(Priority habitats in bold. Numbers after the names are EU codes)

1 Atlantic salt meadows 15.13
2 Decalcified dune heath 16.24
3 Decalcified empetrum dunes 16.23
4 Drift lines 17.2
5 Dune slack 16.31-5
6 Dunes with creeping willow ?
7 Embryonic shifting dunes 16.221
8 Fixed dunes (grey dunes) 16.221-7
9 Halophilous scrub 15.16
10 Hippophae scrub 16.25
11 Lagoons 21
12 Machair 1A
13 Marram dunes (white dunes) 16.212
14 Mediterranean salt meadows 15.15
15 Perrenial vegetation of stoney banks 17.3
16 Salicornia mud 15.11
17 Sea cliffs 18.21
18 Spartinion 15.12

Figure 5.5. The number of maritime communities identified as potential Special Areas of Conservation in Ireland.

1997) which allows the impacts of culture of the different species grown commercially in Ireland to be quickly and easily accessed and makes it possible to gauge their potential influence on candidate SACs.

Table 5.3 A summary of the number of proposed NHAs and SACs and the estimated number with a maritime/marine component.

Total number of proposed NHAs	1200
Estimated total number of proposed NHAs with maritime and marine communities*	320
Estimated total number of proposed SACs including those with a maritime/ marine component.	450
Number of proposed SACs in public consultation	207
Number of proposed SACs in public consultation with maritime/marine habitats	63
Estimated total number of proposed SACs with maritime/marine communities	150

Table 5.4. Candidate SACs with coastal habitats. Listed in tranche order.

First Trancee sites (currently under public consultation).

Site No.	Site name	Coastal habitat
332	**Akeragh, Banna and Barrow Harbour**	Drift lines 17.2 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Sea cliffs 18.21
76	**Ballycotton, Ballynamona and Shanagarry**	Tidal mudflats 14
1975	**Ballyhoorisky Point to Fanad Head**	Perennial vegetation of stony banks 17.3 Sea cliffs 18.21
1089	**Ballymastocker dunes**	Fixed dunes (grey dunes)* 16.221-7
1090	**Ballyness Bay**	Embryonic shifting dunes 16.211 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Machair* 1a Marram dunes (white dunes)16.212
622	**Ballysadare Bay**	Embryonic shifting dunes 16.211 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Large shallow inlets and Bays -- Marram dunes (white dunes)16.212 Tidal mudflats 14
696	**Ballyteige Burrow**	Atlantic salt meadows 15.13 Decalcified dune heath* 16.24 Drift lines 17.2 Embryonic shifting dunes 16.211 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Halophilous scrub 15.16 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
1040	**Barley Cove to Ballyrisode Point**	Atlantic salt meadows 15.13 Fixed dunes (grey dunes)* 16.221-7

		Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11
20	**Black Head-Poulsallagh complex**	Marine caves Reefs --
729	**Buckroney-Brittas dunes and fen**	Decalcified dune heath* 16.24 Drift lines 17.2 Dune slack 16.31-5 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3
625	**Bunduff lough and machair/ Trawalua/Mullaghmore**	Machair* 1a Marram dunes (white dunes)16.212 Reefs --
1021	**Carrowmore Point to Spanish Point and islands**	Lagoons* 21 Perennial vegetation of stony banks 17.3 Reefs -- Tidal mudflats 14
343	**Castlemaine Harbour**	Atlantic salt meadows 15.13 Drift lines 17.2 Dune slack 16.31-5 Dunes with creeping willow 16.26 Embryonic shifting dunes 16.211 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Large shallow inlets and Bays -- Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
477	**Clare Island**	Sea cliffs 18.21
91	**Clonakilty Bay**	Decalcified dune heath* 16.24 Drift lines 17.2 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Tidal mudflats 14
2034	**Connemara bog complex**	Lagoons* 21

1230	**Courtmacsherry Estuary**	Atlantic salt meadows 15.13 Drift lines 17.2 Embryonic shifting dunes 16.211 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Tidal mudflats 14
484	**Cross Lough (Killadoon)**	Lagoons* 21 Perennial vegetation of stony banks 17.3
627	**Cummeen Strand/Drumcliff Bay (Sligo Bay)**	Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Large shallow inlets and Bays -- Marram dunes (white dunes)16.212 Tidal mudflats 14
1257	**Dog's Bay**	Drift lines 17.2 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Machair* 1a Marram dunes (white dunes)16.212
1497	**Doogort machair/Lough Doo**	Machair* 1a
268	**Galway Bay complex**	Atlantic salt meadows 15.13 Lagoons* 21 Large shallow inlets and Bays -- Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Tidal mudflats 14
500	**Glenamoy Bog complex**	Machair* 1a Sea cliffs 18.21
1141	**Gweedore Bay and Islands**	Decalcified dune heath* 16.24 Decalcified empetrum dunes* 16.23 Dune slack 16.31-5 Dunes with creeping willow 16.26 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Hippophae scrub 16.25 Machair* 1a Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Reefs --
147	**Horn Head and Ringclevan**	Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7

		Lagoons* 21 Machair* 1a Marram dunes (white dunes)16.212
36	**Inagh river Estuary**	Atlantic salt meadows 15.13 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Salicornia mud 15.11
507	**Inishkea Islands**	Machair* 1a
212	**Inishmaan Island**	Embryonic shifting dunes 16.211 Machair* 1a Marram dunes (white dunes)16.212 Perennial vegetation of stony banks 17.3 Reefs -- Sea cliffs 18.21
213	**Inishmore Island**	Dune slack 16.31-5 Dunes with creeping willow 16.26 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Machair* 1a Marram dunes (white dunes)16.212 Perennial vegetation of stony banks 17.3 Reefs -- Sea cliffs 18.21
1513	**Keel machair/Menaun cliffs**	Machair* 1a Perennial vegetation of stony banks 17.3
1061	**Kilkeran Lake and Castlefreke dunes**	Lagoons* 21 Perennial vegetation of stony banks 17.3
458	**Killala Bay/Moy Estuary**	Drift lines 17.2 Dune slack 16.31-5 Embryonic shifting dunes 16.211 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Large shallow inlets and Bays -- Marram dunes (white dunes)16.212 Tidal mudflats 14
1741	**Kilmuckridge-Tinnaberna sandhills**	Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212
1742	**Kilpatrick sandhills**	Decalcified dune heath* 16.24 Drift lines 17.2 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Perennial vegetation of stony banks 17.3

516	**Lackan saltmarsh and Kilcummin Head**	Atlantic salt meadows 15.13 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Salicornia mud 15.11
704	**Lady's Island lake**	Lagoons* 21 Perennial vegetation of stony banks 17.3
1529	**Lough Cahasy, Lough Baun and Roonah Lough**	Lagoons* 21 Marram dunes (white dunes)16.212 Perennial vegetation of stony banks 17.3
164	**Lough Nagreany dunes**	Decalcified dune heath* 16.24 Decalcified empetrum dunes* 16.23 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7
1766	**Magherabeg dunes**	Decalcified dune heath* 16.24 Drift lines 17.2 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212
205	**Malahide Estuary**	Atlantic salt meadows 15.13 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
375	**Mount Brandon**	Sea cliffs 18.21
470	**Mullet/Blacksod Bay complex**	Decalcified empetrum dunes* 16.23 Fixed dunes (grey dunes)* 16.221-7 Large shallow inlets and Bays -- Machair* 1a Marram dunes (white dunes)16.212 Salicornia mud 15.11
730	**Murrough, the**	Atlantic salt meadows 15.13 Drift lines 17.2 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3
2129	**Murvey machair**	Machair* 1a
1932	**Mweelrea/Sheeffry/Erriff complex**	Atlantic salt meadows 15.13 Decalcified dune heath* 16.24 Drift lines 17.2 Dunes with creeping willow 16.26

		Embryonic shifting dunes 16.211 Lagoons* 21 Machair* 1a Marram dunes (white dunes)16.212
206	**North Dublin Bay**	Atlantic salt meadows 15.13 Drift lines 17.2 Dune slack 16.31-5 Dunes with creeping willow 16.26 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
2012	**North Inishowen coast**	Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Machair* 1a Perennial vegetation of stony banks 17.3 Sea cliffs 18.21 Tidal mudflats 14
1309	**Omey Island machair**	Lagoons* 21 Machair* 1a Marram dunes (white dunes)16.212
208	**Rogerstown Estuary**	Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
1190	**Sheephaven**	Atlantic salt meadows 15.13 Fixed dunes (grey dunes)* 16.221-7 Machair* 1a Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15
189	**Slieve League**	Sea cliffs 18.21
190	**Slieve Tooey/Tormore Island/Loughros Beg Bay**	Embryonic shifting dunes 16.211 Marram dunes (white dunes)16.212
2074	**Slyne Head peninsula**	Atlantic salt meadows 15.13 Drift lines 17.2 Embryonic shifting dunes 16.211 Lagoons* 21 Large shallow inlets and Bays -- Machair* 1a

		Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Reefs --
191	**St. John's Point**	Marine caves -- Reefs --
1680	**Streedagh Point dunes**	Atlantic salt meadows 15.13 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Tidal mudflats 14
709	**Tacumshin lake**	Atlantic salt meadows 15.13 Drift lines 17.2 Embryonic shifting dunes 16.211 Lagoons* 21 Marram dunes (white dunes)16.212 Perennial vegetation of stony banks 17.3
1195	**Termon strand**	Lagoons* 21
193	**Tory Island**	Perennial vegetation of stony banks 17.3 Sea cliffs 18.21
2070	**Tralee Bay and Magharees peninsula, west to Cloghane**	Atlantic salt meadows 15.13 Drift lines 17.2 Dune slack 16.31-5 Dunes with creeping willow 16.26 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Lagoons* 21 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Spartinion 15.12
671	**Tramore dunes and backstrand**	Atlantic salt meadows 15.13 Drift lines 17.2 Dune slack 16.31-5 Dunes with creeping willow 16.26 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14

194	**Tranarossan and Melmore Lough**	Decalcified empetrum dunes* 16.23 Drift lines 17.2 Dunes with creeping willow 16.26 Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Machair* 1a Marram dunes (white dunes)16.212 Perennial vegetation of stony banks 17.3 Sea cliffs 18.21
197	**West of Ardara/Maas road**	Atlantic salt meadows 15.13 Decalcified dune heath* 16.24 Decalcified empetrum dunes* 16.23 Dune slack 16.31-5 Dunes with creeping willow 16.26 Fixed dunes (grey dunes)* 16.221-7 Lagoons* 21 Large shallow inlets and Bays -- Machair* 1a Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15
1007	**White Strand/Carrowmore marsh**	Embryonic shifting dunes 16.211 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Tidal mudflats 14

Second traunch sites

2123	**Ardmore Head**	Sea cliffs 18.21
199	**Baldoyle Bay**	Atlantic salt meadows 15.13 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
335	**Ballinskelligs Bay and Inny Estuary**	Atlantic salt meadows 15.13 Mediterranean salt meadows 15.15
77	**Ballymacoda (Clonpriest and Pillmore)**	Atlantic salt meadows 15.13 Estuaries 13.2 Large shallow inlets and bays -- Salicornia mud 15.11 Spartinion 15.12
697	**Bannow Bay**	Atlantic salt meadows 15.13 Drift lines 17.2 Embryonic shifting dunes 16.211 Estuaries 13.2

		Fixed dunes (grey dunes)* 16.221-7 Halophilous scrub 15.16 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
2055	**Bellacragher saltmarsh**	Atlantic salt meadows 15.13
2170	**Blackwater River(Cork/Waterford)**	Atlantic salt meadows 15.13 Estuaries 13.2 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Tidal mudflats 14
1957	**Boyne coast and Estuary**	Atlantic salt meadows 15.13 Embryonic shifting dunes 16.211 Estuaries 13.2 Fixed dunes (grey dunes)* 16.221-7 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Spartinion 15.12 Tidal mudflats 14
714	**Bray Head**	Sea cliffs 18.21
1482	**Clew Bay complex**	Atlantic salt meadows 15.13 Drift lines 17.2 Dune slack 16.31-5 Embryonic shifting dunes 16.211 Lagoons* 21 Large shallow inlets and bays -- Marram dunes (white dunes)16.212
1459	**Clogher Head**	Sea cliffs 18.21
2116	**Creadan Head**	Sea cliffs 18.21
2187	**Drongawn Lough**	Lagoons* 21
138	**Durnesh Lough**	Lagoons* 21
2189	**Farranamanagh Lough**	Lagoons* 21
1058	**Great Island channel**	Atlantic salt meadows 15.13 Spartinion 15.12 Tidal mudflats 14
202	**Howth Head**	Sea cliffs 18.21

2193	**Ireland's eye (land)**	Perennial vegetation of stony banks 17.3
370	**Lough Yganavan and Lough Nambrackdarrig**	Fixed dunes (grey dunes)* 16.221-7
2165	**Lower River Shannon**	Atlantic salt meadows 15.13 Estuaries 13.2 Lagoons* 21 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Sea cliffs 18.21 Spartinion 15.12 Tidal mudflats 14
2137	**Lower River Suir**	Atlantic salt meadows 15.13 Mediterranean salt meadows 15.15 Spartinion 15.12
1966	**Minane Bridge marsh**	Mediterranean salt meadows 15.15 Spartinion 15.12
710	**Raven Point Nature Reserve**	Drift lines 17.2 Embryonic shifting dunes 16.211
2162	**River Barrow and River Nore**	Atlantic salt meadows 15.13 Mediterranean salt meadows 15.15 Salicornia mud 15.11 Spartinion 15.12
781	**Slaney River Valley**	Estuaries 13.2 Tidal mudflats 14
210	**South Dublin Bay**	Tidal mudflats 14
109	**Three Castle Head to Mizen Head**	Sea cliffs 18.21

Third traunch sites

111	**Aran Island (donegal) cliffs**	Sea cliffs 18.21
1234	**Bertraghboy Bay**	Large shallow inlets and bays --
2173	**Blasket Islands**	Marine caves -- Reefs --
472	**Broadhaven Bay**	Atlantic salt meadows 15.13 Large shallow inlets and bays -- Tidal mudflats 14
452	**Carlingford Lough**	Drift lines 17.2 Perennial vegetation of stony banks 17.3

1346	**Derrynane Bay Islands and marsh, Lamb's Head**	Atlantic salt meadows 15.13 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Sea cliffs 18.21 Atlantic salt meadows 15.13 Marram dunes (white dunes)16.212 Mediterranean salt meadows 15.15 Sea cliffs 18.21
133	**Donegal Bay (Murvagh)**	Dune slack 16.31-5 Fixed dunes (grey dunes)* 16.221-7 Tidal mudflats 14
455	**Dundalk Bay**	Estuaries 13.2 Perennial vegetation of stony banks 17.3 Salicornia mud 15.11 Sand banks 11.25 Tidal mudflats 14
1500	**Eagle Island**	Reefs --
1501	**Erris Head**	Sea cliffs 18.21
764	**Hook Head**	Sea cliffs 18.21
154	**Inishtrahull**	Marine caves -- Reefs -- Sea cliffs 18.21
2158	**Kenmare River**	Reefs --
2111	**Kilkieran Bay and Islands**	Atlantic salt meadows 15.13 Lagoons* 21 Large shallow inlets and bays -- Machair* 1a Mediterranean salt meadows 15.15 Reefs --
204	**LamBay Island**	Sea cliffs 18.21
97	**Lough Hyne Nature Reserve and environs**	Marine caves -- Reefs --
166	**Lough Swilly including Big Isle, Blanket Nook & Inch Lake**	Embryonic shifting dunes 16.211 Estuaries 13.2 Large shallow inlets and bays -- Marram dunes (white dunes)16.212 Sea cliffs 18.21 Spartinion 15.12
2159	**Mulroy Bay**	Estuaries 13.2 Large shallow inlets and bays --

		Reefs --
2160	**Murles Point**	Reefs --
181	**Rathlin o'birne Island**	Reefs --
707	**Saltee Islands**	Marine caves -- Reefs -- Sea cliffs 18.21
787	**Waterford Harbour**	Estuaries 13.2 Tidal mudflats 14
2161	**Wexford off-shore sandbanks**	Sand banks 11.25
278	**Inishbofin and Inishshark**	Reefs --
1275	**Inisheer Island**	Reefs --
101	**Roaringwater Bay and Islands**	Large shallow inlets and bays -- Reefs -- Sea cliffs 18.21

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Section 6

TASK 6 Develop computerised data storage, analysis, and dissemination systems

LEAD PARTNERS **Trinity College Dublin**
Marine Nature Conservation Review

OBJECTIVE

- Develop and demonstrate the use of computerised systems for storing, analysing and disseminating marine data for conservation management.

The database

A computerised database is today an essential tool for managing large amounts of data. The BioMar project used an existing PC mounted database developed by the MNCR since 1987 using Advanced Revelation DBMS software (Mills 1994). This had been specially designed for such marine ecological surveys and could be adapted as necessary. This software has benefits including variable field length, ability to change the structure of files with data, and sophisticated indexing routines. All the data fields were coded, and the relational features of the databases aid validation and duplication of data (e.g. species are listed only once so spelling errors are reduced). Customised routines store and convert latitude-longitude to either Irish or British land grid references as appropriate. Copies of the BioMar database have been retained with the MNCR and the co-ordinators (NPWS, TCD).

The main modules of the database stored bibliographic and field data. These were linked to a single directory of species names (so incorrect species names cannot be entered), a module holding the biotope classification, and mapping packages. The species data was linked to multivariate analytical packages, of which TWINSPAN and DECORANA were most commonly used. Bibliographic, site, habitats sampled within sites, and biotopes could be searched, selected, their species similarities analysed, and the raw data and analytical results saved as special files (Mills 1994).

A second database, a computerised directory of the over 6000 species of marine fauna and flora occurring in Britain and Ireland developed at the Ulster Museum was further developed. The literature on marine algae in Ireland which will lead to distribution data on species distribution in Ireland a catalogue of the algal herbarium collection held in University College Galway (UCG) is being compiled in a subset of this database at (UCG).

In addition to the two databases mentioned, a collection of over 4000 photographs of marine species and habitats from Ireland and 10,000 from Britain has been established. These colour photographic slides act as a record of a site, confirmation of the occurrence of certain species, and a valuable scientific and educational resource.

Data dissemination

The dissemination of information is an integral part of good scientific practice and environmental management. The effort aimed at dissemination of information about the BioMar project has resulted in 77 publications and reports and 75 presentations; a full list is given in Section 8.

Scientists tend to synthesise rather than publish the original data collected. This is particularly the case for descriptive datasets whose immediate audience is often limited (e.g. checklist of species in a locality). Large descriptive datasets have either been published as reports with a limited distribution, or are not published and reside in large paper or computerised databases. The main weakness of paper media is for publishing large amounts of rarely requested data and colour photographs, and if the information needs to be analysed further it must be re-entered into a computer.

Electronic dissemination was not considered when computerised databases were designed over 10 years ago. It is a weakness of older databases that they are often too large and complex, or tied to expensive software applications, and must be managed and accessed by a few skilled operators. However, well structured information within such databases is ideal for electronic publication. As a part of this project the potential of electronic dissemination of marine species and habitat related information was tested. BioMar examined and published information using three types of electronic device, namely, diskette publishing, CD, and the World Wide Web (WWW).

BioMarLit - a diskette publication.

The BioMar group at TCD exported bibliographic data around which the Irish Marine Data Centre created a windows style interface. This used Visual Basic to search and retrieve data from a Microsoft Access database. The product, called BioMarLit, was distributed as a complete unit on diskettes with map, keyword, author and other search facilities (Kelly *et al.* 1996). It included a free facility for users to compile and edit their own personal bibliographies. Additional data may be added to this publication.

For BioMarLit, the building up the data of about 750 references took about 6 man-months, but writing the software front end and editing the data took as long again. After publication further 'bugs' in the software were discovered illustrating a common problem in developing new software applications. The production of this product involved expertise of (1) marine ecologists to review and edit the data, (2) expertise in manipulating the MNCR database, (3) software engineering, programming, and debugging, (3) writing a User Manual, and (4) printing the manual and diskettes. However, it was intended that similar datasets in preparation could be added to BioMarLit at far lower cost. Its major limitation is the restricted volume of data which can be distributed on diskettes.

The World Wide Web (WWW).

As a first step in electronic publishing, the TCD and UN teams developed a web page for the BioMar project within their respective university's servers (Table 6.1). A web site was also set up by TCD in early 1996, which for several months displayed a directory of marine fauna and fauna, developed at the Ulster Museum and further developed within the BioMar project, which included an identification guide to nudibranch molluscs (marine sea-slugs) with colour photographs previously published by a member of the field team. This site proved to be of considerable interest to web users. University College Galway (UCG) has been displaying a checklist of seaweeds (benthic marine algae of Britain, Ireland and Northern Europe), as a contribution to the BioMar project, on the WWW (Table 6.1) since September 1996 and has continued to build the site, now incorporating a simple seaweed identification guide. The interest in this site is demonstrated by the fact that it has been accessed by 2000 people to date. The use of hypertext links for querying is intuitive to the user and an endless series of links can be built into the text and images.

Table 6.1. A list of the world wide web sites currently displaying information on the BioMar project or which the project has contributed too.

BioMar TCD	http://www2.tcd.ie/Environmental_Sciences/biomar.html
BioMar UN	http://www.ncl.ac.uk/~nbiomar/index.html
Seaweeds	http://seaweed.ucg.ie/Seaweed.html

The BioMar Biotope Viewer: a CD publication

A large number of diskettes (> 20) would be required to publish all the data arising from the TCD portion of the BioMar project, particularly the photographs of species and habitats. A CD provides the required space and readability. As a demonstration of the capabilities of CD publication, the BioMar Biotope Viewer (Picton and Costello, 1997) was developed. A software programme was written by a member of the BioMar team to export the data from the database and a large number of photographs of species and biotopes were scanned. The software development was contracted to Cunav and Mr R. Telford. The BioMar Biotope Viewer contains descriptions of the sites and habitats at each site (with species lists) recorded during the Irish survey by the TCD team, a mapping routine and photographs of species and habitats (Fig. 6.1). It includes the Marine Biotope Classification system for Britain and Ireland (Connor *et al.*, 1997a, 1997b). In addition there are facilities to search for information based on habitat characteristics (e.g. wave exposure, seabed type), species, and location. It had been originally intended to incorporate the bibliography from the database into the viewer but it was not included due to time constraints. The BioMar Biotope Viewer must be view as a demonstration product as it has a number of limitations which have been recognised a number of which would be not be easily rectified using the structure and software on which it was built. However for those who are familiar with databases the tables containing the data can be accessed. Despite the limitations of the Biotope Viewer it is felt that it does demonstrate the capability of this type of publication. Software now exists which would enable future versions to be considerably improved.

The obtaining of an ISBN requires the publisher to place copies in certain libraries where they are then available on loan should the publication be sold out. We recommend that all electronic publications obtain an International Standard Book Numbers (ISBN) for electronic publications.

The *BioMar* Viewer

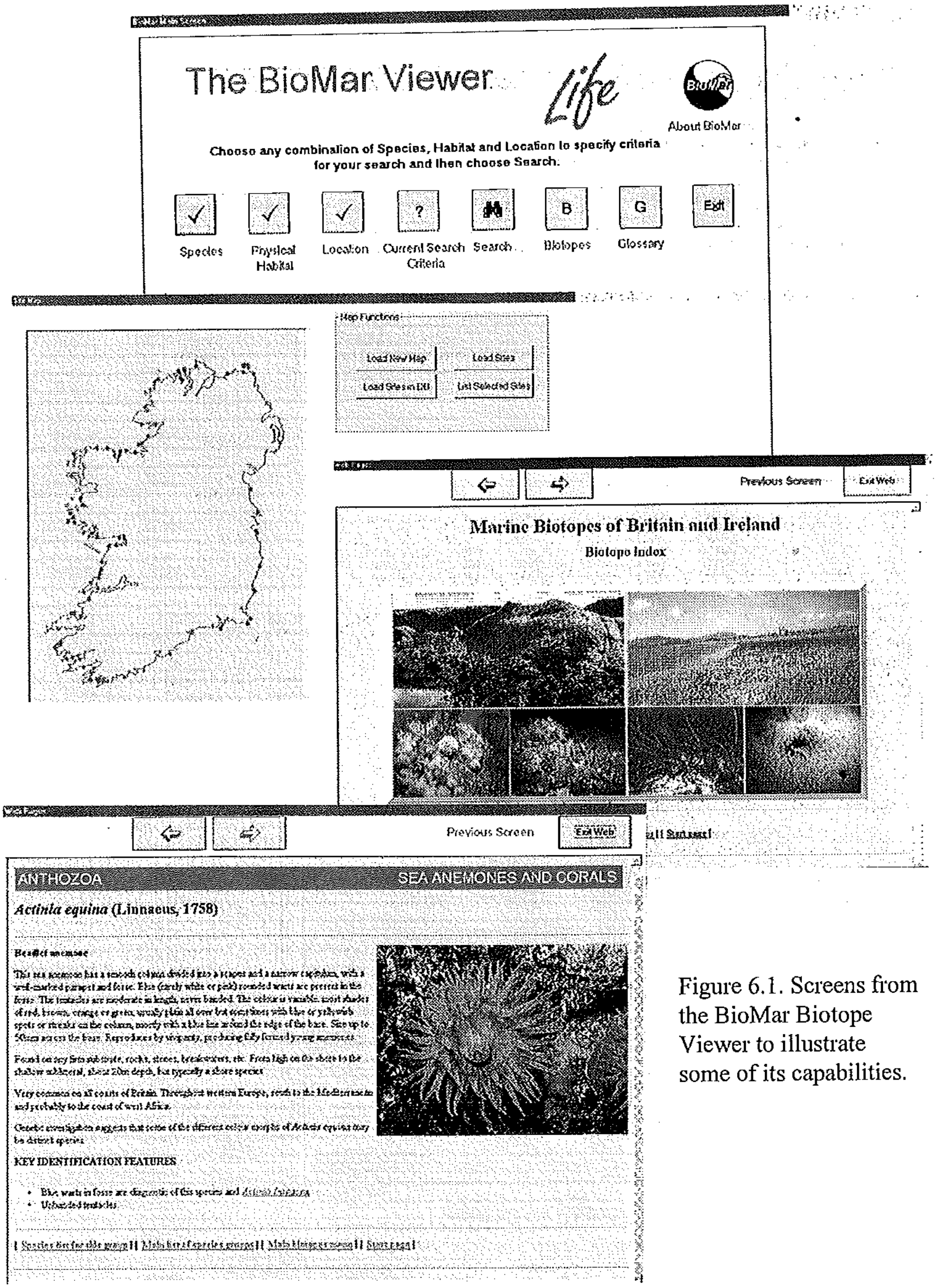

Figure 6.1. Screens from the BioMar Biotope Viewer to illustrate some of its capabilities.

The advantages of electronic publishing

The advantages of disseminating information on the WWW and CD is the volume of data and number of photographs that can be published. The WWW provides a means to link together databases of different kinds (Williams, 1997).

Limitations of electronic publishing on diskette and CD

The publication on diskette of the BioMar Lit and on CD of the BioMar Biotope Viewer have involved software development, programme writing to export the data from the database, debugging and User Manual preparation, in addition to considerable data and text editing and photograph scanning. Thus they required a wider range of expertise than conventional (books) media. The extra expertise and work can result in a greater complexity of the publication process, and higher production costs. Further more use of the product depends on the reader having a computer with the necessary hardware and software capabilities and the necessary aptitude to learn how to access and use the data. Long-term availability (e.g. in libraries) may be compromised by the durability of the disk/CD, and potential changes in hardware in the future. Further more the software and style of publication may be out of date within a year or too.

Conclusions

In spite of work needed to develop the publications on diskette and CD publication the BioMarLit demonstrates the usefulness of a bibliography with electronic search facility that is devoted to marine fauna and fauna for Ireland, with the ability for individuals users to expand the bibliography. The BioMar Biotope Viewer is seen as a pioneering step in making large amounts of environmental data available to those working in the academic, environmental management and teaching professions. As a signal of its potential there is a now proposal within the JNCC to further develop the idea of the BioMar Biotope Viewer, based on the favourable reception that prototype versions received.

References

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Section 7

TASK 7 Inventory of Marine protected areas in Europe

LEAD PARTNER **AIDEnvironment Ltd., Netherlands**

OBJECTIVE

- To identify and map the position of marine protected areas for nature conservation in Europe (especially the former European community States), and conduct a review of the legislation pertaining to marine conservation in these countries.

Introduction

The EU Directive 92/43/EEC creates the opportunity to protect biotopes within the European Union and will lead to a network of sites known as Nature 2000, including marine protected areas in Member States which have a marine territory. To ensure that the marine SACs designated, together with the marine areas already protected, will form a network of sites representing the major biotopes in EU waters it is important that sites already protected, and the reasons for their protection, are well documented. Thus the goal of this report was to identify marine protected areas in Europe and the reasons for their designation.

Central to effective conservation measures is the legislation that underpins it. Thus to determine the strengths and weaknesses of the current legislative situation a review of national and international legalisation was carried out. The findings of this review were compiled into a set of recommendations, highlighting potential actions, legal and otherwise, which could be taken to improve the existing situation at community level and within the community.

Ninety two areas that were wholly or partially marine were identified as protected areas within or adjacent to European waters (Fig. 7.1). The majority of these were found to be in coastal areas and often limited to the intertidal. Thus marine protected areas in European waters are limited, both in number and in coverage, in comparison to the number of terrestrial protected areas.

Recommendations

A set of 15 recommendations were made and a strategy proposed.
The recommendations include:

- A network of marine areas should be protected that are truly marine and underpinned by effective legislation.
- A network of areas should be developed within the water of EU Member States for each of the 5 different marine ecosystems Baltic Sea, North Sea, Celtic-Biscay Shelf, Iberian Atlantic Coast, Mediterranean Sea.

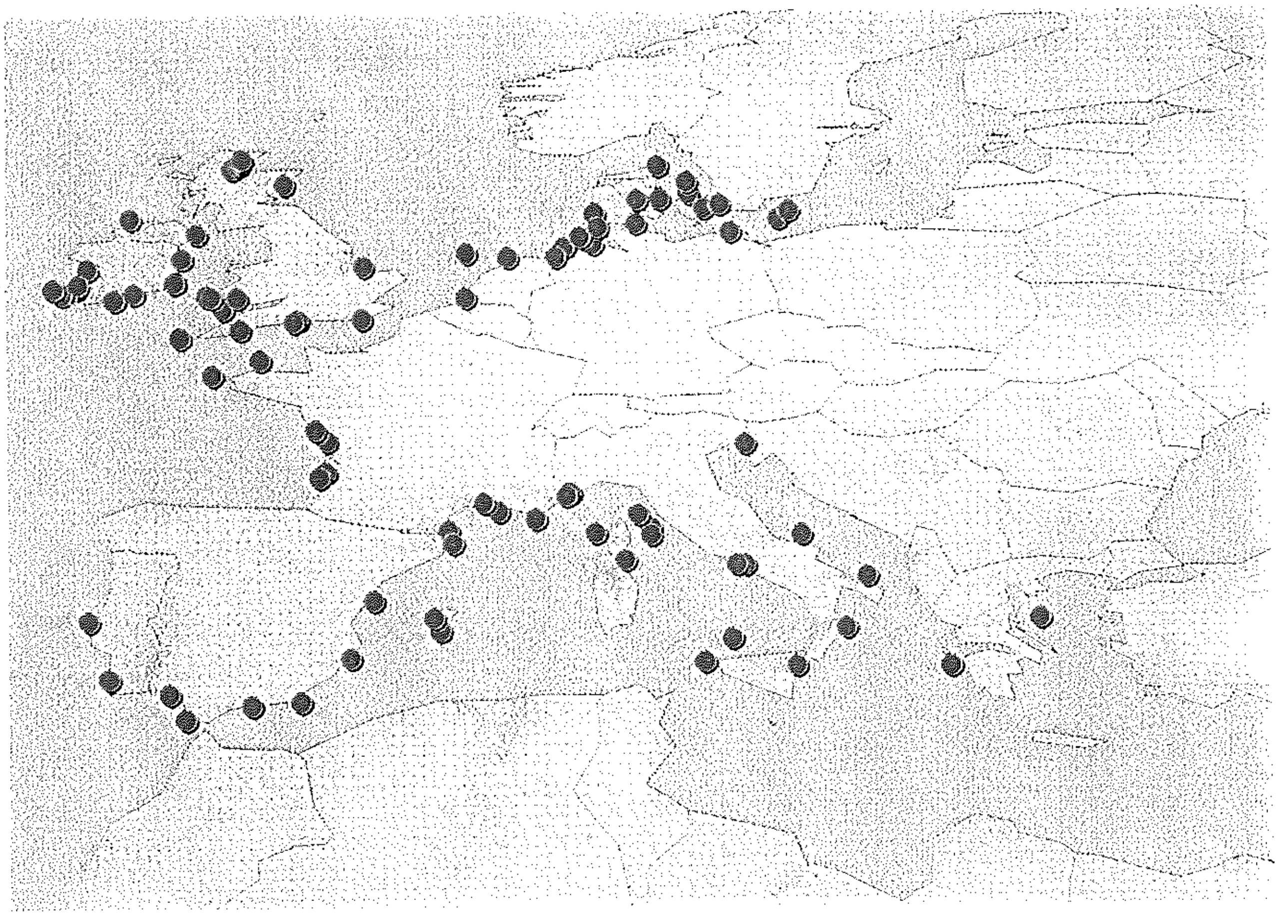

Figure 7.1 Marine protected areas in Europe (from Nijkamp and Peet, 1994)

- Within national legislation Member States should consider explicit provision for the designation of marine protected areas within their internal waters, territorial sea or exclusive economic zone. These national provisions could be encouraged by the EU commission.
- Because there is generally insufficient data on marine habitats and species the criteria outlined in the Habitats Directive should be broadened to facilitate the protection of "representative" marine habitats.
- The characteristic biotopes in the different European marine biogeographic regions need to be identified.
- The EC could usefully consider how to improve (the sustainability) of its fisheries policy by further harmonising it with the objectives of the EU nature conservation policy.
- The EC could consider co-operation with the Barcelona Convention, Conferences for the protection of the North Sea and the Helsinki Commission, with regard to developing a network of marine protected areas incorporating the areas covered by these other international bodies.

A strategy was put forward which would help towards building an ecologically sound network of marine protected areas. This strategy had three steps which are outlined below.

1. European waters should be viewed as one large ecosystem made up of five biogeographic regions. If the networks were '.....designed at the level of single large marine ecosystems they (i) would be representative for the ecological systems of which they are part, (ii) would form a totality within the holistic system of European marine waters because they are representative for a biogeographic region and (iii) would fit into regionally organised international management systems and convention agreements (Table 7.1)

Table 7.1 The relationship between large marine ecosystems, marine biogoegraphic regions and international conventions and or agreements. (From Hijkamp and Peet, 1994).

Large Marine Ecosystems	Marine Biogeographic Region	Conventions/Agreements
Baltic Sea	Baltic Sea	Baltic Sea convention
North Sea (inc. Channel)	Boreal	North Sea conferences OSPAR Convention
Celtic-Biscay shelf	Boreal-Lusitanean Lusitanean-Boreal	OSPAR Convention
Iberian-Atlantic Coast	Lusitanean	OSPAR Convention
Mediterranean Sea	Mediterranean Sea	Barcelona Convention

2. Important sites ' e.g. nursery areas, spawning and feeding areas , frontal systems, upwelling areas........' should be included in a preliminary set of marine protected areas in a European network and in each of the large European marine ecosystems, until such time as there are objective criteria for selecting areas. A comprehensive list of marine areas in need of protection should be developed through inventories of marine biotopes, with the BioMar Biotope Classification System being an important step forward for Britain and Ireland. A comprehensive inventory of biotopes would demonstrate biogeographic differences between similar biotopes and assist in determining 'uniqueness' and 'relative importance' of a biotope. The inclusion of fishery prohibition zones within the network of sites should be considered.

3. Member States should include valuable sites i.e. spawning areas etc. in their national proposals of SACs under the Habitats Directive and Members States should be encouraged to protect these sites by national legislation.

Country Profiles

Part II of the report contained country profiles of marine protected areas in Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain and the United Kingdom.

For each country the national policy and legislation was given and the national legislation relating to the protection of marine areas; membership and or ratification of international organisations and or agreements and the sites designated under both the national and relevant international agreements were included.

For each marine protected area, information was given under the following headings:

National designation
Size (ha)
% that is marine
Marine Jurisdiction
International Status
Location
Marine habitats type(s)
Brief description
Threats
Management
Source of information.

Conclusions

The report concluded *inter alia* that legislation in all EU Member states allows for the designation of protected areas for the purpose of nature conservation and environmental protection. Legislation is limited to territorial sea and does not distinguish between the seabed and the water columns. Only three Member States have explicitly included the option of designating marine protected areas under national legislation. National legislation is strongly influenced by international law. The importance of sectoral legislation makes it imperative that adequate links are established between the application of sectoral legislation and the designation of marine areas based on national nature conservation legalisation.

Table 7.2. The total number of marine protected areas and the number of these protected for important marine communities or species. the figures in brackets are the number of sites for which it the marine importance was uncertain.

Country	Biogeographic Region										Country totals	
	Baltic		North Sea		Celtic-Biscay		Iberian Atlantic		Mediterranean			
	Total number of areas	Areas of marine importance	Total number of areas	Areas of marine importance	Total number of areas	Areas of marine importance	Total number of areas	Areas of marine importance	Total number of areas	Areas of marine importance	Total number of areas	Areas of marine importance
Denmark	9	5 (1)	1	1							10	6 (1)
France					6	0			6	5	12	5
Germany	2	2	4	4							6	6
Greece									2	2	2	2
Ireland					12	2					12	2
Italy									12	9 (3)	12	9 (3)
Monaco									2	2	2	2
Netherlands			4	4							4	4
Portugal							2	1 (1)			2	1 (1)
Spain							2	0	7	5	9	5
United Kingdom			7	5	10	9					17	14
Totals	11	7 (1)	16	14	28	11	4	1 (1)	29	26	88	56

The ninety two marine protected areas identified were found to be un-representative of the different habitat types found within EU waters and the majority of the sites were located in inshore shelf water or sea inlets. Of the eighty eight sites found in the five biogeographic regions only 56 of these were protected because they were sites of marine importance interest (Table 7.2). Those sites not considered of marine importance were generally designated because of a bird interest. Twenty five of the areas were larger than 1,000ha. The inventory also showed that areas designated under international agreements were protected under national legislation, but that the boundaries delimiting sites under the international and the national designations were frequently different.

Reference

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Section 8

TASK 8 Dissemination

PARTNERS **All partners**

OBJECTIVE

- To disseminate information on the project as it progresses, and to publish or otherwise make available, the results of the project.

All partners actively disseminated information on the project and its results through national and international conferences and lectures. The results of the project have become publicly available through a large number of publications and more are in preparation. During the early part of the project copies of the reports and publications were forwarded to the Commission through their consultants EcoTec and then directly to the Commission. Additional papers and reports will be added to this list as a number of reports and publications are in preparation.

A list of publication, reports and presentations arising from the project is given listed below.

1. Publications

All these publications are available on inter-library loan, and have an ISSN or ISBN number.

Barnes, J., Davidson N.C., Hill, T.O., and Jones M. eds. 1993. Coastal and marine UK D MAP datasets: a user manual. *Joint Nature Conservation Committee Report*, No. 209.

Brazier, D.P., and Murray, E. 1994. Littoral survey of the estuaries of south-east Scotland and north-east England. *Joint Nature Conservation Committee Report*, No. 159. (Marine Nature Conservation Review Report, No. MNCR/SR/26.).

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2. Reports which contributed to the project

These reports were internal project reports submitted to the European Commission. Limited copies may be available from the authors. They are not to be cited without permission from the appropriate organisation representative; namely either Dr M. J. Costello (TCD), Mr D. Connor (JNCC), Dr E. Sides (NPWS), or Dr R. Foster-Smith (University of Newcastle). It is suggested that these reports are cited as (contact person or organisation representative, unpublished data). Most of the findings of these reports have been or will be published in a more widely available form.

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Wymer E. 1992. The sites database requirements specifications. National Parks and Wildlife Service, Dublin.

3. Presentations by the project

These presentations were made at meetings to which the public, scientists, authorities and others were free to attend.

By Trinity College Dublin

Author(s)	Date	Title of presentation	Conference and Venue
Costello M.J.	January 1993	An introduction to BioMar. "Marine coastal zone management: identification, description and mapping of biotopes"	3rd Irish Environmental Researchers Colloquium, Belfast
Costello, M.J.	January 1993	Development of the BioMar database, and its contribution to nature conservation management in the Irish Sea	Irish Sea Forum meeting on "Marine and coastal databases", Liverpool, UK
Picton B.E.	March 1993	Species rarity: its assessment and relevance to conservation	Porcupine conference, Peterborough
Costello M.J.	March 1993	The BioMar project: developing a system of the collection and management of marine conservation information	Porcupine conference, Peterborough
Costello M.J. and Mills P.	April 1993	Describing, classifying and mapping of coastal biotopes in Ireland	European Union of Coastal Conservation conference on "Coastal management and habitat conservation", Marathona, Greece
Picton B.E.	October 1993	Surveying marine habitats and communities around Ireland	Annual meeting of the NPWS, Galway
Kelly K.S. and Costello M.J.	January 1994	A review of marine related papers in *The Irish Naturalists' Journal* (1925-1993)	4th Irish Environmental Researchers Colloquium, Galway
Picton B.E., Sides E.M., Emblow C., Morrow C. and Costello M.J.	January 1994	The BioMar project - a survey of marine habitats and species around the Irish coast	4th Irish Environmental Researchers Colloquium, Galway
Picton B.E.	February - March 1994	The BioMar project - a survey of marine habitats and species around the Irish coast	Zoology Department and Environmental Sciences Unit, Trinity College, Dublin
Picton B.E.	April 1994	The BioMar project - a survey of marine habitats and species around the Irish coast	Connemara Seaweek, Letterfrack, Co. Galway
Picton B.E.	October 1994	Identification and mapping of marine biotopes.	The Coastwatch Europe Coastal Zone Management conference, Dublin.
BioMar	October 1994	The BioMar project	The Coastwatch Europe Coastal Zone Management conference, Dublin.
Sides E.M.	December 1994	BioMar: a field survey of the benthic marine habitats of Ireland	Dublin Naturalists' Field Club, Dublin.
Costello M.J., Emblow C.S. and Picton B.E.	September 1994	Long term trends in the discovery of marine species new to science in Britain and Ireland.	Marine Biodiversity: causes and consequences, conference, York.

Picton B.E.	November 1994	The BioMar project - a survey of marine habitats and species around the Irish coast	Marine Conservation Society annual meeting, Manchester
Morrow C.C., Picton B.E., Sides E.M., Emblow C.S. and Costello M.J.	January 1995	The role of sponge taxonomy in the development of a marine biotope classification	5th Irish Environmental Researchers Colloquium, Cork
Morrow C.C., Picton B.E., Hunt J., Sides E.M., Emblow C.S. and Costello M.J.	January 1995	Some rare and under-recorded marine species from the Irish coast	5th Irish Environmental Researchers Colloquium, Cork
BioMar	January 1995	The BioMar project	5th Irish Environmental Researchers Colloquium, Cork
Crean E., Gillmor J., Duffy L., Costello M.J. and Mills P.	February 1995	A computer model for predicting the exposure of coastal areas to wave action	Coastal GIS conference, Cork
Sides E.M.	February 1995	BioMar: a field survey of the benthic marine habitats of Ireland	Biological Society of University College Dublin, Dublin
Picton, B.E.	April 1995	The Species Directory Marine Database: a hierarchical taxonomic database for species-oriented biological recording in the marine environment	Xth Workshop on Atlanto-Mediterranean Sponge Taxonomy - Biodiversity databases and Identification systems
Picton, B.E.	April 1995	Image standards and formats for computer biodiversity databases and identification systems	Xth Workshop on Atlanto-Mediterranean Sponge Taxonomy - Biodiversity databases and Identification systems
Picton, B.E. and Lazo-Wasem, E.	April 1995	Use of the Internet for co-ordination and dissemination of biodiversity data and database projects	Xth Workshop on Atlanto-Mediterranean Sponge Taxonomy - Biodiversity databases and Identification systems
Morrow, C.C.	April 1995	The taxonomy of the Family Polymastiidae (Porifera) in Irish waters	Xth Workshop on Atlanto-Mediterranean Sponge Taxonomy - Biodiversity databases and Identification systems
Morrow, C.C.	May 1995	The role of sponge taxonomy in the development of a marine biotope classification	Porcupine meeting, Millport
Morrow, C.C.	July 1995	The taxonomy of the Family Polymastiidae (Porifera) in Irish waters	Taxonomy: Principles and Practices, at the University of Glasgow in association with the National Environmental Research Council and the Systematics Association
Costello M.J. and Kelly K.S.	Sept. 1995	Temporal trends and gaps in marine publications in Irish periodicals.	Irish Marine Science Symposium, Galway.
Costello, M.J. and the BioMar team	Sept. 1995	Conference organiser Strategies and Methods in Coastal and Estuarine Management	ECSA25 Conference on strategies and methods in coastal and estuarine management, Dublin
Costello, M.J.	Sept. 1995	Marine Nature Conservation in Ireland and the BioMar project	European Nature Conservation Year Seminar series to Local Authorities, Westport, Co. Mayo.
Costello M.J.	March 1996	Aims and progress of the BioMar-LIFE project	Special meeting with representatives of the DGXI, European Environment Agency, European Topic Centre for Nature Conservation, and OSPAR, Brussels

Costello M.J., Picton B.E., Emblow C.S., Guiry M., Connor D.	March 1996	Collection, review, analysis, and electronic dissemination of information related to marine biodiversity	International Workshop on Disseminating Biodiversity Information, Amsterdam
Picton B.E.	May 1996	The role of invertebrates in characterising marine biotopes	Bern Convention colloquium on Conservation, management and restoration of habitats for invertebrates, Killarney, Ireland
Costello M.J.	May 1996	Recommendations for marine conservation	Bern Convention colloquium on Conservation, management and restoration of habitats for invertebrates, Killarney, Ireland
Hunt, J., Emblow C., Costello M.J.	April 1997	Assessing the conservation value of sandy shores	Porcupine Society meeting on Marine Protected Areas, Portaferry, Northern Ireland

By the National Parks and Wildlife Service

Sides, E.M.	May 1996	Management strategies for marine invertebrates in temperate waters.	Bern Convention colloquium on Conservation, management and restoration of habitats for invertebrates, Killarney, Ireland

By the Joint Nature Conservation Committee

Connor D.W.	Sept. 1992	Norwegian fjords - are they really the same as sealochs?	Marine Conservation Society Annual conference, Nottingham
Connor D.W.	Oct. 1992	The sublittoral ecology of Scotland's islands	The islands of Scotland - our marine heritage conference, Scottish Natural Heritage, Inverness
Hiscock K., Covey R. and Connor D.W.	March 1993	Order out of chaos? - classification of intertidal communities	Scottish Marine Group, Aberdeen
Hiscock K.	March 1993	The role of classification of habitats and communities in the work of the MNCR.	Porcupine conference, Peterborough
Hiscock K. and Connor D.W.	March 1993	Why and how to classify marine communities.	Porcupine conference, Peterborough
Covey R.	April 1993	MNCR studies of the eastern basin of the Irish Sea - the Solway in a regional context	Estuarine and Coastal Sciences Association local meeting, Penrith, Cumbria UK
Connor D.W., Hiscock K., Foster-Smith R.L. and Covey R.	Sept. 1993	A classification system for benthic marine biotopes	28th European Marine Biology Symposium, Crete
Holt R., Brazier P. and Murray E.	Sept. 1993	Conservation of marine biotopes on the coastline of SE Scotland and NE England	28th European Marine Biology Symposium, Crete
Connor D.W.	April 1994	Benthic community studies on the North Sea coast of Great Britain: their application for coastal zone management and sensitivity mapping	North Sea Quality Status Report scientific symposium, Ebeltoft, Denmark
Connor D.W.	May 1994	Development of a marine biotopes classification	International Council for the Exploration of the Seas (ICES) Benthic Working Group, Yserke, Netherlands
Holt R.H.J., Brazier P. and Murray E.	June 1994	Marine Nature Conservation Review studies on coastal marine habitats of SE Scotland - NE England	The Yorkshire coast: environmental sciences and management, University College Scarborough
Hiscock K.	Sept. 1994	Conserving biodiversity in NE Atlantic marine ecosystems: a practical guide	Marine Biodiversity: causes and consequences, Marine Biological Association of the UK conference, University of York.
Connor D.W.	Sept. 1994	Marine benthic surveys and their role in the conservation of biodiversity	Marine Biodiversity: causes and consequences, Marine Biological Association of the UK conference, University of York.

MNCR JNCC	June 1995	The MNCR and BioMar marine biotope classification	North Sea Ministerial Conference, Denmark
Sanderson, W.S.	March 1995	Rare marine benthic flora and fauna in Great Britain: criteria and application	Porcupine conference, Isle of Cumbrae, Scotland
Covey, R.	March 1995	The development of a marine biotope classification for the north-east Atlantic	Porcupine conference, Isle of Cumbrae, Scotland
Holt, R.H.F.	March 1995	Comparison of diving and remote video techniques for sublittoral survey	Society for Underwater Technology conference, University of Stirling
Connor, D.W.	May 1995	The BioMar project and development of a marine biotope classification	International Council for the Exploration of the Seas (ICES) Benthic Working Group, Faroe Islands
Connor, D.W. and Hill T.O.	Sept. 95	A classification of marine biotopes and its application for conservation management	ECSA25 Conference on strategies and methods in coastal and estuarine management, Trinity College, Dublin
Sanderson, W.S.	Sept. 1995	Assessing 'rarity' of marine benthic species - development and application of criteria in Great Britain	ECSA25 Conference on strategies and methods in coastal and estuarine management, Dublin
Connor, D.W.	March 1996	The BioMar-LIFE classification for marine biotopes	Special meeting with representatives of the DGXI, European Environment Agency, European Topic Centre for Nature Conservation, and OSPAR, Brussels
Connor D.W.	June 1996	The BioMar-LIFE marine biotope classification methodology	EEA and ETC-NC habitat classification workshop, ITE Monkswood, England
Hill T.O. and Connor D.W.	July 1996	The marine biotope classification: an effective tool for nature conservation	CERCI conference, Scarborough, England

By the University of Newcastle

Author	Date	Title	Venue
Foster-Smith R.L. and Davies J.	Dec. 1993	Development of a methodology for mapping the distribution and extent of intertidal and subtidal habitats	Countryside Council for Wales sponsored Beaumaris workshop
Davies J.	Feb. 1994	Seabed mapping	Meeting of the Underwater Science Group of the Soc. for Underwater Technology
Foster-Smith R.L.	June 1994	Biotope maps and their importance for coastal management in Northumberland	Meeting of the North Sea Forum hosted by Northumberland County Council
Davies J.	Nov. 1994	GIS and mapping seabed biotopes	BioMar workshop Cambridge
Sotheran I.	Feb. 1995	Simple towed video system for observation of the seafloor	Meeting of the Underwater Science Group of the Soc. for Underwater Technology
Foster-Smith, R.L.	Sept. 1995	Scale: an important consideration for the assessment of marine biotopes	ECSA25 Conference on strategies and methods in coastal and estuarine management, Dublin
Sotheran, I.S., Davies, J. and Foster-Smith, R.L.	Sept. 1995	Mapping of marine benthic habitats using image processing techniques within a raster-based GIS	ECSA25 Conference on strategies and methods in coastal and estuarine management, Dublin
Davies, J.	April 1995	Nearshore seabed mapping	RoxAnn workshop, Bangor
Foster-Smith, R. L.	April 1995	Scale and the problems of mapping sublittoral biotopes.	RoxAnn workshop, Bangor
Sotheran, I.	April 1995	Image processing of acoustic data	RoxAnn workshop, Bangor
Foster-Smith, R. L.	June 1995	Marine research and survey techniques.	Northumberland Coast Offshore Perspectives Conference '95

Foster-Smith, R. L.	February 1995	BioMar survey of the North East coast.	Northumberland Coast Marine Forum
Foster-Smith, R L., & Sotheran, I	June 1995	Video presentation of sublittoral biotopes	Northumberland Coast Offshore Perspective Conference '95
Sotheran, I, Foster-Smith, R. & Davies, J.	March 1996	Mapping of marine benthic habitats using image processing within a raster-based geograpbic information system	3rd Underwater Science Symposium, Bristol
Davies, J., Foster-Smith, R. L. & Sotheran, I.	March 1996	A strategy for 'top down' marine benthic mapping using geographic information systems.	3rd Underwater Science Symposium, Bristol.
Bidewell, M.	April 1996	The Tees survey: new strategies for benthic survey	North East of England Marine Group in Scarborough

Section 9

Discussion

The need for a system which made possible the classification of marine and maritime sites, employing definitions of biotopes paralleling the CORINE Habitats Classification system, now in use for terrestrial and freshwater sites, was a driving force which led to the inception of the BioMar project and has been a primary focus of its effort. The resulting Marine Biotope Classification system produced by the project represents a major step forward in this direction, tested and now in use in Britain and Ireland. It has proved possible to bring marine biotope descriptions to a level similar to that achieved in the CORINE system. The marine biotope classification is designed so that it can be expanded to cover the north-east Atlantic, Mediterranean and Baltic Seas, and the addition of further biotopes as the requisite data become available. Since the marine system relies far less heavily upon plants than does the CORINE system, it has a capacity to be both more comprehensive and more flexible. A major advantage of the level of consultation maintained while developing the marine system, and the dissemination of several draft versions of it, has been that specialists throughout Europe are very aware of the classification system's existence. Testimony to its potential success is that it will contribute significantly to the proposed EUNIS classification system. The next logical step would be to ensure that marine site classification systems existing for other sectors of Europe's coasts are incorporated into it, such that truly pan-European marine classification system is developed.

An pivotal feature of the marine biotope classification system is that it provides a framework for compiling inventories and distributional information on Marine Biotopes in EU marine waters and on the biogeographic differences existing between biotopes there. The importance of undertaking such activities was highlighted in the AIDEnvironment report on marine protected areas, produced as part of the BioMar project. Assuming that current efforts to expand the biotope classification system to most sectors of European coast are successful, within the near future it should be possible to assess the need for the conservation of certain marine biotopes within a pan-European context, as well as at a national level. The use of the system as a tool for assisting in evaluation of areas of potential nature conservation interest has already been tested and proven during course of the project.

Synchronous with the process of development of the marine biotope classification system, a standardised methodology for data collection by site survey was developed, tested on the project and then published in book form (Hiscock, 1996). This methodology may now be recommended as a standard protocol, but to transform its significance from that of a potentially valuable tool to one which is actively employed over a wide range of relevant projects, there is probably need to more closely link it with the material disseminated on the classification system itself. For instance, any future development of the BioMar viewer could perhaps incorporate information on the conduct of recommended, standard surveys. The BioMar survey work itself has made a significant contribution to the volume of data now available on marine life in Britain and Ireland, and has played a key role in determining which areas have gone forward for selection as SACs. It is to be hoped that consideration will be given to ensuring that future monitoring activity carried out on such sites will be based on the standardised survey techniques developed during the project, to allow maximal comparability between data sets.

Central to the storage of survey records, data analysis, development of the Marine Biotope Classification System and the assessment of areas of conservation importance is an electronic database. The database structure used in the BioMar project (Hiscock, 1996) has proved effective and can be recommended for similar use elsewhere, although with computer technology advancing so rapidly it would not be appropriate to recommend use of any particular software for use in conjunction with the recommended structures. The fact that the existing structure is so intimately linked to efficient operation of the classification system and the associated standardised survey activities suggests that it would be difficult to ensure efficient development of these inter-dependent elements unless the future of the entire procedure were in the hands of some appropriate, international body with a co-ordinating capacity, such as the EU Topic Centre for Nature Conservation, for instance, which already has responsibility for the further development of the CORINE habitats classification system.

Data analysis of the Irish BioMar survey data has not only contributed to the development of the marine biotope classification system, but also, or the first time, allowed marine biotopes in Ireland to be described in a consistent way. It is highly unlikely that, without this bank of data, the Irish marine/maritime sites selected as candidate SACs would have included the same range of biotopes. With further analysis, and as more data become available, additional biotopes may well be described from Irish coastal waters, leading to selection of further sites as being of conservation interest. Any such data will be added to the existing database, which will be maintained by NPWS, where it is anticipated that it can be made available for public consultation. One priority would be to map the biotopes of the marine SACs on a broadscale, using remote sensing techniques. With the coastline of Ireland being 7524 km, it was impractical for a team of 4 divers to attempt to cover all Irish sublittoral areas comprehensively, and informed prioritisation of areas for survey was a necessity. With hindsight, some gaps can inevitably be detected in the data gathered, caused largely by the combined effects of a restricted field season, the limited number of personnel available and the many restrictions that diving safety imposes on sublittoral survey work. While it is difficult to anticipate the extent to which such factors may actually limit a specific data-gathering exercise, it is clearly necessary that they are taken explicitly into account in gauging what may be accomplished in a given time span. Further survey components which could usefully be explored when considering ways in which survey technique might be improved include methods to transform the basis of data-collection from semi-quantitative to more truly quantitative and methods to incoprorate, more systematically, the survey of species generally smaller than 1 cm that cannot be readily observed and identified *in situ*.

Developing and using transparent and easily understood criteria to select marine areas for nature conservation should mean that the reason for sites having been selected can be readily justified on the basis of scientific information. The majority of marine habitats listed in Annex 1 of the Habitats Directive are very broad e.g. shallow bays and inlets, reefs, etc., each of which encompasses many biotopes. In addition, the Habitat Directive sets out criteria to be used for the selection of SACs. The AidEnivronment report (AidEnviornment, 1994) pointed out the difficulty of using criteria such as 'representativeness' and 'uniqueness' in the marine environment. The biotope classification system employed in the BioMar project allows for the general principals of the criteria given in the Directive to be taken into account, but enables their development in such a way that they can be applied more critically in the marine environment (Connor and Hill, 1997; Costello andEmblow,1997). Hopefully this will provide a more secure basis for the selection of marine sites and more easily permit the application of national legislation supporting the Habitats Directive to their designation for protection, especially since the sea coast throughout Europe is now under rapidly increasing pressure from commercial and recreational use.

This project has tested the application of commercially available, 'state of the art' remote sensing technology developed for use in the sublittoral marine environment, to the broadscale mapping of marine biotopes. This proved to be a major step forward, since prior to this production of this type of maps was difficult to produce for rocky substrata in particular, which could otherwise only be observed remotely using a video camera and for sediment substrata which required intensive sampling.

The grouping of individual biotopes into a hierarchical system of categories provides suitable units for mapping. Biotope maps provide images that are readily understood, by both specialist and non specialists, and they show not only the extent of different biotopes but the juxtaposition of the biotopes occurring in an area. Such maps are of particular importance for the management of areas of nature conservation, since they can help in decisions on the management objectives for the area. In addition, these maps may be linked into a GIS system, providing for multiple overlays of other sets of data which can then be used together, for instance to calculate sensitivity indices of biotopes to anthropogenic impacts. Broadscale survey and biotope mapping are now to be used together in another EU-funded project, aimed at production of management plans for 12 UK SACs by the year 2001. That project will work from the basis provided by mapping work carried out during course of the Biomar project. The relative costs of broadscale mapping and the collection of point source data using divers (Appendix 2) demonstrate that capital expenditure costs involved in the acquisition of remote sensing equipment are less and a much great area can be covered by a remote sensing team than would be covered in the same time by a team of 4 divers. However, the limitation of sublittoral broadscale mapping process is that the level of accuracy of the resultant maps is dependent not only on the spacing of the acoustic tracks, but also on the amount of ground truthing that is carried out, using diver-based video camera and other sampling methods e.g. grab samples, diver collected data. Further considerations are that littoral broadscale mapping requires good colour vertical aerial photographs at a scale of 1:10,000 or less and these are not always available - commissioning aerial photography of large stretches of the coast is expensive.

A primary aim of the Habitats Directive is to create a network of protected sites of international significance. The report on Marine Protected Areas by AidEnvironments has shown that sites currently protected do not achieve this in the coastal zone. It has already been suggested that if fish stock conservation objectives under the EU Common Fisheries Policy could be more directly integrated with Nature Conservation Policy, this would help to safeguard ecologically important coastal zone areas. But, in addition, the BioMar report demonstrates that marine resource conservation could be strengthened if national legislation in the majority of EU Member States made specific provision for the designation of marine protected areas. The site-specific data collected in Britain and Ireland, together with the Marine Biotope Classification System and the candidate SACs selected through use of these tools, represent a potentially major contribution to ensuring the Habitats Directive fulfulls its goal, but can only be translated to actual benefit if national legislation makes it possible to take the product of the project and both designate and manage sites accordingly.

The survey of maritime communities in Ireland, as part of a wider survey in Ireland, has made it possible for more than 60 sites to be selected as candidate SACs and go forward for public consultation. The total number of potential Irish SACs with maritime and/or marine communities identified by the project is approximately 150 The surveys of lagoons and machairs carried out revealed that Ireland has a variety of lagoon types, among which artificially created lagoons are as important as those which have resulted from the formation of natural barriers. This survey also identified a number of differences between Scottish and Irish lagoons, possibly caused by regional factors. However, more data would be needed to clarify this situation. Ecotonal Coleoptera were found to provide useful indicator species. Ireland has special responsibility for the conservation of machair biotopes and the machair survey has led to a comprehensive data set on the vegetation types of 27 sites. As in the case of the data on the marine sites, it is intended that this information will be used to provide the baseline from which to monitor their condition, in conformity with Habitats Directive objectives. Of the 18 maritime communities for which sites have been selected as candidate SACs, the commonest sites were Fixed (grey) dunes and Marram dunes. In Ireland as elsewhere, these two biotopes are under considerable pressure from recreational developments and other forms of land use, highlighting the need for Coastal Zone Management.

During the course of the project, advances made in computer and electronic technology have provided novel mechanisms for disseminating information and BioMar has been able explore some of these. For instance, the World Wide Web was rapidly shown to be an easy and effective way of disseminating knowledge. It has the particular advantage that the information presented can be easily and cheaply updated. Another such mechanism is CDtechnology, which was employed by the project to produce the BioMar Biotope Viewer. The aim of the BioMar Biotope Viewer was to demonstrate that large amounts of data could be made available in a user friendly way, with illustrations, a variety of search options and a mapping routine. The data incorporated was the Irish site data collected by the BioMar team, together with an electronic version of the Marine Biotope Classification system. It is salutory to note that the associated electronic technology has developed at such a rate that various limitations to the programmes used in the viewer could be rectified using software now available - a built-in disadvantage to the CD approach to data dissemination, since a CD, once produced, cannot itself be updated. Nonetheless, the viewer has clearly demonstrated the potential advantage of CD publications as a way of making available very large quantities of marine data for both educational and conservation management purposes.

Experiences gained in production of the BioMar viewer have resulted in an intiative to to further develop the idea using the British data.

Recommendations

The results of the BioMar project highlight the need for further attention to be given to certain marine conservation issues. These are presented as a series of recommendations:

1. that the EU actively support efforts to compile an inventory of biotpes in European waters by:
   a)encouraging initiatives to extend survey work on marine biotopes to parts of Europe's coastline for which data are currently incomplete (including sections of the British and Irish coasts for which there are little data at present),

   b) supporting research to incorporate existing marine biotope classficiation systems relating to European waters (e.g. the Helcom and Baltic Classifications), including that developed during course of the BioMar project, into a pan-European system,

2. that the EU encourage initiatives to define common boundaries for SACs and other protected areas, where they co-exist on the same sites,

3. that the EU encourage Member States to introduce National legislation providing specifically for the protection of marine areas to augment more general legislation,

4. that the EU encourage further study on application of the rapidly developing technologies of remote sensing in the marine environment to biotope mapping and ground truthing activities there,

5. that the EU consider adoption of the protocol developed by MNCR for survey methods and data handling in marine biotopes and marine biotope description, as a basis for standardising these activities in respect of marine SACs,

6. that the EU encourage development of simple but effective sampling techniques for small marine species (i.e. < 1 cm), such that their potential in characterising biotopes may be established..

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Glossary

1. Glossary of terminology
2. Glossary of acronyms

1. Glossary of terminology

Term	Definition	Alternative terms
Biota	All living organisms, including fauna and flora	
Biotope	The physical habitat together with the community of organism that it supports	
Eulittoral	Between the supralittoral and sublittoral fringe	Mediolittoral, hydrolittoral
Circalittoral	Rock dominated by animals, algae rare or absent, seasonally stratified, limited effect of wave action	Inshore
Infralittoral	Rock dominated by algae, water column temperature and salinity variable,	Nearshore
Inshore	Generally within 5 Km of coast and < 50 m depth,	Coastal seas
Littoral	Between upper and lower tidemarks, exposed to air at the lowest tides	Intertidal
Offshore	Stable water column characteristics (stenothermal, stenohaline,), permanently stratified, beyond zone of freshwater influence,	
Rock	With epibiota and infauna absent or rare	Hard substrata
Sediment	With infauna, and usually epibiota	Soft substrata
Supralittoral	Uppermost part of shore affected by wave splash but not regularly submerged by the sea	Strandline, splash zone, epilittoral, littoral fringe
Sublittoral	Below the littoral, never exposed to air	Subtidal
Sublittoral fringe	Transition zone where littoral and sublittoral species occur	
Zones	Areas of vertical height above, and depth below, sea level which have characteristic fauna and flora	étage (French)

2. Glossary of Acronyms

AGDs	Acoustic Ground Discrimination systems
ASIs	Area of Scientific Interest
CCW	Countryside Council for Wales
CD	Compact Disc
CORINE	Co-ORdination of Information on the Environment classification
CZM	Coastal Zone Management
E1	Roughness
E2	Hardness
EC	European Commisssion
EC DG XI	European Commisssion Directorate XI for Nature Conservation ?
EEA	European Environment Agency
EN	English Nature
ETCNC	European topic Centre for Nature Conservation
EU	European Union
EUNIS	European Nature Information System
GIS	Geographic Information System
GPS	Gobal Position System
HELCOM	Helsinki commission
ICES	International Council for the Exploration of the Sea
ITE	Institute of Terrestrial Ecology
JNCC	Joint Nature Conservation Committee of the United Kingdom
MCB	Metropolitan Borough Council of North Tynesides, United Kingdom
MNCR	Marine Nataure Conservation Review of the JNCC
NHAs	Natural Heritage Areas
NPWS	National Parks and Wildlife Service, Ireland
NVC	National Vegetation Classification of the United Kingdom
OSPAR	Oslo and Paris Conventions on Marine Pollution
SACs	Special Areas of Conservation
SNH	Scottish Natural Heritage
TCD	Trinity College, Dublin, Ireland
UCG	University College Galway, Ireland
UN	Univeristy of Newcastle
UK	United Kingdom
WWW	World Wide Web
ZNIEFF-MER	Zones naturelles d'Intérêt Ecologique, Faunistique et Floristqie -Mer, France

Appendix 1.

Time schedule for Administration
Time schedule for Marine Nature Conservation Review
Time schedule for Trinity College Dublin
Time schedule for Newcastle University
Time schedule for National Parks and Wildlife Service

Note: No time schedule is given for AidEnvironment as their task was completed in April, 1994.

TIME SCHEDULE Administration
The timetable for meetings of the project steering committee (representatives of each partner), technical meetings (all partners and other technical participants), and meetings between project managers, EcoTec and the Commission, are outlined below.

	1992	1993	1994	1995	1996	1997
Jan.			Technical			
Feb.		Steering		Steering Technical	Steering Technical	
Mar.				Interim report	Meeting with DGXI	
Apr.		Technical				Steering
May						
June						Draft Final Technical report
July	Steering		EcoTec			
Aug.						
Sept.		Steering Technical	Steering Technical			Final Technical report
Oct.				Steering Technical	Steering Technical	Final Financial Report
Nov.	Steering Technical		Agreeded new Annex I			
Dec.			meet Commission		End of work	

Appendix 1

TIME SCHEDULE - Marine Nature Conservation Review

	1992	1993	1994	1995	1996	1997
Jan.		Database link	Develop littoral classification	Survey reports Data analysis for classification	Data analysis for classification	Prepare drafts for workshop
Feb.		Review existing classification systems	Develop littoral classification	Survey reports Data analysis for classification	Data analysis for classification	Final classification workshop
Mar.		Develop structure of classification	Develop littoral classification	Survey reports Data analysis for classification	DGXI meeting Continue classification work	Revise classification
Apr.		Draft list of habitats	Issue 1st working draft	Continue development of sublittoral classification	Classification workshop	Revise classification
May		CORINE Monkswood Workshop	Survey work	Survey work	Survey work. EEA and ETC-NC meeting	Prepare classification for publication
June	Data collection	Survey Work	Survey work	Survey work	Survey work. Issue revised (4th) draft	Publish classification Final report
July		Survey work	Survey work	Survey work	Survey work.	
Aug.		Survey work	Survey work. Revise littoral classification	Issue revised (3rd) draft of littoral classification	Survey work.	
Sept.		EMBS, Crete, Forum	Develop sublittoral classification	ECSA25, Dublin Workshop	Draft sublittoral report	
Oct.		Data entry and analysis	Issue revised (2nd) draft		Workshop on classification	
Nov.		Data entry and analysis	Data entry and analysis. Workshop Cambridge	Review and continue	Continue work on classification	
Dec.		ZNIEFF, Paris, Meeting	Data entry and analysis	Data analysis for classification	CORINE agreement meeting	

Appendix 3

TIME SCHEDULE - Trinity College, Dublin

	1992	1993	1994	1995	1996	1997
Jan.			Draft version of Biotope Viewer Report writing	Data entry and analysis Report writing.	Data analysis Complete GIS habitat prediction	Biotope identification Scan Photos for Biotope Viewer
Feb.		TCD supplied with MNCR database	Data analysis Prepare for field work	Data analysis Prepare for field work	Data analysis Report writing	Biotope identification Classification Workshop Scan photos for Biotope Viewer
Mar.		Literature Review (this continued until 1997)	TCD + NPWS meeting	Report writing	Prepare for field work	Biotope identification Publication of Bibliography
Apr.		Assemble equipment	Survey Work	Survey work	Survey work	Select areas of nature conservation interest Scan photos for Biotope Viewer Write data a export routine for biotopes
May		Assemble equipment Prepare for field work	Survey Work	Survey Work	Survey work	Select areas of nature conservation interest
June		Survey Work	Survey Work	Survey Work Start GIS habitat prediction	3rd draft of BioMar Biotope Viewer Survey work	Final report Publication of BioMar Biotope Viewer
July		Survey Work	Survey Work	Survey Work	Survey work	
Aug.		Survey Work	Survey Work	Survey Work	Survey Work	
Sept.	Establish field team	Survey Work	Data entry Complete GIS/wave exposure model	Survey Work	ECSA25 Workshop. Survey Work	
Oct.		Start development of GIS/wave exposure model	Data entry Data analysis	Survey Work Write export routine for data from database to Biotope Viewer	Data entry and analysis BioMarLit Bibliography publication	
Nov.			Database update Catalogue specimens	Data analysis Report writing Catalogue specimens	Data entry and analysis Catalogue specimens and photographs	
Dec.			Data analysis Report writing Catalogue specimens Catalogue photographs	Data analysis Report writing Catalogue specimens and photographs	Database update Data entry and analysis. Scan photos for Biotope Viewer	

Appendix 1.

TIME SCHEDULE - University of Newcastle

	1992	1993	1994	1995	1996	1997
Jan.		Assemble & prepare equipment	Review of suitable PC based GISs	Image analysis processing Report writing	Analysis of survey data & use of GIS/image processing	Write survey reports
Feb.		Assemble & prepare equipment	Write survey reports	Submit survey reports	Write & submit survey reports	Submit survey reports
Mar.		Guidelines for use of video and volunteer divers	Write reports. Start inter-agency training.	Test dual frequency acoustic sampler	Interim report on broadscale life form mapping	Final methodology reports for broadscale subtidal and littoral mapping
Apr.			Inter-agency training workshop		Field surveys	Final methodology reports for broadscale subtidal and littoral mapping
May		Subtidal surveys	Subtidal surveys	Field surveys	Field surveys	
June		Subtidal surveys	Subtidal surveys	Field surveys	Field surveys	Final report
July		Subtidal surveys	Subtidal surveys	Field surveys	Field surveys	
Aug.		Subtidal surveys	Littoral surveys	Field surveys	Field surveys	
Sept.		Subtidal surveys	Littoral surveys	Field surveys	Field surveys	
Oct.	Review available technology		Develop image analysis for littoral and acoustic data analysis	Analysis of survey data	Analysis of survey data	
Nov.		Analysis of acoustic data		Interim report on mapping methods	Analysis of survey data	
Dec.					Analysis of survey data	

Appendix 1

TIME SCHEDULE -National Parks and Wildlife Service

	1992	1993	1994	1995	1996	1997
Jan.		Start Ranger survey	7 more field Ecologists employed Field surveys			Machair & estuary surveys draft final reports
Feb.		Analytical plotter purchased	Field surveys			Maricullture report.
Mar.		12 field surveyors + 1 Ecologist employed	Field surveys			
Apr.		Start Ecologists survey	Field surveys	Start selection of SAC		
May		Field surveys	Field survey terminated		Lagoon , machair and coastal rare plant field surveys, start	
June	2 scientists employed	Field surveys	End Field contractors employment		Mudflat field surveys start	Final machair and estuary reports Final technical report
July		Field surveys			Start of mariculture literature survey	
Aug.		2 more Ecologists employed Field surveys	End all Ecologist and other contracts		Start desk top study of offshore sandbanks/ gravel banks. Prepare report from machair and rare plant surveys	
Sept.	Ranger training courses held	Field surveys	Permanent staff review site data	Employ marine biologist and data analyst	Completion of rare plant survey and sandbank survey	
Oct.	2 Ecologists employed	Field surveys	Start public notification of sites		Completion of lagoon , machair and mudflat field surveys	
Nov.	Preparation for field survey					
Dec.						

TRINITY COLLEGE, DUBLIN

BIOMAR
SITE RECORD

LITTORAL/SUBLITTORAL

Field site number		Site name	
Number of habitats		Survey area	
		County/Region	
Survey number			
Report site number			

Grid reference or Latitude/Longitude Site centre (required)

For extensive sites (optional) From ______ to ______

SURVEY DETAILS

		Visit 1	Visit 2
Surveyors	1		
	2		
	3		
	4		
Date (dd/mm/yy)		/ /	/ /
Time at start		:	:
Duration of survey		:	:
Tidal corrections (m)			
Height/depth limits (state +/-)			
Sea level (m)	Upper		
	Lower		
Chart datum (m)	Upper		
	Lower		
Underwater visibility (m)			
Survey type			
Littoral			
Sublittoral			
Recording (on shore or Scuba)			
Photography			
Cores (4 x 0.01m^2)			
Suction sample			
Granulometric sample			
Van Veen grab			
Day grab			
Biological dredge			
Anchor dredge			
Pipe dredge			

BIOMAR COASTAL SECTOR

IR1		North -Malin Head to Fair Head
IR2		North channel -Fair Head to St John's Point
IR3		East -St John's Point to Carnsore Point
IR4		South -Carnsore Point to Mizen Head
IR5		South-west -Mizen Head to Kerry Head
IR6		Greater Galway Bay -Kerry Head to Slynne Head
IR7		Clare Island area -Slynne Head to Erris Head
IR8		North-west -Erris Head to Malin Head

PHOTOGRAPHY DETAILS

Visit number	1		2	
Photographers initials				
Number taken - start				
finish				
Wide-angle lens				
Macro lens				

WEATHER DETAILS

Cloud cover - 1/8ths		
Air temperature		
Wind - direction		
- speed		
Sea state		

Comments:

Survey number [ ] Report site number [ ] √ Tick one box only √√ Tick as many as apply

√ PHYSIOGRAPHIC FEATURES

- [ ] Open coast
- [ ] Straits/Sounds/Narrows
- [ ] Shallow rapids
- [ ] Enclosed coast (inlets, harbours)
- [ ] Saline lagoons

√ SALINITY RANGE & ESTUARINE ZONES

- [ ] 30-40 $^0/_{00}$ [sea]
- [ ] 18-30 $^0/_{00}$ [lower estuary]
- [ ] 8-18 $^0/_{00}$ [middle estuary]
- [ ] 5-8 $^0/_{00}$ [inner estuary]
- [ ] 0.5-5 $^0/_{00}$ [upper estuary]
- [ ] Not known/Uncertain

√ WAVE EXPOSURE

- [ ] Extremely exposed (prevailing wind/swell onshore, deep water)
- [ ] Very exposed (prevailing wind and swell onshore)
- [ ] Exposed (prevailing wind onshore, offshore shallows/obstructions
- [ ] Moderately exposed (prevailing wind offshore but onshore wind frequent)
- [ ] Sheltered (restricted (<20 km) fetch; offshore shallows/obstructions
- [ ] Very sheltered (fetch <20 km in any direction and <3 km to prevailing wind)
- [ ] Extremely sheltered (fully enclosed , fetch <3 km)
- [ ] Ultra sheltered (fetch of few 10s or at most 100s m)

√ MAX. SURFACE TIDAL STREAM STRENGTH

- [ ] Very strong (>6 kn)
- [ ] Strong (3-6 kn)
- [ ] Moderately strong (1-3 kn)
- [ ] Weak (<1 kn)
- [ ] Very weak (negligable.)
- [ ] Uncertain

√√ GEOLOGY

- [ ] Hard
    - [ ] Igneous
    - [ ] Chert/Flint
    - [ ] Slate
    - [ ] Sand/Mudstone
- [ ] Moderately hard
    - [ ] Limestone
- [ ] Friable
    - [ ] Slate/Shale
- [ ] Soft
    - [ ] Sand/Mudstone
    - [ ] Chalk
- [ ] Very soft
    - [ ] Clay
    - [ ] Peat
- [ ] Not known
- [ ] ....

√ STRATIFICATION

- [ ] Thermocline
- [ ] Halocline
- [ ] Not stratified
- [ ] Not known

√√ SHORE BACKING

- [ ] Low cliff (<10 m)
- [ ] Moderate cliff (10-50 m)
- [ ] High cliff (50-100 m)
- [ ] Very high cliff (>100 m)
- [ ] Woodland
- [ ] Grassland
- [ ] Shingle/cobble/boulder ridge
- [ ] Sand dunes
- [ ] Saltmarsh
- [ ] Lagoon
- [ ] Machair
- [ ] Coast protection
- [ ] Urban
- [ ] ....

√ LITTORAL WIDTH (littoral sites only)

HWST-LWST

- [ ] <1 m
- [ ] 1-10 m
- [ ] 10-100 m
- [ ] 100-1000 m
- [ ] >1000 m

√ LITTORAL ASPECT

- [ ] North
- [ ] North-east
- [ ] East
- [ ] South-east
- [ ] South
- [ ] South-west
- [ ] West
- [ ] North-west

√√ OFFSHORE FEATURES (open coast)

- [ ] Islands/islets/rocks
- [ ] Reefs
- [ ] Breakwater
- [ ] Shoal/sandbank

√√ SITE DESIGNATIONS (in or nearby)

- [ ] National Nature reserve
- [ ] Refuge for Fauna
- [ ] Wildfowl Sanctuary
- [ ] Area of Scientific Interest
- [ ] Special Protection Area
- [ ] Biogenetic reserve
- [ ] Biosphere reserve
- [ ] RAMSAR site
- [ ] World Heritage Site
- [ ] Local Nature reserve
- [ ] Private reserve
- [ ] National Trust area
- [ ] IWC reserve
- [ ] National Park
- [ ] Management Agreement Area
- [ ] Environmentally Sensitive Area
- [ ] proposed Marine Nature reserve
- [ ] National Heritage Area
- [ ] proposed Special Area of Conservation
- [ ] ....
- [ ] ....
- [ ] ....

√√ CONSERVATION ASSESSMENT

- [ ] Unspoilt/natural
- [ ] Representative (for area)
- [ ] Unusual/rare habitats
- [ ] Rare species
- [ ] Species near limit of distribution
- [ ] High species richness
- [ ] High habitat diversity
- [ ] Fragile species present
- [ ] Fragile habitats present
- [ ] Previous study area
- [ ] Research/educational use
- [ ] Intrinsic appeal
- [ ] Vulnerable (susceptible)

- [ ] Ornithological interest
- [ ] Seal haul out

√√ KNOWN USAGE AND IMPACTS

- [ ] Fishing- netting
    - [ ] trawling
    - [ ] angling
    - [ ] potting
- [ ] Collection- bait digging
    - [ ] shellfish
    - [ ] algae
- [ ] Boulder turning for peelers
- [ ] Extraction- sand/gravel
    - [ ] maerl
    - [ ] oil/gas
- [ ] Aquaculture- finfish
    - [ ] shellfish
    - [ ] algae
- [ ] Coastal defence- seawalls
    - [ ] dredging
    - [ ] groynes
- [ ] Land claim
- [ ] Military use
- [ ] Sewage discharge
- [ ] Waste dumping
- [ ] Industrial waste discharge
- [ ] Litter and debris
- [ ] Oil/tar/chemicals
- [ ] Educational/scientific study
- [ ] Recreational- facilities
    - [ ] resort
    - [ ] marina
    - [ ] popular beach
    - [ ] water sports
    - [ ] dive site
    - [ ] wind surfing
- [ ] Mooring/beaching/launching
- [ ] Evidence of physical damage
- [ ] ....
- [ ] ....
- [ ] ....
- [ ] ....

√ PUBLIC ACCESS

- [ ] Easy
- [ ] Difficult
- [ ] Very difficult

SITE DESCRIPTION

- include general location of site
- indicate any specific reason for site selection
- give an outline and description habitats and communities present
- highlight any unusual or important features

Location and Sketch/Profile of Site

- include a portion of map/chart to indicate location and mark site (small scale map to show general location and large scale for precise location)
- show clearly depths/heights (relative to chart datum) on sketch/profile
- show biological subzones and habitats on sketch/profile

TRINITY COLLEGE, DUBLIN

BIOMAR
HABITAT RECORD

SUBLITTORAL ROCKY SUBSTRATA

Field site no. [ ]

Site name [ ]

Survey no. [ ] **Report site no.** [ ] **Habitat no.** [ ]

Grid reference or Latitude/Longitude (widely spaced habitats only) [ ]

Sub-habitat of habitat no. [ ]

Habitat nos. of sub-habitat [ ]

SURVEYORS

[ ]
[ ]
[ ]
[ ]

DEPTH LIMITS

- Upper (Sea level)
- Lower "
- Upper (Chart datum)
- Lower "

DEPTH BAND (bcd)

- 0-5 metres
- 5-10 metres
- 10-20 metres
- 20-30 metres
- 30-50 metres
- > 50 metres

BIOLOGICAL SUBZONE

- Sublittoral fringe
- Infralittoral
  - -upper
  - -lower
- Circalittoral
  - -upper
  - -lower
- Not applicable
- Not known

% SUBSTRATUM

%	SUBSTRATUM	
	Bedrock	
	Boulders	
	-v.large	>1024 mm
	-large	512-1024 mm
	-small	256-512 mm
	Cobbles	64-256 mm
	Pebbles	16-64 mm
	Gravel	4-16 mm
	-stone	
	-shell	
	-dead maerl	
	-live maerl	
	Sand	
	-coarse	1-4 mm
	-medium	0.25-1 mm
	-fine	.063-0.25 mm
	Mud	<0.063 mm
	Shells (empty)	
	Artificial	
	-metal	
	-concrete	
	-wood	
	Trees/branches	
	Algae	
	....	
100%	Total	

1-5 FEATURES-ROCK

- Surface relief (even-rugged)
- Texture (smooth-pitted)
- Stability (stable-mobile)
- Scour (none-scoured)
- Silt (none-silted)
- Fissures
- Crevices
- Boulder/cobble/pebble shape (rounded-angular)

√√

- Gully
- Cave
- Tunnel
- Rockmill
- Boulder/cobble -on rock
- -on sediment
- Boulder holes
- Sediment on rock

√√ MODIFIERS

- Freshwater runoff
- Wave surge
- Tidal stream -accelerated
- -decelerated
- Grazing
- Shading
- Pollution

BIOLOGICAL ASSESSMENT

1-5 (for habitats)

- Spp. richness (low-high)
- Abundance (low-high)

EXTENT OF RECORD

- Multiple habs.(whole area)
- Subzone/height band
- Restricted feature

% SUB-HABITATS

- Overhangs
- Vertical faces(80-100°)
- V. steep faces(40-80°)
- Upper faces (0-40°)
- Underboulders

100% Total

SURVEY QUALITY

Flora	Fauna	
		Thorough
		Adequate
		Incomplete

MAIN COVER OR CHARACTERISING SPECIES/TAXA

Abundance	Species/Taxon

HABITAT NAME (key features of substrata, zone/depth and community)

HABITAT DESCRIPTION (clearly describe substrata; main cover species/taxa; any unusual or rare features/species)

Mark Abundance only in box (Superabundant, Abundant, Common, Frequent, Occasional, Rare, Present).
Note Specimen or Photograph to left of code.

PORIFERA :CALCAREA

C0008		Clathrina coriacea
C0025		Leucosolenia botryoides
C0035		Scypha ciliata
C0057		Leuconia johnstoni
C0058		Leuconia nivea
C0070		Grantia compressa

:DEMOSPONGIA

C0095		Oscarella lobularis
C0125		Dercitus bucklandi
C0167		Pachymatisma johnstonia
C0207		Thymosia guernei
C0213		Tethya aurantium
C0220		Suberites carnosus
C0221		Suberites ficus
C0258		Polymastia boletiformis
C0261		Polymastia mamillaris
C0302		Cliona celata
C0351		Axinella damicornis
C0354		Axinella infundibuliformis
C0359		Axinella dissimilis
C0372		Phakellia ventilabrum
C0407		Stelligera rigida
C0408		Stelligera stuposa
C0425		Raspailia hispida
C0429		Raspailia ramosa
C0445		Tethyspira spinosa
C0481		Halichondria bowerbanki
C0484		Halichondria panicea
C0492		Ciocalypta penicillus
C0507		Spongosorites sp.
C0523		Hymeniacidon perleve
C0530		Rhaphidostyla kitchingi
C0543		Mycale contarenii
C0544		Mycale lingua
C0553		Mycale rotalis
C0583		Biemna variantia
C0596		Esperiopsis fucorum
C0643		Myxilla fimbriata
C0645		Myxilla incrustans
C0647		Myxilla rosacea
C0678		Iophonopsis nigricans
C0684		Iophon hyndmani
C0708		Hymedesmia sp.
C0725		Hymedesmia paupertas
C0748		Crella rosea
C0759		Phorbas fictitius
C0770		Stylostichon plumosum
C0775		Hemimycale columella
C0805		Ophlitaspongia seriata
C0821		Microciona spinarcus
C0854		Haliclona sp.
C0856		Haliclona cinerea
C0858		Haliclona fistulosa
C0860		Haliclona oculata
C0863		Haliclona simulans
C0864		Haliclona urceolus
C0865		Haliclona viscosa
C0890		Dysidea fragilis
C0903		Aplysilla rosea
C0910		Halisarca dujardini
C0920		Porifera indet. (crusts)

CNIDARIA :SCYPHOZOA

D0083		Aurelia aurita (scyphistomae)

:HYDROZOA

D0144		Tubularia indivisa
D0145		Tubularia larynx
D0170		Sarsia eximia
D0229		Eudendrium sp.
D0238		Eudendrium ramosum
D0306		Bougainvillia ramosa
D0318		Garveia nutans
D0516		Lafoea dumosa
D0525		Halecium beanii
D0526		Halecium halecinum
D0552		Aglaophenia kirchenpaueri
D0554		Aglaophenia pluma
D0556		Aglaophenia tubulifera
D0561		Gymnangium montagui
D0566		Thecocarpus myriophyllum
D0572		Antennella secundaria
D0578		Halopteris catharina
D0585		Kirchenpaueria pinnata
D0586		Kirchenpaueria similis
D0597		Nemertesia antennina
D0599		Nemertesia ramosa
D0605		Plumularia setacea
D0615		Schizotricha frutescens
D0626		Abietinaria abietina
D0627		Abietinaria filicula
D0636		Diphasia sp.
D0642		Diphasia pinaster
D0643		Diphasia rosacea
D0653		Hydrallmania falcata
D0658		Thuiaria articulata
D0664		Sertularella sp.
D0667		Sertularella gayi
D0669		Sertularella polyzonias
D0676		Sertularia argentea
D0677		Sertularia cupressina
D0703		Clytia hemisphaerica
D0728		Obelia sp.
D0730		Obelia dichotoma
D0731		Obelia geniculata
D0732		Obelia longissima
D0743		Rhizocaulus verticillatus

:ANTHOZOA

D1017		Sarcodictyon roseum
D1024		Alcyonium digitatum
D1025		Alcyonium glomeratum
D1030		Parerythropodium coralloides
D1043		Eunicella verrucosa
D1107		Epizoanthus couchii
D1115		Parazoanthus axinellae
D1116		Parazoanthus anguicomus
D1121		Isozoanthus sulcatus
D1134		Gonactinia prolifera
D1151		Actinia equina
D1158		Anemonia viridis
D1168		Urticina felina
D1169		Urticina eques
D1179		Anthopleura ballii
D1186		Aureliania heterocera
D1203		Aiptasia mutabilis
D1225		Metridium senile
D1231		Sagartia elegans
D1237		Cereus pedunculatus
D1242		Actinothoe sphyrodeta
D1247		Sagartiogeton laceratus
D1253		Phellia gausapata
D1266		Hormathia coronata
D1292		Adamsia carciniopados
D1336		Edwardsiella carnea
D1357		Corynactis viridis
D1370		Caryophyllia smithii

PLATYHELMINTHES

F0162		Prostheceraeus vittatus

NEMERTEA

G0040		Tubulanus annulatus
G0078		Lineus longissimus

ANNELIDA :POLYCHAETA

P0001		Polychaeta indet. (tubes)
P0060		Alentia gelatinosa
P0097		Harmothoe sp.
P0133		Lepidonotus squamatus
P1274		Polydora sp.
P1375		Chaetopterus variopedatus
P1876		Sabellaria spinulosa
P2000		Terebellidae indet.
P2019		Eupolymnia nebulosa
P2157		Bispira volutacornis
P2261		Sabella pavonina
P2304		Pomatoceros triqueter
P2309		Serpula vermicularis
P2326		Filograna implexa
P2346		Protula tubularia
P2351		Salmacina dysteri
P2355		Spirorbidae indet.

CHELICERATA :PYCNOGONIDA

Q		Pycnogonida indet.

CRUSTACEA :CIRRIPEDIA

R0109		Balanus balanus
R0110		Balanus crenatus

:MYSIDACEA

S0046		Mysidae indet.

:AMPHIPODA

S0166		Amphipoda indet. (tubes)
S1070		Caprellidae indet.

:DECAPODA

S2210		Palaemon serratus
S2322		Pandalus montagui
S2360		Homarus gammarus
S2414		Palinurus elephas
S2447		Anapagurus hyndmanni
S2465		Pagurus bernhardus
S2468		Pagurus cuanensis
S2470		Pagurus prideaux
S2471		Pagurus pubescens
S2485		Galathea dispersa
S2486		Galathea intermedia
S2488		Galathea nexa
S2489		Galathea squamifera

S2490	Galathea strigosa
S2495	Munida rugosa
S2502	Pisidia longicornis
S2507	Porcellana platycheles
S2553	Maja squinado
S2559	Hyas araneus
S2560	Hyas coarctatus
S2576	Inachus dorsettensis
S2578	Inachus phalangium
S2585	Macropodia rostrata
S2646	Cancer pagurus
S2672	Liocarcinus puber
S2673	Liocarcinus pusillus
S2690	Carcinus maenas
S2735	Pilumnus hirtellus
S2745	Xantho incisus
S2746	Xantho pilipes

MOLLUSCA :POLYPLACOPHORA

W0055	Leptochiton asellus
W0078	Tonicella marmorea
W0079	Tonicella rubra
W0088	Acanthochitona crinatus

:PROSOBRANCHIA

W0111	Emarginula fissura
W0125	Tectura testudinalis
W0126	Tectura virginea
W0139	Helcion pellucidum
W0161	Margarites helicinus
W0181	Jujubinus clelandi
W0193	Gibbula cineraria
W0200	Calliostoma zizyphinum
W0244	Lacuna vincta
W0455	Bittium reticulatum
W0732	Simnia patula
W0737	Trivia arctica
W0738	Trivia monacha
W0773	Polinices catena
W0829	Ocenebra erinacea
W0844	Buccinum undatum
W0860	Neptunea antiqua
W0874	Colus gracilis
W0887	Hinia incrassata
W0889	Hinia reticulata

:OPISTHOBRANCHIA

W1062	Elysia viridis
W1102	Aplysia punctata
W1242	Tritonia hombergii
W1267	Dendronotus frondosus
W1272	Doto sp.
W1297	Goniodoris nodosa
W1319	Acanthodoris pilosa
W1342	Diaphorodoris luteocincta
W1358	Limacia clavigera
W1362	Polycera faeroensis
W1363	Polycera quadrilineata
W1382	Cadlina laevis
W1392	Rostanga rubra
W1403	Archidoris pseudoargus
W1431	Janolus cristatus
W1450	Coryphella browni
W1452	Coryphella lineata
W1460	Flabellina pedata
W1515	Eubranchus tricolor
W1526	Facelina bostoniensis

:PELECYPODA

W1650	Mytilus edulis
W1739	Limaria hians
W1796	Chlamys distorta
W1800	Chlamys varia
W1820	Pododesmus patelliformis
W2245	Gastrochaena dubia
W2251	Hiatella arctica

:CEPHALOPODA

W2522	Eledone cirrhosa

BRACHIOPODA

X0007	Neocrania anomala
X0043	Terebratulina retusa

BRYOZOA

Y0003	Crisiidae indet.
Y0027	Crisia denticulata
Y0028	Crisia eburnea
Y0137	Alcyonidium diaphanum
Y0139	Alcyonidium hirsutum
Y0237	Vesicularia spinosa
Y0307	Umbonula littoralis
Y0351	Pentapora foliacea
Y0377	Parasmittina trispinosa
Y0383	Porella compressa
Y0448	Schizomavella linearis
Y0606	Cellepora pumicosa
Y0630	Omalosecosa ramulosa
Y0658	Eucratea loricata
Y0664	Membranipora membranacea
Y0678	Electra pilosa
Y0694	Flustra foliacea
Y0710	Securiflustra securifrons
Y0811	Cellaria sp.
Y0814	Cellaria sinuosa
Y0836	Scrupocellaria sp.
Y0838	Scrupocellaria reptans
Y0841	Scrupocellaria scruposa
Y0853	Bicellariella ciliata
Y0870	Bugula avicularia
Y0872	Bugula flabellata
Y0875	Bugula plumosa
Y0879	Bugula turbinata
Y0888	Bryozoa indet. (crusts)

PHORONIDA

ZA0004	Phoronis hippocrepia

ECHINODERMATA : CRINODEA

ZB0011	Antedon bifida

:ASTEROIDEA

ZB0067	Luidia ciliaris
ZB0101	Porania pulvillus
ZB0113	Asterina gibbosa
ZB0114	Asterina phylactica
ZB0143	Solaster endeca
ZB0149	Crossaster papposus
ZB0165	Henricia oculata
ZB0184	Stichastrella rosea
ZB0190	Asterias rubens
ZB0195	Leptasterias muelleri
ZB0200	Marthasterias glacialis

:OPHIUROIDEA

ZB0235	Ophiothrix fragilis
ZB0242	Ophiocomina nigra
ZB0268	Ophiactis balli
ZB0278	Ophiopholis aculeata
ZB0312	Ophiura affinis
ZB0313	Ophiura albida

:ECHINOIDEA

ZB0355	Psammechinus miliaris
ZB0362	Echinus esculentus
ZB0369	Paracentrotus lividus

:HOLOTHUROIDEA

ZB0484	Ocnus lactea
ZB0452	Holothuria forskali
ZB0474	Pawsonia saxicola
ZB0479	Aslia lefevrei
ZB0498	Thyone roscovita

TUNICATA

ZD0006	Clavelina lepadiformis
ZD0012	Pycnoclavella aurilucens
ZD0017	Distaplia rosea
ZD0022	Archidistoma productum
ZD0023	Archidistoma aggregatum
ZD0034	Polyclinum aurantium
ZD0041	Synoicum pulmonaria
ZD0046	Morchellium argus
ZD0052	Sidnyum turbinatum
ZD0061	Aplidium nordmanni
ZD0062	Aplidium pallidum
ZD0064	Aplidium punctum
ZD0068	Didemnidae indet.
ZD0075	Trididemnum cereum
ZD0080	Didemnum sp. (yellow)
ZD0086	Didemnum maculosum
ZD0097	Diplosoma listerianum
ZD0099	Diplosoma spongiforme
ZD0109	Lissoclinum perforatum
ZD0117	Ciona intestinalis
ZD0123	Diazona violacea
ZD0135	Corella parallelogramma
ZD0141	Ascidiella aspersa
ZD0143	Ascidiella scabra
ZD0149	Ascidia conchilega
ZD0150	Ascidia mentula
ZD0153	Ascidia virginea
ZD0187	Polycarpa pomaria
ZD0188	Polycarpa rustica
ZD0194	Dendrodoa grossularia
ZD0204	Stolonica socialis
ZD0209	Botryllus schlosseri
ZD0214	Botrylloides leachi
ZD0240	Pyura microcosmus
ZD0256	Molgula manhattensis

CHONDRICHTHYES

ZF0040	Scyliorhinus canicula (Dogfish)

OSTEICHTHYES

ZG0022	Conger conger (Conger)
ZG0124	Diplecogaster bimaculata (2-spot clingfish)

ZG0136		Lophius piscatorius (Anglerfish)
ZG0196		Molva molva (Ling)
ZG0208		Pollachius pollachius (Pollack)
ZG0209		Pollachius virens (Coalfish)
ZG0218		Trisopterus luscus (Bib)
ZG0219		Trisopterus minutus (Poor cod)
ZG0351		Spinachia spinachia (15 spined stickleback)
ZG0376		Syngnathus acus (Greater pipefish)
ZG0434		Myoxocephalus scorpius (Short spined sea scorpion)
ZG0438		Taurulus bubalis (Long spined sea scorpion)
ZG0592		Centrolabrus exoletus (Rockcook)
ZG0601		Crenilabrus melops (Corkwing wrasse)
ZG0605		Ctenolabrus rupestris (Goldsinny)
ZG0609		Labrus bergylta (Ballan wrasse)
ZG0610		Labrus mixtus (Cuckoo wrasse)
ZG0636		Parablennius gattorugine (Tompot blenny)
ZG0653		Chirolophis ascanii (Yarrell's blenny)
ZG0680		Pholis gunnellus (Butterfish)
ZG0700		Callionymus lyra (Common dragonet)
ZG0702		Callionymus reticulatus (Reticulated dragonet)
ZG0723		Gobius niger (Black goby)
ZG0724		Gobius paganellus (Rock goby)
ZG0728		Gobiusculus flavescens (2 spot goby)
ZG0740		Pomatoschistus sp.
ZG0742		Pomatoschistus minutus (Sand goby)
ZG0744		Pomatoschistus pictus (Painted goby)
ZG0748		Thorogobius ephippiatus (Leopard spotted goby)
ZG0854		Phrynorhombus norvegicus (Norwegian topknot)
ZG0867		Zeugopterus punctatus (Topknot)
ZG0877		Pleuronectidae indet. (juv)

CYANOPHYCOTA

ZL0002		Beggiatoa sp.

RHODOPHYCOTA :BANGIALES

ZM0072		Porphyropsis coccinea
ZM0083		Porphyra sp.
ZM0088		Porphyra miniata

:NEMALIALES

ZM0097		Audouinella sp.
ZM0184		Scinaia forcellata.
ZM0185		Scinaia turgida
ZM0204		Asparagopsis armata(Falkenbergia)
ZM0208		Bonnemaisonia asparagoides
ZM0211		Bonnemaisonia. hamifera (Trailliella)
ZM0216		Gelidium latifolium
ZM0217		Gelidium pusillum

:PALMARIALES

ZM0242		Palmaria palmata

:CRYPTONEMIALES

ZM0256		Dilsea carnosa
ZM0266		Dumontia contorta
ZM0323		Callophyllis laciniata
ZM0328		Kallymenia reniformis
ZM0333		Meredithia microphylla
ZM0364		Peyssonnelia sp.
ZM0369		Peyssonnelia immersa

:CORALLINALES

ZM0384		Corallinaceae indet. (crusts)
ZM0404		Corallina officinalis
ZM0460		Lithothamnion corallioides
ZM0461		Lithothamnion glaciale
ZM0491		Phymatolithon calcareum

:GIGARTINALES

ZM0548		Gracilaria verrucosa
ZM0566		Ahnfeltia plicata
ZM0584		Phyllophora crispa
ZM0586		Phyllophora pseudoceranoides
ZM0588		Phyllophora traillii
ZM0589		Phyllophora truncata
ZM0594		Schottera nicaeensis
ZM0599		Stenogramme interrupta
ZM0605		Mastocarpus stellatus
ZM0611		Chondrus crispus
ZM0625		Polyides rotundus
ZM0631		Plocamium cartilagineum
ZM0643		Furcellaria lumbricalis
ZM0648		Halarachnion ligulatum
ZM0682		Calliblepharis ciliata
ZM0688		Cystoclonium purpureum
ZM0692		Rhodophyllis sp. (big)
ZM0693		Rhodophyllis divaricata

:RHODYMENIALES

ZM0719		Cordylecladia erecta
ZM0725		Rhodymenia delicatula
ZM0726		Rhodymenia holmesii
ZM0728		Rhodymenia pseudopalmata
ZM0729		Rhodymenia ardissonei
ZM0740		Chylocladia verticillata
ZM0751		Lomentaria articulata
ZM0752		Lomentaria clavellosa
ZM0753		Lomentaria orcadensis

:CERAMIALES

ZM0765		Antithamnion sp.
ZM0784		Callithamnion sp.
ZM0801		Callithamnion tetragonum
ZM0807		Ceramium sp.
ZM0818		Ceramium diaphanum
ZM0823		Ceramium rubrum
ZM0824		Ceramium shuttleworthianum
ZM0825		Ceramium strictum
ZM0834		Compsothamnion thuyoides
ZM0844		Griffithsia corallinoides
ZM0846		Griffithsia flosculosa
ZM0883		Plumaria elegans
ZM0888		Pterothamnion plumula
ZM0893		Ptilota plumosa
ZM0935		Acrosorium uncinatum
ZM0940		Apoglossum ruscifolium
ZM0950		Cryptopleura ramosa
ZM0955		Delesseria sanguinea
ZM0960		Drachiella spectabilis
ZM0985		Hypoglossum hypoglossoides
ZM0990		Membranoptera alata
ZM0995		Myriogramme bonnemaisonii
ZM1002		Nitophyllum punctatum
ZM1012		Phycodrys rubens
ZM1018		Polyneura laciniata
ZM1039		Heterosiphonia plumosa
ZM1050		Brongniartella byssoides
ZM1097		Odonthalia dentata
ZM1101		Polysiphonia sp.
ZM1105		Polysiphonia elongata
ZM1117		Polysiphonia nigrescens
ZM1130		Polysiphonia urceolata
ZM1137		Pterosiphonia parasitica
ZM1145		Rhodomela confervoides
ZM1146		Rhodomela lycopodioides
ZM1154		Rhodophyc. indet.(non-calc. crsts)

CHRYSOPHYCOTA

ZQ0001		Diatoms - colonial
ZQ0002		Diatoms - film

CHROMOPHYCOTA :PHAEOPHYCEAE

ZR0003		Ectocarpaceae indet.
ZR0158		Pseudolithoderma extensum
ZR0309		Spermatochnus paradoxus
ZR0331		Chordaria flagelliformis
ZR0342		Eudesme virescens
ZR0354		Mesogloia vermiculata
ZR0389		Cutleria multifida
ZR0390		Cutleria multifida (Aglaozonia)
ZR0412		Sphacelaria sp.
ZR0432		Halopteris filicina
ZR0439		Cladostephus spongiosus
ZR0451		Dictyopteris membranacea
ZR0457		Dictyota dichotoma
ZR0485		Carpomitra costata
ZR0490		Sporochnus pedunculatus
ZR0497		Desmarestia aculeata
ZR0499		Desmarestia ligulata
ZR0500		Desmarestia viridis
ZR0549		Asperococcus compressus
ZR0550		Asperococcus fistulosus
ZR0552		Asperococcus turneri
ZR0596		Dictyosiphon sp.
ZR0625		Chorda filum
ZR0631		Laminaria sp. (sporelings)
ZR0632		Laminaria digitata
ZR0633		Laminaria hyperborea
ZR0636		Laminaria saccharina
ZR0646		Saccorhiza polyschides
ZR0652		Alaria esculenta
ZR0705		Cystoseira sp.
ZR0716		Halidrys siliquosa
ZR0719		Chromophycota indet.(crusts)

CHLOROPHYCEAE

ZS0211		Enteromorpha sp.
ZS0240		Ulva sp.
ZS0331		Chaetomorpha linum
ZS0333		Chaetomorpha melagonium
ZS0338		Cladophora sp.
ZS0389		Bryopsis hypnoides
ZS0392		Bryopsis plumosa
ZS0396		Derbesia sp.
ZS0399		Derbesia sp. (Halicystis)
ZS0414		Codium sp.

TRINITY COLLEGE, DUBLIN — **BIOMAR** — **SUBLITTORAL SEDIMENTS**

HABITAT RECORD

Field site no. ____

Site name ____

Survey no. ____ **Report site no.** ____ **Habitat no.** ____

Grid reference or Latitude/Longitude (widely spaced habitats only) ____

Sub-habitat of habitat no. ____

Habitat nos. of sub-habitat ____

SURVEYORS

DEPTH LIMITS
- Upper (Sea level)
- Lower "
- Upper (Chart datum)
- Lower "

DEPTH BAND (bcd)
- 0-5 metres
- 5-10 metres
- 10-20 metres
- 20-30 metres
- 30-50 metres
- > 50 metres

BIOLOGICAL SUBZONE
- Sublittoral fringe
- Infralittoral
  - -upper
  - -lower
- Circalittoral
  - -upper
  - -lower
- Not applicable
- Not known

% SUBSTRATUM
- Bedrock
- Boulders
  - -v.large >1024 mm
  - -large 512-1024 mm
  - -small 256-512 mm
- Cobbles 64-256 mm
- Pebbles 16-64 mm
- Gravel 4-16 mm
  - -stone
  - -shell
  - -dead maerl
  - -live maerl
- Sand
  - -coarse 1-4 mm
  - -medium 0.25-1 mm
  - -fine .063-0.25 mm
- Mud <0.063 mm
- Shells (empty)
- Artificial
  - -metal
  - -concrete
  - -wood
- Trees/branches
- Algae
- ....

100% Total

1-5 FEATURES-SEDIMENT
- Surface relief (even-uneven)
- Firmness (firm-soft)
- Stability (stable-mobile)
- Sorting (well-poor)

√√
- Mounds/casts
- Burrows/holes
- Tubes
- Algal mat
- Wave/dunes (>10 cm high)
- Ripples (<10 cm high)

Vertical layering
- -black layer
- -subsurface coarse layer
- -subsurface clay/mud
- Surface silt /flocculent

√√ MODIFIERS
- Freshwater runoff
- Wave surge
- Tidal stream -accelerated
- -decelerated
- Grazing
- Shading
- Pollution

BIOLOGICAL ASSESSMENT
1-5 (for habitats)
- Spp. richness (low-high)
- Abundance (low-high)

EXTENT OF RECORD
- Multiple habs.(whole area)
- Subzone/height band
- Restricted feature

% SUB-HABITATS
- Overhangs
- Vertical faces(80-100°)
- V. steep faces(40-80°)
- Upper faces (0-40°)
- Underboulders

100% Total

SURVEY QUALITY

Flora	Fauna	
		Thorough
		Adequate
		Incomplete

MAIN COVER OR CHARACTERISING SPECIES/TAXA

Abundance	Species/Taxon

HABITAT NAME (key features of substrata, zone/depth and community)

HABITAT DESCRIPTION (clearly describe substrata; main cover species/taxa; any unusual or rare features/species)

MNCR CLASSIFICATION TYPES	INFAUNAL SAMPLE NUMBER	GRANULOMETRY SAMPLE NUMBER

Mark Abundance only in box (Superabundant, Abundant, Common, Frequent, Occasional, Rare, Present).
Note Specimen or Photograph to left of code.

PORIFERA		**:DEMOSPONGIA**
C0220		Suberites carnosus
C0221		Suberites ficus
CNIDARIA		**:HYDROZOA**
D0121		Corymorpha nutans
D0335		Hydractinia echinata
D0566		Thecocarpus myriophyllum
		ANTHOZOA
D1056		Virgularia mirabilis
D1075		Cerianthus lloydii
D1080		Pachycerianthus multiplicatus
D1107		Epizoanthus couchii
D1168		Urticina felina
D1169		Urticina eques
D1179		Anthopleura ballii
D1186		Aureliania heterocera
D1225		Metridium senile
D1232		Sagartia troglodytes
D1237		Cereus pedunculatus
D1247		Sagartiogeton laceratus
D1248		Sagartiogeton undatus
D1292		Adamsia carciniopados
D1314		Mesacmaea mitchellii
D1319		Peachia cylindrica
D1325		Halcampa chrysanthellum
D1341		Edwardsia claparedei
D1350		Scolanthus callimorphus
NEMERTEA		
G0040		Tubulanus annulatus
G0078		Lineus longissimus
ECHIURA		**:SIPUNCULA**
O0015		Amalosoma eddystonense
O0026		Maxmuelleria lankesteri
ANNELIDA		**:POLYCHAETA**
P0001		Polychaeta indet. (tubes)
P0027		Aphrodita aculeata
P0568		Ophiodromus flexuosus
P1274		Polydora sp.
P1375		Chaetopterus variopedatus
P1576		Arenicola marina
P1876		Sabellaria spinulosa
P2000		Terebellidae indet.
P2031		Lanice conchilega
P2221		Megalomma vesiculosum
P2227		Myxicola infundibulum
P2261		Sabella pavonina
CHELICERATA		**:PYCNOGONIDA**
Q		
CRUSTACEA		**:MYSIDACEA**
S0046		Mysidae indet.
		:AMPHIPODA
S0166		Amphipoda indet. (tubes)
S1070		Caprellidae indet.
		:DECAPODA
S2210		Palaemon serratus
S2322		Pandalus montagui

S2331		Crangon crangon
S2360		Homarus gammarus
S2365		Nephrops norvegicus
S2378		Calocaris macandreae (burrows)
S2390		Callianassa subterranea (burrows)
S2414		Palinurus elephas
S2447		Anapagurus hyndmanni
S2465		Pagurus bernhardus
S2468		Pagurus cuanensis
S2470		Pagurus prideaux
S2471		Pagurus pubescens
S2485		Galathea dispersa
S2486		Galathea intermedia
S2488		Galathea nexa
S2489		Galathea squamifera
S2490		Galathea strigosa
S2495		Munida rugosa
S2502		Pisidia longicornis
S2507		Porcellana platycheles
S2543		Ebalia tuberosa
S2553		Maja squinado
S2559		Hyas araneus
S2560		Hyas coarctatus
S2576		Inachus dorsettensis
S2577		Inachus leptochirus
S2578		Inachus phalangium
S2585		Macropodia rostrata
S2620		Corystes cassivelaunus
S2626		Atelecyclus rotundatus
S2646		Cancer pagurus
S2669		Liocarcinus depurator
S2672		Liocarcinus puber
S2673		Liocarcinus pusillus
S2690		Carcinus maenas
S2714		Goneplax rhomboides
S2735		Pilumnus hirtellus
S2745		Xantho incisus
S2746		Xantho pilipes
MOLLUSCA		**:POLYPLACOPHORA**
		:GASTROPODA
W0189		Gibbula magus
W0191		Gibbula tumida
W0442		Turritella communis
W0700		Aporrhais pespelecani
W0844		Buccinum undatum
W0860		Neptunea antiqua
W0874		Colus gracilis
W0889		Hinia reticulata
		:OPISTHOBRANCHIA
W0979		Philine aperta
W1062		Elysia viridis
W1102		Aplysia punctata
W1109		Pleurobranchus membranaceus
		:PELECYPODA
W1717		Glycymeris glycymeris
W1739		Limaria hians
W1805		Aequipecten opercularis
W1809		Pecten maximus
W1945		Astarte sulcata

W1991		Cerastoderma edule
W2011		Lutraria lutraria
W2022		Ensis sp.
W2125		Arctica islandica
W2147		Venus verrucosa
W2151		Circomphalus casina
W2227		Mya truncata
W2251		Hiatella arctica
		:CEPHALOPODA
W2408		Sepiola atlantica
W2522		Eledone cirrhosa
BRYOZOA		
Y0351		Pentapora foliacea
Y0694		Flustra foliacea
PHORONIDA		
ECHINODERMATA		**: CRINODEA**
		:ASTEROIDEA
ZB0041		Astropecten irregularis
ZB0067		Luidia ciliaris
ZB0068		Luidia sarsi
ZB0101		Porania pulvillus
ZB0113		Asterina gibbosa
ZB0114		Asterina phylactica
ZB0119		Anseropoda placenta
ZB0143		Solaster endeca
ZB0149		Crossaster papposus
ZB0165		Henricia oculata
ZB0184		Stichastrella rosea
ZB0190		Asterias rubens
ZB0195		Leptasterias muelleri
ZB0200		Marthasterias glacialis
		:OPHIUROIDEA
ZB0235		Ophiothrix fragilis
ZB0242		Ophiocomina nigra
ZB0247		Ophiopsila annulosa
ZB0285		Amphiura brachiata
ZB0286		Amphiura chiajei
ZB0288		Amphiura filiformis
ZB0292		Amphiura chiajei/filiformis
ZB0300		Amphipholis squamata
ZB0312		Ophiura affinis
ZB0313		Ophiura albida
ZB0315		Ophiura ophiura
		:ECHINOIDEA
ZB0401		Spatangus purpureas
ZB0407		Echinocardium cordatum
ZB0408		Echinocardium flavescens
		:HOLOTHUROIDEA
ZB0484		Ocnus lactea
ZB0452		Holothuria forskali
ZB0464		Trachythyone elongata
ZB0495		Thyone fusus
ZB0498		Thyone roscovita
ZB0503		Neopentadactyla mixta
ZB0526		Leptosynapta inhaerens
ZB0533		Labidoplax digitata

TUNICATA

ZD0257		Molgula occulta
ZD0258		Molgula oculata

CHONDRICHTHYES

ZF0040		Scyliorhinus canicula (Dogfish)

OSTEICHTHYES

ZG0136		Lophius piscatorius (Anglerfish)
ZG0448		Agonus cataphractus (Pogge)
ZG0680		Pholis gunnellus (Butterfish)
ZG0686		Ammodytes indet. (Sandeel)
ZG0700		Callionymus lyra (Common dragonet)
ZG0702		Callionymus reticulatus (Reticulated dragonet)
ZG0737		Lesueurigobius friesii (Fries's goby)
ZG0877		Pleuronectidae indet. (juv)
ZG0891		Limanda limanda (Dab)
ZG0895		Microstomus kitt (Lemon sole)
ZG0903		Pleuronectes platessa (Plaice)

CYANOPHYCOTA

ZL0002		Beggiatoa sp.

RHODOPHYCOTA :BANGIALES

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ZQ0002		Diatoms - film

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ZR0631		Laminaria sp. (sporelings)
ZR0632		Laminaria digitata
ZR0633		Laminaria hyperborea
ZR0636		Laminaria saccharina
ZR0646		Saccorhiza polyschides
ZR0652		Alaria esculenta
ZR0705		Cystoseira sp.
ZR0716		Halidrys siliquosa
ZR0719		Chromophycota indet.(crusts)

CHLOROPHYCEAE

ZS0211		Enteromorpha sp.
ZS0240		Ulva sp.
ZS0331		Chaetomorpha linum
ZS0333		Chaetomorpha melagonium
ZS0338		Cladophora sp.
ZS0389		Bryopsis hypnoides
ZS0392		Bryopsis plumosa
ZS0396		Derbesia sp.
ZS0399		Derbesia sp. (Halicystis)
ZS0414		Codium sp.

ANGIOSPERMA

ZX0002		Zostera marina

BIOMAR
Littoral habitat record

Field site no.

Site name

Survey no. | **Report site no.** | **Habitat no.**

Grid reference or Latitude/Longitude (widely spaced habitats only)

Sub-habitat of habitat no.

Habitat nos. of sub-habitat

SURVEYORS

HEIGHT LIMITS
- + Upper (Sea level)
- + Lower "
- + Upper (Chart datum)
- + Lower "

HEIGHT BAND
- Strandline
- Upper shore
- Mid shore
- Lower shore

BIOLOGICAL SUBZONE
- Supralittoral
- Littoral fringe
  - -upper
  - -lower
- Eulittoral
  - -upper
  - -mid
  - -lower
- Sublittoral fringe

EXTENT OF RECORD
- Multiple habs.(whole area)
- Subzone/height band
- Restricted feature

SURVEY QUALITY

Flora | Fauna
- Thorough
- Adequate
- Incomplete

% **SUBSTRATUM**
- Bedrock
- Boulders
  - -v.large >1024 mm
  - -large 512-1024 mm
  - -small 256-512 mm
- Cobbles 64-256 mm
- Pebbles 16-64 mm
- Gravel 4-16 mm
  - -stone
  - -shell
  - -dead maerl
  - -live maerl
- Sand
  - -coarse 1-4 mm
  - -medium 0.25-1 mm
  - -fine .063-0.25 mm
- Mud <0.063 mm
- Shells (empty)
- Artificial
  - -metal
  - -concrete
  - -wood
- Trees/branches
- Algae
- ....

100% Total

% **SUB-HABITATS**
- Overhangs
- Vertical faces(80-100°)
- V. steep faces(40-80°)
- Upper faces (0-40°)
- Underboulders
- Fissures/crevices
- Rkpools/standing water

100% Total

1-5 **FEATURES-ROCK**
- Surface relief (even-rugged)
- Texture (smooth-pitted)
- Stability (stable-mobile)
- Scour (none-scoured)
- Silt (none-silted)
- Boulder/cobble/pebble shape (rounded-angular)

√√
- Gully
- Cave
- Rockmill
- Boulder/cobble -on rock
  - -on sediment
- Boulder holes
- Sediment on rock

√√ **MODIFIERS**
- Freshwater runoff
- Wave surge
- Tidal stream -accelerated
  - -decelerated
- Grazing
- Shading
- Pollution

1-5 **FEATURES-SEDIMENT**
- Surface relief (even-uneven)
- Firmness (firm-soft)
- Stability (stable-mobile)
- Sorting (well-poor)
- Black layer (1=not visible, 2=>20, 3=5-20, 4=1-5, 5=<1 cm)

√√
- Mounds/casts
- Burrows/holes
- Tubes
- Algal mat
- Wave/dunes (>10 cm high)
- Ripples (<10 cm high)
- Drainage channels/creeks
- Standing water
- Vertical layering
  - -subsurface coarse layer
  - -subsurface clay/mud
- Surface silt /flocculent

BIOLOGICAL ASSESSMENT

1-5 **(for habitats and area)**
- Spp. richness (low-high)
- Abundance (low-high)

MAIN COVER OR CHARACTERISING SPECIES/TAXA

Abundance	Species/Taxon

HABITAT NAME (key features of substrata, zone/depth and community)

HABITAT DESCRIPTION (clearly describe substrata; main cover species/taxa; any unusual or rare features/species)

CLASSIFICATION TYPES	INFAUNAL SAMPLE NUMBER	GRANULOMETRY SAMPLE NUMBER

Mark Abundance only in box (Superabundant, Abundant, Common, Frequent, Occasional, Rare, Present).
Note Specimen or Photograph to left of code.

PORIFERA :CALCAREA

C0008		Clathrina coriacea	
C0035		Scypha ciliata	
C0058		Leuconia nivea	
C0070		Grantia compressa	

:DEMOSPONGIAE

C0095		Oscarella lobularis	
C0245		Terpios fugax	
C0484		Halichondria panicea	
C0523		Hymeniacidon perleve	
C0596		Amphilectus fucorum	
C0645		Myxilla incrustans	
C0770		Stylostichon plumosum	
C0805		Ophlitaspongia seriata	
C0890		Dysidea fragilis	
C0903		Aplysilla rosea	
C0904		Aplysilla sulfurea	
C0910		Halisarca dujardini	
C0920		Porifera crusts indet.	

CNIDARIA :HYDROZOA

D0144		Tubularia indivisa	
D0170		Sarsia eximia	
D0358		Clava multicornis	
D0554		Aglaophenia pluma	
D0627		Abietinaria filicula	
D0648		Dynamena pumila	
D0723		Laomedea flexuosa	
D0731		Obelia geniculata	

:ANTHOZOA

D1151		Actinia equina	
D1152		Actinia fragacea	
D1158		Anemonia viridis	
D1168		Urticina felina	
D1174		Bunodactis verrucosa	
D1179		Anthopleura ballii	
D1225		Metridium senile	
D1231		Sagartia elegans	
D1232		Sagartia troglodytes	
D1237		Cereus pedunculatus	
D1370		Caryophyllia smithii	

NEMERTEA

G0078		Lineus longissimus	

SIPUNCULA

N0039		Phascolosoma granulatum	

ANNELIDA :POLYCHAETA

P0001		Polychaeta indet.	
P0060		Alentia gelatinosa	
P0097		Harmothoe sp.	
P0133		Lepidonotus squamatus	
P0277		Eulalia viridis	
P0810		Hediste diversicolor	
P0828		Neanthes virens	
P0867		Nephtys sp.	
P1274		Polydora sp.	
P1576		Arenicola marina	
P1875		Sabellaria alveolata	
P2000		Terebellidae indet.	
P2031		Lanice conchilega	
P2261		Sabella pavonina	
P2303		Pomatoceros lamarcki	
P2304		Pomatoceros triqueter	
P2355		Spirorbidae indet.	
P2366		Janua pagenstecheri	
P2402		Spirorbis corallinae	
P2404		Spirorbis inornatus	
P2405		Spirorbis rupestris	
P2406		Spirorbis spirorbis	
P2407		Spirorbis tridentatus	

CHELICERATA

Q0075		Pycnogonum littorale	
Q0083		Halacaridae indet.	

CRUSTACEA :CIRRIPEDIA

R0021		Cirripedia indet. (juv)	
R0064		Verruca stroemia	
R0072		Chthamalus montagui	
R0073		Chthamalus stellatus	
R0108		Semibalanus balanoides	
R0109		Balanus balanus	
R0110		Balanus crenatus	
R0112		Balanus improvisus	S
R0113		Balanus perforatus	S
R0120		Elminius modestus	

:AMPHIPODA

S0166		Amphipoda indet.	
S0166		Amphipoda indet. (tubes)	
S0392		Hyale nilssoni	
S0759		Gammaridae indet.	
S1017		Corophium sp.	
S1070		Caprellidae indet.	

:ISOPODA

S1451		Sphaeroma rugicauda	
S1559		Idotea sp.	
S1563		Idotea granulosa	
S1789		Ligia oceanica	

:DECAPODA

S2331		Crangon crangon	
S2465		Pagurus bernhardus	
S2489		Galathea squamifera	
S2502		Pisidia longicornis	
S2507		Porcellana platycheles	
S2560		Hyas coarctatus	
S2646		Cancer pagurus	
S2672		Liocarcinus puber	
S2690		Carcinus maenas	
S2735		Pilumnus hirtellus	
S2745		Xantho incisus	
S2745		Xantho pilipes	

:INSECTA

T0007		Insecta indet.	
T0010		Petrobius maritimus	
T0013		Lipura maritima	

MOLLUSCA :POLYPLACOPHORA

W0074		Lepidochitona cinereus	

:GASTROPODA

W0119		Diodora graeca	
W0126		Tectura virginea	
W0133		Patella ulyssiponensis	
W0134		Patella vulgata	
W0139		Helcion pellucidum	
W0161		Margarites helicinus	
W0174		Monodonta lineata	S
W0193		Gibbula cineraria	
W0195		Gibbula umbilicalis	
W0200		Calliostoma zizyphinum	
W0239		Lacuna pallidula	
W0244		Lacuna vincta	
W0250		Littorina littorea	
W0252		Littorina neritoides	
W0254		Littorina mariae	
W0255		Littorina obtusata	
W0258		Littorina neglecta	
W0259		Littorina nigrolineata	
W0260		Littorina saxatilis	
W0274		Hydrobia ulvae	
W0285		Rissoa parva	
W0400		Skeneopsis planorbis	
W0737		Trivia arctica	
W0738		Trivia monacha	
W0817		Nucella lapillus	
W0829		Ocenebra erinacea	
W0844		Buccinum undatum	
W0887		Hinia incrassata	
W0889		Hinia reticulata	

:OPISTHOBRANCHIA

W1062		Elysia viridis	
W1102		Aplysia punctata	
W1113		Berthella plumula	
W1267		Dendronotus frondosus	
W1297		Goniodoris nodosa	
W1332		Onchidoris bilamellata	
W1358		Limacia clavigera	
W1403		Archidoris pseudoargus	
W1413		Discodoris planata	
W1418		Jorunna tomentosa	
W1551		Aeolidia papillosa	
W1557		Aeolidiella sanguinea	

:PELECYPODA

W1650		Mytilus edulis	
W1815		Anomia ephippium	
W1991		Cerastoderma edule	
W2025		Ensis ensis	
W2046		Angulus tenuis	
W2067		Macoma balthica	
W2097		Scrobicularia plana	
W2185		Venerupis senegalensis	
W2229		Mya arenaria	
W2251		Hiatella arctica	

BRYOZOA

Y0003		Crisiidae indet.	
Y0137		Alcyonidium diaphanum	
Y0138		Alcyonidium gelatinosum	
Y0139		Alcyonidium hirsutum	
Y0141		Alcyonidium mytili	
Y0148		Flustrellidra hispida	

Y0249 Bowerbankia sp.
Y0253 Bowerbankia imbricata
Y0307 Umbonula littoralis
Y0448 Schizomavella linearis
Y0664 Membranipora membranacea
Y0678 Electra pilosa
Y0836 Scrupocellaria sp.
Y0838 Scrupocellaria reptans
Y0875 Bugula plumosa
Y0879 Bugula turbinata
Y0888 Bryozoa indet. (crusts)

ECHINODERMATA : ASTEROIDEA

ZB0113 Asterina gibbosa
ZB0114 Asterina phylactica
ZB0164 Henricia sp.
ZB0165 Henricia oculata S,
ZB0166 Henricia sanguinolenta N,
ZB0190 Asterias rubens

:OPHIUROIDEA

ZB0235 Ophiothrix fragilis
ZB0278 Ophiopholis aculeata
ZB0300 Amphipholis squamata

:ECHINOIDEA

ZB0355 Psammechinus miliaris
ZB0362 Echinus esculentus
ZB0369 Paracentrotus lividus
ZB0407 Echinocardium cordatum

:HOLOTHURIOIDEA

ZB0474 Pawsonia saxicola
ZB0479 Aslia lefevrei
ZB0484 Ocnus lactea
ZB0526 Leptosynapta inhaerens
ZB0533 Labidoplax digitata

TUNICATA :ASCIDIACEA

ZD0034 Polyclinum aurantinm
ZD0046 Morchellium argus
ZD0052 Sidnyum turbinatum
ZD0064 Aplidium punctum
ZD0068 Didemnidae indet.
ZD0117 Ciona intestinalis
ZD0141 Ascidiella aspersa
ZD0143 Ascidiella scabra
ZD0149 Ascidia conchilega
ZD0194 Dendrodoa grossularia
ZD0209 Botryllus schlosseri
ZD0214 Botrylloides leachi

OSTEICHTHYES

ZG0129 Lepadogaster lepadogaster
ZG0632 Lipophrys pholis
ZG0675 Zoarces viviparus
ZG0680 Pholis gunnellus
ZG0686 Ammodytes tobianus

RHODOPHYCOTA :BANGIALES

ZM0083 Porphyra sp.
ZM0087 Porphyra linearis
ZM0090 Porphyra umbilicalis

:NEMALIALES

ZM0097 Audouinella sp.
ZM0177 Nemalion helminthoides
ZM0216 Gelidium latifolium
ZM0217 Gelidium pusillum

:PALMARIALES

ZM0242 Palmaria palmata

:CRYPTONEMIALES

ZM0256 Dilsea carnosa
ZM0266 Dumontia contorta

:HILDENBRANDIALES

ZM0376 Hildenbrandia rubra

:CORALLINALES

ZM0384 Corallinaceae indet. (crusts)
ZM0404 Corallina officinalis
ZM0478 Mesophyllum lichenoides

:GIGARTINALES

ZM0548 Gracilaria verrucosa
ZM0566 Ahnfeltia plicata
ZM0584 Phyllophora crispa
ZM0588 Phyllophora traillii
ZM0605 Mastocarpus stellatus
ZM0611 Chondrus crispus
ZM0625 Polyides rotundus
ZM0631 Plocamium cartilagineum
ZM0643 Furcellaria lumbricalis
ZM0671 Catenella caespitosa
ZM0683 Calliblepharis jubata
ZM0688 Cystoclonium purpureum
ZM0706 Petrocelis sp.

:RHODYMENIALES

ZM0740 Chylocladia verticillata
ZM0751 Lomentaria articulata
ZM0752 Lomentaria clavellosa

:CERAMIALES

ZM0784 Callithamnion sp.
ZM0799 Callithamnion sepositnm
ZM0801 Callithamnion tetragonum
ZM0806 Callithamnion spp. (spongy)
ZM0807 Ceramium sp.
ZM0823 Ceramium rubrum
ZM0824 Ceramium shuttleworthianum
ZM0846 Griffithsia flosculosa
ZM0856 Halurus equisetifolius
ZM0883 Plumaria elegans
ZM0893 Ptilota plumosa
ZM0940 Apoglossum ruscifolium
ZM0950 Cryptopleura ramosa
ZM0955 Delesseria sanguinea
ZM0990 Membranoptera alata
ZM1012 Phycodrys rubens
ZM1078 Laurencia hybrida
ZM1080 Laurencia pinnatifida
ZM1097 Odonthalia dentata
ZM1101 Polysiphonia sp.
ZM1115 Polysiphonia lanosa
ZM1117 Polysiphonia nigrescens
ZM1130 Polysiphonia urceolata
ZM1145 Rhodomela confervoides
ZM1146 Rhodomela lycopodioides
ZM1154 Rhphyc.indet.(non-calc.crst)

CHRYSOPHYCOTA

ZQ0001 Diatoms - colonial
ZQ0002 Diatoms - film

CHROMOPHYCOTA

ZR0003 Ectocarpaceae indet.
ZR0119 Spongonema tomentosum
ZR0163 Ralfsia sp.

ZR0247 Elachista sp.
ZR0281 Leathesia difformis
ZR0412 Sphacelaria sp.
ZR0439 Cladostephus spongiosus
ZR0457 Dictyota dichotoma
ZR0605 Colpomenia peregrina
ZR0611 Petalonia fascia
ZR0618 Scytosiphon lomentaria
ZR0625 Chorda filum
ZR0631 Laminaria sp. (sporelings)
ZR0632 Laminaria digitata
ZR0633 Laminaria hyperborea
ZR0636 Laminaria saccharina
ZR0652 Alaria esculenta
ZR0664 Ascophyllum nodosum
ZR0668 Fucus sp. (sporelings)
ZR0669 Fucus ceranoides
ZR0671 Fucus distichus
ZR0672 Fucus evanescens
ZR0673 Fucus muscoides
ZR0674 Fucus serratus
ZR0675 Fucus spiralis
ZR0676 Fucus vesiculosus
ZR0681 Pelvetia canaliculata
ZR0687 Himanthalia elongata
ZR0694 Sargassum muticum
ZR0701 Bifurcaria bifurcata S
ZR0705 Cystoseira sp.
ZR0711 Cystoseira tamariscifolia
ZR0716 Halidrys siliquosa
ZR0719 Chromophycota indet.(crusts)

CHLOROPHYCOTA

ZS0211 Enteromorpha sp.
ZS0240 Ulva sp.
ZS0278 Monostroma sp.
ZS0289 Prasiola stipitata
ZS0327 Chaetomorpha sp.
ZS0333 Chaetomorpha melagonium
ZS0338 Cladophora sp.
ZS0351 Cladophora pellucida
ZS0356 Cladophora rupestris
ZS0392 Bryopsis plumosa
ZS0414 Codium sp.

ANGIOSPERMAE

ZX0003		Zostera angustifolia
ZX0005		Zostera nana

LICHENS

ZY0002		Anaptychia fusca
ZY0009		Caloplaca marina
ZY0010		Caloplaca thallincola
ZY0014		Lecanora atra
ZY0018		Lichina confinis
ZY0019		Lichina pygmaea
ZY0022		Ochrolechia parella
ZY0029		Ramalina sp.
ZY0036		Verrucaria maura
ZY0038		Verrucaria mucosa
ZY0042		Xanthoria parietina
ZY0043		Grey lichens indet.

TRINITY COLLEGE, DUBLIN	BIOMAR HABITAT RECORD	LITTORAL SEDIMENTS

Field site no.		Site name
Survey no.	**Report site no.**	**Grid reference or Latitude/Longitude (widely spaced habitats only)**

SURVEYORS

HEIGHT LIMITS

1	2	3	
+	+	+	Upper (Sea level)
+	+	+	Lower "
+	+	+	Upper (Chart datum)
+	+	+	Lower "

HEIGHT BAND

✓			Strandline
	✓		Mid shore
		✓	Lower shore

BIOLOGICAL SUBZONE

			Supralittoral
			Littoral fringe
			-upper
			-lower
			Eulittoral
			-upper
			-mid
			-lower
			Sublittoral fringe

EXTENT OF RECORD

			Multiple habs.(whole area)
			Subzone/height band
			Restricted feature

SURVEY QUALITY - FAUNA

			Thorough
			Adequate
			Incomplete

% - SUBSTRATUM

1	2	3	
			Bedrock
			Boulders
			v.large >1024 mm
			large 512-1024mm
			small 256-512mm
			Cobbles 64-256mm
			Pebbles 16-64mm
			Gravel 4-16 mm
			-stone
			-shell
			-dead maerl
			-live maerl
			Sand
			-coarse 1-4 mm
			-medium0.25-1 mm
			-fine .063-0.25 mm
			Mud <0.063 mm
			Shells (empty)
			Artificial
			-metal
			-concrete
			-wood
			Trees/branches
			Algae

% - SUBHABITATS

			Overhangs
			Vertical faces (80-100°)
			V. steep faces (40-80°)
			Upper faces (0-40°)
			Underboulders

SURVEY QUALITY - FLORA

			Thorough
			Adequate
			Incomplete

✓✓ - MODIFIERS

1	2	3	
			Freshwater runoff
			Wave surge
			Tidal stream -accelerated
			-decelerated
			Grazing
			Shading
			Pollution

1-5 - FEATURES-SEDIMENT

			Surface relief (even-uneven)
			Firmness (firm-soft)
			Stability (stable-mobile)
			Sorting (well-poor)
			Black layer (1=not visible, 2=>20, 3=5-20, 4=1-5, 5=<1 cm)

✓✓ - FEATURES-SEDIMENT

			Mounds/casts
			Burrows/holes
			Tubes
			Algal mat
			Wave/dunes (>10cm high)
			Ripples (<10 cm high)
			Drainage channels/creeks
			Standing water
			Vertical layering
			-subsurface coarse layer
			-subsurface clay/mud
			Surface silt /flocculent

1-5 - BIOLOGICAL ASSESSMENT (for habitats)

			Spp. richness (low-high)
			Abundance (low-high)

SAMPLES TAKEN

CORE SAMPLE			
GRAN. SAMPLE			
OTHER			

NOTES:

1 Habitat name

Habitat description

		Species/higher taxon
S0166		Amphipoda indet.
S0399		Talitridae indet.

2 Habitat name

Habitat description

		Species/higher taxon
P0001		Polychaeta indet
P1576		Arenicola marina
P2031		Lanice conchilega
S2331		Crangon crangon
S2465		Pagurus bernhardus
W1991		Cerastoderma edule
W2025		Ensis ensis
W2046		Angulus tenuis
W2067		Macoma balthica
W2097		Scrobicularia plana
W2185		Venerupis senegalensis
W2229		Mya arenaria
ZB0407		Echinocardium cordatum
ZB0526		Leptosynapta inhaerans
ZG0686		Ammodytes indet.

3 Habitat name

Habitat description

		Species/higher taxon
P0001		Polychaeta indet
P1576		Arenicola marina
P2031		Lanice conchilega
S2331		Crangon crangon
S2465		Pagurus bernhardus
W1991		Cerastoderma edule
W2025		Ensis ensis
W2046		Angulus tenuis
W2067		Macoma balthica
W2097		Scrobicularia plana
W2185		Venerupis senegalensis
W2229		Mya arenaria
ZB0407		Echinocardium cordatum
ZB0526		Leptosynapta inhaerans
ZG0686		Ammodytes indet.

Appendix 2

Survey forms used by the TCD survey teams
A discussion of sieve size for sediment sampling
Notes on data quality control
Broadscale mapping - the accuracy and limitation of biotope maps
Cost benefit analysis of broad scale mapping and diver collected data.

Appendix 2

Data quality

The results of field surveys vary because of the:

- natural variation in each species abundance and distribution in space and time, including diel (24 hour), tidal, seasonal, and between years,
- use of different survey methods, and
- varying sampling effort.

The relative abundance of species, and the composition of natural communities will always vary in time. Even if we fully understood the biology and ecology of each species the future changes could not be predicted any more accurately than local climate change. Rather than focus on detailed collection of information at a few sites, the approach in BioMar was to collect more limited information from many sites, and to interpret the findings with consideration of the sources of variation (Table A2.1). It was also recognised that factors, perhaps unknown to the surveyors, such as pollution, toxic alga blooms, and fisheries, may have altered the naturalness of the biotopes observed. Trawling, trapping of crabs and lobsters, collection of shore snails, toxic effects of anti-foulant paints such as tri-butyl tin, eutrophication, and other human activities, have all affected coastal marine ecosystems but to an little known extent.

Table A2.1. Methods to account for the variation in marine biotopes (adapted from Hiscock 1996).

- follow and review quality control procedures at all stages of the survey (see Table 4)
- sample large enough areas to account for patchy distributions of species
- limit habitat descriptions to areas > 5 m^2
- do not use species which are very mobile (e.g. birds, some fish) or ephemeral (e.g. some algae, sea slugs) in characterising biotopes
- use a suite of species to characterise a biotope in recognition that a species may not always be recorded in its biotope (exception is where a species forms the biotope, e.g. maerl, kelp, mussel bed)
- survey from May to September when most species are more abundant and conspicuous
- consider natural variation when examining abundance data, typically by not considering one point on the $\log_{10}$ scale as significantly different

Both field and sediment core data, was given an abundance rating on a $\log_{10}$ scale. This data could be analysed according to the actual abundance category, as species presence only, or as combined categories reflecting the error between surveyors, methods, and natural variation. In practice, analysts used several options on the same samples. The differences in consequent results aided understanding of individual species variation and sampling error. Such understanding was essential in interpreting the robustness of the biotope classification.

Caution would be necessary in using inconsistently recorded species (e.g. some fish, ephemeral algae) in comparing the quality of different biotopes in conservation assessment. However, if the species was of nature conservation importance (e.g. particularly rare or threatened) its occurrence may be used in assessments because one must base evaluations on what is known rather than what is not known.

Seasonal variation

Sampling focused on larger, less mobile or sessile species which would generally be present throughout the year. Sampling was also limited to the months April to October, and more usually May to September. It is known that marine species richness at a site varies seasonally (e.g. Costello and Myers 1996), with fewer species being observed in winter. This is particularly true of fish whose activity varies with temperature, and whose visibility to divers varies with their activity and water clarity (e.g. Costello *et al.* 1995). The abundance of some algae also varies seasonally such that a species is more likely to be recorded at some times of the year than others (e.g. Hiscock 1996). In consideration of such factors, species whose recording would be particularly variable were excluded from biotope classification analyses. However, their presence was recorded because with repeated sampling of the same biotope in different localities, years and months, and published information, it may become apparent that the species' were part of the biotope.

Surveyor variation

The dominant sampling method in BioMar was the direct recording of species in the field. This method has the advantage that information is immediately collected with minimal analysis of specimens in the laboratory. However, such a method is sensitive to error due to differences between surveyors and for the same surveyor over time. As in any method, quality control procedures must be utilised (Table A2.1. Inexperienced surveyors may not notice the presence of species, and thus neither record them nor collect them for identification later. Surveyors with particular taxonomic interests may pay more attention to some species and neglect to record others. Surveyors must also be skilled in the recognition of key taxonomic characters, and be able to identify species correctly from the guides. These issues were addressed in BioMar by surveyors (1) completing standard forms which listed the common species, (2) always working in pairs (also important for safety reasons) when recording, (3) collecting species they could not identify in the field for laboratory examination, and (4) having a comprehensive collection of identification guides (listed in Hiscock 1996). The accuracy of surveyors identification was cbecked by their colleagues, and voucher specimens kept for independent examination if necessary. Thus surveyors continuously improved their skills in noticing, identifying and recording species. Despite these procedures it was possible to find differences between surveys which represent tbe varying approaches and skills of staff, and such differences were accounted for in interpreting the results.

The time taken to describe a site will vary between surveyors depending on their expertise, familiarity with the recording procedure, and their attentiveness on the day. Because of this variation it is not possible to use time to standardise survey effort. However, experienced surveyors took about 5 to 30 minutes per habitat, and 40-120 minutes per site. Scuba dives avoided the need for more than 3 minute decompression stops and thus usually involved less than 40 minutes recording. Large mudflats were probably the most time consuming habitat because of the distances to be walked.

Other sampling methods were also used, most commonly hand coring of sediments, grab sampling in deep water muddy sediments, and dredging in coarse sand, gravel and cobble sediments. The use of different methods is unavoidable due to the nature of different habitats. The larger species found in or on the sediments may also be recorded in the field by surveyors. Sediment samples were sorted, sieved and all their fauna identified by microscopic examination. Thus a range of smaller species, particularly polychaete worms and amphipod crustaceans, were identified from sediments but not from rocky habitats. Such groups (but different species) can be even richer in species in rocky habitats. Grabs take a relatively intact sample of sediment, but dredges have a mesh (usually 1 cm square) and thus loose smaller species. Thus dredges contain

Table A2.2. Recommended quality control procedures in marine biotope surveys.

Before surveys	In field	In laboratory
• selection staff with relevant range of expertise	• work in pairs to cross-check observations and confirm identifications in the field	• enter data into standard format into database
• continuous training of staff through fieldwork, data analysis, and literature research	• take photographs as an aid memoir and record of biotopes present	• archive recording forms
• understand sources of error and consider this in analysis and interpretation of data	• collect taxonomically difficult specimens for identification in laboratory and use in training	• archive collected specimens in a voucher collection
	• use standard recording forms	• have specialists confirm identify of specimens
	• completion forms on site or within hours of survey	• synthesise and analyse data
	• independent cross-check that forms are completed fully	• cross-check data with recording forms, especially unusual records
		• subject data to external peer-review (e.g. through publication in peer-reviewed journals)

a range of species from in and on the seabed, and have collected them over a several hundred metre transect which may have sampled several biotopes. The variation in results due to different
survey methods was accounted for by only comparing 'like with like'. Thus biotope classification development first analysed sediment core and field recorded data separately to determine whether different biotopes would be found.

Appendix 2

Sediment sampling

The processing of sediment samples, involving sieving, sorting, faunal identification and analysis of grain size, was usually subcontracted to independent laboratories. Tbis need not have been the case but would have involved additional laboratory facilities and different taxonomic expertise than needed for field survey teams. It did increase co-ordination and administration time, incurred sample transport costs, and the additional number of people involved increased opportunities for mistakes. On balance, it is considered more efficacious to have selected members of the survey team responsible for sample processing, from the field to laboratory and data analyses.

Sediment sampling using cores has the advantage that all specimens within the core will be found and enumerated in the laboratory. In contrast, field recording may be less quantitative. Each core is limited to a size that can be driven into most sediments by hand. Species which are less abundant or very clumped in their distribution will less regularly and predictably be collected in cores. In an attempt to overcome this problem, four replicate cores and digging at the middle and lower shores were conducted. To reduce sample processing costs the four cores were combined before analysis, although this means that information on the dispersion of species is lost. As part of this project, special studies were undertaken by TCD (Hunt 1995) and the MNCR (Brazier 1996) to evaluate sediment sampling methods. Both studies found that for most sites four cores did not adequately sample the range of species present. Furthermore, because many species were represented by only one or two specimens per sample, the variation between samples in the same habitat could often be 50-100 % and the merits of scaling up such counts to numbers per metre squared was doubtful. Reflecting these issues, the MNCR now take and combine eight cores per sampling station. In addition to this spatial variation, there would be ecologically significant variation due to mass settlement of juveniles at different times of the year.

In Ireland, the same sediment biotopes were identified by independent analyses of core and dig results from 89 sandy beaches. It is now known that 4 cores is insufficient for a representative sample of beach habitats. Cores also provide less information than digs, entail additional sample processing and administrative costs, and their results are not available for at least days or weeks after sampling. Future preliminary surveys such as those conducted in this project may be better advised to conduct additional dig sampling, pass sediment through a 0.5 mm or 1.0 mm sieve in the field, and collect representative specimens non-quantitatively. Thus at least a more complete species list would be more quickly obtained, with minimal laboratory costs.

Choice of sieve mesh size

The MNCR have traditionally sieved sediment samples through a 0.5 mm square mesh. At an early stage in the project this procedure was reviewed on the basis that using a 1.0 mm mesh would reduce sample processing time and costs. The following points were made in favour of using a 1.0 mm mesh:

- the International Council for the Exploration of the Sea recommends the use of a 1.0 mm sieve for seabed sediment fauna;
- macro-benthos is defined as that fauna retained in a 1.0 mm mesh sieve (Lincoln *et al.* 1982);
- the smaller specimens collected by a 0.5 mm compared to a 1.0 mm sieve will largely be juveniles and some meio-benthos which are difficult to identify to species level so such results would often be redundant;

- it would take at least twice as much time to sieve, sort, identify and count specimens held on a 0.5 mm mesh than on a 1.0 mm;
- all species used in characterising biotopes would be retained on a 1.0 mm mesh;
- coarse sand will not pass through a 0.5 mm mesh;
- on rocky substrata only conspicuous species are identified, so it seems disproportionate to identify sediment fauna to a 0.5 mm level.

A study by the MNCR found the same biotopes were identified following either 0.5 mm and 1.0 mm sieving of samples from eight cores (Brazier 1996). However, the smaller mesh collected 13 - 53 % more species. Thus the mesh used in sieving sediments will affect species richness and correlated factors such as the likelihood of occurrence of rare species. These differences illustrate the need for caution in comparing species lists and measures of biodiversity derived from different sampling methods.

Following discussion, it was agreed that the MNCR would continue to use a 0.5 mm mesh to maximise comparability of the data they had collected over several years, and TCD would use a 1.0 mm mesh. This would allow TCD to use the saved resources to sample more sites. Comparisons of the results have not shown any differences in either sediment biotopes or species present which could be related to mesh size. While differences in the abundance of smaller species may have been influenced by mesh size, these species were not sufficiently numerous to influence the biotope classification. The choice of mesh in future studies would depend on the requirement of the study to sample smaller species and juvenile macro-benthos more quantitatively.

Granulometry

Sediment characteristics, such as its distribution of grain sizes, is a consequence of the physical environment, including wave action, currents, and storms. Sediment biotopes are generally classified in relation to the sediment grain size (Connor *et al.* 1997). However, field data varies greatly, suggesting that either sampling is insufficient, that the relationship of fauna to sediment is weak, there is analytical error, or a combination of these factors. Routinely collecting additional or replicate samples in the field would be prohibitively expensive, resulting in as much being spent on granulometric as on biological work. Indeed, at up to £20 per sample, the value of granulometry is doubtful. A simpler field method could probably be developed. This may involve determining the volume of two fractions sieved in the field (e.g. retained by 1 mm mesh, lost through 0.5 mm mesh). Further experimental studies on the accuracy and precision of different sampling methods, including sediment analysis, are required to facilitate comparison between different studies.

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Appendix 2

Broadscale mapping using remote sensing: some limitations

1. The accuracy of biotope maps produced by broadscale mapping using remote sensing techniques

Accuracy of maps is reflected in the fineness of detail that can be reliably recognised and the reliability of the positions and boundaries of biotopes. In summary, the following factors are likely to enhance the accuracy of biotope maps.

- **Biotope identification.** Biotopes should only be identified to a level where they can be recognised with confidence by remote viewing techniques and unlikely to be confused with other biotopes.
- **Understanding of local biotope/habitat relationships.** The capability of predicting biotope distribution will be enhanced if there is sufficient data to be able to make general statements on the relationship between biotopes and /or acoustic characteristics.
- **Position and number of ground truth samples.** The selection of ground truth sites, as well as the number of samples taken, will influence map accuracy. It is important the ground truth samples cover the range of ground types (as judged by acoustic parameters in the first instance) found in an area.
- **Quality of ground truth samples.** Some viewing and sampling techniques will be better than others for giving high quality information for the identification of key taxa defining biotopes. Video supplemented by other sampling procedures to collect specimens gives the best ground truthing data for broad scale mapping. Nevertheless, remote sampling will not give the detail achievable using diver-based sampling and this data should be used if available.
- **Collection of acoustic data.** Spacing of tracks is the primary factor that affects the accuracy of the acoustic coverage that can be varied by the operator. Tracks can be closer over variable ground to improve greater accuracy. The density of data collected along the track can also be varied (by altering the save rate and by changing the speed of the vessel) and this might be of importance for some analysis of the track data .
- **Position accuracy.** Global position-fixing systems (GPS) have an accuracy to about 100m. With differential global positioning (DGPS), variation due to positional error can be reduced to less than 10m.
- **Position accuracy of sampling equipment.** Positioning of remote sampling and viewing equipment is limited by the capability of the positioning system and by drifting and lay-back of the sampling equipment relative to the vessel. Positioning the sample within an apparently homogenous area will help to lessen the effects of position errors.

2. Limitations of acoustic remote sensing

It cannot be expected that each habitat, biotope or even life form will have its own, exclusive combination of acoustic properties. In many cases acoustic 'signatures' overlap considerably and a distinction cannot be made between two habitats or biotopes. The following are limitations to the ability of acoustic techniques to discriminate between different habitats or biotopes.

- **Patchy biotopes.** It may be that two or more biotopes need to be combined because they are patchily distributed at a scale below the limits of accuracy with which the ground-truthing device can be positioned within the acoustic map so that uncertainty exists as to the linkage between the acoustic data and the biotope information.
- **Distinct habitats or biotopes with overlapping acoustic characteristics.** Not all biotopes have a distinctive combination of acoustic characteristics and depth range not shared by other biotopes (exclusivity). Biotopes may have to be combined into larger categories where two or more biotopes that are indistinguishable acoustically are found in the same general locality.
- **Overlapping habitats or biotopes.** Acoustic ground discrimination systems are well suited for showing boundaries between sizeable areas of distinct biotopes, such as between rock reefs and sand plains. However, since many biotope types grade into one another in the classification system, boundaries drawn between biotopes may be somewhat artificial.

Broad scale surveys should be seen as part of a continuum ranging from desk-top surveys to detailed, specific issue surveys that form a unified strategy for marine survey. Broad scale mapping integrates with other types of survey and is useful for management in several ways. Statistics on the extents of biotopes can be used to quantify statements about the distribution and rarity of a biotope at the regional, national and international scale. Broad scale maps can be used to plan more detailed survey and sampling by ensuring a adequate and equitable coverage of biotopes. This will lead to a greater return value from detailed survey for the resources committed to it. Broad scale biotope maps are useful for developing a meaningful monitoring programme. Monitoring may require the selection of a limited number of sites for regular detailed sampling (for example, to monitor the population of specific species of interest, general species diversity, biomass and productivity). These sites should be chosen so that the data collected are not susceptible to small fluctuations in biotope boundaries or to poor positioning. In other words, biotope maps would indicate where suitable large homogenous areas are located. Monitoring might also require the repeat survey of transects. Again, biotope maps might be used to select suitable locations for transects.

Guidelines for the displaying maps of seabed biotopes.

◊ **Coastlines** should be heavy solid black lines.

◊ **Bathymetry** should be plotted with contours (thinner lines than coastline), not colours, symbols or shading (as latter needed for biotopes). The frequency of contours (i.e. 1 m, 5 m, 10 m, or more intervals) should be sufficient to indicate depth gradients.

◊ **Biotope boundaries** should be delimited by dashed lines. Dotted lines might be used for other boundaries (e.g. survey area, SAC limits). However, if biotope are coloured then boundary lines may not be necessary (Figure 5).

◊ **Biotopes labels.** Each delimited biotope area should be labelled with a letter code, drawn from the BioMar - MNCR biotopes classification (e.g. LRK = littoral rock). The level of code will vary depending on the information available and scale of the map.

◊ **Biotopes small in area.** Where the scale of a map does not allow all biotopes to be distinguished by 'polygons', but the location of such small biotopes is important to illustrate, then the occurrence of such biotopes may be indicated by symbols (use simple symbols such as squares, triangles, circles in the first instance) or lines (e.g. for intertidal biotope); such lines may be coloured and/or distinguished by a different pattern from other lines on the map. Where such biotopes are less important for management purposes, their presence within the area may be indicated within a text description of the study area and/or other biotopes.

◊ **Map key.** All documents (e.g. reports, maps) should provide a key to lines, symbols, codes, colours and other information on maps. If exceptions to these guidelines were necessary which might cause confusion to readers familiar with them (i.e. who might not bother to read the key), then these exceptions should also be noted.

◊ **The precision of biotope boundaries** should be indicated on the key or text accompanying a map. For example if RoxAnn tracks where spaced at 500 m then precision is at least plus or minus 500 m. If no spatial mapping was done but only spot samples were collected then their density (if sampled on a grid) or location (spot on map) should be indicated.

◊ **Biotope colours** Biotopes may be coloured, with similar biotopes similar shades of colour. Thus adjacent biotopes within the BioMar-MNCR biotopes classification matrices would be more similar in colour than distant biotopes. Colouring may not always be essential. Colour schemes are given in Connor *et al.*, (1997a, 1997b).

◊ **Matching colours** between reports and maps may be difficult due to printer and colour reproduction variation. However, within a report and on each map the range of colours should follow these guidelines.

◊ **The cartographer** is ultimately responsible for the clarity of the map. These guidelines are recommended to reduce variation in mapping styles within marine nature conservation management. However, circumstances may occur where their modification is necessary. In such instances the cartographer must decide how to make the map clear with minimal deviation from these guidelines.

Appendix 2

Costs, personnel and time required for survey work

The following costs are based on the assumption that a small team is established to carry out sublittoral survey and consists, therefore, of fixed and running costs. The costs are approximate and based on the requirements of the team established during the BioMar project. VAT has not been included.

1. **Broadscale mapping using remote acoustic techniques.**

Acoustic ground discrimination system Signal analyser. PC and datalogging software, DGPS, echo sounder, power supply and sundry items	£15,000	-£25,000
For analysis of data - 2 PCs, colour printer (preferably A3), GIS and other software*.	£10,000	
Remote sampling equipment Remote video, umbilical, TV and editing suite; grab and dredge	£7,000	
Total capital costs	**£32,000**	**-£42,000**
Running costs per one week (5 day) of survey		
Boat hire, transport, subsistence and sundry	£2,000	-£3,000
Specialist infaunal analysis (optional)	£2,000	

*Some software may be available at reduced cost for educational establishments.

The amount of ground covered depends upon the coastline and detail required. As a guideline, approximately 15 km of open coast could be surveyed (out to 5 km from the coast) in a week assuming a track spacing of no more than 500m. The area covered might be less if the coast is complex (with islands and inlets) or greater if a wider track spacing could be used for at least some of the survey area. The processing of the data can be time consuming, depending upon the product required. Between 2 and 5 weeks are required for processing and report writing for every week's field data collected.

Surveyors need to be marine biologists with experience in benthic survey. Specialist knowledge of infauna, if required, can be purchased from a contractors. However, skills in computing are required depending upon the level of analysis expected (exploratory - advanced). The amount of field work undertaken by a small team during the field survey season must be balanced against the time required for report write-up. The Newcastle University team undertook between 2 and 3 month's of field work per year, spending about 5 days in the office per day of fieldwork.

Costs, personnel and time required for the collection of point source data using divers.

Capital costs

Full set of diving equipment for 4 people (includes 8 cylinders) plus oxygen kit	8,000	
A semi-rigid inflatable boat, twin engines, marine VHF radio,	£18,000	- £25,000
Scuba air compressor	£4,000	
Van for carrying equipment and towing boat	£10,000	
Total capital costs	**£40,000**	**- £65,000**

Running costs

Boat fuel, travel and subsistence per week	£2,000	-3,000
Specialist infaunal analysis (optional)	£1,000.	

The number of dives per day is generally 2 per pair and may be extended to 3 dives is the area is very shallow. The team at TCD averaged about 40-45 per two week survey period.. Working depths ranged from several metres to a maximum of 50 m and the majority of sites were within 5 km of the shore. The maximum distance travelled to a dive site was about 20 km miles to a dive site but more generally 5-10 km. The distance between dive sites depended on the complexity of the area, the predicted variation in biotopes based on information obtained from charts and other available information and weather conditions.

The surveyors need to be marine biologists with good field identification skills, qualified and experienced divers. In addition some computing skills are required for data analysis and report writing.

Cost benefit analysis

It can be seen that the capital costs for remote sensing are less that than for a team of 4 divers. The area covered by divers may be wider however the number of sites for which detailed point data is collected is relatively small when compared to an area acoustically surveyed and ground truthed. Biotope maps can rarely be generated from diving surveys unless the dive sites are very close together. However it must be remembered that diver collected data is generally the most detailed and needed for full biotope descriptions and is the most reliable form of ground truthing.

Appendix 3.

List of areas surveyed as part of BioMar project

Field survey areas of Marine Nature Conservation Review
Field survey areas of Trinity College Dublin
Field survey areas of University of Newcastle

Areas surveyed by the Marine Nature Conservation Review (JNCC)

Year	Locality	Area
1992	River Deben; River Butley	SE England
	North Berwick to Burnmouth	NE England/SE Scotland
	Berwick-on-tweed to Newbiggin	NE England
	River Orwell; River Stour	SE England
	River Orwell; River Stour; Hamford Water	SE England
	Deben Estuary; Orford Ness	SE England
	River Blackwater; River Colne	SE England
1993	Tweed Estuary; Wansbeck Estuary; Coquet Estuary; Aln Estuary; Blyth Estuary; Tyne Estuary; Tees Estuary; Wear Estuary; Esk Estuary	NE England
	Shetland	NE Scotland
	Swale Estuary; Medway Estuary	SE England
	Blakeney - Brancaster, Norfolk	SE Engalnd
	Mainland Shetland, Unst, Yell (lagoons)	Shetland
	Swale Estuary; Medway Estuary	SE England
	Newbiggin to Flamborough Head	NE Engand
	Isle of Lewis, Harris and North Uist (lagoons)	Outer Hebrides, NW Scotland
1994	Loch Inver - Loch Eriboll (lagoons)	NW Scotland
	North Uist; Benbecula; Grimsay; South Uist (lagoons)	Outer Hebrides, NW Scotland
	Mainland Orkney, Sanday, Eday, Stronsay (lagoons)	Orkney, NE Scotland
	Ardnamurchan Peninsula	NW Scotland
	Lizard Point	SW England
	The Smalls and St Brides Bay	SW Wales
	East Scotland lagoons	E Scotland
1995	Inner Hebrides, south-west mainland Scotland, South Uist lagoons	W Scotland
	Thanet	SE England
	Wide Firth and Shapinsay Sound; Hoy Sound and Bring Deeps; west Mainland and Hoy	Orkney
	Cardigan Bay estuaries, Newquay, mid Cardigan Bay and the Sarns, north Lleyn, sonth LLeyn and Tremadoc Bay	W and NW Wales
	Bishops and Clerks, St Brides Bay	SW Wales
1996	South Cornwall and Devon	SW England
	Eynhallow Sound	Orkney
	Deer Sound and Wide Firth	Orkney
	West Angelsey	Wales
	Barra	Outer Hebridies

Appendix 3

Areas surveyed in Ireland by Trinity College, Dublin.

Year	Location	Region
1993	Bantry Bay	Cork
	Mulroy Bay	Donegal
	Kilkieran Bay and Aran Is.	Galway
	Youghal coast	Cork
1994	Sherkin Is. area	Cork
	S. Donegal Bay	Donegal
	Saltee Is. area	Wexford
	Courtown area coast	Wexford
	Belmullet area	Mayo
1995	Dundalk Bay	Louth
	Dublin Bay; Valentia area	Dublin and Kerry
	Clifden area	Galway
	Kenmare R.; Inishtrahull; Tory Is	Kerry and Donegal
	Bloody Foreland; Kenmare R.	Donegal and Kerry
	Achill; Clew Bay	Mayo
	Waterford	Waterford
1996	Inner Galway Bay; Clare coast	Galway and Clare
	Dingle area	Kerry
	Loop Head; S. of Shannon	Clare
	Aranmore; RathlinO'B.	Donegal
	West Cork	Cork
	Cork Hb; N. Mayo	Cork & Mayo

Additional littoral sediment surveys were carried June - Oct. 1994-1997 and littoral rock surveys June-Sept 1996.

Appendix 3.

Areas surveyed by the University of Newcastle as part of BioMar.

Date	Location	Region	Collaborator
1993	Tremadog Bay	Wales	Countryside Council for Wales
	North Northumberland	NE England	English Nature & National Trust
	Rousay Sound	Orkneys	Scottish Natural Heritage
	Mulroy Bay	NE Ireland	Trinity College Dublin
	Kilkieran Bay	W Ireland	Trinity College Dublin
1994	Donegal Bay	NE Ireland	Trinity College Dublin
	Saltees	SE Ireland	Trinity College Dublin
	Isle of Wight	S England	English Nature
	Falmouth and Lizard	England	English Nature
	Flamborourgh	England	English Nature
	North Tyneside	England	English Nature & N. Tyneside MBC
	Ardnamurchan	SE Scotland	Scottish Natural Heritage
	Berwickshire	Scotland	Scottish Natural Heritage
	Lewis (kelp project)	Scotland	Scottish Natural Heritage
	Cardigan Bay	Wales	Countryside Council for Wales
	Menai Strait	Wales	Countryside Council for Wales
	Arklow to Rosslare	SE Ireland	Trinity College, Dublin
	Skomer, Dyfed	Wales	Countryside Council for Wales
	Loch Maddy	Scotland	ENTECH Ltd
	Fal Bay, Cornwall	SW England	Countryside Council for Wales
1995	Busta Voe	Scotland	ENTECH Ltd
	Loch Roag Lewis	W Scotland	Scottish Natural Heritage
	Loch Duich	W Scotland	Scottish Natural Heritage
	Loch Moidart	W Scotland	Scottish Natural Heritage
	St. Abbs	SE Scotland	Scottish Natural Heritage
	St. Mary's Island	England	English Nature
	Isle of Thanet, Kent	England	English Nature & JNCC
	Beachy Head, Sussex,	England	English Nature & Sussex Co. Co.
	Kenmare River	SW Ireland	Trinity College Dublin
	Lleyn Peninsula	Wales	CCW & JNCC
	Sarns, Cardigan Bay	Wales	Countryside Council for Wales
	Loch Alsh	Scotland	Scottish Natural Heritage
	Loch Boisdale	Scotland	Scottish Natural Heritage
	Northumberland & Farnes	NE England	English Nature, Northumberland Co. Co. & National Trust
1996	Eastborne	S. England	English Nature & Sussex Co. Co
	Mid Northumberland	NE England	English Nature a& Nation Trust
	Farne Islands	NE England	Nation Trust
	Orkney	Scotland	Scottish Natural Heritage
	Northumberland	NE England	English Nature and Environment Agency