MarLIN
The Marine Life Information Network for Britain & Ireland

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

Impact of human activities on benthic biotopes and species

Report to Department for Environment, Food and Rural Affairs

Contract no. CDEP 84/5/244

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FINAL REPORT

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Foreword and acknowledgements

The following report outlines the results of the Defra contract CDEP 84/5/244 'Impact of human activities on benthic biotopes and species' carried out by the Marine Life Information Network for Britain and Ireland (*MarLIN*) on behalf of the Department of the Environment, Food and Rural Affairs (Defra). The contract contributed the majority of the funding for the Biology and Sensitivity Key Information Sub-programme of *MarLIN.*

The *MarLIN* programme provides quality controlled, scientifically based information to a wide and multi-disciplinary audience via the Internet. This information is provided in a form that can support scientifically sound decision-making for marine environmental management and protection. It is not possible to do justice to the volume of work undertaken in this project, its resultant functionality or applicability in a written report of this kind. The reader should refer to the *MarLIN* Web site (www.marlin.ac.uk) to appreciate the results of the contract.

This report addresses each phase of the contract development and each contract deliverable in turn. The report demonstrates how the different phases of the programme integrate to produce the resultant product.

The Biology and Sensitivity Key Information Sub-programme and the *MarLIN* Web site have involved input of time and effort from all members of the *MarLIN* team. The members of the *MarLIN* team responsible for the results of this contract were:

Dr Keith Hiscock (Programme Director); Guy Baker (Communications & Liaison Officer); Dan Lear (Data Systems Developer); Dr Harvey Tyler-Walters (Senior Data Researcher); Will Rayment, Georgina Budd, and Charlotte Marshall (Data Researchers); and Jon Parr (Network Coordinator).

The *MarLIN* team would like to thank our other data research staff and volunteers whose efforts and input have considerably benefited the programme: Kate Reeds, Olwen Ager, Marie Skewes, Susie Ballerstedt, Lisa Curtis, Penny Avant, Joelene Hughes, Catherine MacDougall, Frances Peckett, Hugh Jones, Edward Mayhew, Jenny Smirthwaite, Anna Neish, Elizabeth Barton, Rose Edwards, Michelle Carter, Jack Sewell, Marisa Sabatini, Ken Neal, Sonia Rowley, Judith Oakley, and Jessica Heard. We would also like to thank Dan McGreal for the development of the SEArchable Benthic Data (SEABED) Map and search tools, undertaken as a *MarLIN* student bursary.

The Biology and Sensitivity Key Information Sub-programme has been improved by constructive criticism and additional information from outside experts who have kindly refereed many of our Key Information reviews. *MarLIN* is grateful for the input from all our referees, who are acknowledged on the relevant Key Information review Web pages.

In addition, the Key Information reviews and the *MarLIN* Web site as a whole have been greatly enhanced by the use of photographic images, which bring both marine species and biotopes 'alive' for the user. The *MarLIN* team would like to thank all our image providers for the permission to use their images on our Web site.

The *MarLIN* team is indebted to the members of the Biology and Sensitivity Key Information Sub-programme Technical Management and the Sensitivity Mapping Advisory Groups for their contribution to the development of the sensitivity scales and criteria and the Sub-programme as a whole. Further development of the Biology and Sensitivity Key Information Sub-programme also benefited from additional contract funding from the Countryside Council for Wales (CCW), the Irish Sea Pilot, and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS). We are also grateful to the members of the *MarLIN* Steering Group and our wide-range of funders for their continued support and encouragement, without which the *MarLIN* programme would not be possible.

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

Impact of human activities on benthic biotopes and species

Report to Department for Environment, Food and Rural Affairs

Executive Summary

1. The Marine Life Information Network (*MarLIN*) has been developed since 1998. Defra funding has supported a core part of its work, the Biology and Sensitivity Key Information Sub-programme. This report relates to Biology and Sensitivity work for the period 2001-2004.
2. *MarLIN* Biology and Sensitivity research takes information on the biology of species to identify the likely effects of changing environmental conditions linked to human activities on those species. In turn, species that are key functional, key structural, dominant, or characteristic in a biotope (the habitat and its associated species) are used to identify biotope sensitivity. Results are displayed over the World Wide Web and can be accessed via a range of search tools that make the information of relevance to environmental management.
3. The first Defra contract enabled the development of criteria and methods of research, database storage methods and the research of a wide range of species. A contract from English Nature and Scottish Natural Heritage enabled biotopes relevant to marine SACs to be researched.
4. Defra funding in 2001-2004 has especially enabled recent developments to be targeted for research. Those developments included the identification of threatened and declining species by the OSPAR Biodiversity Committee, the development of a new approach to defining sensitivity (part of the Review of Marine Nature Conservation), and the opportunity to use Geographical Information Systems (GIS) more effectively to link survey data to *MarLIN* assessments of sensitivity.
5. The *MarLIN* database has been developed to provide a resource to 'pick-and-mix' information depending on the questions being asked. Using GIS, survey data that provides locations for species and biotopes has been linked to information researched by *MarLIN* to map the likely sensitivity of an area to a specified factor. Projects undertaken for the Irish Sea pilot (marine landscapes), in collaboration with CEFAS (fishing impacts) and with the Countryside Council for Wales (oil spill response) have demonstrated the application of *MarLIN* information linked to survey data in answering, through maps, questions about likely impacts of human activities on seabed ecosystems.
6. GIS applications that use *MarLIN* sensitivity information give meaningful results when linked to localized and detailed survey information (lists of species and biotopes as point source or mapped extents). However, broad landscape units require further interpretation.
7. A new mapping tool (SEABED map) has been developed to display data on species distributions and survey data according to search terms that might be used by an environmental manager.
8. *MarLIN* outputs are best viewed on the Web site where the most up-to-date information from live databases is available. The *MarLIN* Web site receives about 1600 visits a day.
9. The *MarLIN* approach to assessing sensitivity and its application to environmental management were presented in papers at three international conferences during the current contract and a 'touchstone' paper is to be published in the peer-reviewed

journal *Hydrobiologia*. The utility of *MarLIN* information for environmental managers, amongst other sorts of information, has been described in an article in *Marine Pollution Bulletin.*

10. *MarLIN* information is being used to inform the identification of potential indicator species for implementation of the Water Framework Directive including initiatives by ICES.
11. Non-Defra funding streams are supporting the updating of reviews and increasing the amount of peer review undertaken; both of which are important to the maintenance of the resource. However, whilst *MarLIN* information is sufficiently wide ranging to be used in an 'operational' way for marine environmental protection and management, new initiatives and the new biotopes classification have introduced additional species and biotopes that will need to be researched in the future.
12. By the end of the contract, the Biology and Sensitivity Key Information database contained full Key Information reviews on 152 priority species and 117 priority biotopes, together with basic information on 412 species; a total of 564 marine benthic species.

Impact of human activities on benthic biotopes and species

Report to Department for Environment, Food and Rural Affairs

1. Introduction to the report

The report that follows outlines the tasks and deliverables achieved under a Defra contract between November 2001 and October 2004. The report updates and continues the report of our prior contract (Tyler-Walters *et al.*, 2001) and draws on work already published under other contracts but that fulfilled the objectives of the Defra contract, i.e. Tyler-Walters *et al.* (2002, 2003, 2004), Tyler-Walters & Hiscock (2003) and Tyler-Walters & Lear (2004).

A description of the tasks and milestones of the project and the degree to which they were met is shown below in Sections 3 and 4. The major areas of work under the contract are discussed in detail in Sections 5, 6 and 7 below.

2. Background to the project

The United Kingdom (UK) Department for Environment, Food and Rural Affairs (Defra) supported a programme of research into the sensitivity of seabed species and biotopes and the dissemination of that information on the Internet, between 1998 and 2001, in support of UK commitments to protect species and habitats in the marine environment, particularly those commitments under the Oslo and Paris Commission (OSPAR) Convention. The three year programme of work by the Marine Life Information Network (*MarLIN*) resulted in a Web site (www.marlin.ac.uk), which provides information on the biology and sensitivity of species and habitats, prioritized because they are keystone, characteristic, important for the implementation of conventions and directives or are nationally rare or scarce.

The *MarLIN* Web site and its supporting database require maintenance and development, especially to improve links with survey data. Additional keystone and characteristic species need to be researched to contribute to the identification of species and biotope sensitivity and to improve links with survey data, which can be facilitated by the development of interactive mapping and GIS tools, improving functionality and ease of access. The development of Ecological Quality Objectives for the North Sea (De Boer *et al.,* 2001) and the preparation of a Priority List of threatened or declining species and habitats under the auspices of the OSPAR Biodiversity Committee have or will generate more species requiring research.

The 2001 to 2004 contract aimed to maintain and extend the *MarLIN* database and Web site so that it can support UK commitments under the OSPAR Convention and contribute to reviews of environmental sensitivity data that could be used to establish Marine Environmental High Risk Areas. The contract also required support of any future commitments that may arise related to UK implementation of the Habitats Directive, the further development of the UK Biodiversity Action Plans, the North Sea Conference and the Pilot scheme being undertaken as part of the Review of Marine Nature Conservation. The contractor also required the *MarLIN* team to be aware of, and if necessary, respond to requirements under the Water Framework Directive.

3. Contract objectives

The *MarLIN* team completed all the objectives of the DEFRA contract between November 2001 and October 2004. Each objective and their achievements under those objectives follow.

Objective 1

To maintain the MarLIN Web site and database to ensure it continues to operate to the current high standard.

The Biology and Sensitivity Key Information database, and hence the relevant section of the *MarLIN* Web site, was continuously maintained and updated throughout the contract period. The *MarLIN* approach to sensitivity assessment was revised to accommodate the Review of Marine Nature Conservation (RMNC) definition of 'sensitivity' (see Section 6). The database and hence the biology and sensitivity Web pages were subject to a complete edit to remove typographical errors and improve consistency throughout the site, partly as a result of changes in our sensitivity assessment rationale. In addition, the entire Web site has been revised and redesigned to improve layout and navigation of the Web site and address comments received over the last several years.

Objective 2

To develop links between sensitivity and survey data, utilizing GIS technology to increase functionality and speed of access to data.

MarLIN made considerable progress in linking sensitivity information and marine benthic survey data. *MarLIN* developed in-house Geographical Information Systems (GIS) using both ArcGIS and MapInfo software to map marine benthic survey data and 'tag' that data with sensitivity information extracted from the Biology and Sensitivity Key Information database. In this way, it was possible to display maps of the sensitivity of researched species and biotopes. *MarLIN* has demonstrated its approach to sensitivity mapping for species and biotopes and broad scale mapping units. *MarLIN* mapped the sensitivity of species, biotopes and Marine Landscapes for the Irish Sea Pilot. *MarLIN* mapped the likely sensitivity of Phase I biotopes and species to environmental factors likely to be affected by oil spills for the Pembrokeshire SAC and Severn Estuary SAC under contract to CCW. An approach for using biotope sensitivity to assess biotope complex sensitivity was also developed and tested under contract to CEFAS. Details are given in Section 7.

Objective 3

To undertake further research on species and habitats that are keystone, characterizing or indicator species including species and habitats found in UK waters that are selected under the OSPAR prioritization process.

Biology and Sensitivity Key Information research into priority species, especially those listed under OSPAR Annex V continued throughout the contract. A total of 45 additional full Key Information reviews were researched and placed on-line, and 480 basic information pages researched or updated in the contract period. The species and habitat research is detailed in Section 6.

Objective 4

To apply the Faial/Texel criteria developed under OSPAR, as appropriate, to the preparation of species and habitat information reviews.

The OSPAR priority threatened or declining species are identified on the Web site, and the available information of these species can be retrieved via a separate search field. Biotopes found within or that represent OSPAR threatened or declining habitats are similarly identified.

Objective 5

To contribute to the application of sensitivity information to marine environmental protection especially by promoting approaches developed in the UK to Europe.

At the beginning of the contract, *MarLIN* submitted an EU 6th framework bid to extend the *MarLIN* programme into Europe but it was unsuccessful. Nevertheless, *MarLIN* has taken all available opportunities to present our approach to sensitivity assessment to European fora. In particular, *MarLIN* presented a paper outlining our approach to the 38th European Marine Biology Symposium in Portugal entitled 'Assessing the sensitivity of seabed species and biotopes – the Marine Life Information Network (*MarLIN*)', which will be published in the journal *Hydrobiologia* shortly. Papers that refer to *MarLIN* Biology and Sensitivity Key Information were also presented at the 30th *Pacem in Maribus*, in 2003 and at the Littoral 2004 conferences. In addition, we are involved in the Marine Biodiversity and Ecosystem Functioning (MARBEF) and 'European Lifestyles and Marine Ecosystems (ELME) European projects.

Objective 6

To identify locations of nationally important benthic species and habitats, at particular risk from pollution from accidental oil spills, to contribute to 3-yearly reviews of MEHRAs environmental sensitivity data.

MarLIN was unable to engage with the review of the MEHRA's environmental sensitivity data. However, we negotiated a contract with the Countryside Council for Wales (CCW) to test sensitivity mapping in oil spill pollution incident response. As part of the CCW contract, we were able to map species and biotopes likely to be sensitive to the effects of oil spills (i.e. smothering, physical disturbance, and hydrocarbon contamination) within the Pembrokeshire SAC and Severn Estuary SAC, including nationally important species and biotopes. Therefore, we were able to demonstrate the identification of nationally important benthic species and habitats at particular risk from oil spills as specified in the objective.

4. Tasks and Milestones

4.1 Introduction

The work programme was divided into a number of tasks and associated milestones. The work programme is show in Table 1 below.

4.2 Task 1. Maintain the *MarLIN* database and Web site.

M1 Maintain, improve and develop the database and Web site including software upgrades.

M2 Incorporate fields to the database / Web site that address application of the Faial / Texel criteria

The Web site was maintained and continually updated throughout the contract period, culminating in a major redesign and relaunch of the site in November 2003. Fields to identify OSPAR Annex V threatened and declining species and habitats were added to the Biology and Sensitivity Key Information database when a ratified list became available in 2003. Completion of Task 1 is detailed in Section 5.

4.3 Task 2. Contribute to the application of sensitivity information to marine environmental protection especially by promoting approaches developed in the UK in Europe.

M1 Contribute to appropriate European fora as opportunity arises.

The *MarLIN* has taken every opportunity to promote the application of sensitivity assessment to marine environmental management and protection, and hence the work funded by Defra, in the UK and Europe.

Table 1. Contact tasks (T) and milestones (M)

Due 14/12/01
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T1/M2 Incorporate fields to the database / Web site that address application of the Faial criteria.
T2/M1 Contribute to appropriate European fora as opportunity arises.
Liaison with European scientists to develop the *MarLIN* approach for European seas.
Aggregate EcoQOs 19-20 Oct, 2001. Lowestoft.
T3/M1 Submit list of species to be researched to DEFRA Nominated Officer.
T3/M2 Have agreed species to be researched and prioritize (meeting).
T3/M3 Complete research into tranche 1 species.
T6/M1 Progress reports & invoice on payment milestone dates.

Due 8/3/02
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T3/M4 Complete research into tranche 2 species.
T6/M1 Progress reports & invoice on payment milestone dates.

Due 13/9/02
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T2/M1 Contribute to appropriate European fora as opportunity arises.
InfoCoast meeting (spring 2002)
'Identifying threatened species' workshop as a part of the Review of Marine Nature Conservation.
T3/M5 Complete research into tranche 3 species.
T6/M1 Progress reports & invoice on payment milestone dates.

Due 14/12/02
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T2/M1 Contribute to appropriate European fora as opportunity arises.
United Kingdom 'Biotopes classification' workshop.
T3/M6 Complete research into tranche 4 species.
T4/M1 Advisory group meets to establish information to be displayed, links etc.
T4/M2 Computer software purchased and installed.
T6/M1 Progress reports & invoice on payment milestone dates.

Due 15/03/03
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T2/M1 Contribute to appropriate European fora as opportunity arises.
Anticipate attending the ICES/OSPAR/EEA Habitat classification workshop (dates unknown at present).
T3/M7 Complete research into tranche 5 species.
T6/M1 Progress reports & invoice on payment milestone dates.

Due 15/09/03
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T2/M1 Contribute to appropriate European fora as opportunity arises.
T3/M8 Complete research into tranche 6 species.
T4/M3 Demonstration of link between survey data and sensitivity information.
T6/M1 Progress reports & invoice on payment milestone dates.

Table 1. Contact tasks (T) and milestones (M)

Due 15/03/04
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T2/M1 Contribute to appropriate European fora as opportunity arises.
T3/M9 Complete research into tranche 7 species.
T5/M1 Collaborate in re-development of the oil spill sensitivity atlas as required (meetings).
T5/M2 Demonstrate the identification of areas at risk from oil spills using the survey data-sensitivity link (with T4/M3).
T6/M1 Progress reports & invoice on payment milestone dates.

Due 28/10/04
T1/M1 Maintain, improve and develop the database and Web site including software upgrades.
T2/M1 Contribute to appropriate European fora as opportunity arises.
T6/M2 Final Report on Programme.

The *MarLIN* team has taken a proactive approach and attended and contributed to numerous relevant meetings and workshops during the contract period (Table 2). The following meetings originally specified in the contract were either cancelled or did not take place:

- InfoCoast 2002,
- 'Identifying threatened species' for the Review of Marine Nature Conservation meeting, and the
- UK biotope classification workshop.

In addition, we were not invited to subsequent ICES/EEA/OSPAR Habitat classification workshops.

Table 2. European fora, meetings and workshops attended to promote the use of sensitivity information in marine environmental management, and obtain feedback. Keith Hiscock (KH), Harvey Tyler-Walters (HTW), Dan Lear (DL), Jon Parr (JP).

Date	Conference, workshop or meeting	Contributor
4-5 December 2001	'Managing the resources of the Atlantic Margin' (Atlantic Frontier Environmental Network), Edinburgh.	KH
21 March 2002	'Habitats and Habitat Integrity as Indicators for Interpreting and Describing Change in Marine Ecosystems' Workshop, Edinburgh	HTW
15 August 2002	Offshore wind farms workshop, London.	KH
10 September 2002	Presented 'Sensitivity of marine biodiversity to environmental change' at British Association for the Advancement of Science meeting, Leicester.	KH
11 September 2002	Delivering Integrated Marine Mapping for the UK, London.	KH
16 October 2002	Information Management for Strategic Environmental Assessment and Regulation in the Marine Environment, Chester.	HTW
31 October -1 November 2002	'Oceans of Change' conference, Greenwich, London.	KH
14 November 2002	Marine Stewardship, London.	KH
24 November 2002	Ocean Biodiversity Information System, Brussels.	KH
25 November 2002	Offshore Wind Farms Strategic Environmental Assessment workshop, London.	JP
25-27 November 2002	'Colour of Ocean data' meeting, Brussels.	KH

Table 2 (continued). European fora, meetings and workshops attended to promote the use of sensitivity information in marine environmental management, and obtain feedback. Keith Hiscock (KH), Harvey Tyler-Walters (HTW), Dan Lear (DL), Jon Parr (JP).

Date	Conference, workshop or meeting	Contributor
13 December 2002	Workshop on Sensitivity Mapping, Marine Institute, Dublin.	JP, DL, HTW.
22-23 January 2003	'Coastal futures' meeting, London.	KH
11 February 2003	Meeting with representatives of the Irish Sea Pilot to discuss collaboration and contribution, Peterborough.	KH, HTW
13 February 2003	Assessing the cumulative effects of marine activities, a CCW workshop, Chester.	HTW
6 March 2003	Marine Aggregates and Biodiversity: developing a common understanding, London.	HTW
16 June 2003	Indicators of Marine Biodiversity, Defra, London.	KH
18 June 2003	Important New Developments in Marine and Coastal GIS, Metoc, London.	DL
22 August 2003	Irish Sea Pilot – Mapping Sensitivity within Marine Landscapes - Consultative workshop, Plymouth.	DL, HTW, KH
9-12 September 2003	38th European Marine Biology Symposium, Alveiro, Portugal. Presentation by Keith Hiscock & Harvey Tyler-Walters on "Assessing sensitivity of seabed species and biotopes – the Marine Life Information Network (*MarLIN*)".	KH
18 September 2003	Climate change & Biodiversity Action Plans, Edinburgh.	KH
22 September 2003	Astra Zeneca, Brixham. Presentation on *MarLIN*.	KH
26 September 2003	MIRO Best Practice Guide to Assessing the Impacts of Aggregate Extraction on the Marine Environment: Benthic/Epibenthic ecology workshop. London.	HTW
1 October 2003	Spatial Planning in the Coastal and Marine Environment: next steps to action, London.	HTW
2 October 2003	Climate change and biodiversity, Scottish Executive. Edinburgh.	KH
27-30 October 2003	30th *Pacem in Maribus*, Kiev, Ukraine. Presentation by Keith Hiscock on "Establishing and managing marine protected areas: using science effectively".	KH
11 December 2003.	Inter Agency Committee on Marine Science and Technology Marine Environmental Data Advisory Group, London. [Presentation].	KH
3 March 2004	Water Framework Directive: implications for estuaries and coasts, London.	HTW
22-24 March 2004	ICES Working Group on Sensitivity, Copenhagen.	KH
29 April 2004	UK Climate Impact Programme / MarClim, London.	KH
20–22 September 2004	Littoral 2004 – Delivering Sustainable Coasts: Connecting Science and Policy conference, Aberdeen, Scotland. Presentation of paper by Keith Hiscock, Jon Parr and Harvey Tyler-Walters "Bringing Marine Life Information Together for Decision Making".	KH
18 October 2004	'State of marine benthos', Defra meeting, Peterborough.	KH

MarLIN presented a paper outlining our approach to the 38th European Marine Biology Symposium in Portugal entitled 'Assessing the sensitivity of seabed species and biotopes – the Marine Life Information Network (*MarLIN*)', which will be published in the journal *Hydrobiologia* shortly. *MarLIN* Biology and Sensitivity Key Information was part of a paper

entitled 'Establishing and managing marine protected areas: using science effectively' presented at the 30th *Pacem in Maribus* conference, Kiev, Ukraine in October 2003.

MarLIN also presented a paper entitled 'Bring marine life information together for decision making' at the Littoral 2004 Delivering Sustainable Coasts: Connecting Science and Policy conference in Aberdeen, Scotland. The utility of *MarLIN* information for environmental managers, amongst other sorts of information, has been described in an article in *Marine Pollution Bulletin* (Hiscock *et al.,* 2003). In addition, we are involved in the Marine Biodiversity and Ecosystem Functioning (MARBEF) and 'European Lifestyles and Marine Ecosystems (ELME) European projects.

4.4 Task 3. Undertake further research on species and habitats that are keystone, characterizing or indicator species including species and habitats found in UK waters that are selected under the OSPAR prioritization process.

M1 Submit list of species to be researched to Defra Nominated Officer

M2 Have agreed species to be researched and prioritize (meeting)

M3 Complete research into tranche 1 species

M4 Complete research into tranche 2 species

M5 Complete research into tranche 3 species

M6 Complete research into tranche 4 species

M7 Complete research into tranche 5 species

M8 Complete research into tranche 6 species

M9 Complete research into tranche 7 species

The list of species to be researched was agreed in January 2002. The Biology and Sensitivity Key Information reviews of species listed in tranches 1-7 (see Table 3) were completed to schedule by end March 2004. In some cases, there was not enough information available to complete a full Key Information review and only basic information could be completed. In a few cases, although there was not enough information available on the chosen species to prepare a full review, a similar or surrogate species was chosen. For example, *Electra pilosa* was subject to full Key Information research, while only basic information was completed for *Electra crustulenta*. Similarly, full reviews of *Nephtys hombergii, Spisula solida*, and *Nucula nitidosa* were completed.

The full Key Information reviews and basic information available on the *MarLIN* Web site at the end of the contract (October 2004) are listed in Appendices 1 and 2.

4.5 Task 4. Develop links between sensitivity and survey data

M1 Advisory group meets to establish information to be displayed.

M2 Computer software purchased and installed.

M3 Demonstration of link between survey data and sensitivity information.

The Sensitivity Mapping Advisory Group was convened in December 2001 in Dublin, Ireland, to discuss *MarLIN*'s approach to sensitivity assessment and sensitivity mapping. The advisory group members were consulted on changes to our benchmarks and sensitivity assessment rationale, together with the existing Biology and Sensitivity Technical Advisory Group. Both advisory groups were merged towards the end of the contract and met again in February 2004 to discuss progress made towards sensitivity mapping and its role in marine spatial planning. MySQL was installed to aid queries from the Biology and Sensitivity Key Information database. ArcGIS was adopted as the in-house GIS, although MapInfo was later purchased through a sensitivity mapping contract

with CCW. ArcGIS was used to 'tag' marine benthic survey data held by *MarLIN*, together with additional data from the Marine Nature Conservation Review (MNCR) database and Joint Nature Conservation Committee (JNCC) as part of the Irish Sea Pilot. As a result, we were able to demonstrate linking survey data and sensitivity information to the nominated officer on schedule in September 2003.

Table 3. Biology and Sensitivity Key Information species research tranches completed (*=surrogates).

Species name	Common name	Reason for inclusion	Tranche	Review type
Ahnfeltia plicata	A red seaweed	Representative / Characterizing	1	Full
Brissopsis lyrifera	A burrowing sea urchin	EcoQ vulnerable indicator?	1	Full
Chondrus crispus	Carragheen	Representative / Characterizing; Exploited	1	Full
Fabulina fabula	A bivalve mollusc	Representative / Characterizing	1	Full
Magelona mirabilis	A worm	Representative / Characterizing; EcoQ opportunist indicator?	1	Full
Musculus discors	A mussel	Representative / Characterizing; EcoQ vulnerable indicator?	1	Full
Amphiura chiajei	A brittle star	Representative / Characterizing	2	Full
Bathyporeia pelagica	An amphipod	Representative / Characterizing	2	Full
Cordylophora caspia	A hydroid	Rare or scarce; Representative / Characterizing	2	Full
Electra crustulenta	An encrusting bryozoan	Representative / Characterizing	2	Basic
Electra pilosa	An encrusting bryozoan	Representative / Characterizing	*	Full
Eurydice pulchra	An amphipod	Representative / Characterizing	2	Full
Flustra foliacea	Hornwrack	Representative / Characterizing	2	Full
Gammarus salinus	An amphipod	Representative / Characterizing	2	Full
Hartlaubella gelatinosa	A hydroid	Rare or scarce; Representative / Characterizing	2	Basic
Molgula manhattensis	A sea squirt	Representative / Characterizing	2	Full
Neomysis integer	A mysid	Representative / Characterizing	2	Full
Spio filiformis	A worm	Representative / Characterizing	2	Full
Spiophanes bombyx	A worm	Representative / Characterizing; EcoQ opportunist indicator?	2	Full
Tubificoides benedii	A worm	Representative / Characterizing	2	Full
Abra alba	A bivalve mollusc	Exemplary; Representative / Characterizing	3	Full
Bugula turbinata	A bryozoan	Representative / Characterizing	3	Full
Capitella capitata	A worm	Representative / Characterizing	3	Full
Cladophora rupestris	A green seaweed	Representative / Characterizing	3	Full
Conopeum reticulum	A bryozoan	Representative / Characterizing	3	Full
Lanice conchilega	A tube worm	Representative / Characterizing	3	Full
Pomatoceros triqueter	Keeled tube worm	Representative / Characterizing	3	Full
Suberites carnosus	A sponge	Representative / Characterizing	3	Basic
Talitrus saltator	An amphipod	Representative / Characterizing	3	Full
Eucratea loricata	A bryozoan	Representative / Characterizing	4	Basic
Eudendrium arbusculum	A hydroid	Representative / Characterizing	4	Basic
Nephtys cirrosa	A worm	Representative / Characterizing	4	Basic
Nephtys hombergii	A worm	Representative / Characterizing	*	Full
Obelia longissima	A hydroid	Representative / Characterizing	4	Full
Petricola pholadiformis	A bivalve mollusc	Representative / Characterizing	4	Basic

Table 3 (continued). Biology and Sensitivity Key Information species research tranches completed (*=surrogates).

Species name	Common name	Reason for inclusion	Tranche	Review type
Rhodothamniella floridula	A red seaweed	Representative / Characterizing	4	Full
Corbula gibba	Basket shell	Representative / Characterizing	5	Full
Patella ulyssiponensis	China limpet	OSPAR; Key; Representative / Characterizing	5	Full
Aphrodita aculeata	Sea mouse	Fisheries impacts indicator of, EcoQ vulnerable indicator ; Representative / Characterizing	6	Full
Arctica islandica	Icelandic Cyprine	OSPAR; Eutrophication indicator, EcoQ vulnerable indicator, Representative / Characterizing;	6	Full
Dipturus batis	Common skate	OSPAR; BAP; RDB Endangered A1abcd+2bcd; Exploited	6	Full
Hippocampus guttulatus	Long snouted seahorse	RDB Vulnerable	6	Basic
Hippocampus hippocampus	Short snouted seahorse	RDB Vulnerable	6	Full
Osilinus lineatus	Thick top shell	Key; Representative / Characterizing	6	Full
Cancer pagurus	Edible crab	EcoQ vulnerable indicator; Representative / Characterizing;	7	Full
Carcinus maenas	Common shore crab	Indicator of endocrine disruption, cold winters and hypoxia; Representative / Characterizing	7	Full
Cirratulus cirratus	A polychaete	Indicator; Key; Representative / Characterizing	7	Full
Corophium volutator.	An amphipod	Indicator of endocrine disruption; Representative /Characterizing	7	Full
Crangon crangon	A shrimp	Indicator of cold winters and hypoxia; Representative / Characterizing	7	Full
Nephrops norvegicus	Norway lobster	Indicator of hypoxia; Key; Representative / Characterizing; Exploited	7	Full
Nucula sulcata	A bivalve	Indicator of eutrophication; Representative / Characterizing	7	Basic
Nucula nitidosa	A bivalve	Indicator of eutrophication; Representative / Characterizing	*	Full
Owenia fusiformis	A polychaete	Indicator oil & gas extraction; EcoQ opportunist indicator; Representative / Characterizing	7	Full
Spisula elliptica	A bivalve	Indicator of hypoxia, oil & gas extraction; EcoQ vulnerable indicator; Representative / Characterizing	7	Basic
Spisula solida	A bivalve	Indicator of hypoxia, oil & gas extraction; EcoQ vulnerable indicator; Representative / Characterizing	*	Full

4.6 Task 5. Identify locations of nationally important benthic species and habitats, at particular risk from pollution from accidental oil spills, to contribute to 3-yearly reviews of MEHRA's environmental sensitivity data.

M1 Collaborate in re-development of the oil spill sensitivity atlas as required (meetings).

M2 Demonstrate the identification of areas at risk from oil spills using the survey data-sensitivity link (with T4/M3).

MarLIN was unable to engage with the review of Marine Environmental High Risk Areas (MEHRA). The redevelopment of the national oil spill atlas was lead by the Marine and Coastguard Agency (MCA). In spite of numerous attempts, we were unable to meet with MCA representatives and no representatives were able to attend our Sensitivity Mapping Advisory Group meetings. The MCA eventually decided to adopt the old but safe surrogates for sensitivity in the redevelopment of the national oil spill sensitivity map, and no information was requested from *MarLIN.*

However, we negotiated a contract with the Countryside Council for Wales (CCW) to test sensitivity mapping in oil spill pollution incident response. As part of the CCW contract, we were able to map species and biotopes likely to be sensitive to the effects of oil spills (i.e. smothering, physical disturbance, and hydrocarbon contamination) within the Pembrokeshire SAC and Severn Estuary SAC, including nationally important species and biotopes. Therefore, we were able to demonstrate the identification of nationally important benthic species and habitats at particular risk from oil spills, albeit only within two marine SACs.

4.7 Task 6. Report on programme

M1 Progress reports & invoice on payment milestone dates.

M2 Final Report on Programme.

Progress reports were produced for each invoice period and agreed with the nominated officer on time. The final report was completed to schedule.

5. Maintain the *MarLIN* database and Web site.

5.1 Introduction

The *MarLIN* Web site, database and supporting server have developed substantially throughout the contract period. Development was fueled by the continued growth of the Web site content, feedback from users and the increasing demand for our services.

In 2002, it became apparent that our existing server was unable to cope with the increasing demands placed on it, especially when it was required to serve out detailed searches of our increasing marine life survey data holdings. As a result, the server began to crash periodically. The problem was partly alleviated by increasing its memory capacity, and converting some database software to more powerful MySQL software (an open source product). In addition, some computer code was re-written in a more efficient manner. Nevertheless, demand continued to grow and, in 2003, the existing server was replaced with a modern dedicated server. The *MarLIN* team took the opportunity presented to totally redesign the *MarLIN* Web site, incorporating many of the comments received from users and providing space for future development and growth. The new server was installed in March 2003 and the redesigned Web site launched in October 2003. The following section outlines the *MarLIN* Web site from October 2003 onwards.

5.2 The redesigned *MarLIN* Web site

5.2.1 Introduction

The redesign of the Web site retained and improved existing functionality of the older version, and built on the design principles for the *MarLIN* Web site outlined in Tyler-Walters *et al.* (2001). The Web site redesign removed the use of frames, a format not supported by HTML standards, and replaced much of the navigation functionality with pull down menus using Java Script. The overall appearance of the Web site was standardized using a background Cascading Style Sheet (CSS), so that the style was consistent through-out the site, and retained its style when viewed by users.

Web site upgrades included:

- adoption of a clearer easier to read font (Arial) to improve accessibility to users with reading difficulties;
- inclusion of a systematic header with pull-down menus throughout the site, so that users can navigate to different parts of the site or supporting information with a single 'click';
- adoption of a pull-down menu for each section of the Web site, i.e.
    - Biology and Sensitivity,
    - Data Access,
    - Education and Recording,
    - search tools,
    - publications and products, and
    - *MarLIN* services;
- the introduction of 'thumb-nailed' images to the lists of species information;
- a link from each species page to a search of relevant survey data, to add further value to the species reviews;
- a complete edit of the Active Server Page (ASP) Scripts behind the Web pages to increase speed;
- a complete edit of the species and biotope key information Web pages, and
- a 'search' menu providing searches for species or biotopes, for important species or biotopes, and for species or biotopes likely to be sensitive to human activities, together with a general search tool and database of relevant Web links.

5.2.2 Pull-down menus

The pull-down menus improved navigation greatly, by providing direct links to the relevant sections of the Web site and supporting documentation. The pull-down menus form part of the Web site header and are, therefore, always accessible from any part of the Web site. For example, the Biology and Sensitivity menu includes direct links to:

- a description of the contents of the Key Information reviews;
- species and biotopes information reviews;
- notes on conventions and legislation relevant to marine life protection;
- a summary of the sensitivity assessment rationale;
- the sensitivity assessment benchmarks;
- the matrix linking activities to affected environmental factors;
- species and biotope bibliographies, and

- the glossary of scientific terms.

The description of contents and summary of the sensitivity assessment rationale were prepared specifically to support the biology and sensitivity key information reviews, and to explain the *MarLIN* approach to sensitivity assessment.

The 'Data Access' menu provides direct links to:

- information about the data access sub-programme;
- the search tools for *MarLIN* hosted marine life survey data;
- the SEArchable BEnthic Data (SEABED) Map;
- the National Biodiversity Network (NBN) Gateway, and
- a search by data or information provider.

5.2.3 Search tools

The existing search tools (see Tyler-Walters *et al.*, 2001) were retained and expanded. The search for 'important' species and biotopes now includes those identified as threatened or declining under Annex V of the OSPAR convention (OSPAR, 2003).

A 'general search' of the Web site has also been added. The general search allows users to search either:

- the entire Web site by key words or combinations of key words, or
- within separate sections of the Web site by scientific name, common name or phylum.

The general 'key word' search of the Web site is also available via the home page. The general search enables users to locate information by key word; for example, 'ecological function' will locate every page on the site where the words 'ecology' or 'function' are used.

The 'Search' menu includes direct links to:

- a search for species by scientific name, common name, phylum or words in the species description;
- a search for biotopes by biotope code, biotope name, words in the biotope description or species names within the biotope name;
- a search for species or biotopes likely to be sensitive to the effects of human activities and natural events;
- a search for 'important' species or biotopes;
- a search for biotopes included within interest features of Annex I habitats of the Habitats Directive, and
- a general key word search.

The search for 'important' species or biotopes searches identify species or biotopes in the *MarLIN* Biology and Sensitivity Key Information database that are listed under:

- international conventions (e.g. Berne, CITES);
- European or national legislation (e.g. EC Habitats Directive, Wildlife & Countryside Act 1981, Nature Conservation and Amenity Lands (NI) Order 1985 (as amended 1989) Wildlife (NI) Order 1985);
- IUCN Red list 2000/2003;
- nationally rare or scarce species;
- UK Biodiversity Action Plan species and habitats, and

- OSPAR threatened or declining species and habitats.

5.3 The Biology and Sensitivity Key Information Database

The Biology and Sensitivity Key Information Database (the database) was described in detail by Tyler-Walters *et al*. (2001). The database continued to grow during the contract period as new species were added. The species and biotope coverage is detailed in Section 6.

The database itself has been adjusted to accommodate the requirements of the revised sensitivity assessment rationale (see Section 7). The database now includes fields for the revised (combined) sensitivity scale (Section 7.6). The database uses the relevant intolerance and recoverability ranks to complete the sensitivity field automatically based on the revised sensitivity scale. However, the information can be amended where necessary by the review author based on the Key Information.

In addition, new fields have been added to the 'importance' forms and tables to identify species and habitats that were identified as threatened or declining under Annex V of the OSPAR Convention. These fields allow the database to be searched on-line for OSPAR threatened or declining species and habitats (see Section 5.22 above).

5.4 The SEArchable BEnthic Data (SEABED) Map

5.4.1 Introduction

Objective 2 of the contract placed greater emphasis on building links between sensitivity information and survey data. The link between species and biotope sensitivity information and survey data in a desktop Geographical Information System (GIS) using either ArcGIS or MapInfo is detailed in Section 7.

The Data Access Sub-programme had previously mapped hosted survey data using static outputs from our in-house GIS, which were them manually linked the to survey data information using 'hotspots'; a time consuming task, especially as the volume of hosted survey data increased. Therefore, we took the opportunity of a short term bursary student (Daniel McGreal) to develop an on-line mapping capability.

5.4.2 The Data Access Sub-programme

The Data Access Sub-programme of *MarLIN* began in 1999 and has gradually built-up an extensive metadata catalogue of marine survey data sets; the majority of which can be interrogated on-line to view their metadata, details of the survey type and sampling techniques, and most importantly, a list of the species recorded and their location.

Data Access receives marine survey data in paper or electronic format from data providers, e.g. statutory agencies, marine biology laboratories, consultancies and wildlife trusts. The information is checked in-house and entered into Marine Recorder (see Figure 1). Marine Recorder is the standard data entry tool developed by the UK National Biodiversity Network (NBN) for biological recording within the UK. In addition, the *MarLIN* Web site hosts a sighting scheme for a selection of Biodiversity Action Plan (BAP) species, keystone species, non-native species and species likely to change in distribution due to climate change, under the auspices of the Education and Recording Sub-programme. Sightings can be submitted by users via an on-line recording form, or by the telephone, email or paper recording form. All records are entered into Marine Recorder.

At the end of October 2004 the *MarLIN* Web site hosted information on over 372 datasets (see Appendix 3), which included:

- 5,600 survey events,
- 19,000 samples and

- 230,000 species records.

Information is extracted from Marine Recorder in the form of a 'Snapshot' database. The 'Snapshot' is used by the Web server to power on-line queries, and is interrogated by the SEABED Map. The 'Snapshot' is also sent to the National Biodiversity Network (NBN) for inclusion in the NBN Gateway.

5.4.3 Mapping software

The on-line mapping tool (the SEABED Map) was created using Scaleable Vector Graphics (SVG) and PHP Hypertext Processor (PHP) open-source software. Open source software was chosen because it was readily available and widely supported by a variety of operating systems and Web browsers. The open-source software is freely available, so that users can easily download any upgrades required to view the mapping tools on-line.

The software allows users to interrogate our in-house Marine Recorder 'Snapshot'. The 'snapshot' is converted into MySQL (another open source software programme), which is a much faster and more Web compatible database than MS Access.

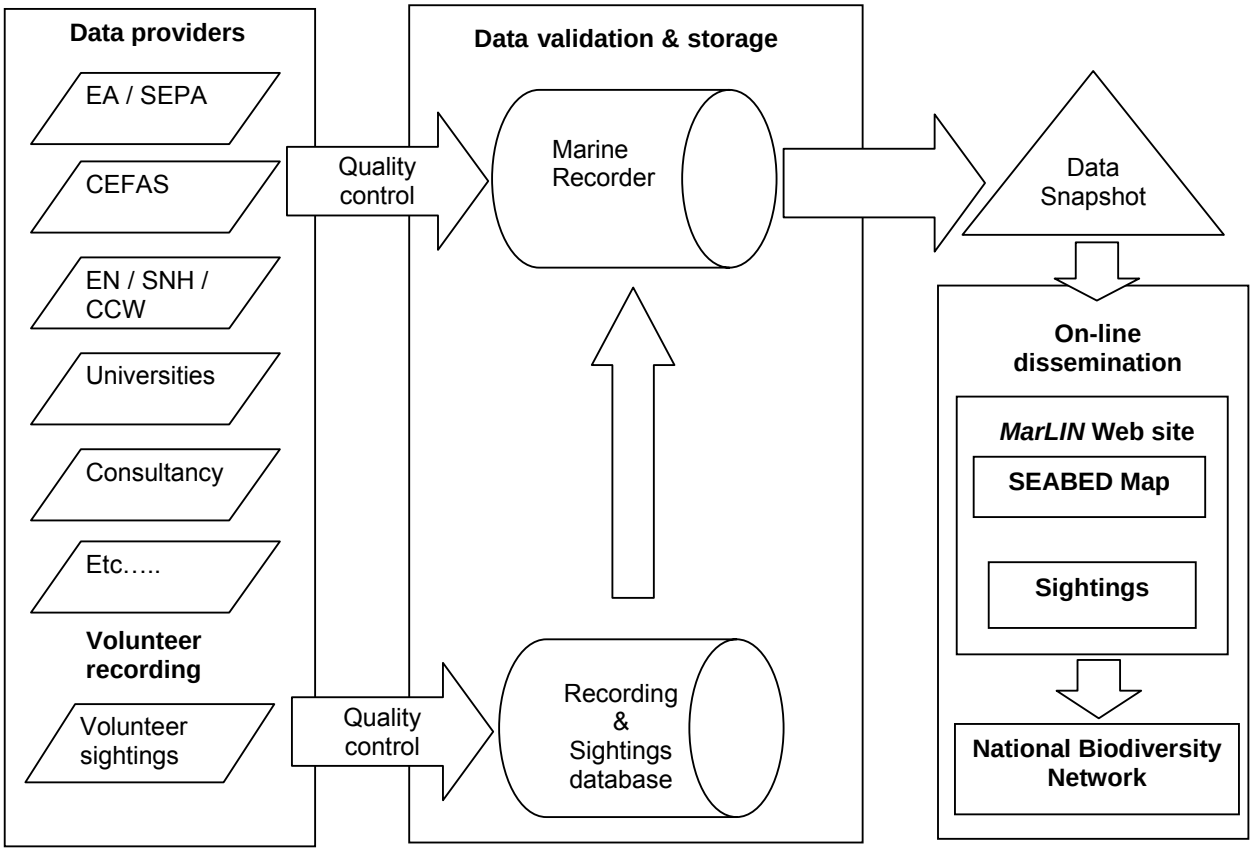


Figure 1. The *MarLIN* Data Access Sub-programme data structure

5.4.4 The SEABED Map

The SEABED Map allows users to search for marine benthic survey data by:

- species name;
- survey name or survey organization name;
- location name or Marine Nature Conservation Review (MNCR) sector, or
- any combination of all three.

A SEABED Map search for species is shown in Figure 2. The SEABED Map tool allows users to compare the distribution of different species. For example, Figure 3 shows a comparative distribution map of *Sabellaria alveolata* and *Sabellaria spinulosa*, based on *MarLIN* hosted data, in which the user can 'zoom in' to view their location of interest.

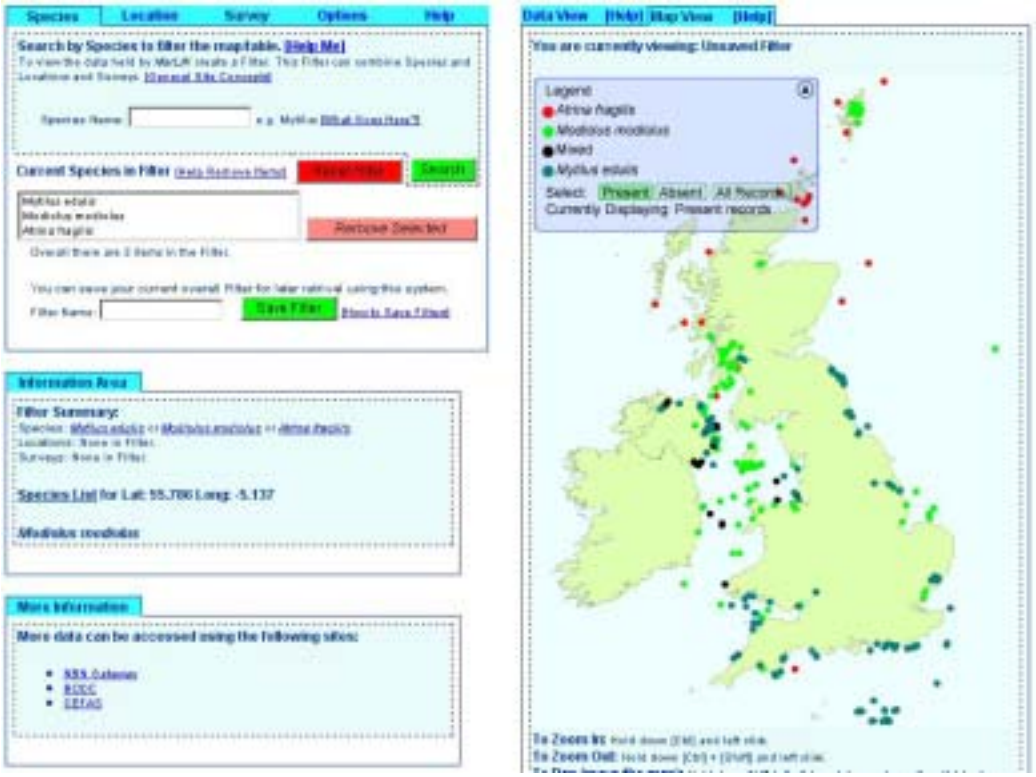


Figure 2. SEABED Map. Example search for survey data for *Mytilus edulis, Modiolus modiolus* and *Atrina fragilis*.

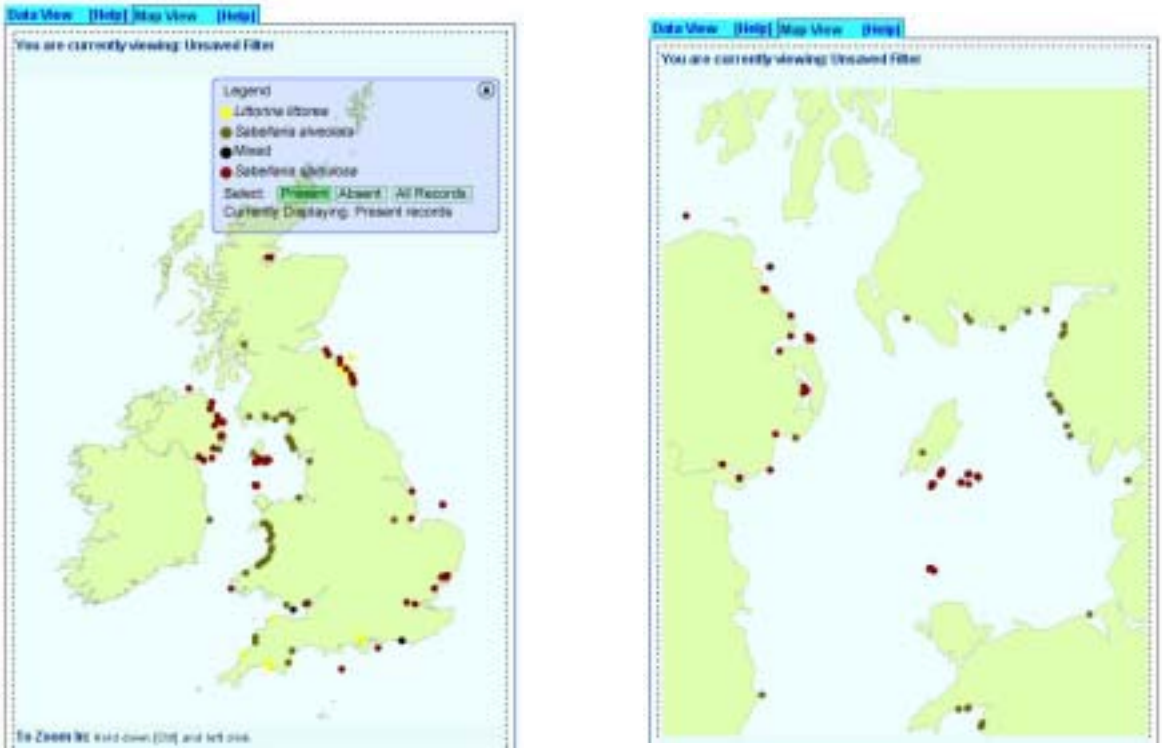


Figure 3. SEABED Map. Comparative distribution of *Sabellaria alveolata* and *Sabellaria spinulosa* (left), with close-up of the north Irish Sea (right).

Each search returns a list of surveys identified and the number of species records per survey. Each survey entry can be interrogated to reveal metadata. The search results can them be mapped. Each survey point is colour coded by search term, e.g. species name, survey name etc.

Clicking on any one survey point lists the species recorded at that point, their relative abundance, and the survey name and sample location (lat/long) (see Figure 4). Where numerical data is available, the relative abundance of species can be displayed as a histogram (see Figure 5). The survey name is in turn linked to the survey metadata. In addition, available physical, biotope or sample replicate data for a species sample can be displayed.

Figure 4. SEABED Map. Species list for an individual survey point.

Overall, the SEABED Map tool provides a simple, fast, interactive mapping tool to display the marine benthic survey data hosted by *MarLIN.* In addition, each species basic information and Biology and Sensitivity Key Information review is linked directly to the SEABED Map, so that a single click presents the user with an interactive map of *MarLIN* hosted survey data for that species.

5.5 Use of the *MarLIN* Web site

The *MarLIN* Web site continued to grow under the 2001-2004 Defra contract. During the contract period the Web site reached a 'critical mass' of species and biotope information, having researched the majority of key structural, key functional or characterizing species and the biotopes (or their representatives) that constitute Habitats Directive Annex I marine habitats in England and Scotland, together with the majority of Scheduled, UK BAP or OSPAR Annex V marine benthic species It now represents a major source of information on the biology and ecology of key marine species and habitats in the UK, and the likely effects of human activities and natural events.

The *MarLIN* Web site continues to attract a large user group, including statutory environmental protection agencies, environmental consultancies, marine biologists, university students, amateur naturalists and members of public. During the contract period, Web site usage overwhelmed our previous server, which was then upgraded (see

Section 5.1). The *MarLIN* Web site consistently attracts large numbers of 'hits' and 'visitors'.

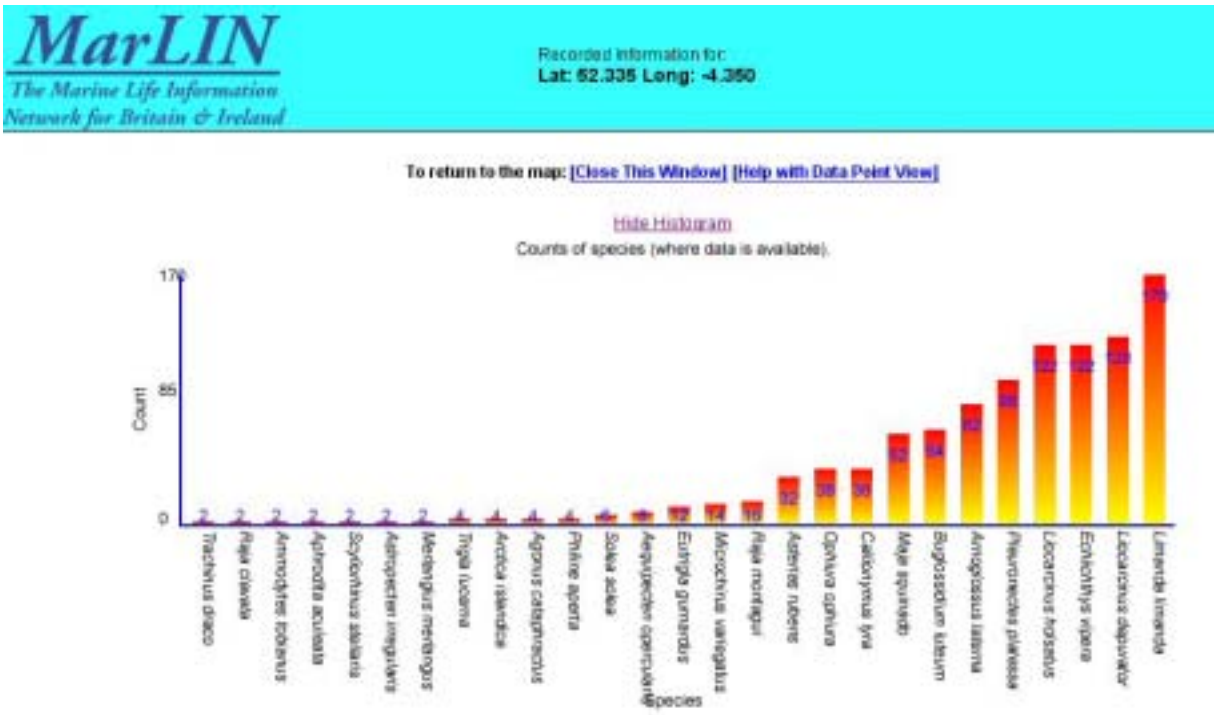


Figure 5. SEABED Map. Histogram of relative species abundance within survey sample.

The Web statistics since the site was re-launched in November 2003 are shown in Table 4. Statistics for previous years are not available. It can be seen from Table 4 that we received over 10 million hits from over 500,000 visitors, and averaged over 1,600 visitors a day in the last 11 months alone.

Table 4. Web statistics since the re-launch of the Web site (November 2003 to mid September 2004).

Hits	Total hits	10,622,908
	Total cached hits	10,319,990
	Average hits per day	33,830
	Average hits per hour	1,415
	Average hits per visitor	21
Visitors	Total visitors	504,715
	Average visitors per day	1,607
	Average time spent	568 Seconds
Unique IPs	Total unique IPs	147,177
	Visitors who visit once	121,656
	Visitors who visit more than once	25,521
Page Views	Total page views	2,494,386
	Average page views per day	7,943
	Total images	7,085,725
	Average images per day	22,566
	Number of visitors that book-marked the web site	14,797

The Web site received users from over 139 different countries since November 2003. The use of the Web site was dominated (69%) by the United States of America (USA). However, the Web site also attracted users from Europe and Worldwide. The top twenty

countries (excluding the USA) are shown is Figure 6. The majority (60%) of visits were from search engines (e.g. Google) or could not be identified. However, the Web site was primarily visited by academic or private users, where identified, in the 11 months since November 2003 (Figure 7).

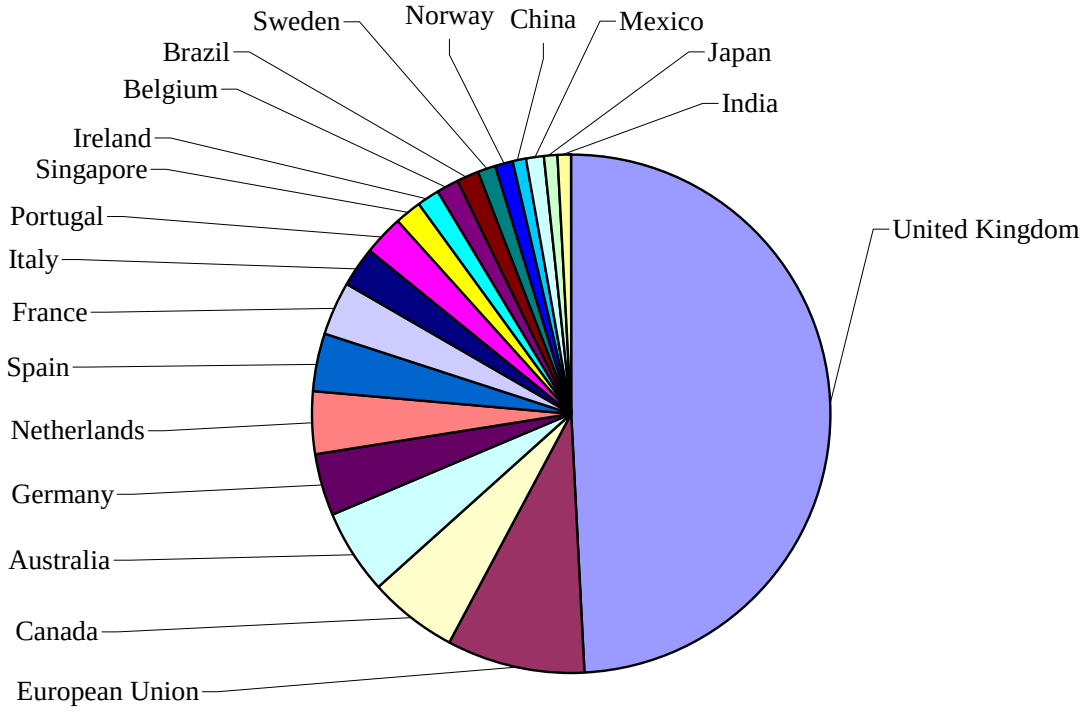


Figure 6. The top twenty countries of origin of our users (excluding the USA).

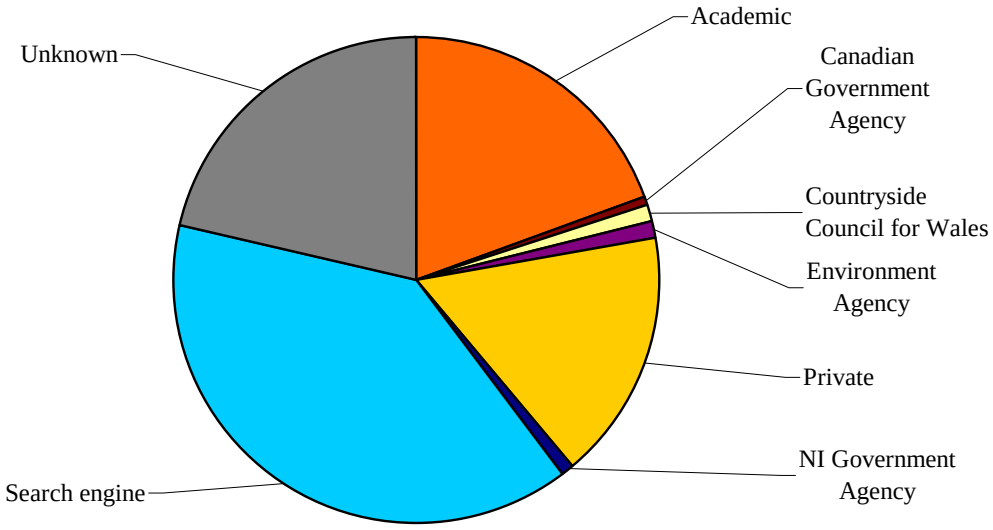


Figure 7. The range of different organization types using the Web site.

Government or statutory agencies contributed a relatively small number of visitors. However, it should be noted that many statutory environmental protection agency users use their home systems to access the Internet, and may be included in the 'unknown'

category. In addition, we cannot identify users that access the Web site via a search engine (e.g. Google, Alta Vista etc).

6. Undertake further research on species and habitats that are keystone, characterizing or indicator species

6.1 Introduction

Objective 3 of the contract specified:

To undertake further research on species and habitats that are keystone, characterizing or indicator species including species and habitats found in UK waters that are selected under the OSPAR prioritization process.

Objective 4 of the contract specified:

To apply the Faial / Texel criteria developed under OSPAR, as appropriate, to the preparation of species and habitat information reviews.

The development and dissemination of Biology and Sensitivity Key Information species reviews were detailed by Tyler-Walters *et al*. (2001), while the biotope reviews, funded by English Nature (EN) and Scottish Natural Heritage (SNH), were detailed by Tyler-Walters & Hiscock (2003). The structure and content of the reviews were retained with only minor adjustments through the contract period. However, the sensitivity assessment rationale was amended in March 2003 to take into account recent developments under the Review of Marine Nature Conservation (RMNC) (Laffoley *et al.,* 2000) and to facilitate sensitivity mapping (see Section 7).

6.2 The Biology and Sensitivity Key Information database

The Biology and Sensitivity Key Information database holds the key information, and supports the queries run via the Web site. The Biology and Sensitivity Key Information Web pages are generated from the information in the database using in house Visual Basic scripts (see Tyler-Walters *et al.*, 2001).

The database increased in size as new species and biotope information were added. The following additional fields were added to the database in the contract period:

- revised intolerance, recoverability and sensitivity fields;
- identified as an OSPAR threatened or declining species;
- identified as an OSPAR threatened or declining habitat, and
- the OSPAR threatened or declining habitat in which a biotope is likely to occur.

Species Key Information Web pages now identify species that have been identified as threatened or declining by the Biodiversity Committee of OSPAR (OSPAR, 2003). Biotope Key Information pages now identify OSPAR threatened and declining habitat in which the relevant biotope occurs. For example the *Lophelia* reef biotope (COR.Lop) is clearly identified as an OSPAR priority habitat.

6.3 Revision of benchmarks

The benchmarks used in the assessment of intolerance (= sensitivity *sensu stricto*) were agreed in late 1999 (Tyler-Walters & Jackson, 1999; Tyler-Walters *et al.*, 2001). The *MarLIN* team has since accrued over five years experience of sensitivity assessment. Therefore, a few of the benchmarks were revised, in light of this experience and in discussion with our Technical Advisory Management Group and Sensitivity Mapping Advisory Group, in April 2003.

6.3.1 Physical disturbance and abrasion

The 1999 benchmark sets the magnitude of physical disturbance as equivalent to a 'standard boat anchor'. However, physical disturbance as a result of mobile fishing gear continues to be a concern in marine conservation. In most cases, the weight of evidence regarding habitat or species sensitivity to physical disturbance concerns the effects of mobile fishing gear. Several of the biotope and species sensitivity assessments made since 1999, were based on their sensitivity to physical disturbance by mobile fishing gear, where their sensitivity to 'anchorage' would have been un-representative, e.g. epifaunal communities or *Modiolus modiolus* beds.

Therefore, the benchmark was revised and the magnitude of impact set as equivalent to that caused by a passing scallop dredge. A scallop dredge was more representative of the impact likely to cause damage to a habitat or species, and to be of concern for marine conservation or environmental management (see Table 5).

Table 5. Revision of physical disturbance and abrasion benchmark March 2003

Benchmark (1999 version)	
	The level of effect against which intolerance is rated.
Abrasion or physical impact	This factor includes mechanical interference, crushing, physical blows against, or rubbing and erosion of the organism or habitat of interest. Force equivalent to a standard boat anchor landing on or being dragged across the organism e.g., a 5 –10 kg anchor and its chain (used by a 7-8 m boat). A single event is assumed for assessment. Where trampling is relevant, the evidence and trampling intensity will be reported in the rationale.
Revised benchmark (April 2003 onwards)	
	The level of effect against which intolerance is rated.
Physical disturbance or abrasion	This factor includes mechanical interference, crushing, physical blows against, or rubbing and erosion of the organism or habitat of interest. Force equivalent to a standard scallop dredge landing on or being dragged across the organism. A single event is assumed for assessment. Where trampling is relevant, the evidence and trampling intensity will be reported in the rationale.

6.3.2 Changes in nutrient levels

The 1999 benchmark (Table 6), suggests a magnitude of nutrient enrichment of 3 mg/l N, or 0.3 mg/l P, or a 50% change in nutrient concentration. In our experience, it was extremely difficult to obtain information on the effects of nutrient enrichment that included the level of accuracy required to make an assessment against the benchmark. In practice, it has proven to be neither practical nor accurate to set quantified benchmark levels for nutrient enrichment and an evidence based approach has been used (Table 6). Therefore, the evidence based benchmarks used for other chemical contaminants are now used for changes in nutrient levels.

6.4 Update of database and Key Information reviews

The combination of 'intolerance' (previously sensitivity *sensu stricto*) and 'recoverability' and the development of a revised 'sensitivity' scale (Section 7), together with the revision of two benchmarks meant that the database and Key Information reviews has to be

updated. It was decided to undertake a complete edit of the Key Information reviews, and hence the entire Biology and Sensitivity Key Information section of the Web site.

As a result, all the relevant on-line glossaries, scales and definitions, were updated together with the sensitivity assessment protocol (Section 7). The physical disturbance and abrasion sensitivity assessments for all 152 of the species reviews and all 117 biotope sensitivity assessments were also updated. The combined 'sensitivity' scale also revealed inconsistencies in some of our older sensitivity assessments, and a running system of updates has been put in place. We have also replaced virtually every instance of 'sensitive' or 'sensitivity' on the Web site with the terms 'intolerant' or 'intolerance' respectively. A task roughly consistent with editing every paragraph in the sensitivity assessment sections of the biotope and species reviews sections, which contained over 750,000 words of text.

The entire database, and hence biotope and species Key Information Web pages, were subject to a complete edit, to remove typographical errors and inconsistent use of terms. All relevant glossaries and supporting documentation provided on the Web site was also checked and edited prior to the launch of our redesigned Web site in November 2003 (Section 4). The revised sensitivity scales and definitions came on-line with the revision of the Web site.

In addition, the distribution maps of all the algal (seaweed) reviews on the Web site were revised to take into account the recent British Phycological Society's 'Checklist and Atlas of the Seaweeds of Britain and Ireland' (Hardy & Guiry, 2003). The general glossary of terms was continuously updated, as new terms were required by species or biotope research. New images were also added to the Web site as they became available.

Table 6. Revision of the changes in nutrient levels benchmark March 2003.

<table>
<tr><th colspan="2">Benchmark (1999 version)</th></tr>
<tr><td></td><td>The level of effect against which sensitivity is rated.</td></tr>
<tr><td>Changes in levels of nutrient</td><td>A change in background nutrient concentrations, e.g., a change of total nitrogen of 3 mg/l and/or phosphorus of 0.3 mg/l as an annual average. Alternatively, a 50% change in of nutrient concentration as an annual average.</td></tr>
<tr><th colspan="2">Revised benchmark (April 2003 onwards)</th></tr>
<tr><td></td><td>The level of effect against which sensitivity is rated.</td></tr>
<tr><td>Changes in levels of synthetic chemicals
Changes in levels of heavy metals
Changes in levels of hydrocarbons
Changes in levels of radionuclides
Changes in levels of nutrient</td><td>Sensitivity is assessed against the available evidence for the effects of contaminants on the species (or closely related species at low confidence) or community of interest. For example:
evidence of mass mortality of a population of the species or community of interest (either short or long term) in response to a contaminant will be ranked as high sensitivity;
evidence of reduced abundance, or extent of a population of the species or community of interest (either short or long term) in response to a contaminant will be ranked as intermediate sensitivity;
evidence of sub-lethal effects or reduced reproductive potential of a population of the species or community of interest will be assessed as low sensitivity.
The evidence used is stated in the rationale. Where the assessment can be based on a known activity then this is stated. The tolerance to contaminants of species of interest will be included in the rationale when available, together with relevant supporting material.</td></tr>
</table>

6.5 Biology and Sensitivity Key Information research

Biology and Sensitivity Key Information research continued during the contract period. Priority was given to species research.

A list of over 150 species was compiled at the beginning of the contract. The list included species that were listed under international convention (i.e. OSPAR, CITES, and Berne), EC Directive, national statute, the UK Biodiversity Action Plan (BAP), nationally rare and scarce species, and species that are potentially indicator species, either for Ecological Quality Objectives (EcoQOs) (de Boer *et al.,* 2001) or for use in biotic indices. The list also included species identified as gaps in our present coverage of key, representative or characterizing species.

6.5.1 Priority species

The list of 150 species contained too many to be researched within the contract period. Therefore, the species were prioritized for research using the priorities listed in Table 7, with an emphasis on OSPAR species as laid out under Objective 4.

The *MarLIN* Web site already contained at least basic information on all UK BAP species, including species listed under UK statute or international convention.

Table 7. Species research priorities

Reasons for inclusion	Priority	Comment
Statute	**1**	Included in a UK statute or as indicated
Habitats Directive Annex	**1**	Listed in one of the Annexes to the Habitats Directive
Habitats Directive	**1**	Key characterizing species of one of the Annex I Habitats.
Red List/ Red Data Book	**1**	Species listed in National Red Data Books or IUCN Red List (2000/2003).
UK BAP	**1**	UK Biodiversity Action Plan species (including species included in Habitat Action Plans)
OSPAR	**1**	Included in OSPAR Annex V list of threatened and/or declining species and habitats (Jan. 2003 version).
Lagoon	**1**	Lagoonal species
Indicator	**(In)**	Indicator species
Key	**2**	Key structural or functional species. Researched especially for biotope sensitivity.
Representative / Characterizing	**2**	Representative / characterizing of the species in a biotope
Exploited	**3**	Commercially important species
Rare or scarce	**4**	Nationally rare or scarce species (basic information research only)
Non-native	**5**	Non-native or alien species (basic information research only).
Climate	**6**	Chosen as likely to change distribution due to climate change (basic information research only).
Exemplary	**E**	Example of a species from a particular taxonomic group

Indicator species are currently being identified in various fora. At present, potential indicator seabed species (but not including commercial fish species) were identified at the OSPAR Leiden workshop in September 2001 and in the list of “Potential indicator species” suggested by de Boer *et al.* (2001). The species were identified as either ‘EcoQ vulnerable indicator’ or ‘EcoQ opportunist indicator’ species.

Additional potential 'indicator' species have been suggested by *MarLIN*, based on the following reports of time series data or reviews of the effects of particular impacts: Pearson *et al.* (1985), Beukema (1990), Rees & Dare (1993), Suchanek, (1993), Hardy *et al.* (1993), Kenney & Rees (1994, 1996), Diaz & Rosenberg (1995), Olsgard & Gray (1995), Holt *et al.* (1995), Fletcher (1996), Kaiser *et al*. (1998), Depledge & Billinghurst (1999), Bradshaw *et al.* (2000, 2002), and Göransson (2002). Only the major species identified in the above reports were included in the list.

Where little information on species was expected to be available, e.g. for nationally rare or scarce species, only basic information was researched. Basic information research continued as part of the development of the Web site. Additional basic information species were researched to ensure interconnectivity within the site, i.e. so that species mentioned in biotope reviews or reported in our on-line recording schemes were represented on the Web site.

6.5.2 Key information research completed

At the end of the contract in October 2004, the Biology and Sensitivity Key Information database contained full Key Information reviews on 152 priority species and 117 priority biotopes, together with basic information on 412 species, a total of 564 marine benthic species. The Web site hosted the following:

- information on all the UK BAP species of which 14 were full Key Information species reviews;
- information on 11 OSPAR Annex V species, of which 7 were full Key Information species reviews;
- information on 11 species listed under the EC Habitats Directive, of which 2 were full Key Information species reviews;
- information on 25 species listed under the Wildlife and Countryside Act (1981 with amendments), of which 15 were full Key Information species reviews;
- information on 16 species listed in national Red Data Books or the IUCN Red List (2000/2003) of which 7 were full Key Information species reviews;
- information on 89 nationally rare or scarce species of which 18 were full Key Information species reviews;
- full Key Information on 117 biotopes included within interest features of UK proposed or candidate marine Special Areas of Conservation (SAC), of which:
    - 38 are nationally rare or scarce;
    - 99 are representative of UK BAP habitats, and
    - 10 are representative of OSPAR Annex V threatened or declining habitats, and
- ca 1,200 species and ca 250 biotope images.

The range of species and biotope information available on the *MarLIN* Web site in October 2004 is shown in Figures 8, 9, and 10.

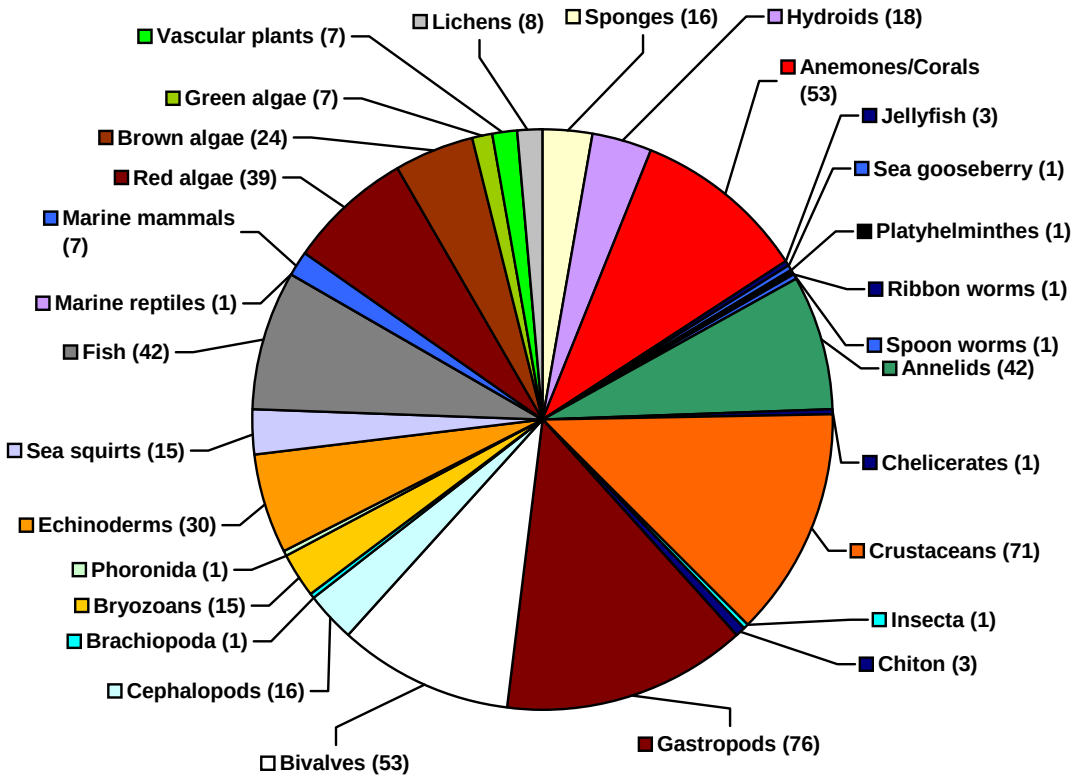


Figure 8. Range of species information on the *MarLIN* Web site (October 2004).

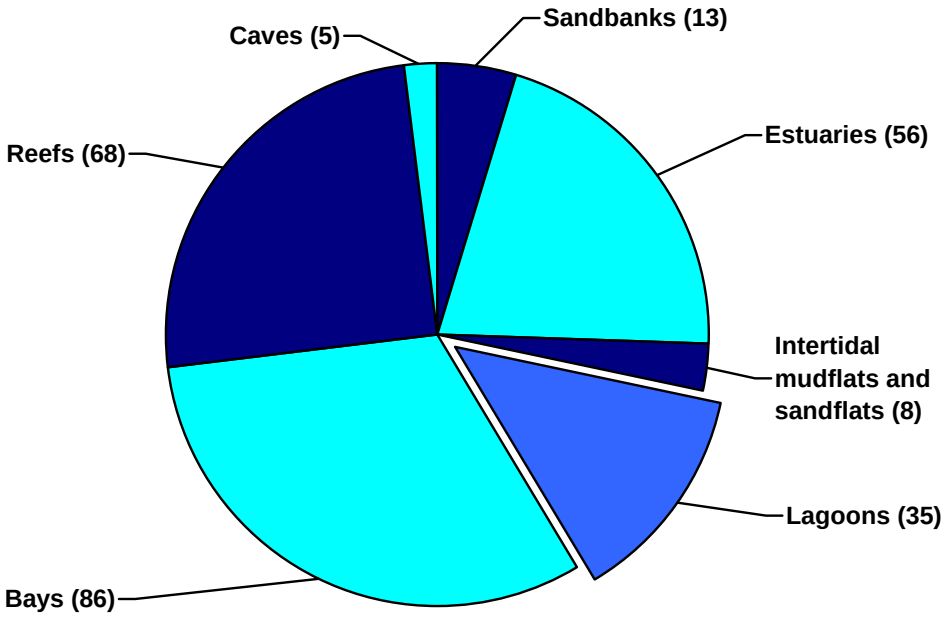


Figure 9. Number of research biotopes representative of the interest features of the EC Habitats Directive Annex I habitats (October 2004).

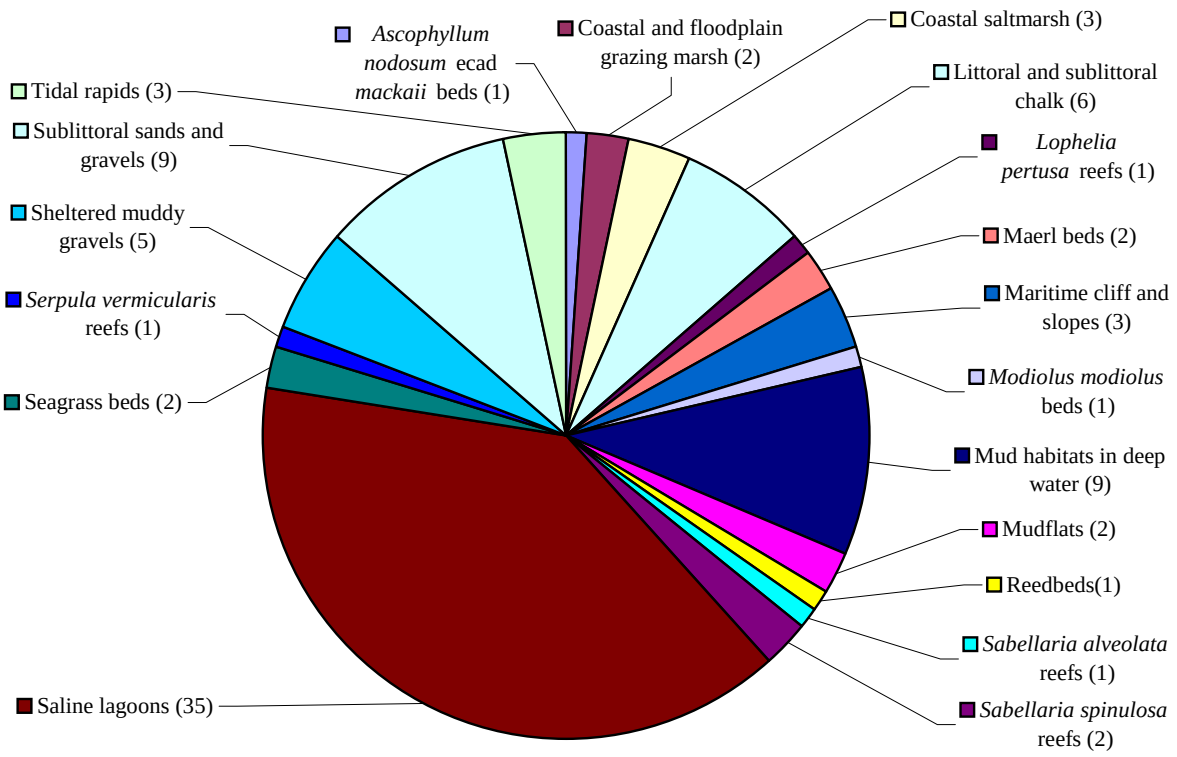


Figure 10. Number of researched biotopes that represent UK BAP habitats (October 2004).

A complete list of Biology and Sensitivity Key Information reviews completed by the end of October 2004 and their importance is given in Appendix 1. A complete list of species basic information and their importance is shown in Appendix 2. Species research completed or updated in the contract period is shown in Table 8 below.

6.5.3 OSPAR Annex V threatened and declining species

The OSPAR Annex V list of threatened and declining species and habitats was ratified late in the contract period (OSPAR, 2003). Therefore, *Aphrodita aculeata* was researched in 2002 because it was included on a preliminary list, although it was subsequently dropped from the OSPAR Annex V list of threatened and declining species in 2003. All the UK marine invertebrate species listed in the 2003 list have now been researched and full reviews are available on-line (Table 9). In addition, we researched Key Information reviews of the common skate *Dipturus batis* and the seahorse *Hippocampus hippocampus.* The review of *Gobius couchi* was completed in 2000. Although, *MarLIN* specializes in marine benthic species, we also host basic information on several vertebrates listed under OSPAR Annex V, i.e. the seahorse *Hippocampus guttulatus*, basking shark *Cetorhinus maximus,* leatherback turtle *Dermochelys coriacea,* and harbour porpoise *Phocoena phocoena.*

Table 8. Species information reviews researched or updated in the contract period. OSPAR= OSPAR Annex V threatened / declining species; UK BAP = UK Biodiversity Action Plan; W&C Act = Wildlife & Conservation Act (1981); Hab. Dir. = EC Habitat Directive; NI Act = Wildlife (NI) Order 1985; CITES = CITES Convention; Berne = Berne Convention. Review type; Basic= Basic information; Full= Biology and Sensitivity Key Information review.

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Full	A bivalve mollusc	*Abra alba*								Widespread	None	On-line
Basic	Spiny cockle	*Acanthocardia aculeata*								Rare	None	On-line
Basic	A bristled chiton	*Acanthochitona fascicularis*								Not available	None	On-line
Basic	A sea slug	*Acanthodoris pilosa*								Not available	None	On-line
Basic	Strawberry anemone	*Actinia fragacea*								Not available	None	On-line
Basic	Sandalled anemone	*Actinothoe sphyrodeta*								Not available	None	On-line
Basic	A sea slug	*Adalaria proxima*								Not available	None	On-line
Basic	Cloak anemone	*Adamsia carciniopados*								Not available	None	On-line
Basic	A sponge	*Adreus fascicularis*								Rare	None	On-line
Basic	Grey sea slug	*Aeolidia papillosa*								Not available	None	On-line
Basic	A sea slug	*Aeolidiella alderi*								Scarce	None	On-line
Basic	Queen scallop	*Aequipecten opercularis*								Not available	None	On-line
Basic	A red seaweed	*Aglaothamnion diaphanum*								Rare	None	On-line
Basic	A red seaweed	*Aglaothamnion priceanum*								Rare	None	On-line
Basic	Pogge	*Agonus cataphractus*								Not available	None	On-line
Full	A red seaweed	*Ahnfeltia plicata*								Widespread	None	Refereed
Basic	An erect bryozoan	*Alcyonidium diaphanum*								Not available	None	On-line
Basic	Pink sea fingers	*Alcyonium hibernicum*								Scarce	None	On-line
Basic	Pistol shrimp	*Alpheus glaber*								Not available	None	On-line
Basic	A spoon worm	*Amalosoma eddystonense*								Scarce	None	On-line
Basic	Lesser sand eel	*Ammodytes tobianus*								Not available	None	On-line
Basic	An amphipod	*Ampelisca brevicornis*								Not available	None	On-line
Basic	Small brittle star	*Amphipholis squamata*								Not available	None	On-line
Full	A brittlestar	*Amphiura chiajei*								Not available	None	With Referee
Basic	Wolf fish or Catfish	*Anarhichas lupus*								Not available	None	On-line
Basic	Common eel	*Anguilla anguilla*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	Thin tellin	*Angulus tenuis*								Not available	None	On-line
Basic	Saddle oyster	*Anomia ephippium*								Not available	None	On-line
Basic	Red speckled anemone	*Anthopleura ballii*								Not available	None	On-line
Full	Sea mouse	*Aphrodita aculeata*								Not available	None	On-line
Basic	A sea hare	*Aplysia punctata*								Not available	None	On-line
Basic	Common pelican's foot	*Aporrhais pespelecani*								Not available	None	On-line
Basic	Sea lemon	*Archidoris pseudoargus*								Not available	None	On-line
Full	Icelandic cyprine	*Arctica islandica*	•							Not available	None	On-line
Basic	Thrift	*Armeria maritima*								Not available	None	On-line
Basic	A sea slug	*Armina loveni*								Not available	None	On-line
Full	A sea squirt	*Ascidiella scabra*								Widespread	None	On-line
Basic	Brown sea cucumber	*Aslia lefevrei*								Not available	None	On-line
Basic	A brown seaweed	*Asperococcus scaber*								Scarce	None	On-line
Basic	A bivalve mollusc	*Astarte sulcata*								Not available	None	On-line
Basic	A sand star	*Astropecten irregularis*								Not available	None	On-line
Basic	Hooded shrimp	*Athanas nitescens*								Not available	None	On-line
Basic	Moon jellyfish	*Aurelia aurita*								Not available	None	On-line
Basic	A sponge	*Axinella damicornis*								Scarce	None	On-line
Basic	Minke whale	*Balaenoptera acutorostrata*		•	•	•	•	•	•	Not available	Low risk, near threatened (LR/nt)	On-line
Full	An amphipod	*Bathyporeia pelagica*								Not available	None	On-line
Basic	White piddock	*Barnea candida*								Not available	None	On-line
Basic	Yellow-plumed sea slug	*Berthella plumula*								Not available	None	On-line
Basic	Twin fan worm	*Bispira volutacornis*								Not available	None	On-line
Basic	Needle whelk	*Bittium reticulatum*								Not available	None	On-line
Basic	A green seaweed	*Blidingia minima*								Not available	None	On-line
Basic	A red seaweed	*Bornetia secundiflora*								Rare	None	On-line
Basic	A colonial sea squirt	*Botrylloides leachi*								Not available	None	On-line
Full	A heart urchin	*Brissopsis lyrifera*								Not available	None	Refereed
Basic	An erect bryozoan	*Bugula flabellata*								Not available	None	On-line
Basic	An erect bryozoan	*Bugula purpurotincta*								Scarce	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Full	An erect bryozoan	*Bugula turbinata*								Not available	None	On-line
Basic	Eyelash weed	*Calliblepharis ciliata*								Not available	None	On-line
Basic	Lance-shaped eyelash weed	*Calliblepharis jubata*								Not available	None	On-line
Basic	Common dragonet	*Callionymus lyra*								Not available	None	On-line
Basic	Painted top shell	*Calliostoma zizyphinum*								Not available	None	On-line
Basic	A red seaweed	*Callophyllis laciniata*								Not available	None	On-line
Basic	Orange sea lichen	*Caloplaca marina*								Not available	None	On-line
Basic	Chinaman's hat	*Calyptraea chinensis*								Not available	None	On-line
Full	Edible crab	*Cancer pagurus*								Not available	None	On-line
Full	Gallery worm	*Capitella capitata*								Widespread	None	On-line
Full	Common shore crab	*Carcinus maenas*								Not available	None	On-line
Basic	A brown seaweed	*Carpomitra costata*								Scarce	None	On-line
Basic	Southern cup coral	*Caryophyllia inornata*							•	Rare	None	On-line
Basic	Devonshire cup-coral	*Caryophyllia smithii*							•	Not available	None	On-line
Basic	A tube anemone	*Cerianthus lloydii*								Not available	None	On-line
Basic	A gastropod	*Cerithiopsis tubercularis*								Not available	None	On-line
Basic	A hermit crab	*Cestopagurus timidus*								Rare	None	On-line
Basic	Parchment worm	*Chaetopterus variopedatus*								Not available	None	On-line
Basic	Striped Venus clam	*Chamelea gallina*								Not available	None	On-line
Basic	Humpback scallop	*Chlamys distorta*								Not available	None	On-line
Basic	Variegated scallop	*Chlamys varia*								Not available	None	On-line
Basic	A red seaweed	*Chondria coerulescens*								Not available	None	On-line
Full	Carragheen	*Chondrus crispus*								Widespread	None	On-line
Basic	Compass jellyfish	*Chrysaora hysoscella*								Not available	None	On-line
Basic	A sponge	*Ciocalypta penicillus*								Not available	None	On-line
Basic	A bivalve	*Circomphalus casina*								Not available	None	On-line
Full	A bristleworm	*Cirratulus cirratus*								Not available	None	On-line
Full	A green seaweed	*Cladophora rupestris*								Widespread	None	Refereed
Basic	A gastropod	*Colus islandicus*								Not available	None	On-line
Full	A bryozoan	*Conopeum reticulum*								Not available	None	On-line
Full	Basket shell	*Corbula gibba*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Full	A hydroid	*Cordylophora caspia*								Not available	None	On-line
Full	A mud shrimp	*Corophium volutator*								Not available	None	On-line
Basic	A sea slug	*Coryphella gracilis*								Not available	None	On-line
Basic	Montagu's blenny	*Coryphoblennius galerita*								Not available	None	On-line
Full	Brown shrimp	*Crangon crangon*								Not available	None	On-line
Basic	Portuguese oyster	*Crassostrea gigas*								Not available	None	On-line
Basic	American Oyster	*Crassostrea virginica*								Not available	None	On-line
Basic	Corkwing wrasse	*Crenilabrus melops*								Not available	None	On-line
Basic	A red seaweed	*Cryptopleura ramosa*								Not available	None	On-line
Basic	A sea slug	*Cuthona foliata*								Not available	None	On-line
Basic	Lion's mane jellyfish	*Cyanea capillata*								Not available	None	On-line
Basic	Blue jellyfish	*Cyanea lamarckii*								Not available	None	On-line
Basic	A bryozoan	*Cylindroporella tubulosa*								Rare	None	On-line
Basic	Rainbow wrack	*Cystoseira tamariscifolia*								Not available	None	On-line
Basic	Short-beaked common dolphin	*Delphinus delphis*		•	•	•	•	•		Not available	None	On-line
Basic	Baked bean ascidian	*Dendrodoa grossularia*								Not available	None	On-line
Basic	A sea slug	*Dendronotus frondosus*								Not available	None	On-line
Basic	A sponge	*Desmacidon fruticosum*								Rare	None	On-line
Basic	A sea anemone	*Diadumene cincta*								Not available	None	On-line
Basic	A cumacean	*Diastylis rathkei*								Not available	None	On-line
Basic	Red rags	*Dilsea carnosa*								Not available	None	On-line
Full	Common skate	*Dipturus batis*	•	•						Not available	Endangered (EN A1abcd + 2bcd)	On-line
Basic	Lesser gooseberry sea squirt	*Distomus variolosus*								Not available	None	On-line
Basic	Rayed Artemis	*Dosinia exoleta*								Not available	None	On-line
Basic	Smooth Artemis	*Dosinia lupinus*								Not available	None	On-line
Basic	A red seaweed	*Drachiella spectabilis*								Not available	None	On-line
Basic	A nut crab	*Ebalia granulosa*								Scarce	None	On-line
Basic	A sea anemone	*Edwardsiella carnea*								Not available	None	On-line
Basic	An encrusting bryozoan	*Electra crustulenta*								Not available	None	On-line
Full	A sea mat	*Electra pilosa*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	An acorn barnacle	*Elminius modestus*								Not available	None	On-line
Basic	Slit limpet	*Emarginula fissura*								Not available	None	On-line
Basic	A sea slug	*Embletonia pulchra*								Not available	None	On-line
Basic	Common wentletrap	*Epitonium clathrus*								Not available	None	On-line
Basic	A sea anemone	*Epizoanthus couchii*								Widespread	None	On-line
Basic	Chinese mitten crab	*Eriocheir sinensis*								Not available	None	Signed-off
Basic	A sponge	*Esperiopsis fucorum*								Not available	None	On-line
Basic	A bristleworm	*Eteone longa*								Not available	None	On-line
Basic	An encrusting bryozoan	*Eucratea loricata*								Not available	None	On-line
Full	Speckled sea louse	*Eurydice pulchra*								Not available	None	On-line
Basic	Necklace shell	*Euspira catena*								Not available	None	On-line
Full	Bean-like tellin	*Fabulina fabula*								Widespread	None	On-line
Basic	A sea slug	*Facelina auriculata*								Not available	None	On-line
Full	Hornwrack	*Flustra foliacea*								Not available	None	On-line
Basic	Shore rockling	*Gaidropsarus mediterraneus*								Not available	None	On-line
Basic	A squat lobster	*Galathea squamifera*								Not available	None	In Progress
Basic	A sand shrimp	*Gammarus chevreuxi*								Scarce	None	On-line
Full	A gammarid shrimp	*Gammarus salinus*								Not available	None	On-line
Basic	Three-spined stickleback	*Gasterosteus aculeatus*								Not available	None	On-line
Basic	Dog cockle	*Glycymeris glycymeris*								Not available	None	On-line
Basic	Black goby	*Gobius niger*								Not available	None	On-line
Basic	Two spotted goby	*Gobiusculus flavescens*								Not available	None	On-line
Basic	A red seaweed	*Gracilaria multipartita*								Scarce	None	On-line
Basic	Herring-bone hydroid	*Halecium halecinum*								Not available	None	On-line
Basic	Grey seal	*Halichoerus grypus*			•			•		Not available	None	On-line
Full	Bowerbank's halichondria	*Halichondria bowerbanki*								Not available	None	On-line
Full	Breadcrumb sponge	*Halichondria panicea*								Widespread	None	With Referee
Basic	Mermaid's Glove	*Haliclona oculata*								Not available	None	On-line
Basic	Stalked jellyfish	*Haliclystus auricula*								Not available	None	On-line
Basic	Green ormer	*Haliotis tuberculata*								Not available	None	On-line
Basic	A scale worm	*Harmothoe lunulata*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	A hydroid	*Hartlaubella gelatinosa*								Rare	None	On-line
Basic	Wrinkled rock borer	*Hiatella arctica*								Not available	None	On-line
Basic	Thick-lipped dog whelk	*Hinia incrassata*								Not available	None	On-line
Basic	Long snouted seahorse	*Hippocampus guttulatus*	●					●	●	Not available	Vulnerable A2cd	On-line
Full	Short snouted seahorse	*Hippocampus hippocampus*	●					●	●	Not available	Data Deficient	Refereed
Basic	Weymouth carpet coral	*Hoplangia durotrix*							●	Rare	None	On-line
Basic	A sea anemone	*Hormathia coronata*								Not available	None	On-line
Basic	Great spider crab	*Hyas araneus*								Not available	None	On-line
Basic	A hydroid	*Hydractinia echinata*								Not available	None	On-line
Basic	A sponge	*Hymeniacidon perleve*								Not available	None	On-line
Basic	An isopod	*Idotea baltica*								Not available	None	On-line
Basic	A sea slater	*Idotea granulosa*								Not available	None	In Progress
Basic	Scorpion spider crab	*Inachus dorsettensis*								Not available	None	On-line
Basic	A bristleworm	*Janua pagenstecheri*								Not available	None	On-line
Basic	Grooved top shell	*Jujubinus striatus*								Rare	None	On-line
Basic	A hydroid	*Kirchenpaueria pinnata*								Not available	None	On-line
Basic	Ballan wrasse	*Labrus bergylta*								Not available	None	On-line
Basic	Cuckoo wrasse	*Labrus mixtus*								Not available	None	On-line
Basic	A bristleworm	*Lagis koreni*								Not available	None	On-line
Basic	A kelp	*Laminaria ochroleuca*								Not available	None	On-line
Basic	Foxtail stonewort	*Lamprothamnium papulosum*		●		●				Rare	Vulnerable	On-line
Full	Sand mason	*Lanice conchilega*								Not available	None	On-line
Basic	Common goose barnacle	*Lepas anatifera*								Not available	None	On-line
Basic	A chiton	*Leptochiton scabridus*								Scarce	None	On-line
Basic	Black lichen	*Lichina pygmaea*								Not available	None	On-line
Basic	Orange-clubbed sea slug	*Limacia clavigera*								Not available	None	On-line
Basic	Gaping file shell	*Limaria hians*								Not available	None	On-line
Basic	An oligochaete	*Limnodrilus hoffmeisteri*								Not available	None	On-line
Basic	Bootlace worm	*Lineus longissimus*								Not available	None	On-line
Basic	Shanny	*Lipophrys pholis*								Not available	None	On-line
Basic	Rough periwinkle	*Littorina saxatilis*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	A cold water coral	*Lophelia pertusa*			•				•	Not available	None	On-line
Basic	A red seaweed	*Lophosiphonia reptabunda*								Rare	None	On-line
Basic	Seven-armed starfish	*Luidia ciliaris*								Not available	None	On-line
Basic	A bristleworm	*Lumbrineris tetraura*								Not available	None	On-line
Basic	Slender spider crab	*Macropodia tenuirostris*								Not available	None	On-line
Full	A bristleworm	*Magelona mirabilis*								Widespread	None	Refereed
Basic	A fanworm	*Manayunkia aestuarina*								Not available	None	On-line
Basic	Pearly top shell	*Margarites helicinus*								Not available	None	On-line
Basic	Spiny starfish	*Marthasterias glacialis*								Not available	None	On-line
Basic	An acorn barnacle	*Megatrema anglicum*								Not available	None	On-line
Basic	Sea mat	*Membranipora membranacea*								Not available	None	On-line
Basic	A red seaweed	*Membranoptera alata*								Not available	None	On-line
Basic	Hard-shell clam	*Mercenaria mercenaria*								Not available	None	On-line
Basic	A sea anemone	*Mesacmaea mitchellii*								Scarce	None	On-line
Full	Plumose anemone	*Metridium senile*								Widespread	None	On-line
Basic	Marbled crenella	*Modiolarca tumida*								Not available	None	On-line
Full	Sea grapes	*Molgula manhattensis*								Widespread	None	On-line
Basic	Green crenella	*Musculus discors*								Widespread	None	On-line
Basic	Blunt gaper	*Mya truncata*								Not available	None	On-line
Basic	A bivalve mollusc	*Mysella bidentata*								Not available	None	On-line
Full	Common mussel	*Mytilus edulis*								Widespread	None	Refereed
Basic	A fanworm	*Myxicola infundibulum*								Not available	None	On-line
Basic	Sea beard	*Nemertesia antennina*								Not available	None	On-line
Basic	A pseudoscorpion	*Neobisium maritimum*								Not available	None	On-line
Full	An opossum shrimp	*Neomysis integer*								Not available	None	On-line
Full	Norway lobster	*Nephrops norvegicus*								Not available	None	On-line
Basic	White catworm	*Nephtys cirrosa*								Not available	None	On-line
Full	A catworm	*Nephtys hombergii*								Not available	None	On-line
Basic	A catworm	*Nephtys incisa*								Not available	None	On-line
Basic	Red whelk	*Neptunea antiqua*								Not available	None	On-line
Basic	Worm pipefish	*Nerophis lumbriciformis*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	A bristleworm	*Notomastus latericeus*								Not available	None	On-line
Full	Dog whelk	*Nucella lapillus*	●							Not available	None	Refereed
Full	A bivalve mollusc	*Nucula nitidosa*								Not available	None	On-line
Basic	A bivalve mollusc	*Nucula sulcata*								Not available	None	On-line
Full	A hydroid	*Obelia longissima*								Not available	None	On-line
Basic	Oyster drill	*Ocenebra erinacea*								Not available	None	On-line
Basic	Parelle	*Ochrolechia parella*								Not available	None	On-line
Basic	A sea cucumber	*Ocnus planci*								Not available	None	On-line
Basic	Celtic sea slug	*Onchidella celtica*								Scarce	None	On-line
Basic	A sea slug	*Onchidoris bilamellata*								Not available	None	On-line
Basic	A sea slug	*Onchidoris muricata*								Not available	None	On-line
Basic	Black brittlestar	*Ophiocomina nigra*								Not available	None	On-line
Basic	Crevice brittlestar	*Ophiopholis aculeata*								Not available	None	On-line
Full	Thick top shell	*Osilinus lineatus*								Widespread	None	On-line
Full	A tubeworm	*Owenia fusiformis*								Not available	None	On-line
Basic	A marbled rock crab	*Pachygrapsus marmoratus*								Not available	None	On-line
Basic	A sponge	*Pachymatisma johnstonia*								Not available	None	On-line
Basic	Hairy hermit crab	*Pagurus cuanensis*								Not available	None	On-line
Basic	A prawn	*Palaemon elegans*								Not available	None	On-line
Basic	Common prawn	*Palaemon serratus*								Not available	None	On-line
Basic	A sea slug	*Palio nothus*								Not available	None	On-line
Full	Lagoon snail	*Paludinella litorina*				●				Rare	None	Refereed
Basic	Tompot blenny	*Parablennius gattorugine*								Not available	None	On-line
Basic	Yellow cluster anemone	*Parazoanthus axinellae*								Scarce	None	On-line
Basic	A cockle	*Parvicardium ovale*								Not available	None	On-line
Basic	Black-footed limpet	*Patella depressa*								Not available	None	On-line
Full	China limpet	*Patella ulyssiponensis*	●							Widespread	None	On-line
Basic	Sea gherkin	*Pawsonia saxicola*								Not available	None	On-line
Basic	A burrowing sea anemone	*Peachia cylindrica*								Not available	None	On-line
Basic	An amphipod	*Pectenogammarus planicrurus*								Scarce	None	On-line
Basic	Phosphorescent sea pen	*Pennatula phosphorea*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	American piddock	*Petricola pholadiformis*								Not available	None	On-line
Basic	Sea bristletail	*Petrobius maritimus*								Not available	None	On-line
Basic	A razor shell	*Phaxas pellucidus*								Not available	None	On-line
Basic	Common or Harbour seal	*Phoca vitulina*			•		•			Not available	None	On-line
Basic	Butterfish	*Pholis gunnellus*								Not available	None	On-line
Basic	A horseshoe worm	*Phoronis hippocrepia*								Not available	None	On-line
Basic	Common reed	*Phragmites australis*								Widespread	None	On-line
Basic	Bristly crab	*Pilumnus hirtellus*								Not available	None	On-line
Basic	Sea gooseberry	*Pleurobrachia pileus*								Not available	None	On-line
Basic	A sea slug	*Pleurobranchus membranaceus*								Not available	None	On-line
Basic	A red seaweed	*Plocamium cartilagineum*								Not available	None	On-line
Basic	A red seaweed	*Plumaria plumosa*								Not available	None	On-line
Basic	Alder's necklace shell	*Polinices pulchellus*								Not available	None	On-line
Basic	A sea slug	*Polycera quadrilineata*								Not available	None	On-line
Basic	A sponge	*Polymastia mamillaris*								Not available	None	On-line
Full	A tubeworm	*Pomatoceros triqueter*								Not available	None	On-line
Basic	Fennel pondweed	*Potamogeton pectinatus*								Not available	None	On-line
Basic	A green seaweed	*Prasiola stipitata*								Not available	None	On-line
Basic	Candy striped flatworm	*Prostheceraeus vittatus*								Not available	None	On-line
Full	Green sea urchin	*Psammechinus miliaris*								Not available	None	Refereed
Basic	Turbot	*Psetta maxima*								Not available	None	On-line
Basic	A red seaweed	*Pterosiphonia pennata*								Scarce	None	On-line
Basic	A bristleworm	*Pygospio elegans*								Not available	None	On-line
Basic	Sea ivory	*Ramalina siliquosa*								Not available	None	On-line
Basic	Dustbin-lid jellyfish	*Rhizostoma octopus*								Not available	None	On-line
Full	A red seaweed	*Rhodothamniella floridula*								Uncommon	None	On-line
Basic	A snail	*Rissoa parva*								Not available	None	On-line
Basic	A mantis shrimp	*Rissoides desmaresti*								Scarce	None	On-line
Basic	Peacock worm	*Sabella pavonina*								Not available	None	On-line
Basic	A sea anemone	*Sagartia elegans*								Not available	None	On-line
Basic	Coral worm	*Salmacina dysteri*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	A bristleworm	*Scolelepis squamata*								Widespread	None	On-line
Basic	A bristleworm	*Scoloplos armiger*								Not available	None	On-line
Basic	Fifteen-spined stickleback	*Spinachia spinachia*								Not available	None	On-line
Full	A bristleworm	*Spio filicornis*								Not available	None	On-line
Full	A bristleworm	*Spiophanes bombyx*								Not available	None	On-line
Basic	A tubeworm	*Spirorbis spirorbis*								Not available	None	On-line
Basic	A bivalve mollusc	*Spisula elliptica*								Not available	None	On-line
Full	A surf clam	*Spisula solida*								Not available	None	On-line
Basic	Atlantic surf clam	*Spisula solidissima*								Not available	None	On-line
Basic	Orange sea grapes	*Stolonica socialis*								Not available	None	On-line
Basic	A sea squirt	*Styela clava*								Not available	None	On-line
Basic	A sea-squirt	*Styela gelatinosa*		•						Rare	None	On-line
Basic	A sponge	*Suberites carnosus*								Not available	None	On-line
Basic	A sponge	*Suberites ficus*								Not available	None	On-line
Basic	A sponge	*Suberites massa*								Not available	None	On-line
Basic	A sea slater	*Synisoma lancifer*								Scarce	None	On-line
Full	A sand hopper	*Talitrus saltator*								Widespread	None	On-line
Basic	Chequered carpet shell	*Tapes decussatus*								Not available	None	On-line
Basic	Manila clam	*Tapes philippinarum*								Not available	None	On-line
Basic	Long-spined sea scorpion	*Taurulus bubalis*								Not available	None	On-line
Basic	A bivalve mollusc	*Tellimya ferruginosa*								Not available	None	On-line
Basic	Black shields	*Tephromela atra*								Widespread	None	On-line
Basic	Leopard-spotted goby	*Thorogobius ephippiatus*								Not available	None	On-line
Basic	A bivalve mollusc	*Thracia convexa*								Not available	None	On-line
Basic	A bivalve mollusc	*Thracia villosiusucla*								Not available	None	On-line
Basic	A chiton	*Tonicella marmorea*								Not available	None	On-line
Basic	Pheasant shell	*Tricolia pullus*								Not available	None	On-line
Basic	Bib or Pouting	*Trisopterus luscus*								Not available	None	On-line
Basic	Arctic cowrie	*Trivia arctica*								Not available	None	On-line
Basic	Spotted cowrie	*Trivia monacha*								Not available	None	On-line
Basic	A sludge-worm	*Tubifex tubifex*								Not available	None	On-line

Review Type	Common Name	Scientific name	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National status	Red List (IUCN)	Review Status
Basic	A sludge-worm	*Tubificoides benedii*								Not available	None	On-line
Basic	Football jersey worm	*Tubulanus annulatus*								Not available	None	On-line
Basic	Oaten pipes hydroid	*Tubularia indivisa*								Not available	None	On-line
Basic	Orange peel bryozoan	*Turbicellepora magnicostata*								Rare	None	On-line
Basic	An auger shell	*Turritella communis*								Not available	None	On-line
Basic	Bottle-nose dolphin	*Tursiops truncatus*		•	•	•	•		•	Not available	Data deficient	On-line
Basic	A green seaweed	*Urospora wormskioldii*								Not available	None	On-line
Basic	By-the-wind-sailor	*Velella velella*								Not available	None	On-line
Basic	Velvet shell	*Velutina velutina*								Not available	None	On-line
Basic	Tar lichen	*Verrucaria maura*								Not available	None	On-line
Basic	A lichen	*Verrucaria mucosa*								Not available	None	On-line
Basic	Montagu's crab	*Xantho incisus*								Not available	None	On-line
Basic	Risso's crab	*Xantho pilipes*								Not available	None	On-line
Basic	Common orange lichen	*Xanthoria parietina*								Widespread	None	On-line
Basic	Penny weed	*Zanardinia typus*								Scarce	None	On-line

Table 9. OSPAR Annex V threatened and declining species on the *MarLIN* Web site

SPECIES			
Scientific name	**Common name**	***MarLIN* information**	**Comments**
Invertebrates			
Arctica islandica	Ocean quahog	Yes	Full review on-line
Megabalanus azoricus	Azorean Barnacle	None	Not UK
Nucella lapillus	Dog Whelk	Yes	Full review on-line
Ostrea edulis	Flat Oyster	Yes	Full review on-line
*Patella ulyssiponensis (*synonym *P. aspersa*)	Azorean Limpet	Yes	Full review on-line
Fish			
Acipenser sturio	Sturgeon	No	
Alosa alosa	Allis Shad	No	
Cetorhinus maximus	Basking Shark	Yes	Basic information
Coregonus lavaretus oxyrhinchus	Houting	No	
Dipturus batis (syn. Raja batis)	Common Skate	Yes	Full review on-line
Dipturus montagui (syn. Raja montagui)	Spotted Ray	No	
Gadus morhua – populations in the OSPAR regions II and III	Cod	No	
Gobius couchi	Couch's Goby	Yes	Full review on-line
Hippocampus hippocampus	Short-snouted Seahorse	Yes	Full review on-line
Hippocampus guttulatus (syn. Hippocampus ramulosus)	Long-snouted Seahorse	Yes	Basic information
Hoplostethus atlanticus	Orange Roughy	No	
Petromyzon marinus	Sea Lamprey	No	
Salmo salar	Salmon	No	
Thunnus thynnus	Bluefin tuna	No	
Reptiles			
Caretta caretta	Loggerhead Turtle	No	
Dermochelys coriacea	Leatherback Turtle	Yes	Basic information
Mammals			
Balaena mysticetus	Bowhead Whale	No	
Balaenoptera musculus	Blue Whale	No	
Eubalaena glacialis	Northern Right Whale	No	
Phocoena phocoena	Harbour Porpoise	Yes	Basic information

6.5.4 OSPAR Annex V threatened and declining habitats

Although biotope research was not included under the Defra contract, the *MarLIN* Web site hosts Biology and Sensitivity Key Information reviews of numerous relevant biotopes. The OSPAR Annex V list of threatened and declining habitats is shown in Table 10, together with their likely representative biotopes on the *MarLIN* Web site. Only two UK habitats are not represented by biotope reviews; 'Carbonate mounds' and 'Seamounts'. In both cases, there is little information at present on the communities likely to be associated with the habitat.

6.5.5 Indicator species

A preliminary list of potential indicator species was included in the list of priority species agreed at the beginning of the contract. At the end of the October 2004, the *MarLIN* Web site hosted 12 full Key Information reviews of potential indicator species and basic information on a further 22 species, many identified as EcoQO indicators (de Boer *et al.,* 2001) (Table 11).

Table 10. OSPAR Annex V threatened and declining habitats on the *MarLIN* Web site

HABITATS	*MarLIN* review	Comments
Carbonate mounds	No	No information on associated communities
Deep sea sponge aggregations	Yes	Represented by '*Suberites* spp. and other sponges with solitary ascidians on very sheltered circalittoral rock' (SCR.SubSoAs) biotope review.
Oceanic ridges with hydrothermal vents/fields	No	Not UK
Intertidal mudflats	Yes	Represented by 'Muddy sand shores' (LMS.MS) biotope complex review, and the '*Hediste diversicolor* and *Macoma balthica* in sandy mud shores' (LMU.HedMac) and 'Dense *Lanice conchilega* in tide-swept lower shore sand' (LGS.Lan) biotope reviews.
Littoral chalk communities	Yes	Represented by 'Chrysophyceae on vertical upper littoral fringe soft rock' (LR.Chr) and '*Rhodothamniella floridula* in upper littoral fringe soft rock caves' biotope reviews.
Lophelia pertusa reefs	Yes	Represented by '*Lophelia* reefs' (COR.Lop) biotope review
Ostrea edulis beds	Yes	Represented by '*Ostrea edulis* beds on shallow sublittoral muddy sediment' (IMX.Ost) biotope review.
Seamounts	No	No information on associated communities
Sea pen and burrowing megafauna communities	Yes	Represented by 'Sea pens and burrowing megafauna in circalittoral soft mud' (CMU.SpMeg) biotope review.
Zostera beds	Yes	Represented by '*Zostera marina*/*angustifolia* beds in lower shore or infralittoral clean or muddy sand' (IMS.Zmar) and *Zostera noltii* beds in upper to mid shore muddy sand (LMS.Znol) biotope reviews

Table 11. Potential indicator species information on *MarLIN.*

Common Name	Scientific name	Type	Review status	Potential indicator of
Icelandic cyprine	*Arctica islandica*	Full	On-line	Eutrophication, EcoQ vulnerable indicator
Sea mouse	*Aphrodita aculeata*	Full	On-line	Fisheries, EcoQ vulnerable indicator
Edible crab	*Cancer pagurus*	Full	On-line	EcoQ vulnerable indicator
Gallery worm	*Capitella capitata*	Full	On-line	Eutrophication
Common shore crab	*Carcinus maenas*	Full	On-line	Endocrine disruption, cold winters, and hypoxia
A bristleworm	*Cirratulus cirratus*	Full	On-line	Eutrophication
A mud shrimp	*Corophium volutator*	Full	On-line	Endocrine disruption
Brown shrimp	*Crangon crangon*	Full	On-line	Cold winters and hypoxia
Norway lobster	*Nephrops norvegicus*	Full	On-line	Hypoxia
A bivalve mollusc	*Nucula nitidosa*	Full	On-line	Eutrophication
A tubeworm	*Owenia fusiformis*	Full	On-line	Oil & gas extraction, EcoQ opportunist indicator
A surf clam	*Spisula solida*	Full	On-line	Hypoxia, oil & gas extraction EcoQ vulnerable indicator
An amphipod	*Ampelisca brevicornis*	Basic	On-line	EcoQ vulnerable indicator
A bristleworm	*Ampharete falcata*	Basic	On-line	Hypoxia
Thin tellin	*Angulus tenuis*	Basic	On-line	Cold winters
A cumacean	*Diastylis rathkei*	Basic	On-line	Hypoxia

Table 11 (continued). Potential indicator species information on *MarLIN.*

Common Name	Scientific name	Type	Review status	Potential indicator of
A scale worm	*Harmothoe lunulata*	Basic	On-line	Cold winters
A red seaweed	*Membranoptera alata*	Basic	On-line	Oil & gas extraction
A bivalve mollusc	*Mysella bidentata*	Basic	On-line	Cold winters, oil & gas extraction
A catworm	*Nephtys incisa*	Basic	On-line	EcoQ opportunist indicator
A green seaweed	*Prasiola stipitata*	Basic	On-line	Eutrophication
A bristleworm	*Scoloplos armiger*	Basic	On-line	Oil & gas extraction
Common pelican's foot	*Aporrhais pespelecani*	Basic	On-line	Eutrophication
Smooth Artemis	*Dosinia lupinus*	Basic	On-line	EcoQ vulnerable indicator
Dog cockle	*Glycymeris glycymeris*	Basic	On-line	EcoQ vulnerable indicator
Red whelk	*Neptunea antiqua*	Basic	On-line	EcoQ vulnerable indicator
A bristleworm	*Notomastus latericeus*	Basic	On-line	EcoQ opportunist indicator
Crevice brittlestar	*Ophiopholis aculeata*	Basic	On-line	Fisheries
A razor shell	*Phaxas pellucidus*	Basic	On-line	EcoQ vulnerable indicator
A horseshoe worm	*Phoronis hippocrepia*	Basic	On-line	Fisheries
A bivalve mollusc	*Spisula elliptica*	Basic	On-line	Hypoxia, oil & gas extraction, EcoQ vulnerable indicator
A bivalve mollusc	*Thracia convexa*	Basic	On-line	EcoQ vulnerable indicator
A bivalve mollusc	*Thracia villosiusucla*	Basic	On-line	EcoQ vulnerable indicator
An auger shell	*Turritella communis*	Basic	On-line	Eutrophication

7. Linking sensitivity information and marine benthic survey data

7.1 Introduction

Objective 2 of the contract was:

To develop links between sensitivity and survey data, utilizing GIS technology to increase functionality and speed of access to data.

While Objective 6 of the contract was:

To identify locations of nationally important benthic species and habitats, at particular risk from pollution from accidental oil spills, to contribute to 3-yearly reviews of MEHRAs environmental sensitivity data.

There is an increasing demand for accessibility to map-based information in environmental management. For example, the commercial sector (e.g. consultants and developers) requires site-based information on existing survey data and map-based data to place proposed developments into a regional context for cumulative impact assessment. While government regulators and statutory agencies require map-based data to provide a regional or strategic overview of the extent of species/biotope distributions, biodiversity, their sensitivity, and their importance for regional environmental management and planning policy development.

From its inception, *MarLIN* aimed to develop a map-based decision support tool in environmental management and protection. In order to achieve this, links need to be made between information on the distribution of marine species, biotopes and habitats, and information on their importance and likely sensitivity to environmental perturbation. Therefore, objectives 2 and 4 aimed to develop in house Geographical Information Systems (GIS) to map the distribution of sensitive species habitats within the UK. The functionality of GIS allows the information to be interrogated directly to display the relevant benthic survey data and hyperlink to relevant sensitivity information via the Internet.

7.2 Sensitivity Mapping Advisory Group

The Sensitivity Mapping Advisory Group was convened on 10 December 2002, in Dublin, Ireland. The advisory group included representatives of statutory conservation agencies, environmental consultancies and marine industries (e.g. oil and gas). The members of the advisory group are shown in Table 12.

Table 12. Sensitivity Mapping Advisory Group members

Representative	Organization
Mr David Connor	Joint Nature Conservation Committee
Ms Victoria Copley	English Nature
Mr Matt Dalkin	Scottish Natural Heritage
Dr Paul Gilliland	English Nature
Dr Anthony Grehan	Martin Ryan Institute
Dr Beth Greenaway	Department for Environment, Food and Rural Affairs
Dr Dan Laffoley	English Nature
Dr John Hartley	UKOOA
Dr Keith Hiscock	Marine Biological Association of the UK (MBA)
Dr Louise Lieberknecht	Joint Nature Conservation Committee
Dr Mandy McMath / Dr James Dargie	Countryside Council for Wales
Dr Stuart Rogers	Centre for Environment, Fisheries and Aquaculture Sciences
Mr Mike Kendall	Plymouth Marine Laboratory (PML)

The inaugural meeting of the Sensitivity Mapping Advisory Group in Dublin (December 2002) agreed that the sensitivity information prepared by *MarLIN* to produce sensitivity maps had a potentially important role in environmental management and protection. The Advisory Group made the following key recommendations:

i) combine sensitivity (=intolerance) and recoverability to provide a single sensitivity scale;

ii) identify opportunities to 'tag' broad-scale maps with sensitivity information; and

iii) further development would require collaboration with others.

The Sensitivity Mapping Advisory Group was combined with the existing Biology & Sensitivity Key Information Technical Advisory Group towards the end of the contract. Members of both advisory groups were consulted about development of the combined 'sensitivity' scale and sensitivity mapping during the contract and provided useful feedback and comments.

7.3 A combined 'sensitivity' scale

7.3.1 Introduction

The *MarLIN* programme used a *sensu stricto* definition of 'sensitivity', while SensMap and other reports developed a more broad sense (*sensu lato*) definition. The definition of 'sensitivity' used in the Marine Stewardship Report (Defra, 2002), and that was developed as part of the Review of Marine Nature Conservation (RMNC), differs from that developed in the *MarLIN* programme (Hiscock *et al.,* 1999; Tyler-Walters *et al.*, 2001). The RMNC (see Laffoley *et al.*, 2000) defined 'sensitivity' as follows:

"A very sensitive habitat or species is one that is very easily adversely affected by external factors arising from human activities and is expected to recover over a very long period or not at all. A sensitive habitat or species is one that is easily affected by a human activity, and is expected to only recover over a long period."

The JNCC Marine Habitats Team also suggested a single 'sensitivity' rank (*sensu lato*) as part of JNCC's advice to OSPAR for the identification of priority species.

While the *MarLIN* definition of sensitivity was strictly correct, it was felt that a broader definition would convey a general level of understanding to a wider audience. In addition, the practical application of sensitivity information in a map-based system required the combination of the *MarLIN* 'sensitivity' and 'recoverability' ranks, in order to give a single overall assessment of the likely damage to the habitat or species, as agreed by the Sensitivity Mapping Advisory Group. A single scale would have considerable benefits for those involved in environmental protection, who do not want too many steps in their interpretation of likely damage to species or biotopes.

7.3.2 Rationale and approach

MarLIN adopted the term 'intolerance' for 'sensitivity' *sensu stricto*, and used the rationale developed below to combine 'intolerance' and 'recoverability' into an overall 'sensitivity' *sensu lato* scale. Therefore, 'intolerance' was used for all prior instances of the term 'sensitivity' including prior 'sensitivity assessments'. The term 'sensitivity' now refers to the combination of 'intolerance' and 'recoverability'.

The rationale uses the following definitions.

- **'Intolerance' (was 'sensitivity' *sensu stricto)*** is the susceptibility of a habitat, community or species (i.e. the components of a biotope) to damage, or death, from an external factor. Intolerance must be assessed relative to change in a specific factor.
- **'Recoverability'** is the ability of a habitat, community or species (i.e. the components of a biotope) to return to a state close to that which existed before the activity or event caused change.
- **'Sensitivity'** is dependent on the intolerance of a species or habitat to damage from an external factor and the time taken for its subsequent recovery. For example, a "highly sensitive" species or habitat is one that is very adversely affected by an external factor arising from human activities or natural events (killed / destroyed, 'high' intolerance) and is expected to recover only over a very long period of time, (10 to 25 years, 'low' recoverability). Intolerance, and hence sensitivity, must be assessed relative to a specified change in a specific environmental factor.

The rationale shown in Table 13 takes into account the fact that, while many sensitive habitats and species will be adversely affected, even destroyed, by an activity or event, such effects 'matter' to the continued survival of that feature if it does not have the potential to recover. 'Intolerance' and hence 'sensitivity' are assessed relative to a change in a specified external factor.

The rationale uses the question 'does it matter if…?', together with the definitions of sensitive habitats and species proposed in the RMNC (Laffoley *et al.*, 2000) as touch-stones throughout. In addition, due to the importance of recoverability in assessing the overall survival of a habitat or species population, the sensitivity scale proposed below is intuitively weighted towards recoverability. The sensitivity scales and definitions were designed to be meaningful in marine environmental management, protection, and conservation.

NB: Where there is insufficient information to assess the recoverability of a habitat or species ('insufficient information') the 'precautionary principle' is used and the 'recovery' *assumed* to take a very long time i.e. 'low' recoverability in the derivation of a sensitivity rank.

Table 13. Defining 'sensitivity' *sensu lato* for habitats and species. **='Reduced viability' includes physiological stress, reduced fecundity or growth, and partial death of a colonial animal or plant.

Sensitivity scale	Sensitivity definition or scenario
Very High	'Very high' sensitivity is indicated by the following scenario: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (either killed/destroyed, 'high' intolerance) and is expected to recover only over a prolonged period of time, i.e. >25 years or not at all (recoverability is 'very low' or 'none'). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is not expected to recover at all (recoverability is 'none').
High	'High' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years ('low' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) and is expected to recover over a very long period of time, i.e. >10 years (recoverability is 'low', or 'very low'). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is not expected to recover at all (recoverability is 'none'), so that the habitat or species may be vulnerable to subsequent damage.
Moderate	'Moderate' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to take more than 1 year or up to 10 years to recover ('moderate' or 'high' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) and is expected to recover over a long period of time, i.e. >5 or up to 10 years ('moderate' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover over a very long period of time, i.e. >10 years (recoverability is 'low', 'very low'), during which time the habitat or species may be vulnerable to subsequent damage.
Low	'Low' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to recover rapidly, i.e. within 1 year ('very high' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is expected to recover in a short period of time, i.e. within 1 year or up to 5 years ('very high' or 'high' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to take more than 1 year or up to 10 years to recover ('moderate' or 'high' recoverability).
Very low	'Very low' is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to recover rapidly i.e. within a week ('immediate' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is expected to recover rapidly, i.e. within a week ('immediate' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover within a year ('very high' recoverability).

Table 13 (continued). Defining 'sensitivity' *sensu lato* for habitats and species. **='Reduced viability' includes physiological stress, reduced fecundity or growth, and partial death of a colonial animal or plant.

Sensitivity scale	Sensitivity definition or scenario
Not sensitive	'Not sensitive' is indicated by the following scenarios: • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover rapidly, i.e. within a week ('immediate' recoverability). • The habitat or species is tolerant of changes in the external factor.
Not sensitive*	The habitat or species may benefit from the change in an external factor (intolerance has been assessed as 'tolerant*').
Not relevant	The habitat or species is protected from changes in an external factor (i.e. through a burrowing habit or depth), or is able to avoid the external factor.

The above definitions and scenarios give rise to the decision matrix shown in Table 14. The decision matrix is used to automate the combination of 'intolerance' and 'recoverability' within the *MarLIN* biology and sensitivity database (see Section 5).

The decision matrix shown in Table 14 is not symmetrical because the scale represents scenarios, in which the potential damage to the species or habitat 'matters'. The scale is intuitively weighted towards recoverability, although in a few cases intolerance has been given a greater weight rather than under-estimate the potential sensitivity of marine habitats and species.

Table 14. Combining 'intolerance' and 'recoverability' assessments to determine 'sensitivity'.

		Recoverability						
		None	***Very low (>25 yr.)***	***Low (>10–25 yr.)***	***Moderate (>5 -10 yr.)***	***High (1 -5 yr.)***	***Very high (<1 yr.)***	***Immediate (< 1 week)***
Intolerance	***High***	**Very high**	**Very high**	**High**	**Moderate**	**Moderate**	**Low**	**Very low**
	Intermediate	**Very high**	**High**	**High**	**Moderate**	**Low**	**Low**	**Very Low**
	Low	**High**	**Moderate**	**Moderate**	**Low**	**Low**	**Very Low**	**Not sensitive**
	Tolerant	**Not sensitive**	**Not sensitive**	**Not sensitive**	**Not sensitive**	**Not sensitive**	**Not sensitive**	**Not sensitive**
	Tolerant*	**Not sensitive***	**Not sensitive***	**Not sensitive***	**Not sensitive***	**Not sensitive***	**Not sensitive***	**Not sensitive***
	Not relevant	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*

7.4 Updating existing scales and definitions

The adoption of the term 'intolerance' for sensitivity *sensu stricto* required the amendment of the former definition of sensitivity and our sensitivity assessment rationale. The revised sensitivity assessment rationale and definitions are shown in Appendix 4.

The revisions also had the following consequences for the database and the Web site:

- amendment of the on-line glossaries of terms;
- amendment of the 'sensitivity' matrix shown on the Web pages to accommodate an additional column for the revised sensitivity scale (intolerance, recoverability and confidence will still be shown);

- amendment of all mentions of the term 'sensitivity' *sensu stricto* in the explanatory text for each 'intolerance' assessment;
- amendment of our decision trees and rationale for biotope 'intolerance' assessment, and
- amendment of the activities to factors search to query for 'sensitive' rather than 'intolerant' habitats and species.

The definitions and scales used for recoverability did not need to be amended. Data researchers continued to assess 'intolerance' and 'recoverability', which were then combined, as above, to give an assessment of 'sensitivity'. Biotope 'intolerance' will be derived from the 'intolerance' assessments of the 'species indicative of sensitivity' using the same rationale as previously used to derive biotope 'sensitivity' *sensu stricto*. The rationale remains the same while the term used were changed as shown in Appendix 4.

7.5 Review of sensitivity, intolerance and recoverability across species and biotopes

A review of the relative sensitivities of the ca 150 species and 117 biotopes in the Biology and Sensitivity Key Information was carried out in order to check that the combined sensitivity scale resulted in meaningful results.

The sensitivity, intolerance and recoverability of all the species or biotopes in the biology and sensitivity database were tabulated for all of the environmental factors assessed, with the exception of 'noise', 'visual presence', 'radionuclide contamination', 'diseases and parasites', and 'non-native species'. The above were excluded because the vast majority of assessments were 'not sensitive', 'not relevant' or insufficient information'. Decreases in a factor, where relevant, were also been excluded since assessments had only been made for less than 50% of the reviews, since the distinction between 'increase' and 'decrease' was made in 2001 (see Tyler-Walters *et al.*, 2001).

The relative sensitivity of researched species is shown in Appendix 5 and biotopes in Appendix 6. Those species assessed as 'Very high' or 'High' sensitivity to any factor are listed in Table 15. 'Very high' and 'High' sensitivity biotopes are shown in Table 16.

Overall, the review demonstrated the following:

- in the majority of cases, species that are considered to be 'sensitive' or 'threatened' (i.e. are protected or designated) are amongst the most sensitive species in the *MarLIN* database;
- with the exception of the factors excluded and listed above, the factors result in a range of sensitivities from very high to very low;
- 'moderate' and 'low' sensitivity are recorded more than any other;
- species and biotopes exhibit the greatest sensitivity to 'substratum loss' but the lowest sensitivity to changes in turbidity (light attenuation);
- the greatest number of records of 'insufficient information' were reported for chemical contaminants in both species and biotopes, and
- the majority of species and biotopes were recorded to have a 'high' recoverability (greater than 1 but less than 5 years) from 'high' or 'intermediate' intolerance;

No other trends were noticeable. Targeted extraction and non-targeted extraction (e.g. by-catch) showed marked numbers of records of 'not relevant' because in many cases species that were not subject to commercial fisheries were vulnerable to by-catch, and *vice-versa*.

Overall, the combined sensitivity ranks were consistent with those marine benthic species and habitats that were thought to be sensitive, in decline, threatened, or need or protection, e.g. UK BAP species and habitats. For example, maerl and *Zostera* seagrass beds are assessed as particularly sensitive species and habitats, while deep sea sponge communities, serpulid worm and deep water coral (*Lophelia)* reefs are particularly sensitive habitats.

Tables similar to those shown in Table 15 were prepared for a meeting of the International Council for the Exploration of the Sea (ICES) 'Study Group on Ecological Quality Objectives for Sensitive and for Opportunistic Benthos Species' (SGSOBS) in Copenhagen in April 2004. In addition, the tables were used to inform a report on potential seabed indicator species for the Environment Agency (EA) and JNCC in support of implementation of the Water Framework Directive (Hiscock *et al.*, 2004).

Table 15. Very highly and highly sensitive (combined scale) species within the Biology and Sensitivity Key Information database (VH= VH; H= High; M= Moderate) in order of sensitivity.

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Sunset cup coral	*Leptopsammia pruvoti*	VH	VH	H	VH	VH		H		H					VH	H	VH	VH		
Maerl	*Lithothamnion corallioides*	VH	VH	VH	VH	VH									VH		VH			
Northern hatchet shell	*Thyasira gouldi*	VH			VH	VH		VH		VH				VH			VH			
Starlet sea anemone	*Nematostella vectensis*	VH			VH	VH	VH			VH							VH			
Maerl	*Phymatolithon calcareum*	VH	VH	VH	VH	VH											VH			
Maerl	*Lithothamnion glaciale*	VH	VH	H	VH	VH	H	H	H	H				H			VH	H	H	H
Common eelgrass	*Zostera marina*	VH	VH						VH	VH				VH				H		
Native oyster	*Ostrea edulis*	VH	VH		H	H				H	VH	H				H	H		VH	
A hydroid	*Clavopsella navis*	VH	H	H	VH	VH											H	VH		
Lagoon sea slug	*Tenellia adspersa*	VH	VH		VH	VH				H										
Fan mussel	*Atrina fragilis*	VH	H				H	H		H							VH	VH	H	
Lagoon sandworm	*Armandia cirrhosa*	VH					H			VH					VH					
Looping snail	*Truncatella subcylindrica*	H	H							H	VH						VH	H		H
Pink sea fan	*Eunicella verrucosa*	VH														VH				
Lagoon snail	*Paludinella litorina*	H	H		H					H							VH	H		H
Tentacled lagoon worm	*Alkmaria romijni*	VH	H				H			H							H	H		
Sea fan anemone	*Amphianthus dohrnii*	VH															H	H		
DeFolin's lagoon snail	*Caecum armoricum*	VH			H	H											H			
An amphipod	*Jassa falcata*												VH							
A surf clam	*Spisula solida*															VH				
A branching sponge	*Axinella dissimilis*	H	H	H	H	H		H		H					H	H	H	H		

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Horse mussel	*Modiolus modiolus*	H	H		H	H	H	H		H	H						H		H	H
Gravel sea cucumber	*Neopentadactyla mixta*	H		H	H	H	H	H		H					H		H			H
Knotted wrack	*Ascophyllum nodosum*	H	H			H	H			H	H						H	H	H	
Lagoon cockle	*Cerastoderma glaucum*	H	H		H	H	H			H				H		H				
Ivell's sea anemone	*Edwardsia ivelli*	H	H		H	H	H			H							H			
Lagoon sand shrimp	*Gammarus insensibilis*	H							H	H	H		H					H		
The tall sea pen	*Funiculina quadrangularis*	H					H			H										H
An encrusting coralline alga	*Lithophyllum incrustans*	H			H	H					H									
Dwarf eelgrass	*Zostera noltii*	H	H							H										H
A bristleworm	*Cirratulus cirratus*	H	H								H									
Dog whelk	*Nucella lapillus*	H									H			H						
Icelandic cyprine	*Arctica islandica*	H						H												
Common Skate	*Dipturus batis*																		H	

Table 16. 'Very high' and 'high' sensitivity (combined scale) biotopes within the Biology and Sensitivity Key Information database (VH= Very high; H= H), in order of sensitivity.

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Phymatolithon calcareum maerl beds with hydroids and echinoderms in deeper infralittoral clean gravel or coarse sand	IGS.Phy.HEc	VH	VH	VH	VH	VH			H						VH	VH	VH			
Lithothamnion glaciale maerl beds in tide-swept variable salinity infralittoral gravel	IGS.Lgla	VH	VH	H	VH	VH	H	H		H				H			VH		VH	VH
Erect sponges, *Eunicella verrucosa* and *Pentapora fascialis* on slightly tide-swept moderately exposed circalittoral rock.	MCR.ErSEun	VH								H					VH	H	VH	VH	VH	H
Ostrea edulis beds on shallow sublittoral muddy sediment	IMX.Ost	VH	VH				H			VH	VH	H							VH	
Zostera marina/*angustifolia* beds in lower shore or infralittoral clean or muddy sand	IMS.Zmar	VH	VH						VH	VH				VH				H		
Serpula vermicularis reefs on very sheltered circalittoral muddy sand	CMS.Ser	VH					VH			VH					VH			VH		
Modiolus modiolus beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata	MCR.ModT	VH	H				H	H		H	VH						H	H	VH	VH
Yellow and grey lichens on supralittoral rock	LR.YG	VH			H					*	VH		VH	H			H	VH	H	
Lophelia reefs	COR.Lop	VH						VH									VH	H	H	VH
Zostera noltii beds in upper to mid shore muddy sand	LMS.Znol	H	H							VH				VH				VH		VH
Caves and overhangs (deep)	CR.Cv	VH	H							H						H	VH	VH	H	
Muddy sand shores	LMS.MS									H	VH	VH	VH							

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Halcampa chrysanthellum and *Edwardsia timida* on sublittoral clean stone gravel	IGS.HalEdw	H					VH			VH										
Ceramium sp. and piddocks on eulittoral fossilised peat	MLR.RPid	VH																		
Brissopsis lyrifera and *Amphiura chiajei* in circalittoral mud	CMU.BriAchi			*						VH										
Styela gelatinosa and other solitary ascidians on very sheltered deep circalittoral muddy sediment	COS.Sty							VH												
Ascophyllum nodosum ecad *mackaii* beds on extremely sheltered mid eulittoral mixed substrata	SLR.AscX.mac	H	H				H			H				H	H					
Limaria hians beds in tide-swept sublittoral muddy mixed sediment	IMX.Lim	H					H			H	H						H		H	
Ascophyllum nodosum on very sheltered mid eulittoral rock.	SLR.Asc	H								H					H		H	H		
Ascophyllum nodosum with epiphytic sponges and ascidians on variable salinity infralittoral rock	SIR.AscSAs	H								H	H						H	H		
Halidrys siliquosa and mixed kelps on tide-swept infralittoral rock with coarse sediment.	MIR.HalXK									H									*	
Overhangs and caves	LR.Ov										H									
Pioneer saltmarsh.	LMU.Sm												H							
Foraminiferans and *Thyasira* sp. in deep circalittoral soft mud	COS.ForThy							H												

7.6 Assessing sensitivities at the biotope complex, lifeform, and habitat complex levels

The Sensitivity Mapping Advisory Group suggested that *MarLIN* developed an approach to assessing the sensitivity of broader scale units than biotopes, i.e. biotope complexes, habitat complexes or 'lifeforms'. Environmental managers require information at different scales, depending on the spatial scale of the management plan or the management scenario. For example, site managers, e.g. of intertidal SSSIs or marine SACs, require detailed information to biotope and species scales. However, emergency response and contingency planning probably requires information at the habitat complex (e.g. littoral mudflats, seagrass beds) scales, while regional planning or strategic environmental assessment may require information at the marine landscape level.

The SensMap report (McMath *et al.,* 2000) suggested the following approaches for the derivation of the sensitivity of biotope complexes, lifeform or habitat complexes.

Where information on the sensitivity of biotopes exists:

1. **a mean sensitivity** of a geographically refined list of component biotopes, taking biotope areas into consideration; ***or***
2. **the highest sensitivity** of a geographically refined list of component biotopes can be used.

Alternatively, where no biotope sensitivity information exists:

3. **the sensitivity of the biotope complex or 'lifeform'** can be derived in the same manner as biotopes themselves, by identification of species indicative of sensitivity.

The first proposal would require an accurate knowledge of the extent of the component biotopes in order to 'weight' the mean sensitivity. However, *MarLIN* felt that a mean sensitivity could potentially underestimate sensitivity.

The second proposal agrees with present thinking by *MarLIN*, that is:

- **Reporting the highest sensitivity of the component biotopes** is simple and practical but does not detract from the information on the sensitivity of the component biotopes since, in any computer-based system, the information for the derivation of sensitivity is directly available.
- **Reporting the highest or worst-case sensitivity may exaggerate overall sensitivity.** However, the author considers that the worst-case scenario fulfils the aims of coastal sensitivity mapping, i.e. to identify or 'flag' potential impacts and areas where special care or management may be required.
- **Reporting the worst case sensitivity can also be applied with equal transparency** to all levels of the biotope hierarchy, biotope complex, lifeform or habitat complex.

In the absence of biotope sensitivity information, it may be possible to assess the sensitivity of biotope complexes based on the sensitivity of their component species (the third proposal). *MarLIN* has researched two biotope complexes, pioneer salt marsh (LMU.Sm) and muddy sand shores (LMS.MS), as separate entities. However, no species indicative of sensitivity were identified since the biotope complexes encompassed a wide range of biotopes of different community composition. Similarly, the chosen 'represented' biotopes were grouped by their similarity in species composition ('key' and 'important characterizing') as well as by habitat. It was found that while biotopes within a biotope complex shared a similar habitat, they often did not share 'important characterizing' or characterizing species. The difference in the general ecology and species composition of the component biotopes is likely to increase further up the biotope hierarchy, i.e. at the 'lifeform' or habitat complex level. Therefore, biotope sensitivities are probably the most

practical units for the derivation of the sensitivities of biotope complexes, lifeforms, or habitat complexes. Overall, *MarLIN* endorsed the second proposal suggested in the SensMap report.

In concept, if provided with map-based data on the distribution of species, biotopes or broader-scale mapping units, then:

- the biotope sensitivities determined within the *MarLIN* programme could easily be linked to geographically refined lists of biotopes to produce overall sensitivities;
- a computer-based mapping system would allow the users to interrogate sensitivity maps of, for example biotope complexes or 'lifeforms', to display the list of component biotopes and their sensitivities, and
- where a geographical area contains sensitive biotopes of very limited extent, their sensitivities could be 'flagged' by means of target noting.

7.7 Sensitivity mapping in marine environmental management

7.7.1 Introduction

Objectives 2 and 6 above required *MarLIN* to link marine benthic data and sensitivity information in a GIS to map the likely sensitivity of species and biotopes. *MarLIN* took advantage of additional contracts to test our ideas and demonstrate our approach. The first contract experimented with the sensitivity assessment of broad scale mapping units, the Marine Landscapes, as part of the Irish Sea Pilot under contract to English Nature (EN) and the JNCC. The second contract used Phase I biotope maps of two marine SACs to identify areas likely to be sensitive to oil spills for CCW, a demonstration of the identification of areas sensitive to oil spills, under Objective 6 of the contract. In addition, we have recently taken advantage of a CEFAS contract to trial mapping of biotope complex sensitivity.

7.7.2 Irish Sea Pilot trial sensitivity maps.

The purpose of the Irish Sea Pilot contract was to trial mapping the sensitivity of species, biotopes, and Marine Landscapes within the Irish Sea. The results of the Irish Sea Pilot trial are discussed in Tyler-Walters *et al.* (2003) and summarized below.

Marine survey data from the Marine Nature Conservation Review database (2001 version) and additional data collated by the Irish Sea Pilot, supplied by the JNCC, together with survey data hosted by *MarLIN,* was 'tagged' with *MarLIN* sensitivity information for 150 species and 117 biotopes. The survey data and sensitivity information were collated in a GIS for mapping. Although we have researched 117 biotopes, the biotopes researched can be used represent another 157 biotopes within the 1997 version of the UK biotope classification (Connor *et al.,* 1997a,b).

All of the available survey data was point source data, i.e. no information on the spatial extent of the species or biotopes was available. It was probably unrepresentative to extrapolate directly from biotope or biotope complex level sensitivities to the Marine Landscape level. Therefore, it was decided to assess the intolerance, likely recoverability and hence sensitivity of the Marine Landscapes based on knowledge already researched by *MarLIN* of the effects of environmental perturbation with reference to the *MarLIN* sensitivities of representative component biotopes.

The sensitivity of eleven Marine Landscapes to change in three environmental factors (substratum loss, smothering, and physical disturbance and abrasion) was assessed and mapped in GIS. The sensitivities of all researched species and biotopes, nationally rare and scarce, UK BAP species, UK BAP biotopes, and the provisional list of important species and habitats in the Irish Sea were also mapped. The report and the preliminary

sensitivity maps were subject to consultation, including a consultative workshop (see Tyler-Walters *et al.*, 2003). The key conclusions and recommendations follow.

- Sensitivity mapping has the potential to 'flag' locations, sites, or areas that are likely to be adversely affected by activities in the marine environment.
- Sensitivity assessments cannot consider every eventuality, and practical decisions and assumptions are required to make the assessments. Therefore, the assessments and sensitivity maps must always be interpreted by marine experts on a site-by-site and activity-by-activity basis.
- Potential users were un-aware of the assumptions inherent in our approach to sensitivity assessment and that the assumptions and limitations of the approach required further clarification.
- Users of sensitivity information based on biotope complexes, biotopes, nationally important features, species etc. need to know how they can and cannot be used, i.e. the inherent assumptions used in assessment.
- The proposed sensitivities of Marine Landscapes provide an overall indication of sensitivity to the environmental factors shown based on a limited review of the literature. Sensitivity maps at the Marine Landscape level provide useful information for broad scale spatial planning and management of the marine environment.
- Geographical Information Systems allow sensitivity maps, survey data and sensitivity information to be interrogated at a variety of scales, depending on user requirements, e.g. to provide information for Strategic Environmental Assessment at the broad scale or 'zoom in' to inform local development planning, Environmental Impact Assessment, or emergency response.
- Information on the relative intensity or extent of marine activities and the resultant changes in environmental factors should be used together with sensitivity information to identify 'vulnerable' species, habitats and areas to target environmental management effort effectively.

The preliminary sensitivity maps demonstrated that species and biotope survey data could be 'tagged' with available sensitivity information to identify the location of potentially sensitive habitats and species. In addition, an approach to assessing the sensitivity of Marine Landscapes was also demonstrated. The Marine Landscape sensitivity maps for the Irish Sea are shown in Figures 11, 12 and 13. Figures 14 and 15 show Bardsey Island and part of the Lleyn Peninsula together with the distribution of species (Figure 14) and biotopes (Figure 15) likely to be sensitive to physical disturbance. Figures 14 and 15 clearly show the distribution of highly sensitive species or biotopes within the relevant Marine Landscapes but at a scale more appropriate for environmental site management.

Each survey data point can be interrogated in the GIS to provide a summary of the background data including a list of species or biotope and their sensitivities where available. Each point is colour coded according to the worst-case sensitivity.

The consultative workshop also discussed our existing benchmarks and agreed that the benchmarks were not fixed. Three scenarios emerged:

1. If benchmarks are not considered realistic in a management context, they need to be changed.
2. If the benchmarks are relevant for the majority of Marine Landscapes but may give rise to significant under or over-estimates of sensitivity under particular circumstances, then their limitations need to be clarified.

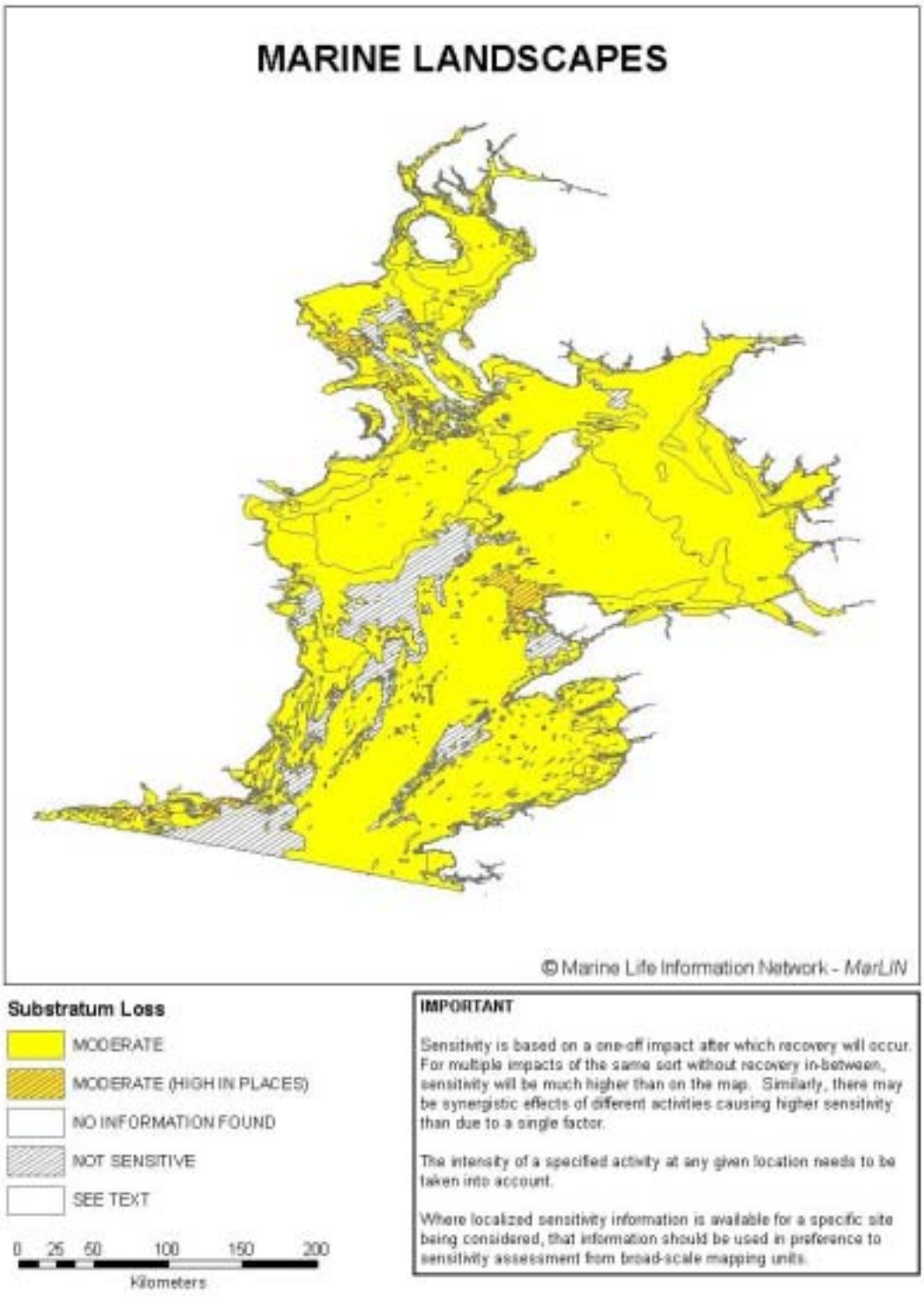


Figure 11. Sensitivity of Marine Landscapes to substratum loss as assessed by *MarLIN* for the Irish Sea Pilot.

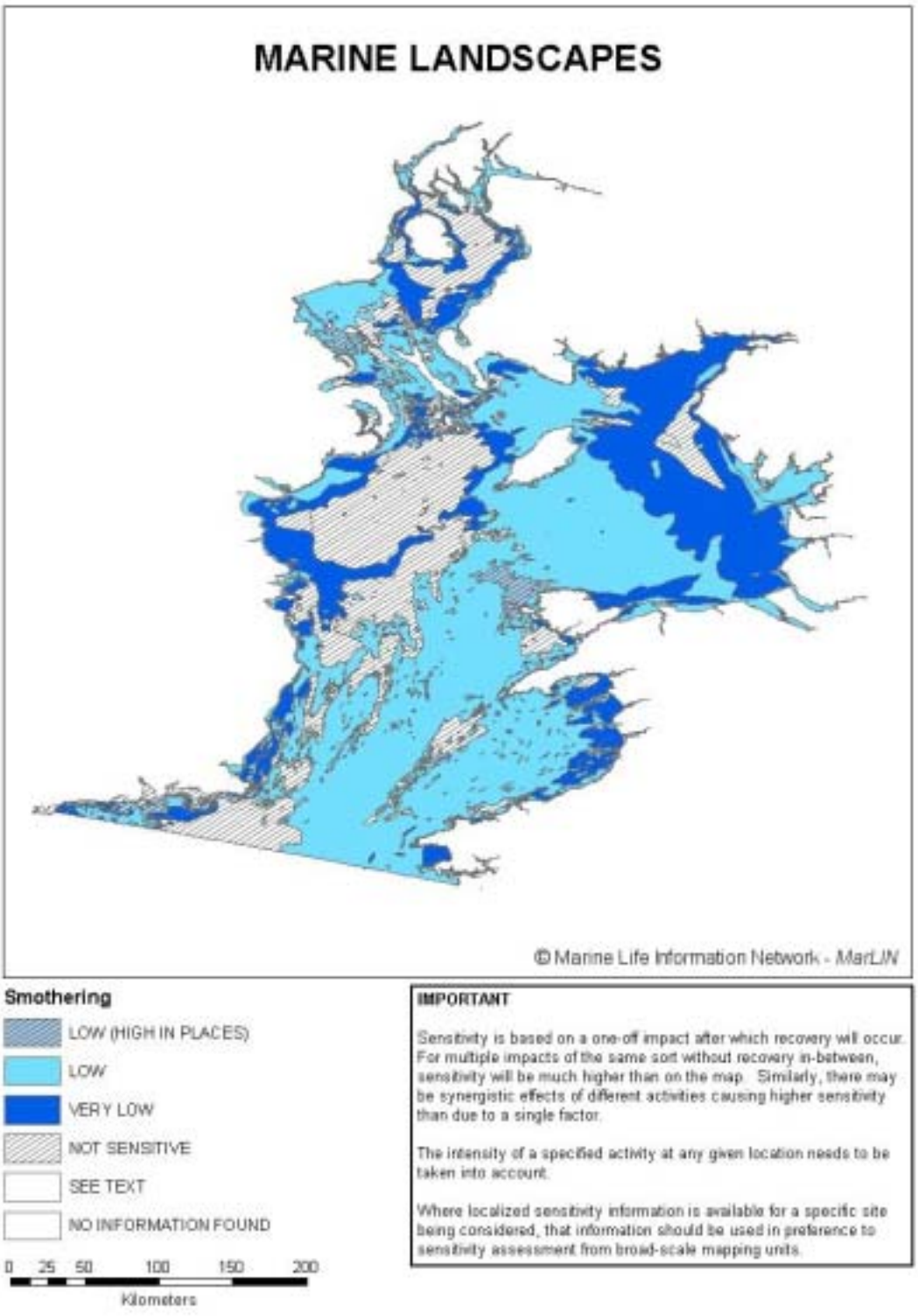


Figure 12. Sensitivity of Marine Landscapes to smothering as assessed by *MarLIN* for the Irish Sea Pilot.

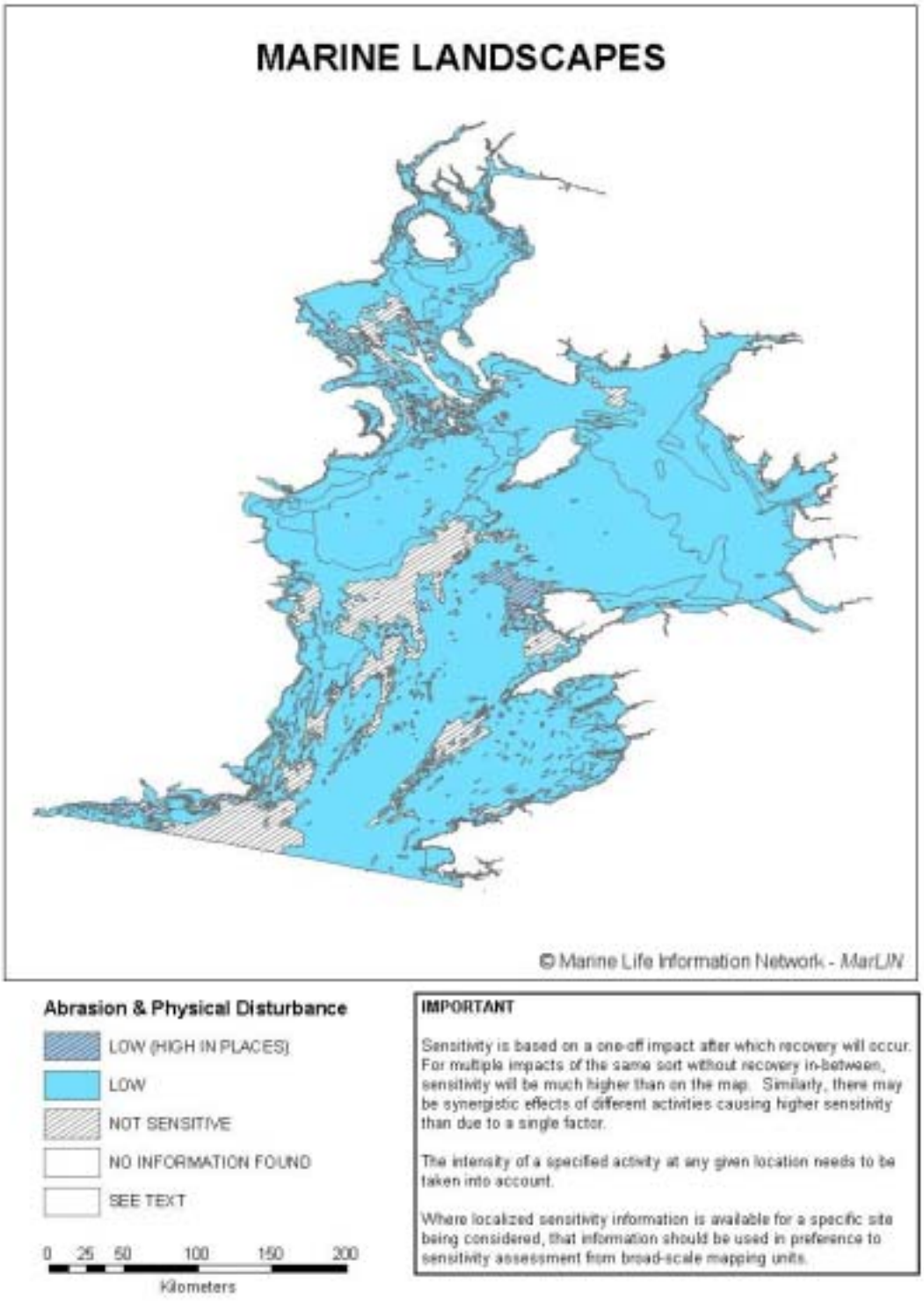


Figure 13. Sensitivity of Marine Landscapes to physical disturbance and abrasion as assessed by *MarLIN* for the Irish Sea Pilot.

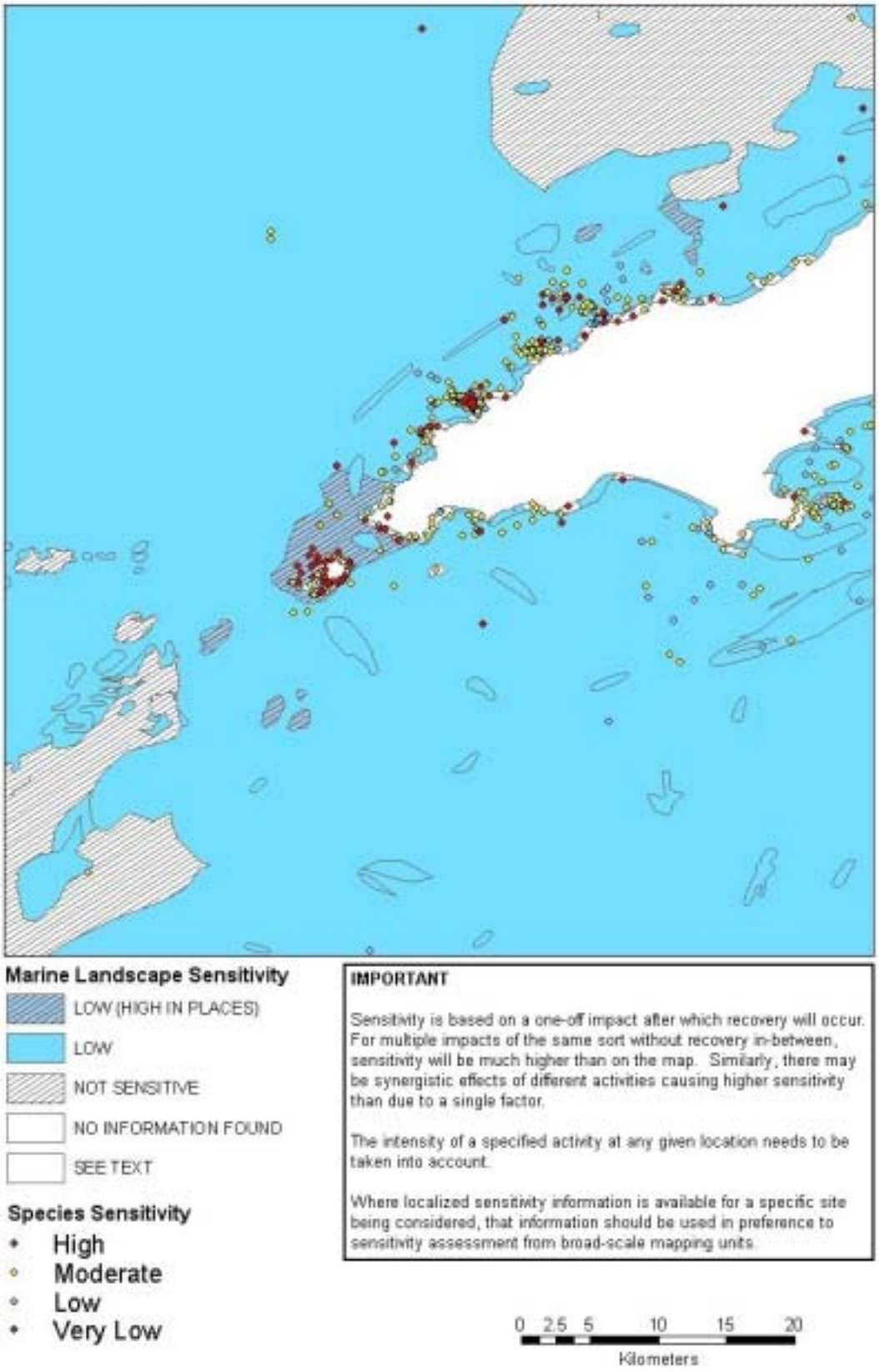


Figure 14. Sensitivity of species to physical disturbance and abrasion within Marine Landscapes in the vicinity of Bardsey Island, as assessed by *MarLIN* for the Irish Sea Pilot.

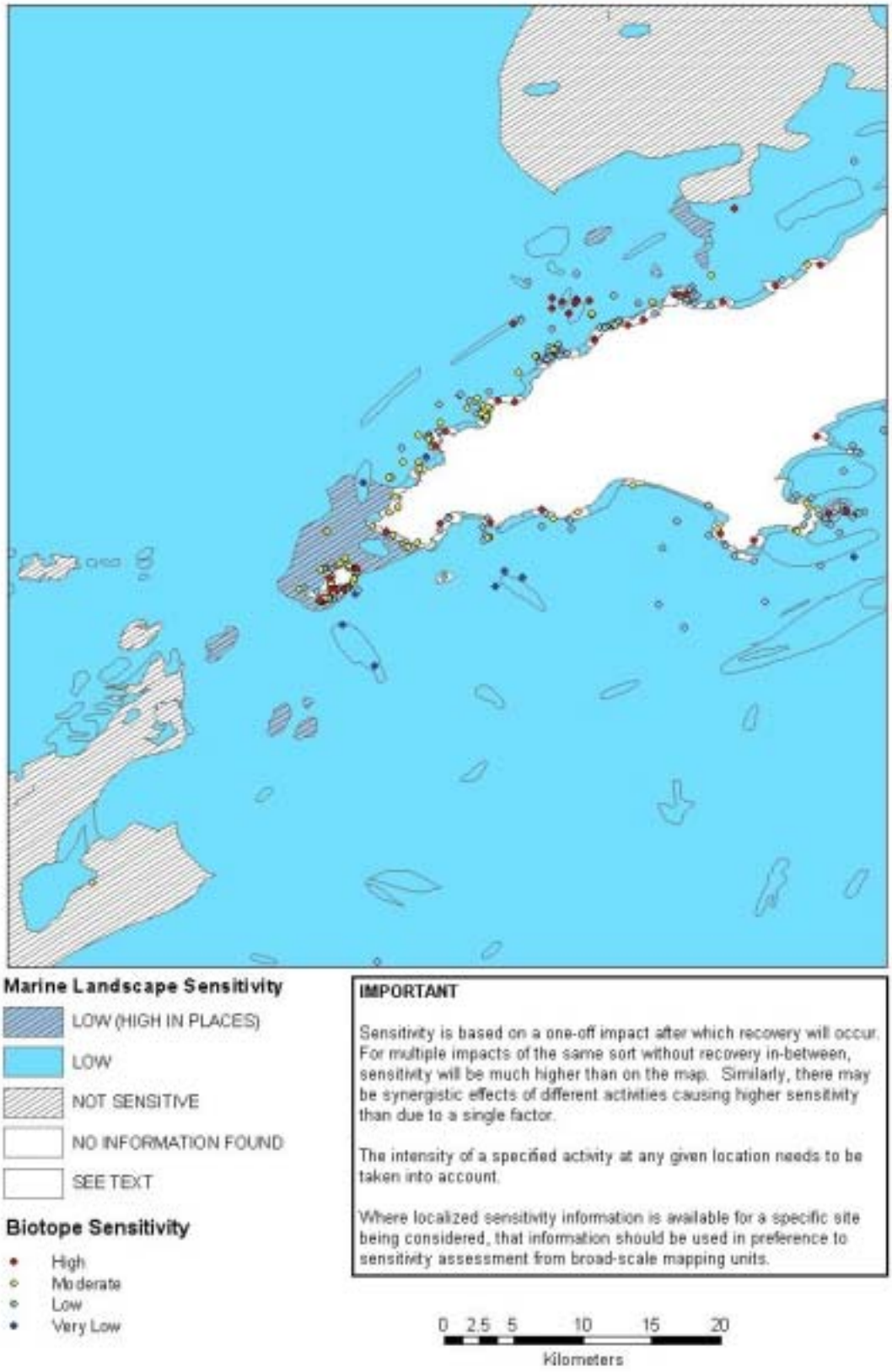


Figure 15. Sensitivity of biotopes to physical disturbance and abrasion within Marine Landscapes in the vicinity of Bardsey Island, as assessed by *MarLIN* for the Irish Sea Pilot.

3. If there are management-relevant alternative scenarios, more than one benchmark and therefore assessment might be needed.

Concerns were expressed by those involved in the Irish Sea Pilot that the benchmarks might significantly underestimate the time taken for the substratum itself to recover to a condition that would enable the species or biotope to start recovery. For example, under very sheltered conditions, a 5 cm depth of smothering material may take a long time to be removed or incorporated into the sediment. The time taken for the habitat to return to a state suitable for the habitat or species, is not included into the sensitivity ranking but conditions in which the sensitivity are likely to be higher or lower are outlined in the explanatory text for each assessment. However, the sensitivity assessments generated for the effect of physical disturbance and in particular, smothering were felt by JNCC to under-estimate sensitivity. As a result, the Irish Sea Pilot has not published the relevant sensitivity maps in their reports.

It was agreed that:

- there were a wide range of alternative scenarios but that it is not practical or appropriate to develop and work with large numbers of benchmarks;
- the three benchmarks considered were likely to be broadly appropriate, and that
- the benchmarks should not be changed at this stage.

The workshop suggested that additional clarification/caveats should be considered to highlight their limitations e.g. factors/conditions which may lead to significant under or over-estimation of sensitivity. Where the clarification/caveats are of particular relevance to a species or biotopes it might be possible to refer to it in that sensitivity assessment but also to show how they can be used for comparison with predicted levels of impact.

7.7.3 CCW trial of sensitivity maps in oil spill response

MarLIN was asked to develop trial sensitivity maps for oil pollution related disturbance for evaluation, using a GIS. Therefore, *MarLIN* developed GIS based sensitivity maps based on three disturbance factors related to an oil pollution incident (smothering, physical disturbance and abrasion, and hydrocarbon contamination) for intertidal and subtidal biotopes and species within the Pembrokeshire SAC and the Severn Estuary SAC. The results of the contract are discussed in detail by Tyler-Walters & Lear (2004) and summarized below.

The *MarLIN* Biology and Sensitivity Key Information database was queried for sensitivity information on the three environmental factors most relevant to oil pollution; smothering, physical disturbance and abrasion, and hydrocarbon contamination. The resultant information was imported into MapInfo where it was queried against the geo-referenced marine survey data of Phase I biotopes and species to tag them with sensitivity information, where available. The following datasets were provided by CCW:

- Phase I intertidal biotope data for Pembrokeshire SAC and Severn Estuary;
- Phase I intertidal target note data for Pembrokeshire SAC and Severn Estuary, and
- marine survey data for biotopes and species, from the CCW Marine Recorder database.

The resultant geo-referenced sensitivities were then mapped in three separate MapInfo Workspaces, one for each environmental factor. Example GIS output for West Angle Bay in the Pembrokeshire SAC is shown in Figure 16 and for the Severn Estuary in Figure 17. Each dataset was marked with a separate symbol and the sensitivity scales labeled with standard colour-codes consistent with those used on the *MarLIN* Web site.

In the GIS, each sample point, target note or biotope can be interrogated to reveal the underlying species and/or biotope data together with relevant sensitivity information. Sensitivity information is tagged with the relevant Web address (URL) so that the relevant *MarLIN* Web pages can be accessed directly, when used on a computer with Internet access.

The following deliverables were produced in MapInfo format:

- MapInfo tables, tagged with sensitivity values;
- three MapInfo workspaces (one for each of the three chosen factors) that allow the display of sensitivity maps for biotopes and species;
- three MapInfo workspaces (one for each of the three chosen factors) that display the sensitivity and map the location of biotopes and species of nature conservation importance (e.g. nationally rare or scarce and UK BAP species and habitats).

Evaluation of sensitivity mapping for use in oil pollution incident response

The trial sensitivity maps were evaluated by CCW staff in two consultative workshops. The CCW staff included a variety of marine specialists; representatives of the CCW Intertidal Survey team, staff responsible for policy development and the management of marine sites, and specialists in GIS and environmental data management. The following is a critical assessment by these staff of the added value that the sensitivity maps could give in support of the provision of environmental advice during the different stages of oil pollution response and clean-up, and is extracted from Tyler-Walters & Lear (2004).

Benefits

The following benefits for incident response were identified.

- The GIS maps summarize the likely sensitivity of benthic marine species and biotopes to environmental perturbation (by changes in the factors examined) in a simple and user-friendly format.
- The maps allow potentially sensitive areas or the location of potentially sensitive species or nationally important biotopes and species to be identified. Where sensitivity information is available, the sensitivity scales ‘flag’ the most sensitive areas, biotopes, or species.
- Interrogation of the survey data identifies the biotopes or species at that location, and their likely relative sensitivity to the benchmark level of disturbance in the environmental factors chosen, in this case, smothering, physical disturbance and abrasion and hydrocarbon contamination.
- In GIS, the sensitivity maps could be included with other layers, e.g. the Ordnance Survey (OS) maps, Admiralty charts, aerial photographs, and the CCW map of resources likely to be sensitive to oil pollution (Moore, 2003), and could be used as an integrated management tool for both day-to-day marine and coastal site management and emergency or incident response.
- It is possible to hyperlink from the sensitivity maps to relevant supporting information on the *MarLIN* Web site, including an explanation of the sensitivity assessment, the benchmark and evidence used in the assessment, and supporting key information on the biology and sensitivity of the ‘representative’ biotope or species. The more detailed sensitivity information available through the Web site was thought to be particularly useful.

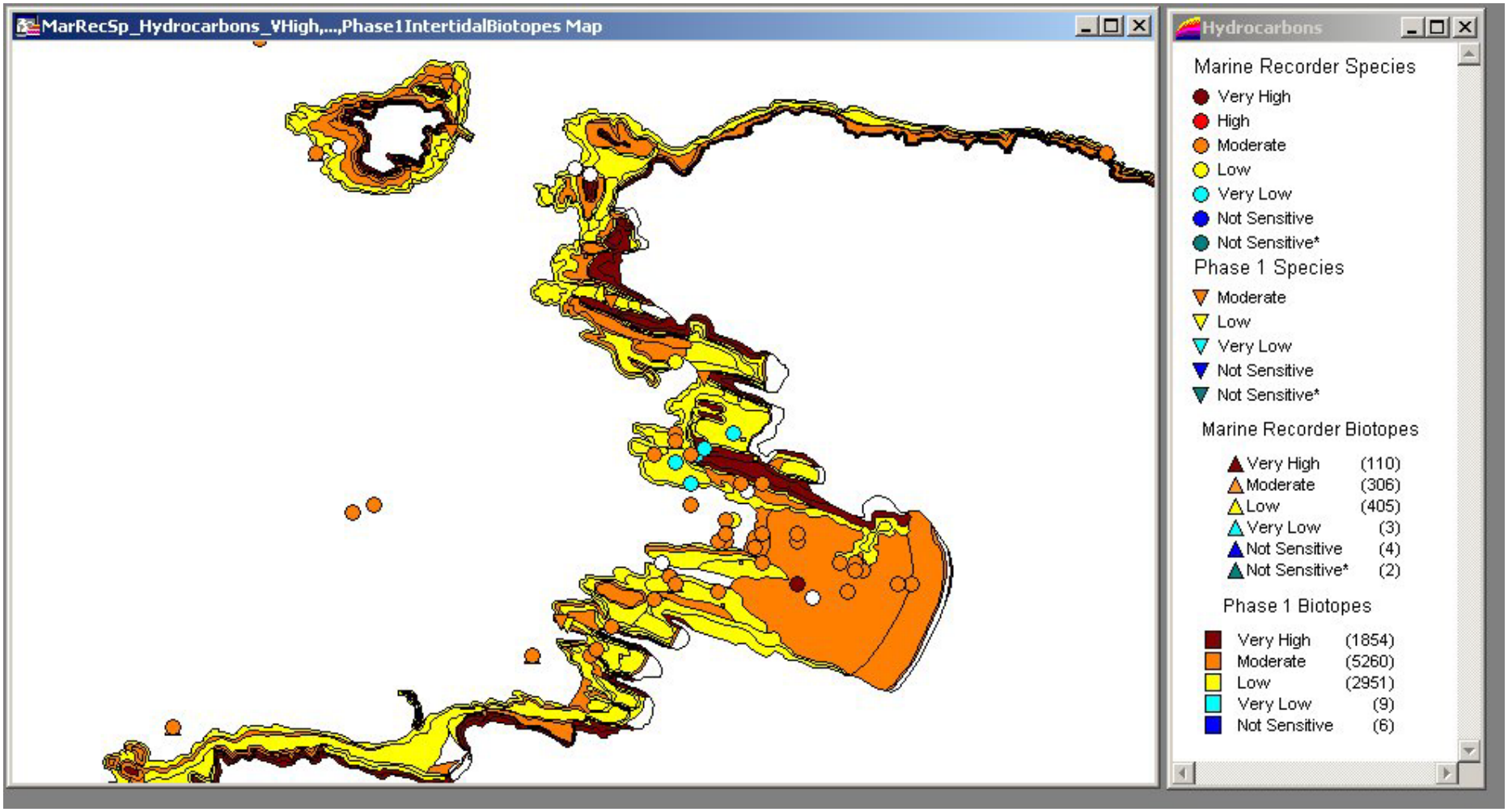


Figure 16. Example sensitivity map of West Angle Bay, Pembrokeshire to hydrocarbon contamination.

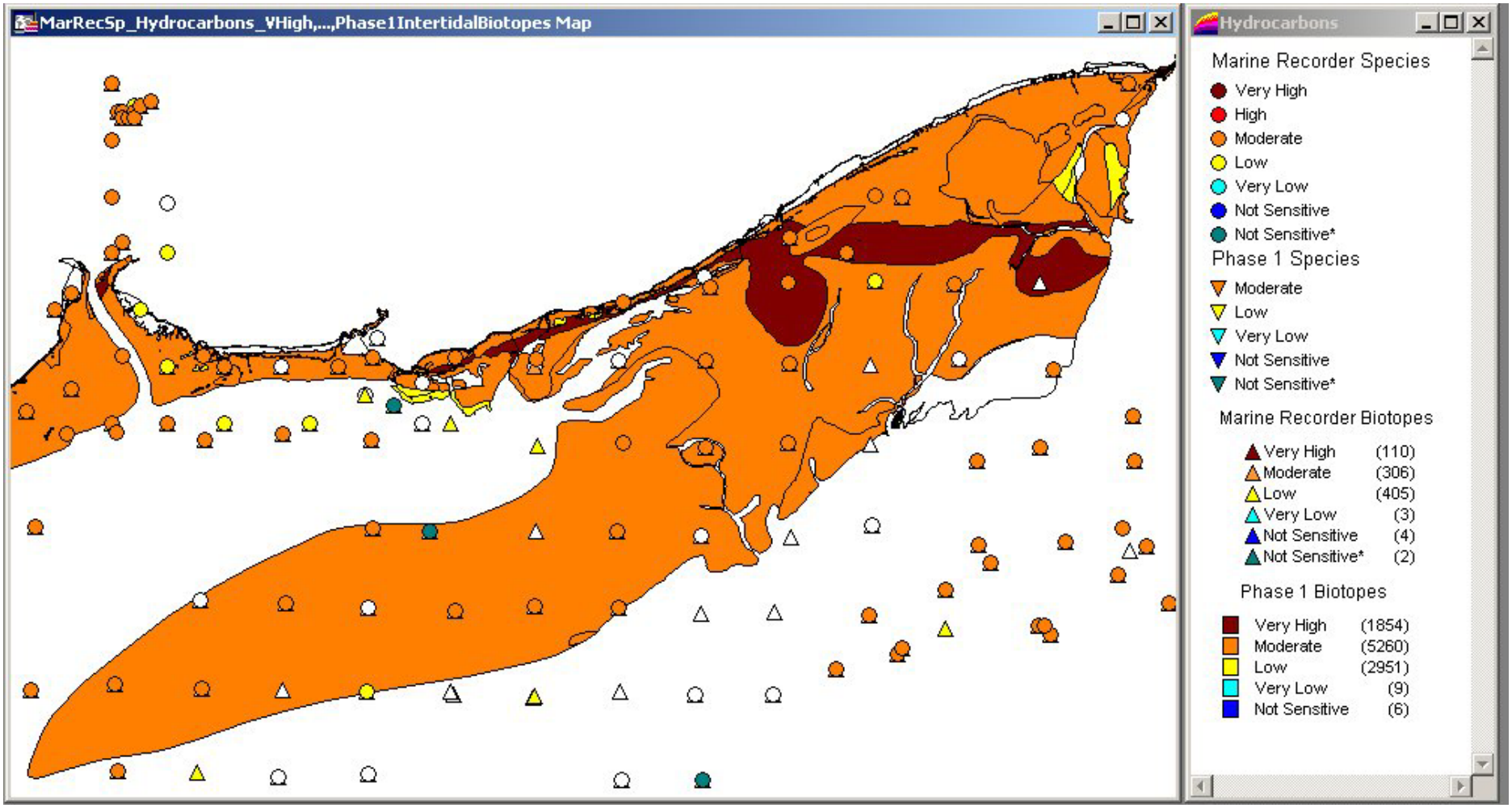


Figure 17. Example map of sensitivity to hydrocarbon contamination for sedimentary biotopes from Caldicot to Newport, Severn Estuary.

- The GIS format allows the maps to be interrogated at a variety of scales. This may be particularly useful in incident response where evaluation of environmental impacts may be required at different scales depending on the situation, e.g. at the scale of the whole of the Milford Haven to identify the location of priority sensitive natural resources, or at the more detailed scale of individual beaches during up clean up operations.
- The ability to query the maps in GIS (e.g. by sensitivity) or to examine just the important biotope and species was felt to be especially useful.
- An integrated GIS that incorporated sensitivity information would build upon the GIS based information (e.g. resource maps (Moore, 2003), aerial photographs, Phase 1 biotope maps) already in place in CCW to support decision making in oil pollution response.

Limitations

The following limitations were identified.

- The sensitivity maps are not definitive and represent the most likely (or probable) result of a given change in an environmental factor on a species population or biotope. They require substantial interpretation based on an understanding of the benchmark level of disturbance in the environmental factor used and the way in which sensitivity is assessed. Any sensitivity maps produced would be restricted to trained CCW staff with marine biological expertise only.
- In addition, since the *MarLIN* sensitivity assessments are not site-specific, staff with local knowledge would be essential to provide the site-specific dimension during interpretation of the maps and information.
- The information that the maps provide can only be as good as:

  a. the survey data on which they are based[1];

  b. the information available to underpin the sensitivity assessment[2];

  and thus, any limitations in these are carried forward into the sensitivity maps themselves. A key concern was that information presented as a coloured map, looks authoritative and may be taken at face value. It was felt important to stress that further interpretation is usually required.
- The assumptions inherent in sensitivity assessment are not obviously apparent when viewing the maps. These need to be clearly stated, together with the benchmark level of disturbance in environmental factors, in order to facilitate correct interpretation of the sensitivity maps.
- In terms of oil pollution, the benchmarks (especially smothering) do not well represent the likely impact of this type of disturbance. The benchmarks for

[1] For example, it was noted that the presence of *Modiolus modiolus* in the Severn is likely to relate to juveniles that do not persist or form beds, thus the high sensitivity of the species might not be of relevance at this particular site. The quality of the maps is dependent on the quality of the survey data, in addition to the sensitivity assessment itself. These issues highlight the limitations of the available survey data used to develop the sensitivity maps and underline the importance of having staff with a good understanding of marine ecosystems to interpret the information accurately.

[2] There are gaps in the current maps as not all biotopes and species have been subject to sensitivity assessment. There are gaps in the sensitivity information, for example, important LMX biotopes. This situation will improve as more biotopes and species are researched by *MarLIN*. In addition, the appropriateness of several 'representative' biotopes was questioned, e.g. for tidally-swept biotopes, and a few sensitivity assessments were questioned.

smothering, physical disturbance and abrasion, and hydrocarbon contamination are generic. Some staff considered benchmarks so general as to make them difficult to apply to any disturbance likely to occur during an oil pollution incident and response, whilst others considered them to be useful baselines from which to predict likely impacts. Significant interpretation is required to compare the sensitivity assessments with the likely effects of an oil pollution incident, which may be time consuming and thus erodes their use as a decision support tool for emergency response.

- It was felt that there may not be sufficient time in an emergency (e.g. oil spill incident or grounding) to fully interrogate the maps (i.e. use the *MarLIN* website to interpret the information properly) and that, in the wrong hands, this could lead to misinterpretation of the information. However, there would be more time available to consult the maps and information to plan or inform clean-up activities.

Suggested future modifications

The CCW workshops thought that the sensitivity maps would benefit from the following modifications:

- include the relevant benchmark in the legend and make assumptions inherent in sensitivity assessment clearly available;
- clearly label the fields in the 'Info Tool' popup box within MapInfo;
- include importance fields in the main MapInfo workspace tables (e.g. BAP habitat/species, rare and scarce biotopes/species) to allow queries to be created;
- research additional biotopes to fill existing gaps in important and priority biotopes, and
- revisit a few 'representative' biotopes and sensitivity assessments to address CCW staff comments.

General conclusions of CCW contract

Overall, it was thought that the sensitivity maps added value to existing products that CCW holds to support decision making during incident response. There were concerns about using such a product within the tight timeframe of incident response but it was also suggested that sensitivity information would be particularly useful in supporting casework. It was felt that the sensitivities displayed on the maps were about right, with a few exceptions. However, the importance of thorough interpretation of the maps by trained staff with marine biological expertise is a limitation to the broad use of such a product, even within CCW. There was concern that the maps looked authoritative, and could be taken at face value. Thus, all limitations should be clearly understood by users. Nevertheless, it was generally agreed that the sensitivity maps and the information linked to them would allow better informed decisions to be made.

7.7.4 CEFAS contract to identify offshore biotope complexes and their sensitivities.

Approach and evaluation

MarLIN was commissioned by the Centre for Environment, Fisheries, and Aquaculture Sciences (CEFAS) to process existing CEFAS benthic beam trawl datasets to identify offshore biotope complexes (the habitat and its associated species) and test an approach to assessing the likely sensitivities of those biotope complexes. The *MarLIN* contract contributed to the integration of spatial data and mapping the sensitivity of offshore biotopes as part of an integrated approach to marine spatial planning. The contract was carried out in collaboration with Dr Jim Allen at the Institute of Estuarine and Coastal

Studies (ICES), Hull. The results of the contract are detailed by Tyler-Walters *et al.* (2004) and summarized below.

Beam trawl datasets were supplied by CEFAS and included species abundance and biomass data from 674 stations sampled between 1999 and 2003. The datasets were analyzed by Dr Jim Allen and stations assigned to biotope complexes catalogued in the MNCR biotope classification scheme (2004 version) (Connor *et al.,* 2004).

Sensitivity was then assessed for biotope complexes using the sensitivity of researched biotopes. An approach to biotope sensitivity assessment that used the highest sensitivity of component biotopes in a biotope complex (see Section 7.6 above) was trialed using the 1997 biotope classification (Connor *et al.,* 1997a,b), for which *MarLIN* has researched sensitivity information, and the 'Sublittoral Sediment (SS)' section of the revised 2004 version of the biotope classification (Connor *et al.,* 2004). The evaluation was carried out using sensitivity to physical disturbance.

Several biotopes differed markedly in sensitivity characteristics from the other biotopes in their biotope complex by virtue of differences in their ecology. Therefore, it was suggested that the following sublittoral sediment biotopes should be mapped separately from the biotope complex, and their sensitivities not used to derive biotope complex sensitivities:

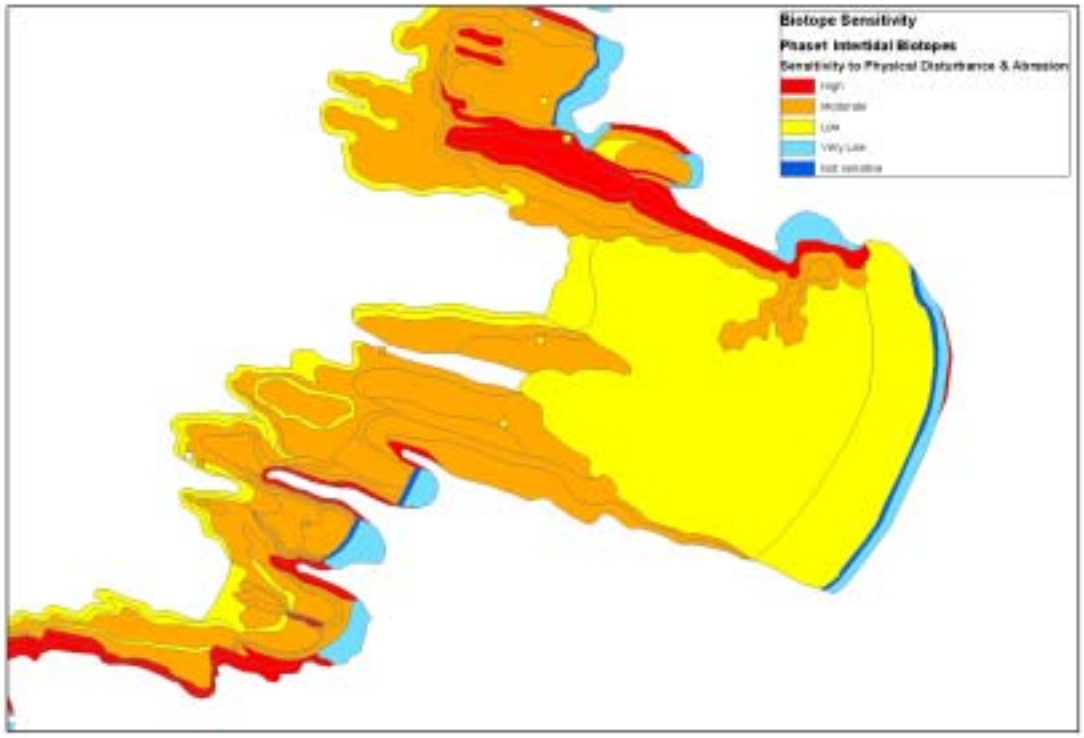
- *Serpula vermicularis* reefs on very sheltered circalittoral muddy sand (CMS.Ser)
- *Philine aperta* and *Virgularia mirabilis* in soft stable infralittoral mud (IMU.PhiVir)
- *Beggiatoa* spp. on anoxic sublittoral mud (CMU.Beg)
- *Limaria hians* beds in tide-swept sublittoral muddy mixed sediment (IMX.Lim)
- Horse mussel bed biotopes, e.g. *Modiolus modiolus* beds on circalittoral mixed sediment (CMX.ModMx)

The distribution of sensitivity to physical disturbance is compared between Phase I biotopes within West Angle Bay, Pembrokeshire and biotope complexes in Figure 18. The differences in overall sensitivity were minor, with only a few biotopes being reported as of higher sensitivity due to the higher overall biotope complex sensitivity. For example:

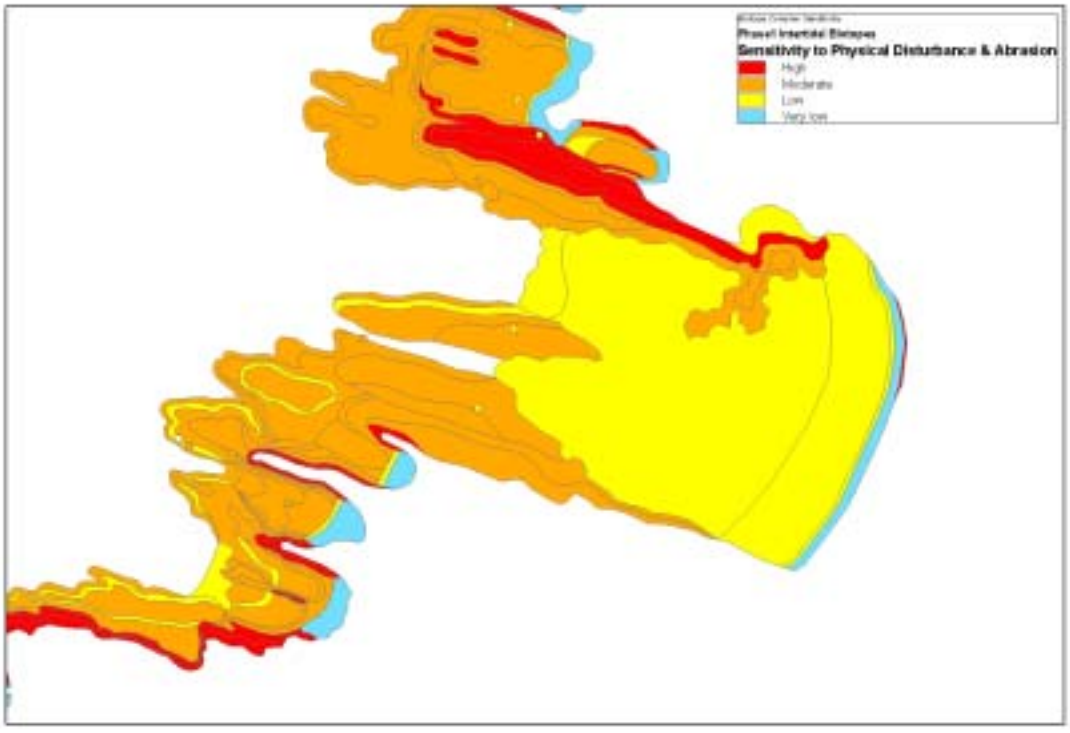
- *'Himanthalia elongata* and red seaweeds on exposed lower eulittoral rock' (ELR.Him) in 'Robust fucoids or red seaweeds' (ELR.FR), and
- 'Barren coarse sand shores' (LGS.BarSnd) in 'Sand shores' (LGS.S).

Using the 1997 version of the biotope classification, the approach to biotope complex sensitivity assessment (Section 7.6) provided reasonable estimates of biotope complex sensitivity. The only sublittoral sediment biotope complex that could not be assigned a sensitivity rank was 'Circalittoral mixed sediment' (CMX) due to the difference in horse mussel bed sensitivities and the absence of researched 'representative' or 'represented' biotopes within the biotope complex.

The 2004 version biotopes and biotope complexes were compared to 1997 version biotopes and biotope complexes, and the sensitivity of the 1997 biotopes used to represent the sensitivity of the 2004 version biotopes wherever possible. The 2004 biotope classification had significantly expanded the number of biotope complexes and biotopes recorded within sublittoral sediments. Therefore, several of the 2004 version biotopes could not be assigned a sensitivity, especially in offshore habitats (see Appendix 7).



a).



b).

Figure 18. Similarity between biotope complex and biotope sensitivity of Phase I biotopes in West Angle Bay, Pembrokeshire to physical disturbance and abrasion, a) Phase I biotopes b) Phase I biotope complexes. Data courtesy of CCW (see Tyler-Walters & Lear, 2004).

A few specific biotopes were identified with different ecological or recovery characteristics than the relevant biotope complex. When mapping sensitivity it was suggested that the following biotopes are mapped separately, and their sensitivities not used to assign and overall biotope complex sensitivity:

- SS.SCS.CCS.PomB / ECR.PomByC, which are ephemeral communities, differing significantly from others in its biotope complex;
- SS.SMu.IFiMu.PhiVir / IMU.PhiVir sea pen biotopes, characterized by *Virgularia mirabilis* are likely to have prolonged recoverabilities;
- SS.SMu.IFiMu.Beg / CMU.Beg *Beggiatoa* biotopes are characteristic of anoxic, often abiotic, habitats;
- SS.SMx.IMx.Lim / IMX.Lim *Limaria hians* beds represents a distinct epifaunal rather than infaunal community;
- SS.SMx.IMx.Ost / IMX.Ost *Ostrea edulis* beds are a distinct epifaunal community, with prolonged recovery, and
- horse mussel *Modiolus modiolus* beds are distinct communities with prolonged recovery rates.

In the sublittoral mussel bed biotope complex, the majority of constituent biotopes are characterized by beds of *Modiolus modiolus.* However, it may be possible for an area to be dominated by *Mytilus* beds alone, in which instance the sensitivity of IMX.MytV is probably more representative.

Conclusions of CEFAS contract

Overall, using the highest or worst-case sensitivity of component biotopes to derive an overall biotope complex sensitivity (Section 7.6) was practical and transparent. Where geographically refined lists of component biotopes were available, it would be possible to assign biotope complex sensitivities accordingly. However, the approach assumes that the lists of component biotopes, taken from the biotope classification, are of similar 'ecological character' with respect to sensitivity. It has been necessary to identify specific biotopes whose intolerance, but more often recoverability characteristics, differ significantly from other biotopes within the same biotope complex. The presence of component biotopes in a complex that are of a higher sensitivity to the majority of biotopes makes it necessary to identify and map the sensitivity of those biotopes separately.

The approach for biotope complex sensitivity assessment was tested used sensitivity to physical disturbance and abrasion (i.e. a factor related to towed fishing gears and dredging activity). The approach will need further testing using other factors. Biotopes within a biotope complex are likely to exhibit similar 'sensitivity characteristics' to physical factors but may differ in their sensitivity to chemical factors.

Biotopes, biotope complexes and species indicative of sensitivity that require additional research were identified. The greatest number of gaps in the *MarLIN* biotope sensitivity information related to the revised (2004 version) of the 'Sublittoral sediment' biotope classification, which has been significantly expanded since the 1997 version (Appendix 7). Biotope complexes are thought to be most representative in the offshore environment. Therefore, it would seem more appropriate to research the sensitivity characteristics of biotope complexes in future, rather than biotopes, in the offshore environment.

7.8 Benefits and limitations of sensitivity mapping in environmental management

Overall, mapping the potential sensitivity of marine biotopes and species to environmental perturbation has considerable potential for improving or supporting marine environmental decision-making. The majority of the limitations identified in the above trials stem from the

need to interpret sensitivity assessments correctly and hence the need for an understanding of the assumptions, scales and benchmarks used, and appropriate marine biology expertise. Nevertheless, its benefits outweigh its limitations and *MarLIN* believes that the limitations can be resolved, and that sensitivity mapping is a potential tool to support science-based decision making.

Gaps in the *MarLIN* coverage of biotopes and species were identified in Tyler-Walters *et al.* (2002, 2004). A small number of additional, priority biotopes and species require research, especially any missing nationally or regionally important biotopes, e.g. LMX biotopes. In addition, our work with offshore biotope complexes for CEFAS identified further biotope and biotope complex research in order to extend sensitivity mapping offshore (Tyler-Walters *et al.,* 2004). The sensitivities of 'representative' biotopes questioned in the CCW trial workshops will be revisited in due course.

Although, the *MarLIN* approach to sensitivity assessment is systematic, practical, and above all transparent, users often failed to take account of the supporting or background information that detailed the approach used. All our definitions and scales, the approach to sensitivity assessment and its assumptions have been published on the *MarLIN* Web site since 1999 (Hiscock *et al.*, 1999; Tyler-Walters & Jackson, 1999), with subsequent revisions (Tyler-Walters *et al.,* 2001; *MarLIN*, 2004). The definitions of sensitivity, intolerance and recoverability, together with the approach to sensitivity assessment, were not generated in isolation but in consultation with the major agencies responsible for marine environmental management and protection through our technical advisory groups and expert workshops (Hiscock *et al.*, 1999; Tyler-Walters & Jackson, 1999; Tyler-Walters *et al.,* 2001).

Improving information on the MarLIN approach to sensitivity assessment

The recent (November 2003) revision of the Web site has made information on the sensitivity assessment rationale, scales, assumptions, and benchmarks even more accessible from every Web page and Key Information review. Additional guidance notes (Appendix 8), on the assumptions inherent in sensitivity assessment and advice on interpreting the predicted impact of an activity, plan or proposal against our benchmarks were prepared in response to the Irish Sea Pilot contract findings. These guidance notes were circulated during the CCW trial workshops and found to be useful. The additional guidance notes, a summary of the sensitivity assessment rationale, and the sensitivity benchmarks have been added to the Biology and Sensitivity Key Information Sub-programme menu for ready reference from any part of the Web site (see Section 5).

Interpreting sensitivity assessments

Sensitivity assessments are not site-specific, as we cannot consider every eventuality during assessment. Therefore, the sensitivity assessments and hence the sensitivity maps require interpretation by staff with relevant marine biology/ecology expertise and preferably local knowledge of the habitats affected. The key information reviews linked to the sensitivity assessments provide a wealth of information, albeit targeted information, which also needs to be read and interpreted for a given impact at a given site on a given habitat or species. But this is equally true of any other information sources used in marine environmental management, e.g. marine survey data, contract and research reports, research papers or relevant texts.

The *MarLIN* Biology and Sensitivity Key Information reviews and their sensitivity assessments represent an information resource; the largest information resource dedicated to information to support environmental management and protection in the United Kingdom. Linking this information resource to survey data, in the form of sensitivity maps, places this information in its spatial context and highlights potentially sensitive areas. However, answering 'does it matter….' questions, and the actions taken based on

available information must always rest with the statutory environmental protection agencies and decision-makers themselves.

Some of the limitations of the *MarLIN* approach to identifying the likely sensitivity of species or habitats at a location relate to situations where the level of impact of a factor differ from that in the standard benchmark *MarLIN* used in sensitivity assessment. There is scope to identify more than one benchmark for a particular factor (e.g. oil spills) but it will never be possible to address every possible scenario. The benchmarks were designed to representative of the most likely magnitude or duration of the relevant impact within the marine environment. Providing a standard magnitude and duration against which to assess sensitivity also allows the benchmark to be comparable to predicted impacts.

Sensitivity mapping in incident response

The overall response to the sensitivity maps was positive, especially the ability to link to supporting information on the *MarLIN* Web site. However, a few limitations were suggested.

The sensitivity benchmarks were too generic to be applicable to oil pollution incidents. However, the benchmarks can be compared to the predicted impacts with appropriate interpretation by a relevant expert. In addition, the explanation behind each sensitivity assessment for hydrocarbon contamination includes evidence of the effects of oil spills where available and physical disturbance and abrasion takes into account evidence concerning the effects of trampling on intertidal communities. If required, it would be possible to reassess the sensitivity of the biotopes and species, so far researched, for more specific benchmarks directly relevant to oil pollution incidents, e.g. using an 'oil spill' and 'clean-up' as separate environmental factors.

There was not enough time to read all the available information in an emergency response scenario, and Internet access may not be readily available 24 hours-a-day. However, recent developments in waterproof/weatherproof portable computers (laptops) and wireless technology should allow Internet and GIS decision support tools to be used in the field, irrespective of weather conditions and time of day. While it may be difficult to assimilate all the available information in an emergency situation, the information is probably most useful during the following days after an incident to support decisions concerning mitigation and clean-up responses.

Broad-scale maps alone are required in the initial stages of oil pollution incident. *MarLIN* trialed an approach to assess the sensitivity at the biotope complex for CEFAS, which could potentially be applied to at the habitat complex level. It was noted by CCW staff that different scales were appropriate at different stages during emergency response and clean up operations.

General conclusion

Sensitivity maps were not designed to be a stand-alone tool. It was always envisaged that they would be one layer in an integrated marine environmental management tool using GIS. The sensitivity maps help to identify areas, biotopes, and species potentially sensitive to the effects of an oil pollution incident. When combined with aerial photographs of the region, the location of other potentially sensitive resources (e.g. seals, sea birds, and cetaceans) (Moore, 2003), the location of socio-economic resources (e.g. tourist beaches, shellfisheries, marinas), and the physiochemical characteristics of the region (e.g. hydrography and bathymetry) in a single GIS system, sensitivity maps (linked to the Biology and Sensitivity Key Information on-line) contribute to a powerful, 24 hour-a-day, tool to support decision-making.

8. Conclusions

Contract deliverables

The Biology and Sensitivity Key Information Sub-programme of *MarLIN* has completed all of the tasks and objectives under the 2001 to 2004 contract. The sub-programme has achieved the following deliverables.

- Continuously maintained and updated the *MarLIN* Web site, including both software and hardware upgrades, culminating in a complete redesign and relaunch of the Web site.
- Redesigned the Web site to incorporate comments received by users over the last five years, vastly improve navigation and speed of access, improve access to supporting information, and modernize its overall appearance.
- Identified OSPAR Annex V threatened or declining species and habitats (OSPAR, 2003) on-line.
- Continued Biology and Sensitivity Key Information research into priority species, especially those listed under OSPAR Annex V throughout the contract. A total of 45 additional full Key Information reviews were researched and placed on-line, and 480 basic information species were researched or updated in the contract period.
- At the end of the contract in October 2004, the *MarLIN* Web site hosted at least basic information on over 560 marine benthic species, of which 152 are full Key Information reviews, together with 117 reviews of marine biotopes included within the interest features of the SACs of England and Scotland.
- Revised the *MarLIN* approach to sensitivity assessment in line with recommendations of the Review of Marine Nature Conservation and our Sensitivity Mapping Advisory Group, and developed a rationale to combine ‘intolerance’ and ‘recoverability’ to derive a single ‘sensitivity’ scale, with a view to sensitivity mapping.
- Developed the ability to link sensitivity information on marine species and biotopes with marine benthic survey data using in-house GIS to map the distribution of potentially sensitive species and biotopes.
- Developed approaches to assessing the sensitivity of broad scale mapping units, namely Marine Landscapes for the Irish Sea Pilot and biotope complexes for CEFAS.
- Demonstrated the application of sensitivity information, linked to marine benthic surveys, in regional environmental management and incident response, via two additional contracts.
    - Mapped the distribution of potentially sensitive and/or important species and biotopes, and Marine Landscapes in the Irish Sea as a contribution to the Irish Sea Pilot.
    - Mapped the distribution of species and biotopes likely to be sensitive to an oil pollution incident within the Pembrokeshire SAC and Severn Estuary SAC as an exercise for CCW.
- Collaborated with the Irish Sea Pilot, JNCC, EN, CCW and CEFAS on the development of sensitivity mapping within marine environmental management and conservation.
- Developed an interactive, on-line, map-based search facility for *MarLIN* hosted survey data, the SEArchable BEnthic Data (SEABED) Map, using open-source

software. The SEABED Map allows users to search for marine surveys, survey metadata, and to map survey information and species distribution.

The information on the biology and sensitivity of marine species and habitats collated and reviewed by the Defra funded programme has contributed to several environmental management initiatives, most notably the 'High Level Environmental Screening Study for Offshore Wind Farm Developments – Marine Habitats and Species' conducted for the Department of Trade and Industries (DTI) as part of its strategic environmental review of offshore wind farms (Hiscock *et al.*, 2002). The Sub-programme information contributed to the review and sensitivity maps produced for the Irish Sea Pilot (Tyler-Walters *et al.*, 2003). Information on the relative sensitivity of marine species also contributed to a study of potential seabed indicator species to support the EU Habitats Directive and the Water Framework Directive (Hiscock *et al.,* 2004). The utility of *MarLIN* information for environmental managers, amongst other sorts of information, has been described in an article in *Marine Pollution Bulletin* (Hiscock *et al.,* 2003).

The *MarLIN* team continued to promote the Biology and Sensitivity Key Information Sub-programme and our approach to sensitivity assessment under Defra funding in the UK and in Europe. *MarLIN* Biology and Sensitivity Key Information was part of a paper entitled 'Establishing and managing marine protected areas: using science effectively' presented at the 30th *Pacem in Maribus* conference, Kiev, Ukraine in October 2003. *MarLIN* presented a paper concerning our approach to the 38th European Marine Biology Symposium in Portugal entitled 'Assessing the sensitivity of seabed species and biotopes – the Marine Life Information Network (*MarLIN*)', which will be published in the journal *Hydrobiologia* shortly. *MarLIN* also presented a paper entitled 'Bringing marine life information together for decision making' at the Littoral 2004 Delivering Sustainable Coasts: Connecting Science and Policy conference in Aberdeen, Scotland. In addition, we are involved in the Marine Biodiversity and Ecosystem Functioning (MARBEF) and 'European Lifestyles and Marine Ecosystems' (ELME) European projects.

Support for Defra initiatives

MarLIN aims to provide information to support marine environmental management, protection and education. As a result of Defra funding, the *MarLIN* Web site represents the major source of information in the UK on the ecology and habitat requirements of marine species and ecosystems, together with the likely sensitivity of marine species and biotopes to natural or anthropogenic change. The present contract has expanded the species coverage of the *MarLIN* Web site, to encompass marine benthic species listed under OSPAR, funded the development of the a modern, user-friendly Web site, funded the development of on-line interactive mapping tools and the development of sensitivity mapping in the UK. As a Web-based programme, *MarLIN* provides a platform to freely disseminate marine environmental information and survey data.

The Biology and Sensitivity Key Information Sub-programme was designed to provide information to support management decisions taken to implement:

- the Habitats Directive;
- OSPAR Annex V;
- UK Biodiversity Action Plan;
- the European Marine Strategy, and
- Strategic Environmental Assessment and Environmental Impact Assessment Directives.

MarLIN information supports the policy aims of the Marine Stewardship Report prepared by UK Government (Defra, 2002). For example, the Marine Stewardship Report (Defra 2002) made the following statements.

- *Integrated management must be informed by improved co-ordination and access to spatial data and mapping of the marine environment. We will move towards ensuring that publicly-funded marine environmental data is made as freely available as possible.*
- *Decisions will be based on a clear understanding of natural processes and the ecological requirements of marine species, habitats, and ecosystems.*
- *To reflect the importance of marine science we [Defra] will work with stakeholders to develop coordinated monitoring and open access to marine environmental data.*
- *We [Defra] will strive to improve our scientific understanding of our seas in order to base our decisions on the best available knowledge.*

The Biology and Sensitivity Key Information Sub-programme provides free access to the best-available scientific knowledge over the World Wide Web, through the *MarLIN* Web site. Biology and Sensitivity Key Information reviews collate information on the ecological requirements of marine species, habitats and the likely effects of human activities and natural events, and make that information readily available over the Internet. The Web site and underlying database support search tools, and decision support tools to present data directly relevant to environmental management at the strategic, regional or site-based levels.

The Data Access Sub-programme has also worked to improve the co-ordination and availability of existing marine spatial data, through our collaboration with the National Biodiversity Network, testing of their software and approaches, and by collating marine survey data from disparate sources. The SEABED Map now provides an interactive, on-line spatial search tool to interrogate the *MarLIN* hosted datasets. The SEABED Map and *MarLIN* Web site provide free and open access to hosted marine benthic survey data.

The *MarLIN* Web site provides a 'one-stop-shop' for information on priority marine species and habitats in the UK. The Biology and Sensitivity Key Information database represents a major review of the literature on the biology or species, ecology of habitats, their habitat requirements, and environmental impacts in the marine environment. The Sub-programme has cited ca 4,000 pieces of literature so far. Therefore, it represents a major review of the natural and human influences on ecological processes and systems in UK waters, both coastal and offshore.

MarLIN Biology and Sensitivity Key Information provides a significant evidence base to ensure that policy making is based on the best available scientific knowledge. In addition, it provides much of the known information about the impacts of human activities on marine ecosystems. The *MarLIN* Web site, therefore, supports several of Defra's present objectives and principles. For example:

- *we [Defra] will use science to underpin sound international policies and encourage our research contractors to engage actively in EU programmes.*
- *to support the development of an ecosystem-based approach to marine management by improving understanding of the structure and functioning of marine ecosystems and the impact of human activities;*
- *to investigate the natural and human influences on physical and ecological processes and systems operating around our coasts and estuaries and;*
- *to promote the use of marine science so that our policy making is based upon the* ***best available scientific knowledge*** *about the ecosystem and its dynamics*

- *current uncertainties and science needs include…….coordination of geographical information on biology and human activities; identifying and testing appropriate indicators to aid management how to build knowledge of ecosystem function into ecosystem-based management.*
- *to have developed by 2006 a methodology for preparing habitat maps of the OSPAR area, and to implement a system for integrated mapping of biological information and human activities*

In this contract, *MarLIN* developed its in-house GIS capability, developed a combined 'sensitivity' scale, and demonstrated the use of sensitivity maps in environmental management at the regional level (the Irish Sea) and incident response at the site based level (i.e. Pembrokeshire and Severn Estuary SACs).

However, sensitivity maps should not be a stand-alone tool. It was always envisaged that they would be one layer in an integrated marine environmental management tool using GIS. The sensitivity maps help to identify areas, biotopes, and species potentially sensitive to the impacts of human activities or natural effect. When combined with aerial photographs of the region, the location of other potentially sensitive resources (e.g. seals, sea birds, and cetaceans) (Moore, 2003), the location of socio-economic resources (e.g. tourist beaches, shellfisheries, marinas), and the physiochemical characteristics of the region (e.g. hydrography and bathymetry) in a single GIS system, sensitivity maps (linked to the Biology and Sensitivity Key Information on-line) could contribute to a powerful, 24 hour-a-day, tool to support marine spatial planning.

9. Recommendations

The *MarLIN* programme is keen to develop the outcomes of this Defra contract further, especially the development of information resources to support marine spatial planning (e.g. sensitivity mapping, vulnerability mapping), and adding value to survey data to support marine stewardship. Recommendations for further work and development follow, for which funding will be sought in due course.

Contribute to marine spatial planning

The 'marine spatial planning' conference in October 2003 concluded that marine spatial planning was a useful approach to bring together multi-sectoral data and interests, and to allow better planning and management of our coastal waters and regional seas, especially if the present legislative land-use planning framework was to a developed for the marine environment. In order to support science-based management planning decisions, a marine spatial plan requires information on the natural resources present (species, biotopes and habitats) and their ecological requirements, anthropogenic infrastructure and activities, and activities or proposals likely to damage valued ecosystem components.

In the present contract period, *MarLIN* demonstrated clearly its ability to link marine survey datasets and sensitivity information to produce sensitivity maps for a variety of activities, in work commissioned for the Irish Sea Pilot and the Countryside Council for Wales (Tyler-Walters *et al.,* 2003; Tyler-Walters & Lear, 2004). Both exercises produced extremely positive results but highlighted several limitations in our approach. However, the limitations are relatively minor and easy to resolve.

It is therefore recommended that *MarLIN* works to*:*

- develop 'intolerance' maps, to identify areas susceptible to damage by specific activities, to support emergency response;
- develop 'sensitivity' maps for species and habitats likely to be affected by specific activities;
- research and develop an approach to incorporate 'exposure' or the 'level' of an activity into 'sensitivity assessment' to develop 'vulnerability mapping' within specified areas or regional seas, and
- develop the application of sensitivity assessments to units such as biotope complexes and marine landscapes.

Vulnerability mapping will identify areas likely to be vulnerable to an activity (e.g. fisheries) using site or area specific information on the intensity or duration of an activity or activities. The approach to vulnerability assessment developed by Oakwood Environmental (2002) and to the environmental risk assessment of dredging by CEFAS (2002) would be taken into account. *MarLIN* is presently in negotiation with CEFAS to investigate offshore sensitivity and vulnerability indices.

Adding value to marine survey data

The *MarLIN* Web site now hosts information on 372 marine life datasets and access to over 250,000 species records. It is recommended that *MarLIN* analyses the hosted datasets, including the use of suites of multivariate statistics such as PRIMER, to:

- analyse marine datasets to update the distributions of marine species and habitats, especially designated or UK BAP or OSPAR Annex V species and habitats;
- identify the distribution of taxa identified as indicator species;
- identify changes in the distribution of climate change species;

- further improve our knowledge of the distribution and rate of spread on non-native species;
- identify offshore communities, biotope complexes and biotopes [note a proposal has also been submitted to DTI that would address offshore species and biotopes.], and
- look for evidence of natural and anthropogenic induced change in marine species distribution and communities.

We would need to continue expansion of our data holdings.

Expansion of the Biology & Sensitivity Key Information database

The Biology & Sensitivity Key Information database already includes information on the biology, ecological requirements, seasonal and temporal change, life history, and sensitivity characteristics of over 152 species, and community ecology, seasonal and temporal change, and sensitivity and recoverability characteristics of 117 biotopes. It is recommended that research continues to target:

- indicator species of ecosystem quality under the Water Framework Directive;
- species indicative of ecosystem function, and
- species characteristic of offshore biotopes [a proposal has also been submitted to DTI that would address offshore species and biotopes].

Maintenance and improvement of Web site and databases

Continued development of the Web site and database is required to support new and developing imperatives, e.g. the Water Framework Directive, marine spatial planning, and Defra's data management strategy. It is recommended that the site continues to improve, including:

- installation of SQL-Server;
- software upgrades;
- development of tools to support the Water Framework Directive, e.g. a search by priority pressures;
- search for 'climate change' species and non-native species;
- additional fields to address specific policy needs, such as information on the dynamic nature of ecosystems, and
- development of in-house XML capability to facilitate data exchange with other groups, specifically NBN, OBIS and GBIF.

In addition, continued development requires *MarLIN* staff to keep up-to-date and contribute to meetings and workshops, including ensuring that the information systems being developed by *MarLIN* are promoted.

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11. Publications

The following publications and contract reports were published by the *MarLIN* team in the contract period. Each report or publication either contributed directly to the development of the Biology and Sensitivity Key Information Sub-programme, relied on sensitivity information within the study or publicized the sub-programme and our approach to sensitivity assessment and information dissemination.

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Appendix 1. Biology and Sensitivity Key Information reviews completed, in priority order. OSPAR= OSPAR Annex V threatened / declining species; UK BAP = UK Biodiversity Action Plan; W&C Act = Wildlife & Conservation Act (1981); Hab. Dir.= EC Habitat Directive; NI Act = Wildlife (NI) Order 1985; CITES = CITES Convention; Berne = Berne Convention; Nat = National Status. Prioritization criteria (see text for details): 1 = Statute, Habitats Directive Annex, Red list, UK BAP, OSPAR Annex V or Lagoonal species; 2 = Key; Representative; 3 = Exploited; 4 = Nationally rare or scarce; 5 = Non-native; 6 = Climate change; In = Indicator species E = Exemplary. (*= includes *Ascophyllum nodosum* ecad *mackaii*).

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Tentacled lagoon worm	*Alkmaria romijni*	1,4				●				Scarce	None	Refereed
Sea fan anemone	*Amphianthus dohrnii*	1,4,6		●						Rare	None	Refereed
Icelandic cyprine	*Arctica islandica*	1,2,In	●							Not available	None	On-line
Lagoon sandworm	*Armandia cirrhosa*	1,4		●		●				Rare	None	Refereed
Knotted wrack	*Ascophyllum nodosum**	1,2		●		●				Widespread	None	Refereed
Fan mussel	*Atrina fragilis*	1,4,6		●		●	●			Scarce	None	Refereed
DeFolin's lagoon snail	*Caecum armoricum*	1,4				●				Rare	Insufficiently known	Refereed
Lagoon cockle	*Cerastoderma glaucum*	1,6								Not available	None	Refereed
A hydroid	*Clavopsella navis*	1,4,5		●		●				Rare	None	Refereed
Common Skate	*Dipturus batis*	1	●	●						Not available	Endangered (EN A1abcd + 2bcd)	On-line
Edible sea urchin	*Echinus esculentus*	1,2					●			Widespread	Lower Risk (LR/nt)	Refereed
Ivell's sea anemone	*Edwardsia ivelli*	1,4		●		●				Rare	Data deficient	Refereed
Pink sea fan	*Eunicella verrucosa*	1,2,6		●		●				Uncommon	Vulnerable (VU A1d).	On-line
The tall sea pen	*Funiculina quadrangularis*	1,2		●						Uncommon	None	On-line
Lagoon sand shrimp	*Gammarus insensibilis*	1,4		●		●				Scarce	None	Refereed
Giant goby	*Gobius cobitis*	1,3,4				●				Rare	None	On-line
Couch's goby	*Gobius couchi*	1,3,4	●			●				Rare	None	On-line
Short snouted seahorse	*Hippocampus hippocampus*	1,6	●					●	●	Not available	Data Deficient	Refereed
Sunset cup coral	*Leptopsammia pruvoti*	1,4,6		●					●	Rare	None	Refereed
Maerl	*Lithothamnion corallioides*	1,6			●					Not available	None	Refereed
Starlet sea anemone	*Nematostella vectensis*	1,4		●		●				Scarce	Vulnerable (VU A1ce)	Refereed
Dog whelk	*Nucella lapillus*	1,2	●							Not available	None	Refereed
Native oyster	*Ostrea edulis*	1,2,6	●	●						Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Lagoon snail	*Paludinella litorina*	1,4				●				Rare	None	Refereed
China limpet	*Patella ulyssiponensis*	1,2,6	●							Widespread	None	On-line
Maerl	*Phymatolithon calcareum*	1,2,6			●					Not available	None	Refereed
Common goby	*Pomatoschistus microps*	1,2						●		Widespread	None	Refereed
Sand goby	*Pomatoschistus minutus*	1,2						●		Widespread	None	On-line
Lagoon sea slug	*Tenellia adspersa*	1,4		●		●				Rare	None	Refereed
Northern hatchet shell	*Thyasira gouldi*	1,4,6		●		●				Rare	None	Refereed
Looping snail	*Truncatella subcylindrica*	1,4								Rare	Rare	Refereed
Common eelgrass	*Zostera marina*	1,2,4						●		Scarce	None	Refereed
A bivalve mollusc	*Abra alba*	2								Widespread	None	On-line
A red seaweed	*Ahnfeltia plicata*	2								Widespread	None	On-line
Dabberlocks	*Alaria esculenta*	2,6								Not available	None	Refereed
Dead man's fingers	*Alcyonium digitatum*	2								Widespread	None	Refereed
A brittlestar	*Amphiura chiajei*	2								Not available	None	On-line
A brittlestar	*Amphiura filiformis*	2								Widespread	None	On-line
Rosy feather-star	*Antedon bifida*	2								Not available	None	On-line
A bristleworm	*Aphelochaeta marioni*	2								Not available	None	Refereed
Sea mouse	*Aphrodita aculeata*	2,In								Not available	None	On-line
Blow lug	*Arenicola marina*	2								Widespread	None	Refereed
A sea squirt	*Ascidiella scabra*	2								Widespread	None	On-line
Common starfish	*Asterias rubens*	2								Widespread	None	Refereed
A branching sponge	*Axinella dissimilis*	2,6								Not available	None	On-line
An acorn barnacle	*Balanus crenatus*	2								Widespread	None	Refereed
A sand digger shrimp	*Bathyporeia pelagica*	2								Not available	None	Refereed
Star ascidian	*Botryllus schlosseri*	2								Widespread	None	On-line
A heart urchin	*Brissopsis lyrifera*	2								Not available	None	On-line
An erect bryozoan	*Bugula turbinata*	2								Not available	None	On-line
A burrowing mud shrimp	*Callianassa subterranea*	2								Not available	None	On-line
Edible crab	*Cancer pagurus*	2,3,In								Not available	None	On-line
Gallery worm	*Capitella capitata*	2,In								Widespread	None	On-line
Common shore crab	*Carcinus maenas*	2,3,In								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
A red seaweed	*Ceramium virgatum*	2								Widespread	None	On-line
Common cockle	*Cerastoderma edule*	2,3								Widespread	None	On-line
Carrageen	*Chondrus crispus*	2								Widespread	None	On-line
Sea lace or Dead man's rope	*Chorda filum*	2								Not available	None	On-line
Montagu's stellate barnacle	*Chthamalus montagui*	2,6								Widespread	None	Refereed
Poli's stellate barnacle	*Chthamalus stellatus*	2,6								Widespread	None	Refereed
A sea squirt	*Ciona intestinalis*	2								Not available	None	Refereed
A bristleworm	*Cirratulus cirratus*	2,In								Not available	None	On-line
A green seaweed	*Cladophora rupestris*	2								Widespread	None	On-line
Light bulb sea squirt	*Clavelina lepadiformis*	2								Widespread	None	On-line
An encrusting bryozoan	*Conopeum reticulum*	2								Not available	None	On-line
Coral weed	*Corallina officinalis*	2								Widespread	None	Refereed
Basket shell	*Corbula gibba*	2								Not available	None	On-line
A hydroid	*Cordylophora caspia*	2								Not available	None	On-line
A mud shrimp	*Corophium volutator*	2,In								Not available	None	On-line
Brown shrimp	*Crangon crangon*	2,3,In								Not available	None	On-line
Slipper limpet	*Crepidula fornicata*	2,5,6								Not available	None	Refereed
Sea beech	*Delesseria sanguinea*	2								Widespread	None	Refereed
Sea potato	*Echinocardium cordatum*	2								Not available	None	Refereed
A sea mat	*Electra pilosa*	2								Not available	None	On-line
Razor shell	*Ensis spp.*	2,3								Not available	None	Refereed
Speckled sea louse	*Eurydice pulchra*	2								Not available	None	On-line
Bean-like tellin	*Fabulina fabula*	2								Widespread	None	On-line
Hornwrack	*Flustra foliacea*	2								Not available	None	On-line
Horned wrack	*Fucus ceranoides*	2								Not available	None	Refereed
A brown seaweed	*Fucus distichus*	2,6								Not available	None	Refereed
Toothed wrack	*Fucus serratus*	2								Not available	None	Refereed
Spiral wrack	*Fucus spiralis*	2								Not available	None	Refereed
Bladder wrack	*Fucus vesiculosus*	2								Widespread	None	On-line
A red seaweed	*Furcellaria lumbricalis*	2								Not available	None	On-line
A gammarid shrimp	*Gammarus salinus*	2,3								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Bowerbank's halichondria	*Halichondria bowerbanki*	2								Not available	None	On-line
Breadcrumb sponge	*Halichondria panicea*	2								Widespread	None	On-line
Sea oak	*Halidrys siliquosa*	2								Not available	None	On-line
Ragworm	*Hediste diversicolor*	2								Widespread	None	Refereed
Blue-rayed limpet	*Helcion pellucidum*	2								Not available	None	Refereed
Bloody Henry starfish	*Henricia oculata*	2								Not available	None	Refereed
Thong weed	*Himanthalia elongata*	2								Not available	None	Refereed
An amphipod	*Hyale prevostii*	2,3								Not available	None	Refereed
Laver spire shell	*Hydrobia ulvae*	2								Not available	None	Refereed
An amphipod	*Jassa falcata*	2,3								Not available	None	Refereed
Banded chink shell	*Lacuna vincta*	2								Not available	None	Refereed
Oarweed	*Laminaria digitata*	2								Widespread	None	On-line
Tangle or cuvie	*Laminaria hyperborea*	2								Widespread	None	Refereed
Sugar kelp	*Laminaria saccharina*	2								Widespread	None	Refereed
Sand mason	*Lanice conchilega*	2								Not available	None	On-line
Harbour crab	*Liocarcinus depurator*	2,3								Not available	None	On-line
An encrusting coralline alga	*Lithophyllum incrustans*	2,3								Widespread	None	Refereed
Maerl	*Lithothamnion glaciale*	2,6								Not available	None	On-line
Common periwinkle	*Littorina littorea*	2								Widespread	None	Refereed
Baltic tellin	*Macoma balthica*	2								Widespread	None	Refereed
A bristleworm	*Magelona mirabilis*	2								Widespread	None	Refereed
Plumose anemone	*Metridium senile*	2								Widespread	None	On-line
Horse mussel	*Modiolus modiolus*	2,6								Not available	None	On-line
Sea grapes	*Molgula manhattensis*	2,3								Widespread	None	On-line
A colonial sea squirt	*Morchellium argus*	2,3								Not available	None	On-line
Sand gaper	*Mya arenaria*	2,5								Widespread	None	Refereed
Common mussel	*Mytilus edulis*	2								Widespread	None	Refereed
A hydroid	*Nemertesia ramosa*	2,3								Not available	None	Refereed
A brachiopod	*Neocrania anomala*	2,3								Not available	None	On-line
An opossum shrimp	*Neomysis integer*	2,3								Not available	None	On-line
Gravel sea cucumber	*Neopentadactyla mixta*	2,3								Not available	None	Refereed

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Norway lobster	*Nephrops norvegicus*	2,3,In								Not available	None	On-line
A catworm	*Nephtys hombergii*	2								Not available	None	On-line
A bivalve mollusc	*Nucula nitidosa*	2,In								Not available	None	On-line
A hydroid	*Obelia longissima*	2,3								Not available	None	On-line
Common brittlestar	*Ophiothrix fragilis*	2								Not available	None	Refereed
Thick top shell	*Osilinus lineatus*	2,6								Widespread	None	On-line
A tubeworm	*Owenia fusiformis*	2,In								Not available	None	On-line
Dulse	*Palmaria palmata*	2								Widespread	None	Refereed
Common limpet	*Patella vulgata*	2								Widespread	None	Refereed
Great scallop	*Pecten maximus*	2,3								Not available	None	On-line
Channelled wrack	*Pelvetia canaliculata*	2								Not available	None	Refereed
Ross	*Pentapora fascialis*	2,3,6								Not available	None	Refereed
Lobe shell	*Philine aperta*	2								Not available	None	On-line
Common piddock	*Pholas dactylus*	2,3						●		Not available	None	Refereed
Long clawed porcelain crab	*Pisidia longicornis*	2								Widespread	None	On-line
A bristleworm	*Polydora ciliata*	2								Not available	None	On-line
A tubeworm	*Pomatoceros triqueter*	2								Not available	None	On-line
Sealoch anemone	*Protanthea simplex*	2								Not available	None	Refereed
Green sea urchin	*Psammechinus miliaris*	2,3								Not available	None	Refereed
A red seaweed	*Rhodothamniella floridula*	2								Uncommon	None	On-line
Honeycomb worm	*Sabellaria alveolata*	2,6								Not available	None	Refereed
Ross worm	*Sabellaria spinulosa*	2								Not available	None	Refereed
Furbelows	*Saccorhiza polyschides*	2								Not available	None	On-line
An acorn barnacle	*Semibalanus balanoides*	2,6								Widespread	None	Refereed
A tubeworm	*Serpula vermicularis*	2								Not available	None	On-line
A bristleworm	*Spio filicornis*	2,3								Not available	None	On-line
A bristleworm	*Spiophanes bombyx*	2,3								Not available	None	On-line
A surf clam	*Spisula solida*	2,In								Not available	None	On-line
A sand hopper	*Talitrus saltator*	2								Widespread	None	On-line
Gut weed	*Ulva intestinalis*	2,3								Common	None	On-line
An encrusting bryozoan	*Umbonula littoralis*	2,3								Widespread	None	Refereed

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Dahlia anemone	*Urticina felina*	2								Widespread	None	Refereed
Pullet carpet shell	*Venerupis senegalensis*	2								Not available	None	On-line
Slender sea pen	*Virgularia mirabilis*	2								Not available	None	On-line
Dwarf eelgrass	*Zostera noltii*	2,4								Scarce	None	Refereed

Appendix 2. Basic information pages completed, in priority order. OSPAR= OSPAR Annex V threatened / declining species; UK BAP = UK Biodiversity Action Plan; W&C Act = Wildlife & Conservation Act (1981); Hab. Dir.= EC Habitat Directive; NI Act = Wildlife (NI) Order 1985; CITES = CITES Convention; Berne = Berne Convention. Prioritization criteria (see text for details): 1 = Statute, Habitats Directive Annex, Red list, UK BAP, OSPAR Annex V or Lagoonal species; 2 = Key; Representative; 3 = Exploited; 4 = Nationally rare or scarce; 5 = Non-native; 6 = Climate change; In = Indicator species E = Exemplary.

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Bearded red seaweed	*Anotrichium barbatum*	1,4		●						Rare	None	On-line
Minke whale	*Balaenoptera acutorostrata*	1		●	●	●	●	●	●	Not available	Low risk, near threatened (LR/nt)	On-line
Scarlet and gold star coral	*Balanophyllia regia*	1,2,6						●	●	Scarce	None	On-line
Basking shark	*Cetorhinus maximus*	1	●	●		●			●	Not available	Vulnerable (VU A1ad+2d)	On-line
Short-beaked common dolphin	*Delphinus delphis*	1		●	●	●	●	●		Not available	None	On-line
Leatherback turtle	*Dermochelys coriacea*	1,6	●	●	●	●		●	●	Not available	Critically Endangered (CR A1abd)	On-line
Grey seal	*Halichoerus grypus*	1			●			●		Not available	None	On-line
Long snouted seahorse	*Hippocampus guttulatus*	1	●					●	●	Not available	Vulnerable (A2cd)	On-line
Foxtail stonewort	*Lamprothamnium papulosum*	1,2,4		●		●				Rare	Vulnerable	On-line
A cold water coral	*Lophelia pertusa*	1,2			●				●	Not available	None	On-line
Killer whale	*Orcinus orca*	1		●	●	●	●	●		Not available	Lower risk (LR/cd)	On-line
Common or Harbour seal	*Phoca vitulina*	1			●		●			Not available	None	On-line
Harbour porpoise	*Phocoena phocoena*	1	●	●	●	●	●	●	●	Not available	Vulnerable (VU A1cd)	On-line
A sea-squirt	*Styela gelatinosa*	1,4,6		●						Rare	None	On-line
Bottle-nose dolphin	*Tursiops truncatus*	1		●	●	●	●		●	Not available	Data deficient	On-line
Trembling sea mat	*Victorella pavida*	1,4				●				Rare	Insufficient information	On-line
Beadlet anemone	*Actinia equina*	2								Widespread	None	On-line
Strawberry anemone	*Actinia fragacea*	2								Not available	None	On-line
Queen scallop	*Aequipecten opercularis*	2								Not available	None	On-line
An erect bryozoan	*Alcyonidium diaphanum*	2								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Red sea fingers	*Alcyonium glomeratum*	2,6								Not available	None	On-line
Pink sea fingers	*Alcyonium hibernicum*	2,4								Scarce	None	On-line
A spoon worm	*Amalosoma eddystonense*	2,4								Scarce	None	On-line
Lesser sand eel	*Ammodytes tobianus*	2,3								Not available	None	On-line
An amphipod	*Ampelisca brevicornis*	2,In								Not available	None	On-line
A bristleworm	*Ampharete falcata*	2,In								Not available	None	On-line
Small brittle star	*Amphipholis squamata*	2								Not available	None	On-line
Wolf fish or Catfish	*Anarhichas lupus*	2								Not available	None	On-line
Snakelocks anemone	*Anemonia viridis*	2,6								Widespread	None	On-line
Common eel	*Anguilla anguilla*	2								Not available	None	On-line
Thin tellin	*Angulus tenuis*	2,In								Not available	None	On-line
Saddle oyster	*Anomia ephippium*	2,6								Not available	None	On-line
Red speckled anemone	*Anthopleura ballii*	2,6								Not available	None	On-line
Glaucus pimplet	*Anthopleura thallia*	2,4								Scarce	None	On-line
A sea hare	*Aplysia punctata*	2								Not available	None	On-line
Thrift	*Armeria maritima*	2								Not available	None	On-line
A sea squirt	*Ascidiella aspersa*	2								Not available	None	On-line
Brown sea cucumber	*Aslia lefevrei*	2								Not available	None	On-line
A bivalve mollusc	*Astarte sulcata*	2								Not available	None	On-line
A cushion star	*Asterina gibbosa*	2,6								Widespread	None	On-line
A sand star	*Astropecten irregularis*	2								Not available	None	On-line
Gem anemone	*Aulactinia verrucosa*	2,6								Not available	None	On-line
A sponge	*Axinella damicornis*	2								Scarce	None	On-line
An acorn barnacle	*Balanus perforatus*	2,6								Not available	None	On-line
White piddock	*Barnea candida*	2								Not available	None	On-line
A brown seaweed	*Bifurcaria bifurcata*	2,6								Not available	None	On-line
A green seaweed	*Blidingia minima*	2								Not available	None	On-line
A colonial sea squirt	*Botrylloides leachi*	2								Not available	None	On-line
Common whelk	*Buccinum undatum*	2								Widespread	None	On-line
An erect bryozoan	*Bugula flabellata*	2								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Parasitic anemone	*Calliactis parasitica*	2								Not available	None	On-line
Painted top shell	*Calliostoma zizyphinum*	2								Not available	None	On-line
Orange sea lichen	*Caloplaca marina*	2								Not available	None	On-line
Devonshire cup-coral	*Caryophyllia smithii*	2,6							•	Not available	None	On-line
A tube anemone	*Cerianthus lloydii*	2								Not available	None	On-line
Parchment worm	*Chaetopterus variopedatus*	2								Not available	None	On-line
Variegated scallop	*Chlamys varia*	2,3								Not available	None	On-line
A sponge	*Ciocalypta penicillus*	2,6								Not available	None	On-line
Club-headed hydroid	*Clava multicornis*	2								Not available	None	On-line
Velvet horn	*Codium tomentosum*	2,6								Not available	None	On-line
Jewel anemone	*Corynactis viridis*	2,6								Not available	None	On-line
Masked crab	*Corystes cassivelaunus*	2,6								Not available	None	On-line
Portuguese oyster	*Crassostrea gigas*	2,3,5,6								Not available	None	On-line
American Oyster	*Crassostrea virginica*	2,3,6								Not available	None	On-line
A red seaweed	*Cryptopleura ramosa*	2								Not available	None	On-line
A sea cucumber	*Cucumaria frondosa*	2,4,6								Scarce	None	On-line
Rainbow wrack	*Cystoseira tamariscifolia*	2,6								Not available	None	On-line
Baked bean ascidian	*Dendrodoa grossularia*	2								Not available	None	On-line
A cumacean	*Diastylis rathkei*	2,In								Not available	None	On-line
Football sea squirt	*Diazona violacea*	2,6								Not available	None	On-line
A brown seaweed	*Dictyopteris membranacea*	2,6								Not available	None	On-line
Red rags	*Dilsea carnosa*	2								Not available	None	On-line
Lesser gooseberry sea squirt	*Distomus variolosus*	2,6								Not available	None	On-line
A sea mat	*Electra crustulenta*	2								Not available	None	On-line
An acorn barnacle	*Elminius modestus*	2,5								Not available	None	On-line
A sponge	*Esperiopsis fucorum*	2								Not available	None	On-line
Green-leaf worm	*Eulalia viridis*	2								Not available	None	On-line
Three-spined stickleback	*Gasterosteus aculeatus*	2								Not available	None	On-line
Grey top shell	*Gibbula cineraria*	2								Not available	None	On-line
Flat top shell	*Gibbula umbilicalis*	2,6								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
A scale worm	*Harmothoe lunulata*	2,In								Not available	None	On-line
A hydroid	*Hartlaubella gelatinosa*	2,4								Rare	None	On-line
Wrinkled rock borer	*Hiatella arctica*	2								Not available	None	On-line
Cotton spinner	*Holothuria forskali*	2,6								Not available	None	On-line
Common lobster	*Homarus gammarus*	2								Not available	None	On-line
A sponge	*Hymeniacidon perleve*	2								Not available	None	On-line
An isopod	*Idotea baltica*	2								Not available	None	On-line
A hydroid	*Kirchenpaueria pinnata*	2								Not available	None	On-line
A sea cucumber	*Labidoplax media*	2								Not available	None	On-line
A kelp	*Laminaria ochroleuca*	2,5,6								Not available	None	On-line
Black lichen	*Lichina pygmaea*	2								Not available	None	On-line
Common sea slater	*Ligia oceanica*	2								Not available	None	On-line
Gaping file shell	*Limaria hians*	2,6								Not available	None	On-line
An oligochaete	*Limnodrilus hoffmeisteri*	2								Not available	None	On-line
Arch-fronted swimming crab	*Liocarcinus arcuatus*	2,6								Not available	None	On-line
Wrinkled swimming crab	*Liocarcinus corrugatus*	2,6								Not available	None	On-line
Flying crab	*Liocarcinus holsatus*	2								Not available	None	On-line
Marbled swimming crab	*Liocarcinus marmoreus*	2								Not available	None	On-line
Shanny	*Lipophrys pholis*	2,6								Not available	None	On-line
Common flat periwinkle	*Littorina obtusata*	2								Not available	None	On-line
Rough periwinkle	*Littorina saxatilis*	2								Not available	None	On-line
Seven-armed starfish	*Luidia ciliaris*	2								Not available	None	On-line
A bristleworm	*Lumbrineris tetraura*	2								Not available	None	On-line
Spiny starfish	*Marthasterias glacialis*	2								Not available	None	On-line
False Irish moss	*Mastocarpus stellatus*	2								Not available	None	On-line
Small periwinkle	*Melarhaphe neritoides*	2								Not available	None	On-line
Sea mat	*Membranipora membranacea*	2								Not available	None	On-line
A red seaweed	*Membranoptera alata*	2,In								Not available	None	On-line
Rugose squat lobster	*Munida rugosa*	2								Not available	None	On-line
Green crenella	*Musculus discors*	2								Widespread	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Blunt gaper	*Mya truncata*	2								Not available	None	On-line
A bivalve mollusc	*Mysella bidentata*	2,In								Not available	None	On-line
A fanworm	*Myxicola infundibulum*	2								Not available	None	On-line
Velvet swimmer crab	*Necora puber*	2								Not available	None	On-line
Sea beard	*Nemertesia antennina*	2								Not available	None	On-line
A pseudoscorpion	*Neobisium maritimum*	2								Not available	None	On-line
White catworm	*Nephtys cirrosa*	2								Not available	None	On-line
A catworm	*Nephtys incisa*	2,In								Not available	None	On-line
Parelle	*Ochrolechia parella*	2								Not available	None	On-line
A sea cucumber	*Ocnus planci*	2								Not available	None	On-line
A brittlestar	*Ophiura albida*	2								Not available	None	On-line
Pepper dulse	*Osmundea pinnatifida*	2								Not available	None	On-line
Fireworks anemone	*Pachycerianthus multiplicatus*	2,6								Scarce	None	On-line
Hermit crab	*Pagurus bernhardus*	2								Not available	None	On-line
Hairy hermit crab	*Pagurus cuanensis*	2								Not available	None	On-line
Hermit crab	*Pagurus prideaux*	2								Not available	None	On-line
A prawn	*Palaemon elegans*	2								Not available	None	On-line
Common prawn	*Palaemon serratus*	2								Not available	None	On-line
Spiny lobster	*Palinurus elephas*	2,3,6								Not available	None	On-line
Purple sea urchin	*Paracentrotus lividus*	2,4,6								Scarce	None	On-line
A cockle	*Parvicardium ovale*	2								Not available	None	On-line
Black-footed limpet	*Patella depressa*	2,6								Not available	None	On-line
A burrowing sea anemone	*Peachia cylindrica*	2								Not available	None	On-line
An amphipod	*Pectenogammarus planicrurus*	2,4								Scarce	None	On-line
Phosphorescent sea pen	*Pennatula phosphorea*	2,6								Not available	None	On-line
Sea bristletail	*Petrobius maritimus*	2								Not available	None	On-line
Chalice sponge	*Phakellia ventilabrum*	2								Not available	None	On-line
Common reed	*Phragmites australis*	2								Widespread	None	On-line
A red seaweed	*Phycodrys rubens*	2								Not available	None	On-line
A red seaweed	*Plocamium cartilagineum*	2								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
A red seaweed	*Plumaria plumosa*	2,In								Not available	None	On-line
A red seaweed	*Polyides rotundus*	2								Not available	None	On-line
A sponge	*Polymastia mamillaris*	2								Not available	None	On-line
A red seaweed	*Polysiphonia lanosa*	2								Not available	None	On-line
Broad-clawed porcelain crab	*Porcellana platycheles*	2								Not available	None	On-line
Purple laver	*Porphyra umbilicalis*	2								Not available	None	On-line
Fennel pondweed	*Potamogeton pectinatus*	2								Not available	None	On-line
A green seaweed	*Prasiola stipitata*	2,In								Not available	None	On-line
Common saltmarsh grass	*Puccinellia maritima*	2								Not available	None	On-line
A bristleworm	*Pygospio elegans*	2								Not available	None	On-line
Sea ivory	*Ramalina siliquosa*	2								Not available	None	On-line
Beaked tasselweed	*Ruppia maritima*	2								Not available	None	On-line
Peacock worm	*Sabella pavonina*	2								Not available	None	On-line
A sea anemone	*Sagartia elegans*	2								Not available	None	On-line
A sea anemone	*Sagartiogeton undatus*	2								Not available	None	On-line
Wireweed	*Sargassum muticum*	2,5								Not available	None	On-line
A bristleworm	*Scolelepis squamata*	2								Widespread	None	On-line
A bristleworm	*Scoloplos armiger*	2,In								Not available	None	On-line
Peppery furrow shell	*Scrobicularia plana*	2								Not available	None	On-line
Purple heart urchin	*Spatangus purpureus*	2								Not available	None	On-line
Fifteen-spined stickleback	*Spinachia spinachia*	2								Not available	None	On-line
A tubeworm	*Spirorbis spirorbis*	2								Not available	None	On-line
A sponge	*Suberites carnosus*	2								Not available	None	On-line
A sponge	*Suberites ficus*	2								Not available	None	On-line
A sponge	*Suberites massa*	2								Not available	None	On-line
Northern sea fan	*Swiftia pallida*	2,6								Not available	None	On-line
Common tortoiseshell limpet	*Tectura testudinalis*	2,5								Not available	None	On-line
Black shields	*Tephromela atra*	2								Widespread	None	On-line
Bottle-brush hydroid	*Thuiaria thuja*	2,6								Not available	None	On-line
A sludge-worm	*Tubifex tubifex*	2								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
A sludge-worm	*Tubificoides benedii*	2								Not available	None	On-line
The oaten pipes hydroid	*Tubularia indivisa*	2								Not available	None	On-line
Orange peel bryozoan	*Turbicellepora magnicostata*	2								Rare	None	On-line
Sea lettuce	*Ulva lactuca*	2								Not available	None	On-line
A green seaweed	*Urospora wormskioldii*	2								Not available	None	On-line
Tar lichen	*Verrucaria maura*	2								Not available	None	On-line
A lichen	*Verrucaria mucosa*	2								Not available	None	On-line
Common orange lichen	*Xanthoria parietina*	2								Widespread	None	On-line
Lumpsucker	*Cyclopterus lumpus*	3,6								Not available	None	On-line
Flounder	*Platichthys flesus*	3								Not available	None	On-line
Turbot	*Psetta maxima*	3								Not available	None	On-line
Atlantic surf clam	*Spisula solidissima*	3								Not available	None	On-line
John dory	*Zeus faber*	3,6								Not available	None	On-line
Spiny cockle	*Acanthocardia aculeata*	4								Rare	None	On-line
Cranch's spider crab	*Achaeus cranchii*	4								Scarce	None	On-line
A sponge	*Adreus fascicularis*	4								Rare	None	On-line
A sea slug	*Aeolidiella alderi*	4								Scarce	None	On-line
A sea slug	*Aeolidiella sanguinea*	4								Rare	None	On-line
A hydroid	*Aglaophenia kirchenpaueri*	4								Scarce	None	On-line
A red seaweed	*Aglaothamnion diaphanum*	4								Rare	None	On-line
A red seaweed	*Aglaothamnion priceanum*	4								Rare	None	On-line
Trumpet anemone	*Aiptasia mutabilis*	4,6								Scarce	None	On-line
A sea anemone	*Anemonactis mazeli*	4								Scarce	None	On-line
A sea anemone	*Arachnanthus sarsi*	4								Rare	None	On-line
A brown seaweed	*Asperococcus scaber*	4								Scarce	None	On-line
A sea slug	*Atagema gibba*	4								Rare	None	On-line
A red seaweed	*Bornetia secundiflora*	4								Rare	None	On-line
An erect bryozoan	*Bugula purpurotincta*	4								Scarce	None	On-line
A sea slug	*Caloria elegans*	4								Scarce	None	On-line
A brown seaweed	*Carpomitra costata*	4,6								Scarce	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Southern cup coral	*Caryophyllia inornata*	4							•	Rare	None	On-line
Latticed corklet	*Cataphellia brodricii*	4								Scarce	None	On-line
A hermit crab	*Cestopagurus timidus*	4								Rare	None	On-line
A hermit crab	*Clibanarius erythropus*	4								Rare	None	On-line
A mud shrimp	*Corophium lacustre*	4								Scarce	None	On-line
A bryozoan	*Cylindroporella tubulosa*	4								Rare	None	On-line
A sponge	*Desmacidon fruticosum*	4								Rare	None	On-line
A sea slug	*Doris sticta*	4								Scarce	None	On-line
Sponge crab	*Dromia personata*	4								Scarce	None	On-line
A nut crab	*Ebalia granulosa*	4								Scarce	None	On-line
A sea anemone	*Edwardsia timida*	4								Scarce	None	On-line
A sand shrimp	*Gammarus chevreuxi*	4								Scarce	None	On-line
A red seaweed	*Gracilaria multipartita*	4								Scarce	None	On-line
Blue spot slug	*Greilada elegans*	4,6								Rare	None	On-line
A sea anemone	*Halcampoides elongatus*	4								Rare	None	On-line
A sea slug	*Hero formosa*	4								Scarce	None	On-line
Weymouth carpet coral	*Hoplangia durotrix*	4							•	Rare	None	On-line
Grooved top shell	*Jujubinus striatus*	4								Rare	None	On-line
Sea grass sea fir	*Laomedea angulata*	4								Scarce	None	On-line
A chiton	*Leptochiton scabridus*	4								Scarce	None	On-line
A red seaweed	*Lophosiphonia reptabunda*	4								Rare	None	On-line
A sea anemone	*Mesacmaea mitchellii*	4								Scarce	None	On-line
A hydroid	*Obelia bidentata*	4								Rare	None	On-line
Yellow skirt slug	*Okenia elegans*	4								Scarce	None	On-line
Celtic sea slug	*Onchidella celtica*	4								Scarce	None	On-line
Peacocks tail	*Padina pavonica*	4,6								Scarce	None	On-line
White cluster anemone	*Parazoanthus anguicomus*	4,6								Scarce	None	On-line
Yellow cluster anemone	*Parazoanthus axinellae*	4,6								Scarce	None	On-line
A red seaweed	*Pterosiphonia pennata*	4								Scarce	None	On-line
Worm anemone	*Scolanthus callimorphus*	4								Rare	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
A sea slug	*Stiliger bellulus*	4								Rare	None	On-line
Northern sea urchin	*Strongylocentrotus droebachiensis*	4,6								Rare	None	On-line
A sea slater	*Synisoma lancifer*	4								Scarce	None	On-line
A hydroid	*Tamarisca tamarisca*	4								Scarce	None	On-line
A sea slug	*Trapania maculata*	4								Rare	None	On-line
A sea slug	*Trapania pallida*	4								Scarce	None	On-line
A sea slug	*Tritonia nilsodhneri*	4,6								Scarce	None	On-line
Penny weed	*Zanardinia typus*	4,6								Scarce	None	On-line
Harpoon weed	*Asparagopsis armata*	5,6								Not available	None	On-line
Chinese mitten crab	*Eriocheir sinensis*	5								Not available	None	On-line
Hard-shell clam	*Mercenaria mercenaria*	5								Not available	None	On-line
A sea squirt	*Perophora japonica*	5								Not available	None	On-line
American piddock	*Petricola pholadiformis*	5								Not available	None	On-line
A sea squirt	*Styela clava*	5								Not available	None	On-line
Trigger fish	*Balistes carolinensis*	6								Not available	None	On-line
Deeplet sea anemone	*Bolocera tuediae*	6								Not available	None	On-line
Rock cook	*Centrolabrus exoletus*	6								Not available	None	On-line
Corkwing wrasse	*Crenilabrus melops*	6								Not available	None	On-line
Goldsinny	*Ctenolabrus rupestris*	6								Not available	None	On-line
A red seaweed	*Drachiella spectabilis*	6								Not available	None	On-line
Bryer's nut crab	*Ebalia tumefacta*	6								Not available	None	On-line
Red starfish	*Echinaster sepositus*	6								Not available	None	On-line
Angular crab	*Goneplax rhomboides*	6								Not available	None	On-line
Yellow feathers	*Gymnangium montagui*	6								Not available	None	On-line
Cuckoo wrasse	*Labrus mixtus*	6								Not available	None	On-line
Shore clingfish	*Lepadogaster lepadogaster*	6								Not available	None	On-line
Northern stone crab	*Lithodes maia*	6								Not available	None	On-line
Common spider crab	*Maja squinado*	6								Not available	None	On-line
Pearly top shell	*Margarites helicinus*	6								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Sunfish	*Mola mola*	6								Not available	None	On-line
Worm pipefish	*Nerophis lumbriciformis*	6								Not available	None	On-line
Oyster drill	*Ocenebra erinacea*	6								Not available	None	On-line
A red seaweed	*Odonthalia dentata*	6								Not available	None	On-line
Olive green wart anemone	*Phellia gausapata*	6								Not available	None	On-line
Bristly crab	*Pilumnus hirtellus*	6								Not available	None	On-line
A mantis shrimp	*Rissoides desmaresti*	6								Scarce	None	On-line
Orange sea grapes	*Stolonica socialis*	6								Not available	None	On-line
Leopard-spotted goby	*Thorogobius ephippiatus*	6								Not available	None	On-line
A chiton	*Tonicella marmorea*	6								Not available	None	On-line
Montagu's crab	*Xantho incisus*	6								Not available	None	On-line
Risso's crab	*Xantho pilipes*	6								Not available	None	On-line
Common pelican's foot	*Aporrhais pespelecani*	In								Not available	None	On-line
Smooth Artemis	*Dosinia lupinus*	In								Not available	None	On-line
Dog cockle	*Glycymeris glycymeris*	In								Not available	None	On-line
Red whelk	*Neptunea antiqua*	In								Not available	None	On-line
A bristleworm	*Notomastus latericeus*	In								Not available	None	On-line
Crevice brittlestar	*Ophiopholis aculeata*	In								Not available	None	On-line
A razor shell	*Phaxas pellucidus*	In								Not available	None	On-line
A horseshoe worm	*Phoronis hippocrepia*	In								Not available	None	On-line
A bivalve mollusc	*Spisula elliptica*	In								Not available	None	On-line
A bivalve mollusc	*Thracia convexa*	In								Not available	None	On-line
A bivalve mollusc	*Thracia villosiusucla*	In								Not available	None	On-line
An auger shell	*Turritella communis*	In								Not available	None	On-line
A bristled chiton	*Acanthochitona fascicularis*	E								Not available	None	On-line
A sea slug	*Acanthodoris pilosa*	E								Not available	None	On-line
Sandalled anemone	*Actinothoe sphyrodeta*	E								Not available	None	On-line
A sea slug	*Adalaria proxima*	E								Not available	None	On-line
Cloak anemone	*Adamsia carciniopados*	E								Not available	None	On-line
Grey sea slug	*Aeolidia papillosa*	E								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Pogge	*Agonus cataphractus*	E								Not available	None	On-line
Pistol shrimp	*Alpheus glaber*	E								Not available	None	On-line
Sea lemon	*Archidoris pseudoargus*	E								Not available	None	On-line
A sea slug	*Armina loveni*	E								Not available	None	On-line
Hooded shrimp	*Athanas nitescens*	E								Not available	None	On-line
A crab	*Bathynectes longipes*	E								Not available	None	On-line
Yellow-plumed sea slug	*Berthella plumula*	E								Not available	None	On-line
Twin fan worm	*Bispira volutacornis*	E								Not available	None	On-line
Needle whelk	*Bittium reticulatum*	E								Not available	None	On-line
Eyelash weed	*Calliblepharis ciliata*	E								Not available	None	On-line
Lance-shaped eyelash weed	*Calliblepharis jubata*	E								Not available	None	On-line
Common dragonet	*Callionymus lyra*	E								Not available	None	On-line
A red seaweed	*Callophyllis laciniata*	E								Not available	None	On-line
Chinaman's hat	*Calyptraea chinensis*	E								Not available	None	On-line
A red seaweed	*Catenella caespitosa*	E								Not available	None	On-line
Daisy anemone	*Cereus pedunculatus*	E								Not available	None	On-line
A gastropod	*Cerithiopsis tubercularis*	E								Not available	None	On-line
Striped venus clam	*Chamelea gallina*	E								Not available	None	On-line
Humpback scallop	*Chlamys distorta*	E								Not available	None	On-line
A red seaweed	*Chondria coerulescens*	E								Not available	None	On-line
Compass jellyfish	*Chrysaora hysoscella*	E								Not available	None	On-line
A bivalve	*Circomphalus casina*	E								Not available	None	On-line
A gastropod	*Colus islandicus*	E								Not available	None	On-line
A sea slug	*Coryphella gracilis*	E								Not available	None	On-line
Montagu's blenny	*Coryphoblennius galerita*	E								Not available	None	On-line
Common sun star	*Crossaster papposus*	E								Not available	None	On-line
A sea slug	*Cuthona foliata*	E								Not available	None	On-line
Blue jellyfish	*Cyanea lamarckii*	E								Not available	None	On-line
A sea slug	*Dendronotus frondosus*	E								Not available	None	On-line
A sea anemone	*Diadumene cincta*	E								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Rayed Artemis	*Dosinia exoleta*	E								Not available	None	On-line
Lesser weever fish	*Echiichthys vipera*	E								Not available	None	On-line
A sea anemone	*Edwardsiella carnea*	E								Not available	None	On-line
Slit limpet	*Emarginula fissura*	E								Not available	None	On-line
A sea slug	*Embletonia pulchra*	E								Not available	None	On-line
Common wentletrap	*Epitonium clathrus*	E								Not available	None	On-line
A sea anemone	*Epizoanthus couchii*	E								Widespread	None	On-line
A bristleworm	*Eteone longa*	E								Not available	None	On-line
An encrusting bryozoan	*Eucratea loricata*	E								Not available	None	On-line
Necklace shell	*Euspira catena*	E								Not available	None	On-line
A sea slug	*Facelina auriculata*	E								Not available	None	On-line
Shore rockling	*Gaidropsarus mediterraneus*	E								Not available	None	On-line
A squat lobster	*Galathea squamifera*	E								Not available	None	On-line
Black goby	*Gobius niger*	E								Not available	None	On-line
Two spotted goby	*Gobiusculus flavescens*	E								Not available	None	On-line
A sea anemone	*Halcampa chrysanthellum*	E								Not available	None	On-line
Herring-bone hydroid	*Halecium halecinum*	E								Not available	None	On-line
Mermaid's Glove	*Haliclona oculata*	E								Not available	None	On-line
Stalked jellyfish	*Haliclystus auricula*	E								Not available	None	On-line
Green ormer	*Haliotis tuberculata*	E								Not available	None	On-line
Thick-lipped dog whelk	*Hinia incrassata*	E								Not available	None	On-line
Netted dog whelk	*Hinia reticulata*	E								Not available	None	On-line
A sea anemone	*Hormathia coronata*	E								Not available	None	On-line
Great spider crab	*Hyas araneus*	E								Not available	None	On-line
A hydroid	*Hydractinia echinata*	E								Not available	None	On-line
Scorpion spider crab	*Inachus dorsettensis*	E								Not available	None	On-line
A bristleworm	*Janua pagenstecheri*	E								Not available	None	On-line
Ballan wrasse	*Labrus bergylta*	E								Not available	None	On-line
A bristleworm	*Lagis koreni*	E								Not available	None	On-line
A bivalve mollusc	*Lasaea adansoni*	E								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Common goose barnacle	*Lepas anatifera*	E								Not available	None	On-line
Orange-clubbed sea slug	*Limacia clavigera*	E								Not available	None	On-line
Bootlace worm	*Lineus longissimus*	E								Not available	None	On-line
A red seaweed	*Lomentaria articulata*	E								Not available	None	On-line
Slender spider crab	*Macropodia tenuirostris*	E								Not available	None	On-line
A fanworm	*Manayunkia aestuarina*	E								Not available	None	On-line
An acorn barnacle	*Megatrema anglicum*	E								Not available	None	On-line
Marbled crenella	*Modiolarca tumida*	E								Not available	None	On-line
A bivalve mollusc	*Nucula sulcata*	E								Not available	None	On-line
A sea slug	*Onchidoris bilamellata*	E								Not available	None	On-line
A sea slug	*Onchidoris muricata*	E								Not available	None	On-line
Black brittlestar	*Ophiocomina nigra*	E								Not available	None	On-line
A marbled rock crab	*Pachygrapsus marmoratus*	E								Not available	None	On-line
A sponge	*Pachymatisma johnstonia*	E								Not available	None	On-line
A sea slug	*Palio nothus*	E								Not available	None	On-line
Tompot blenny	*Parablennius gattorugine*	E								Not available	None	On-line
Sea gherkin	*Pawsonia saxicola*	E								Not available	None	On-line
Butterfish	*Pholis gunnellus*	E								Not available	None	On-line
Sea gooseberry	*Pleurobrachia pileus*	E								Not available	None	On-line
A sea slug	*Pleurobranchus membranaceus*	E								Not available	None	On-line
Alder's necklace shell	*Polinices pulchellus*	E								Not available	None	On-line
A sea slug	*Polycera quadrilineata*	E								Not available	None	On-line
Candy striped flatworm	*Prostheceraeus vittatus*	E								Not available	None	On-line
Dustbin-lid jellyfish	*Rhizostoma octopus*	E								Not available	None	On-line
A snail	*Rissoa parva*	E								Not available	None	On-line
Coral worm	*Salmacina dysteri*	E								Not available	None	On-line
Small-spotted catshark	*Scyliorhinus canicula*	E								Not available	None	On-line
Great pipefish	*Syngnathus acus*	E								Not available	None	On-line
Chequered carpet shell	*Tapes decussatus*	E								Not available	None	On-line

Common Name	Scientific name	Priority	OSPAR	UK BAP	Hab. Dir.	W&C Act	NI Act	Berne	CITES	National importance	Red list (IUCN)	Review status
Manila clam	*Tapes philippinarum*	E								Not available	None	On-line
Long-spined sea scorpion	*Taurulus bubalis*	E								Not available	None	On-line
A bivalve mollusc	*Tellimya ferruginosa*	E								Not available	None	On-line
Thumbnail crab	*Thia scutellata*	E								Not available	None	On-line
Pheasant shell	*Tricolia pullus*	E								Not available	None	On-line
Black faced blenny	*Tripterygion delaisi*	E								Not available	None	On-line
Bib or Pouting	*Trisopterus luscus*	E								Not available	None	On-line
Arctic cowrie	*Trivia arctica*	E								Not available	None	On-line
Spotted cowrie	*Trivia monacha*	E								Not available	None	On-line
Football jersey worm	*Tubulanus annulatus*	E								Not available	None	On-line
By-the-wind-sailor	*Velella velella*	E								Not available	None	On-line
Velvet shell	*Velutina velutina*	E								Not available	None	On-line

Appendix 3. *MarLIN* hosted datasets (October 2004).

Dataset name
1764-1969 Scotland *Pinna fragilis* records
1800-1954 Fauna of Strangford Lough and neighbouring coasts
1845-1855 Guernsey *Okenia elegans* observation
1878 Fan mussel *Pinna (Atrina) fragilis* in Scotland (metadata only)
1900 Salcombe estuary faunal observations
1904 Port Erin, Isle of Man long-term monitoring: Port Erin Breakwater
1918-1984 England, Wales and Scotland geographical distribution of *Sabellaria alveolata*
1919 Eddystone Lighthouse *Palinurus vulgaris* collection
1920-1974 *Modiolus modiolus* in small Mid-tidal rock pools at Penrhyn Bay, North Wales.
1924 Fal estuary oyster bed survey
1924-1952 Scotland *Palinurus vulgaris* surveys
1930-1934 Marine Fauna of the Isle of Man (metadata only)
1935 Firth of Forth *Tenellia adspersa* record (JNCC candidate rare/scarce species files)
1939-1946 southern Isle of Man Amphipoda records
1939-1954 Scotland spiny lobsters surveys
1940 Saltdean beach Sussex *Gammarus (Pectenogammarus) planicrurus* observation
1946-1950 Southern Isle of Man bottom fauna survey
1948-1952 Norfolk amphiphod survey
1949-1950 Cumbrian coast bottom fauna and food of flatfish
1951-1952 County Dublin amphipods new to Britain and Ireland (metadata only)
1952-1953 Port Erin Isle of Man Fauna of a muddy sand deposit
1953-1955 Kent, Essex, Dorset, Devon and Cornwall *Ostrea edulis* survey
1953-1957 Scotland rare marine invertebrate survey
1954 Port Erin, Isle of Man long-term monitoring: Cypris Station
1954-1955 Scotland spiny lobster surveys
1955-1956 Sublittoral algal populations in Port Erin Bay, Isle of Man
1956-1957 Scotland rare marine invertebrate surveys
1957 Plymouth Marine Fauna
1957-1961 Scotland rare marine invertebrate survey
1957-1962 Rare marine invertebrates found in the Scottish area (metadata only).
1961 Essex, Dorset, Cornwall observations on the fertility of the oyster (*Ostrea edulis*)
1961-1962 Fal estuary *Ostrea edulis* collection
1961-1970 Duckpool, north Cornwall Sabellaria survey
1962-1980 Dorset, Hampshire and Isle of Wight biological survey of the littoral zone
1963 Isle of Man marine fauna
1963 Marine Fauna of the Isle of Man and its Surrounding Seas (metadata only)
1964 Isles of Scilly marine flora & fauna observations Cnidaria & Ctenophora
1964-1965 Blackwater Estuary benthic and littoral fauna
1965 Brighton to Deal beach survey
1965-1972 Variation in the shell of the dog whelk *Nucella lapillus*: Pembrokeshire
1966 Isles of Scilly marine flora & fauna observations (Crustacea, Eucarida)
1966 Milford Haven effects of oil spillages ecological survey
1966-1975 Cornwall *Palinurus elephas* fishery survey
1970 Aberystwyth *Pectenogammarus planicrurus* survey
1970-1971 Blackwater estuary faunal survey
1970-1980 Echinodermata records
1970-1980 Isopod Crustacea records

Dataset name
1970-2004, NMA - United Kingdom Marine Fish Recording Scheme (Welsh data)
1970s-1980s Marine Mollusca: biological records centre
1971 Kent, Hampshire, Dorset, Devon, Cornwall *Polydora* and *Ostrea edulis* investigation
1971 Lundy marine fauna observations (Euphausiacea and Decapoda)
1971 Solent preliminary survey of macroscopic bottom fauna
1971-1973 Duckpool, North Cornwall *Sabellaria* survey
1971-1976 *Modiolus modiolus* - an autecological study
1972 Diving survey of Strangford Lough: the benthic communities and their relation to substrate
1972 Millport Isle of Cumbrae *Modiolus modiolus* collection
1972-1973 Bristol Channel sublittoral macrofaunal survey
1972-1975 Scotland spiny lobster *Palinurus elephas* surveys
1973 Solent oyster ground survey
1973-1983 Countryside Council for Wales Coastal Surveillance Unit monitoring programme
1974 Galloway Estuaries, Solway, intertidal algae
1974 Restronguet Creek oyster collection
1974 River Add, Argyllshire intertidal algae
1974-1975 Beaulieu River oyster collection
1974-1975 Beaulieu River oyster survey
1975 Duckpool, north Cornwall *Sabellaria alveolata* survey
1975 Strangford Lough investigations into a *Modiolus modiolus* community
1975-1999 UK offshore oil and gas inventory of all environmental surveys
1976 Channel Isles, Cornwall and Milford Haven, *Okenia elegans* observations (metadata)
1976 Faunal data generated by James G Parker
1976 Lundy Island *Caloria elegans* observation
1976 Scottish west coast *Modiolus modiolus* records
1976 Shetland Voes *Modiolus modiolus* records (abs. recs included)
1976 Solent and adjoining harbours oyster survey
1976-1977 Bristol Channel macrofaunal survey
1976-1985 Lundy, Northern Ireland *Okenia elegans* records (JNCC candidate rare/scarce species files)
1976-1987 Guernsey, Lundy, *Leptopsammia pruvoti* records (JNCC candidate rare/scarce species files)
1977 Berwickshire Underwater observation scheme
1977 Cornwall underwater observation scheme
1977 Essex Underwater observation scheme
1977 Isle of Man underwater observation scheme
1977 Isle of Mull underwater observation scheme
1977 Isles of Scilly underwater observation scheme
1977 Liverpool Bay and Solway underwater observation scheme
1977 Pembrokeshire littoral zone survey
1977 Solent the public oyster fishery survey
1977 Wales underwater observation scheme
1977-1979 Sussex underwater observation scheme
1977-1980 Dorset underwater observation scheme
1977-1982 Devon underwater observation scheme
1977-1986 north Wales distribution of some sublittoral species
1978 Beaulieu River Ostrea edulis survey
1978 Devon and Cornwall shore survey

Dataset name
1978 Diving survey of the substrates and benthic fauna of Dundrum Bay, Northern Ireland
1978 Dorset County Council Planning Department Underwater Survey
1978 Glamorgan Marine Algae
1978 Sullom Voe Biological Monitoring
1978-1981 Studies on populations of *Echinus esculentus* from Skomer Voluntary Marine Nature Reserve
1978-1982 St. Abbs and Skomer studies on the populations of *Echinus esculentus*
1979 Beaulieu River oyster investigation
1979 Cornwall *Pectenogammarus planicrurus* records
1979 Hamworthy shore, Poole Harbour oyster survey
1979 Lymington oyster investigations
1979 River Blackwater benthic survey
1979 south Wales survey of the littoral Anthozoa
1979 South-west Britain Sublittoral Survey
1979 Sullom Voe Macrobenthic Monitoring
1979-1980 Hampshire underwater observation scheme
1980 Marine algal records for Kent
1980 Sullom Voe macrobenthic monitoring
1981 Arran and adjacent seas marine Mollusca survey
1981 Millport *Echinus esculentus* survey
1981 South Cornwall subtidal survey
1981 Sullom Voe macrobenthic monitoring survey
1981 Sullom Voe, observations on the distribution of heavy metals
1981-1983 Firth of Clyde *Echinus esculentus* survey
1981-1986 Brighton, East Sussex shore fauna survey (absence records included)
1981-1991 JNCC candidate rare species files, *Palinurus elephas* records
1981-1997 Humber Estuary Annual Survey
1982 Burnham-on-Crouch, Roach at Paglesham and Brighton oyster survey
1982 Falmouth *Crassostrea gigas* and *Ostrea edulis* collection
1982 Isle of Wight benthic algae species list
1982 Menai Strait sublittoral survey
1982 Skomer sublittoral surveys
1982 Sullom Voe macrobenthic monitoring
1982-1984 Isle of Man observations on the reproduction of *Modiolus modiolus*
1982-1986 The Wash and its environment
1982-1996 North Irish Sea distribution & damage to by-catch assemblages from scallop dredging
1983 Bardsey and the Lleyn Peninsula sublittoral survey
1983 Firth of Lorn benthic brachiopod collection
1983 Isles of Scilly study of the animal communities from sublittoral sediments
1983 Sullom Voe macrobenthic monitoring survey
1983 Wales *Okenia elegans* record
1983-1984 Lundy and Isles of Scilly sessile epifaunal survey
1984 Bristol Channel benthic survey
1984 Forties Bravo, Humber estuary and Loch Spelve *Modiolus modiolus* from collection
1984 Great Britain biogeography of *Sabellaria alveolata* (metadata)
1984 Loch Long, Clyde estuary *Modiolus modiolus* collection
1984 Poole Harbour *Ostrea edulis* collection
1984 Sarn Badrig reef, mid Wales sublittoral algal community survey

Dataset name
1984 Skomer surveys of sublittoral habitats and communities around the Marine Reserve
1984 South Deep, Poole Harbour oyster population survey
1984 Sullom Voe macrobenthic monitoring survey (absence records included)
1984 Wales *Caloria elegans* record
1984 Wales, Isle of Man, Irish Sea & Strangford Lough *Modiolus modiolus* study
1984-1987 Western North Sea *Modiolus modiolus* collection
1984-1991 Lundy and isles of Scilly report on the marine monitoring programmes (metadata)
1985 Blackwater Estuary oyster fishery survey
1985 Blackwater Estuary quality survey
1985 Dorset *Sabellaria spinulosa* record
1985 Menai marine conservation area molluscan and polychaete faunas of selected sites
1985 Skomer a brief review of the ecology of the sea fan
1985 Solent European flat oyster spawning stock survey
1985 Sullom Voe biological monitoring survey (absence records included)
1985-1991 Wales *Okenia elegans* records (JNCC candidate rare specie files)
1986 Fecundity & seasonal changes in reproductive output of female *Pectenogammarus planicrurus*
1986 Southwest England *Alcyonium glomeratum* records (JNCC candidate rare/scare species files)
1986 Sullom Voe chemical and biological monitoring survey
1986 Widemouth Bay, Cornwall Sabellariid polychaete collection
1986-1989 England, Wales and Scotland report on TBT contamination of *Nucella lapillus*
1987 Guernsey *Parazoanthus axinellae* record (JNCC candidate rare/scarce species files)
1987 Guernsey *Polysyncraton lacazei* record (JNCC candidate rare/scarce species files)
1987 Hengistbury Head seaweed survey
1987 North Wales River Clwyd - Aberystwyth survey of the coastal lagoons
1987 Sullom Voe chemical and biological monitoring survey
1987 Swanage, Dorset Bryozoa collection
1987-1988 Skomer Marine Reserve subtidal monitoring project animal communities on stones
1987-1989 Crouch Estuary epibenthic survey
1987-1990 Skomer *Alcyonium glomeratum* records (JNCC candidate rare species files)
1988 Isles of Scilly sub sea survey
1988 Loch Fyne survey
1988 Selsey, Sussex *Ostrea edulis* collection
1988 Severn estuary benthic macrofauna and sediment survey
1988 Sullom Voe chemical and biological monitoring survey
1988-2001 Wales *Polysyncraton lacazei* records
1989 Belfast Lough Sewage Sludge Disposal Monitoring (1998??)
1989 County Donegal *Caloria elegans* record (JNCC candidate rare/scarce species files)
1989 Garroch Head, Scotland, sludge disposal ground survey
1989 Ironotter Point Benthos Survey
1989 Skomer *Hoplangia durotrix* record (JNCC candidate rare species files)
1989 Sullom Voe chemical and biological monitoring survey
1989-1990 BP Amethyst sublittoral survey
1989-1990 Skomer *Parazoanthus axinellae* records (JNCC candidate rare species files)
1990 Loch Sween, Conwy and the Solent *Ostrea edulis* collection
1990 Plymouth sludge disposal ground, environmental survey
1990 Sewage Sludge Disposal Monitoring
1990 Sullom Voe chemical and biological monitoring survey

Dataset name
1990 Teignmouth, Devon, seabed environmental survey
1990 Teignmouth, Devon, seabed environmental survey (second survey)
1990-1991 County Dublin *Zostera* distribution and ecology
1990-1996 National Marine Monitoring Programme
1990-1997 Cromarty Firth Scottish Environmental Protection Agency Surveys
1991 Belfast Lough Sewage Sludge Disposal Monitoring
1991 Exeter sewage sludge disposal ground, environmental survey
1991 Eype, West Dorset *Pectenogammarus planicrurus* observation
1991 Fal Estuary benthic community structure
1991 Isle of Man *Aeolidiella sanguinea* record (JNCC candidate rare species files)
1991 Isles of Scilly marine monitoring
1991 River Blackwater estuary subtidal survey
1991 Yell Sound, Shetland Islands benthic baseline survey
1991-1992 Skomer *Caryophyllia inornata* records (JNCC candidate rare species files)
1992 Coombe Creek, Saltash, Plymouth Marine Scheme Intertidal Benthic Studies
1992 Falmouth benthic survey
1992 Gorran Haven Sewage Outfall Survey
1992 Ironotter Point Benthos Survey
1992 MNCR Eyemouth (Berwickshire) to Alnmouth (Northumberland) survey
1992 MNCR south-east Scotland from North Berwick to River Tweed survey
1992 Morecambe Bay - Carlingford Lough Port Erin Marine Lab. (Isle of Man) long term monitoring
1992 Norfolk macrobenthos survey
1992 Polgaber beach, Par, Cornwall intertidal survey
1992 Sewage Sludge Disposal Monitoring
1992 Sullom Voe chemical and biological monitoring survey
1992 Tamar estuary Plymouth Marine Scheme subtidal benthic studies
1992-1994 Offshore north Norfolk macrobenthos survey
1993 Isle of Man Mollusca
1993 Isles of Scilly and Cornwall comparative study
1993 Lyme Bay effects of scallop dredging survey
1993 National Monitoring Plan - Spatial Survey
1993 North of Coal Pit, North Sea. Marine aggregate extraction benthic survey
1993 North Sea, English Channel, and Celtic Sea biodiversity
1993 South Wales and Cornwall *Palinurus elephas* fishing survey
1993 Studies on the Crawfish *Palinurus elephas* in south Wales (and Cornwall)
1993-1996 Isle of Wight and Solent littoral algae PhD
1994 Aggregate extraction area 430 east of Southwold : Final environmental statement
1994 East of Skegness environmental status report of area 107 aggregate extraction site
1994 Port Erin, Isle of Man long-term monitoring: Bayrnagh Station
1994 Sewage Sludge Disposal Monitoring
1994 Strangford Lough DARDNI SAC Monitoring
1994 Sullom Voe chemical and macrobenthic monitoring survey
1994-1995 Teignmouth Riverside Environmental Study
1994-1997 Isle of Man short-term effects of scallop dredging
1994-1997 Isle of Man sublittoral survey : phase I
1995 Estuarine Classification (Northern Ireland)
1995 Exeter sewage sludge disposal ground monitoring survey
1995 Helford River distribution of oysters and other molluscs

Dataset name
1995 Inner Owers benthos survey
1995 Ironotter Point Benthos Survey
1995 JNCC candidate rare species files, *Caloria elegans* records
1995 National Marine Monitoring Program - Inshore
1995 Offshore of Harwich, macroinvertebrate samples
1995 Plymouth sewage sludge disposal ground environmental monitoring survey
1995 Sewage Sludge Disposal Monitoring
1995 Strangford Lough DARDNI SAC Monitoring
1995-1997 Bigbury Bay to Start Point marine survey
1995-1999 Isle of Man Intertidal survey (metadata only)
1995-1999 *Limaria hians* in Loch Fyne
1996 Atlantic Margin Environmental Survey (part 1) AFEN
1996 Atlantic Margin Environmental Survey (part 2) AFEN
1996 Bangor Outfall Comprehensive Studies
1996 Bude, Cornwall, benthic survey
1996 Dawlish Marine Survey
1996 Hayle, Cornwall, benthic survey
1996 Off Folkestone (West Varne) licensed dredging survey
1996 Off Lowestoft, marine aggregate application, area 454 benthic ecology
1996 Off Suffolk (Shipwash Gabbard): marine aggregate application area 452 benthic ecology
1996 Selsey Bill UMD marine aggregate extraction benthic survey
1996 Sewage sludge disposal monitoring
1996 St. Catherine's, Isle of Wight, marine aggregate licensed dredging area 407 benthic survey
1996 Sullom Voe chemical and macrobenthic monitoring survey
1997 Bangor Outfall Comprehensive Studies 1997 - Follow-up survey
1997 Crouch estuary improvements of the epifauna
1997 Estuarine Classification (Northern Ireland)
1997 IRTU Northern Ireland estuarine classification monitoring programme
1997 National Monitoring Plan - Inshore
1997 National Monitoring Plan - Offshore
1997 Occurrence of a subtidal *Sabellaria alveolata* reef off Wicklow Head, Irish Sea
1997 Sewage Sludge Disposal Monitoring
1997 Stour and Orwell estuary benthic survey Unicomarine Ltd
1997 Strangford Lough DARDNI SAC Monitoring
1997 Subtidal habitat & biotope mapping survey Isles Of Scilly
1997 Survey of the current status of *Ostrea edulis* in Strangford Lough, Northern Ireland
1997-2001 DARD (Northern Ireland) Surveys
1998 - Britain and Ireland marine species biology and sensitivity key information
1998 - Current Britain & Ireland volunteer collected Sealife Survey records
1998 Atlantic Margin Environmental Survey (part 2) AFEN
1998 Atlantic Margin Environmental Survey (part 1) AFEN
1998 Beaulieu estuary *Ostrea edulis* specimen collection
1998 CEFAS 4m beam trawl survey
1998 Hastings shingle bank : southern England, biological and habitat survey
1998 Ironotter Point Benthos Survey
1998 National Monitoring Plan - Inshore
1998 National Monitoring Plan - Offshore
1998 Offshore north Norfolk macrobenthos survey

Dataset name
1998 Sewage Sludge Disposal Monitoring
1998 St. Osyth in Essex *Tenellia adspersa* (Nordmann, 1845)
1998 STW Outfalls MM98-12
1998 Sullom Voe chemical and macrobenthic monitoring survey
1998-1999 Intertidal survey of National Trust properties in Cornwall
1998-2000 Stour Estuary macrobenthos survey (dredge monitoring) Unicomarine Ltd
1998-2001 Isle of Man long-term effects of scallop dredging: closed area experiment
1998-2001 Isle of Man long-term effects of scallop dredging: high/low effort areas
1998-2001 Isle of Man long-term effects of scallop dredging: re-analysis of historical data
1999 CEFAS Beam Trawl Survey (Cory 8-99)
1999 CEFAS Beam Trawl Survey (Cory 9-99)
1999 Estuarine Classification (Northern Ireland)
1999 Exeter sewage sludge disposal ground: environmental assessment
1999 Inner Dowsing & North Dowsing marine aggregate extraction application baseline survey
1999 Milford Haven, damage assessment survey of salt marsh affected by the Sea Empress oil spillage
1999 National Marine Monitoring Program MM99-06
1999 North Channel Disposal Ground Monitoring MM00-09
1999 South-west of the Isle of Wight : marine aggregate extraction benthic ecology survey
1999 Strangford Lough DARDNI SAC Monitoring
1999 West Bassurelle (south of Beachy Head) marine aggregate extraction application survey.
1999-2001 Farne Islands marine monitoring programme, marine life log
1999-2001 Northumberland Coast Marine Biodiversity project (Berwick to Tynemouth)
2000 - 2002 CEFAS 2m beam trawl survey of Celtic Sea
2000 Antrim Coast Outfall Survey - MM99-16
2000 *BP Pandora* (UKCS Block 22/25) seabed environmental survey
2000 Coal Pit, North Sea, marine aggregate area macrofaunal survey
2000 East of Great Yarmouth and Lowestoft biological resource survey
2000 East of Great Yarmouth and Lowestoft, distribution of Sabellaria spinulosa
2000 Estuarine Classification (Northern Ireland)
2000 Isle of Man sublittoral survey : phase II
2000 Larne Waste Water Treatment Works Outfall Survey MM00-10
2000 National Marine Monitoring Program MM00-09
2000 North Channel Disposal Ground Monitoring MM00-09
2000 North coast dredge disposal monitoring
2000 Strangford Lough DARDNI SAC Monitoring
2000 Sullom Voe chemical and macrobenthic monitoring survey
2000-2001 Stour and Orwell Estuaries Biotope Mapping Unicomarine Ltd
2001 Benthic Biodiversity in the Irish Sea
2001 Deben cores bird study Environment Agency & Unicomarine
2001 Estuarine Classification (Northern Ireland)
2001 National Marine Monitoring Program MM01-09
2001 North Channel Disposal Ground Monitoring MM01-12
2001 North Lincolnshire Coastal Survey of Potential Saline Lagoons Unicomarine Ltd
2001 North Sea assessing the history of trace metal contamination
2001 Strangford Lough DARDNI SAC Monitoring
2001 Yell Sound and Orka Voe chemical and macrobenthic monitoring: Interim survey
2002 CEFAS Beam Trawl Survey (Cory 10/02)

Dataset name
2002 CEFAS Beam Trawl Survey (Cory 13/02)
2002 National Marine Monitoring Program MM02-05
2003 CEFAS 4m beam trawl survey
2003 Pink sea fan survey
2003 West Hoe Plymouth, *Atrina fragilis* record
2004 Loch Ryan, *Sargassum muticum* survey
Amphipoda of Dalkney Island and its neighbouring waters.
Analysis of underwater visual data to identify the impact of physical disturbance on horse mussel
Britain & Ireland marine molluscs records
British Phycological marine algal mapping scheme
Clyde Sea area faunal records
Conchological Society marine census
Cornwall and the Isles of Scilly marine life records
Cornwall Marine algal collection
Countryside Council for Wales Intertidal Phase 1 Survey Database
Cullercoats marine fauna and flora
Dunstaffnage marine laboratory benthic samples
Fauna of the Clyde Sea Area: Crustacea
Fauna of the Clyde sea area: Mollusca
Hannafore Reef, Looe, Cornwall, intertidal flora and fauna
Historical Marine Biological Association invertebrate collection
Isle of Man scallop fishery monitoring project
Lundy marine fauna, Lundy Field Society
Lyme Bay survey, Devon Wildlife Trust
Marine invertebrates records for Northern Ireland
Marine life survey of Devon.
Marine molluscs (Cornwall): dry collection
Marine species checklist, Marine Conservation Society
National marine and estuarine fish records database
Norfolk marine algal records
North Devon Museum marine species collections
North-east Atlantic Pycnogonidae
Northern Ireland marine algal records
Pembrokeshire marine species atlas
Pembrokeshire, Sea Empress disaster marine survey data
Personal Observation: P.G. Moore
Plymouth Marine Laboratory benthic samples/meiofauna database
SAMS & SMBA collections
South-east Scotland and north-east England marine algal records
Sussex Marine algal records
Torquay Museum Amelia Griffiths algal collection and invertebrate collection
Wales Marine monitoring data using RoxAnn

Appendix 4. Sensitivity assessment rationale - a summary

Introduction

The sensitivity assessment rationale was developed by the *MarLIN* team in consultation with the Biology & Sensitivity Key Information Sub-programme Technical Management Group and ratified by the *MarLIN* programme Steering Group, both of which include representatives of the major users of marine information, statutory agencies, regulators, and marine research institutes. The *MarLIN* sensitivity assessment rationale, definitions of terms and scales used prior to March 2003 are given by Tyler-Walters *et al.* (2001) and their development in Tyler-Walters & Jackson (1999) and Hiscock *et al.* (1999). The definitions of sensitivity used after March 2003 are based on definitions suggested by the RMNC (Laffoley *et al.*, 2000) and developed by *MarLIN* in consultation with our Biology & Sensitivity Key Information Sub-programme Technical Management Group and Sensitivity Mapping Advisory Group.

The revised 'sensitivity' scale introduced another step into the *MarLIN* approach to sensitivity assessment previously outlined in Tyler-Walters *et al.* (2001) and on the *MarLIN* Web site. The revised sensitivity assessment rationale for species and biotopes, as amended in March 2003, is summarized below together with the relevant definitions of intolerance, recoverability, and sensitivity.

Box 1. Core definitions

'Biotope' refers to the combination of physical environment (habitat) and its distinctive assemblage of conspicuous species. For practical reasons of interpretation of terms used in directives, statutes and conventions, in some documents, 'biotope' is sometimes synonymized with 'habitat'.

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

'Community' refers to a group of organisms occurring in a particular environment, presumably interacting with each other and with the environment, and identifiable by means of ecological survey from other groups. The community is usually considered the biotic element of a biotope.

'Intolerance' is the susceptibility of a habitat, community, or species (i.e. the components of a biotope) to damage, or death, from an external factor. Intolerance must be assessed relative to specified change in a specific environmental factor.

'Recoverability' is the ability of a habitat, community, or species (i.e. the components of a biotope) to return to a state close to that which existed before the activity or event caused change.

'Sensitivity' is dependent on the intolerance of a species or habitat to damage from an external factor and the time taken for its subsequent recovery. For example, a "highly sensitive" species or habitat is one that is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) and is expected to recover only over a very long period of time, (10 to 25 years: 'low' recoverability). Intolerance, and hence sensitivity, must be assessed relative to a specified change in a specific environmental factor.

The *MarLIN* approach to assessing sensitivity is built on a review of the strengths and weaknesses of existing and prior approaches to sensitivity assessment, especially earlier

work by Holt *et al.* (1995, 1997), which thought through many of the concepts of vulnerability, sensitivity, and recoverability. Studies commissioned or undertaken by the nature conservation agencies in the UK, the ICES Benthos Working Group workshops and meetings of the OSPAR IMPACT group, the recent Review of Marine Nature Conservation (RMNC) (Laffoley *et al.*, 2000), together with subsequent development by *MarLIN*, have all contributed to the standard terms shown in Box 1.

Assessing the sensitivity of species

The assessment process involves judging the intolerance of a species to change in an external factor arising from human activities or natural events. The rationale then assesses the likely recoverability of the species following cessation on the human activity or natural event. Intolerance and recoverability are then combined to provide a meaningful assessment of their overall sensitivity to environmental change.

1. Collate the key information for the species. The best available scientific information required to describe the biology and likely sensitivity of the species is collated using the resources of the National Marine Biological Library (NMBL), the World Wide Web, and the expertise of marine biologists based at the Marine Biological Association of the UK (MBA), Plymouth.

2. Indicate quality of available data. The *MarLIN* programme operates an internal quality assurance procedure, to ensure that only the most accurate available information is provided on-line. The quality of the available evidence and our confidence in our assessments (based on availability of information) is clearly stated (see Table A4.1).

Table A4.1. Scale used to rank the level of information available to support the assessment of intolerance and recoverability

EVIDENCE / CONFIDENCE The scale indicates an appraisal of the specificity of the information (data) available to support the assessment of intolerance and recoverability.	
Rank	**Definition (adapted from Hiscock *et al.*, 1999)**
High	Assessment has been derived from sources that specifically deal with sensitivity and recoverability to a particular factor. Experimental work has been done investigating the effects of such a factor.
Moderate	Assessment has been derived from sources that consider the likely effects of a particular factor.
Low	Assessment has been derived from sources that only cover aspects of the biology of the species or from a general understanding of the species. No information is present regarding the effects of factors.
Very low	Assessment derived by 'informed judgement' where very little information is present at all on the species.
Not relevant	The available information does not support an assessment, the data is deficient, or no relevant information has been found.
Note: In some cases it is possible for limited evidence to be considered 'high' for the assessment of sensitivity to a specific factor. For example, if a species is known to lack eyes (or equivalent photoreceptors) then it could confidently be considered 'not sensitive' to visual disturbance and the level of evidence would be recorded as 'high'.	

3. Assess the intolerance of the species to change in environmental factors. The likely intolerance (Table A4.2) of the species is assessed with respect to a specified magnitude and duration of change (the standard benchmark) for 24 separate environmental factors (see Table A4.3).

Table A4.2. Species intolerance (previously 'sensitivity' and revised April 2003).

SPECIES INTOLERANCE The susceptibility of a species population to damage, or death, from an external factor. Intolerance is assessed relative to change in a specific factor.	
Rank	**Definition**
High	The species population is likely to be killed/destroyed by the factor under consideration.
Intermediate	Some individuals of the species may be killed/destroyed by the factor under consideration and the viability of a species population may be reduced.
Low	The species population will not be killed/destroyed by the factor under consideration. However, the viability of a species population may be reduced.
Tolerant	The factor does not have a detectable effect on survival or viability of a species.
Tolerant*	Population of a species may increase in abundance or biomass as a result of the factor.
Not relevant	This rating applies to species where the factor is not relevant because they are protected from the factor (for instance, through a burrowing habit), or can move away from the factor.

Table A4.3. Environmental factors for which intolerance and hence sensitivity is assessed.

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

Precedence is given to direct evidence of effect or impact. For example, information from targeted studies / experiments that looked at the effect of the specific factor on the species, or targeted work / experiments on the effects of similar factors on similar species or studies of the likely effects of a factor. The assessment of intolerance (Table A4.2) is then made by reference to the reported change in environmental factors and their impact, relative to the magnitude and duration of the standard benchmarks and other relevant key information.

In the absence of direct evidence, the *MarLIN* rationale includes simple decision trees to aid intolerance and recoverability assessment based on the available key information for the species. The decision trees provide a systematic and transparent approach to assessment. The decision trees are described in full by Tyler-Walters *et al.* (2001).

4. Assess the recoverability of the species. The likely recoverability of a species from disturbance or damage is dependent on its ability to regenerate, regrow, recruit or recolonize, depending on the extent of damage incurred and hence its intolerance. The recoverability of a species is assessed against the recoverability scale (Table A4.4) by reference to direct evidence of recruitment, recolonization or recovery (e.g. after environmental impact or experimental manipulation in the field) and/or key information on the reproductive biology, habitat preferences and distribution of the species.

Table A4.4. Recoverability.

RECOVERABILITY The ability of a habitat, community, or individual (or individual colony) of species to redress damage sustained as a result of an external factor.	
Recoverability is only applicable if and when the impacting factor has been removed or has stopped. Ranks also only refer to the recoverability potential of a species, based on their reproductive biology etc.	
Rank	**Definition (From Hiscock *et al*. 1999)**
None	Recovery is not possible
Very low / none	Partial recovery is only likely to occur after about 10 years and full recovery may take over 25 years or never occur.
Low	Only partial recovery is likely within 10 years and full recovery is likely to take up to 25 years.
Moderate	Only partial recovery is likely within 5 years and full recovery is likely to take up to 10 years.
High	Full recovery will occur but will take many months (or more likely years) but should be complete within about five years.
Very high	Full recovery is likely within a few weeks or at most 6 months.
Immediate	Recovery immediate or within a few days.
Not relevant	For when intolerance is not relevant or cannot be assessed. Recoverability cannot have a value if there is no intolerance and is thus 'Not relevant'.

5. Assess the sensitivity of the species. The overall sensitivity rank is derived from the combination of intolerance and recoverability using the rationale shown in Tables A4.5 and A4.6 below.

Table A4.5. Defining 'sensitivity' *sensu lato* for habitats and species. **='Reduced viability' includes physiological stress, reduced fecundity, reduced growth, and partial death of a colonial animal or plant.

Sensitivity scale	Sensitivity definition or scenario
Very High	'Very high' sensitivity is indicated by the following scenario: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (either killed/destroyed, 'high' intolerance) and is expected to recover only over a prolonged period of time, i.e. >25 years or not at all (recoverability is 'very low' or 'none'). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is not expected to recover at all (recoverability is 'none').
High	'High' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years ('low' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) and is expected to recover over a very long period of time, i.e. >10 years (recoverability is 'low', or 'very low'). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is not expected to recover at all (recoverability is 'none'), so that the habitat or species may be vulnerable to subsequent damage.
Moderate	'Moderate' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to take more than 1 year or up to 10 years to recover ('moderate' or 'high' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) and is expected to recover over a long period of time, i.e. >5 or up to 10 years ('moderate' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover over a very long period of time, i.e. >10 years (recoverability is 'low', 'very low'), during which time the habitat or species may be vulnerable to subsequent damage.
Low	'Low' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to recover rapidly, i.e. within 1 year ('very high' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is expected to recover in a short period of time, i.e. within 1 year or up to 5 years ('very high' or 'high' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to take more than 1 year or up to 10 years to recover ('moderate' or 'high' recoverability).

Sensitivity scale	Sensitivity definition or scenario
Very low	'Very low' is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to recover rapidly i.e. within a week ('immediate' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is expected to recover rapidly, i.e. within a week ('immediate' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover within a year ('very high' recoverability).
Not sensitive	'Not sensitive' is indicated by the following scenarios: • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover rapidly, i.e. within a week ('immediate' recoverability). • The habitat or species is tolerant of changes in the external factor.
Not sensitive*	The habitat or species may benefit from the change in an external factor (intolerance has been assessed as 'tolerant*').
Not relevant	The habitat or species is protected from changes in an external factor (i.e. through a burrowing habit or depth), or is able to avoid the external factor.

The sensitivity assessment rationale uses the question 'does it matter if……?', together with the definitions of sensitive habitats and species proposed in the Review of Marine Nature Conservation (Laffoley *et al.*, 2000) as touch-stones throughout. Due to the importance of recoverability in assessing the continued survival of a habitat or species population, the scale is intuitively weighted towards recoverability. However, where recovery is likely to occur in a short period of time, intolerance has been given a greater weight rather than under-estimate the potential sensitivity of marine habitats and species. The sensitivity scales and definitions are designed to be meaningful in marine environmental management, protection, and conservation.

For example, if a habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years ('low' recoverability) then it would be considered to be highly sensitive. Similarly, if a habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is expected to recover in a short period of time, i.e. within 1 year or up to 5 years ('very high' or 'high' recoverability) then it would be considered to be of low sensitivity. The scenarios used to derive the sensitivity scale are listed in Table 6.

NB: Where there is insufficient information to assess the recoverability of a habitat or species ('insufficient information') the 'precautionary principle' will be used and the 'recovery' *will be assumed* to take a very long time i.e. 'low' recoverability in the derivation of a sensitivity rank.

The above definitions and scenarios give rise to the decision matrix shown in Table A4.6. The decision matrix is used to automate the combination of 'intolerance' and 'recoverability' within the *MarLIN* biology and sensitivity database.

The decision matrix shown in Table A4.6 is not symmetrical because the scale represents scenarios in which the potential damage to the species or habitat 'matters'. The scale is

intuitively weighted towards recoverability, although in a few cases intolerance has been given a greater weight rather than under-estimate the potential sensitivity of marine habitats and species.

Table A4.6. Combining 'intolerance' and 'recoverability' assessments to determine 'sensitivity'. NS = not sensitive, NR = not relevant.

		Recoverability						
		None	***Very low (>25 yr.)***	***Low (>10–25 yr.)***	***Moderate (>5 -10 yr.)***	***High (1 -5 yr.)***	***Very high (<1 yr.)***	***Immediate (< 1 week)***
Intolerance	***High***	Very high	Very high	High	Moderate	Moderate	Low	Very low
	Intermediate	Very high	High	High	Moderate	Low	Low	Very Low
	Low	High	*Moderate*	*Moderate*	Low	Low	Very Low	Not sensitive
	Tolerant	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive
	Tolerant*	Not sensitive*	Not sensitive*	Not sensitive*	Not sensitive*	Not sensitive*	Not sensitive*	Not sensitive*
	Not relevant	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*	*Not relevant*

Please note that the intolerance, recoverability and sensitivity ranks should be read in conjunction with the on-line rationale for each assessment, which outline the evidence and key information used and any judgements made in the assessment. The information used and evidence collated is fully referenced throughout.

6. Signing-off. *MarLIN* reviews are checked by the Programme Director for accuracy and clarity and the required changes made before the review goes 'on-line' on the Web site.

7. Referee. As a final stage in the *MarLIN* quality assurance, Key Information reviews are subject to peer review by an external marine biologist where possible.

Assessing the sensitivity of habitats and their associated species (biotopes)

The *MarLIN* approach to the assessment of the sensitivity of biotopes assumes that the sensitivity of a community within a biotope is dependent upon and, therefore, is indicated by the sensitivity of the species within that community. The species that indicate the sensitivity of a biotope are identified as those species that significantly influence the ecology of that component community (see Table A4.7). The loss of one or more of these species would result in changes in the population(s) of associated species and their interactions. The criteria used to identify species that indicate biotope sensitivity subdivide species into 'key' and 'important' based on the likely magnitude of the resultant change.

The protocol used to prepare a review of the biology and sensitivity key information for a biotope is given below.

1. Collate key information on the biotope. The best available scientific information required to describe the ecology and likely sensitivity of the biotope is collated using the resources of the National Marine Biological Library (NMBL), the World Wide Web, and the expertise of marine biologists based at the MBA, Plymouth.

2. Select species indicative of biotope sensitivity. Species are selected based on the review of the ecology of habitat and community, where direct evidence of community interaction or dependency is available, or where the species are 'important characterizing' (Table A4.7).

Table A4.7. Species that indicate biotope sensitivity.

SELECTION CRITERIA The following criteria are used to decide which species best represent the sensitivity of a biotope or community as a whole.	
Rank	**Criteria**
Key structural species	The species provides a distinct habitat that supports an associated community. Loss/degradation of the population of this species would result in loss/degradation of the biotope.
Key functional species	The species maintains community structure and function through interactions with other members of that community (for example, predation, grazing, competition). Loss/degradation of the population of this species would result in rapid, cascading changes in the biotope.
Important characterizing species	The species is/are characteristic of the biotope and are important for the classification of the biotope. Loss/degradation of the population of these species would result in loss of that biotope.
Important structural species	The species positively interact with the key or characterizing species and is important for their viability. Loss/degradation of populations of these species would result likely reduce the viability of the key or characterizing species. For example, these species may prey on parasites, epiphytes, or disease organisms of the key or characterizing species.
Important functional	The species is/are the dominant source of organic matter or primary production within the ecosystem. Loss/ degradation of these species could result in changes in the community function and structure.
Important other species	Additional species that do not fall under the above criteria but where present knowledge of the ecology of the community suggests they may affect the sensitivity of the community.
Note: All key species will be used in the sensitivity assessment. However, where several important species satisfy the above criteria examples from each rank should be used. Preference should be given to examples where direct evidence of community interaction is available or they are characteristic (highly faithful) of the biotope.	

3. Review key information for the selected species. Key information on the biology and sensitivity of the indicative species is researched.

4. Indicate quality of available data. The *MarLIN* programme operates an internal quality assurance procedure, to ensure that only the most accurate available information is provided on-line. The quality of the available evidence and our confidence in our assessments (based on availability of information) is clearly stated.

5. Assess the intolerance, recoverability, and sensitivity of indicative species to environmental factors. The sensitivity of the indicative species is assessed with respect to change in 24 separate environmental factors (see Table 3 above). Precedence is given to direct evidence of effect or impact. In the absence of direct evidence, the *MarLIN* rationale includes simple decision trees to aid intolerance and recoverability assessment based on the available information. The decision trees provide a systematic and transparent approach to assessment. The decision trees are described in full by Tyler-Walters *et al.* (2001).

6. Assess overall intolerance and recoverability of the biotope. The intolerance and recoverability of the biotope are derived from the intolerance and recoverability of the species identified as indicative of sensitivity, using a simple procedure shown in Figure

A4.1 for intolerance and in Figure A4.2 for recoverability. The definitions of biotope intolerance (revised in April 2003) are shown in Table A4.8.

Knowledge of the biology of other species in the biotope, especially if they have been researched as a part of the *MarLIN* programme, is also taken into account.

Table A4.8. Biotope intolerance (previously 'sensitivity' and revised April 2003)

BIOTOPE INTOLERANCE The susceptibility of a habitat, community or species (i.e. the components of a biotope) to damage, or death, from an external factor. Intolerance must be assessed relative to change in a specific factor.	
Rank	**Definition**
High	Species important for the structure and/or function of the biotope, or its identification ('important characterizing' species), are likely to be killed and/or the habitat is likely to be destroyed by the factor under consideration.
Intermediate	The population(s) of species important for the structure and/or function of the biotope, or its identification ('important characterizing' species), may be reduced or degraded by the factor under consideration, the habitat may be partially destroyed, or the viability of a species population, diversity and function of a community may be reduced.
Low	Species important for the structure and/or function of the biotope, or its identification ('important characterizing' species), will not be killed or destroyed by the factor under consideration and the habitat is unlikely to be damaged. However, the viability of a species population or the diversity / functionality in a community will be reduced.
Tolerant	The factor does not have a detectable effect on the structure and/or function of a biotope or the survival or viability of species important for the structure and/or function of the biotope or its identification.
Tolerant*	The extent or species richness of a biotope may be increased or enhanced by the factor.
Not relevant	Intolerance may be assessed as not relevant where communities and species are protected or physically removed from the factor (for instance circalittoral communities are unlikely to be affected by increased emergence regime).

Precedence is given to direct evidence of the effects of changes in environmental factors on a habitat, its community and associated species (i.e. the components of a biotope), and its subsequent recovery. The intolerance of a biotope to change in each environmental factor is assessed against a standard 'benchmark' level of effect, which allows the user to compare the recorded sensitivity to the level of effect predicted to be caused by a proposed development or activity. The evidence and key information used to assess intolerance, recoverability, and sensitivity, and any judgements made are explained in the on-line rationale for each assessment. The source of all information used is clearly referenced on-line.

7. Assess sensitivity of the biotope. The overall sensitivity rank is derived from the combination of intolerance and recoverability using the rationale shown in Tables A4.5 and A4.6 above.

8. Assess the likely effect of the environmental factors on species richness. Change in an environmental factor may not significantly damage key or important species but may still degrade the integrity of the biotope due to loss of species richness. Therefore, the likely effect of the factor on species richness in the biotope is indicated (see Table A4.9).

9. Signing-off. *MarLIN* reviews are checked by the Programme Director for accuracy and clarity and the required changes made before the review goes 'on-line' on the Web site.

10. Referee. As a final stage in the *MarLIN* quality assurance, Key Information reviews are subject to peer review by an external marine biologist where possible.

Table A4.9. The likely response of species richness to an external factor

SPECIES RICHNESS The number of species in a given habitat, biotope, community or assemblage	
The following scale is used to judge the likely response of species richness to an external factor.	
Rank	**Definition**
Major decline	The number of species in the community is likely to decrease significantly (>75% of species) in response to the factor, probably because of mortality and loss of habitat. For example, a change from very rich to very poor on the NHAP scales (Hiscock, 1996).
Decline	The community is likely to loose some of its species in response to the factor by either direct mortality or emigration.
Minor decline	The community is likely to loose few species (<25% of species) in response to the factor. For example, a decrease of one level on the NHAP scales (Hiscock 1996).
No change	The factor is unlikely to change the species richness of the community
Rise	The number of species in the community may increase in response to the factor. (Note the invasion of the community by aggressive or non-native species may degrade the community).
Not relevant	It is extremely unlikely for a factor to occur (e.g. emergence of a deep water community) or the community is protected from the factor.

Appendix references

Hiscock, K, Jackson, A. & Lear, D., 1999. Assessing seabed species and ecosystem sensitivities: existing approaches and development, October 1999 edition. *Report to the Department of Environment, Transport and the Regions form the Marine Life Information Network (MarLIN), Marine Biological Association of the United Kingdom, Plymouth.* [*MarLIN* Report No. 1.]

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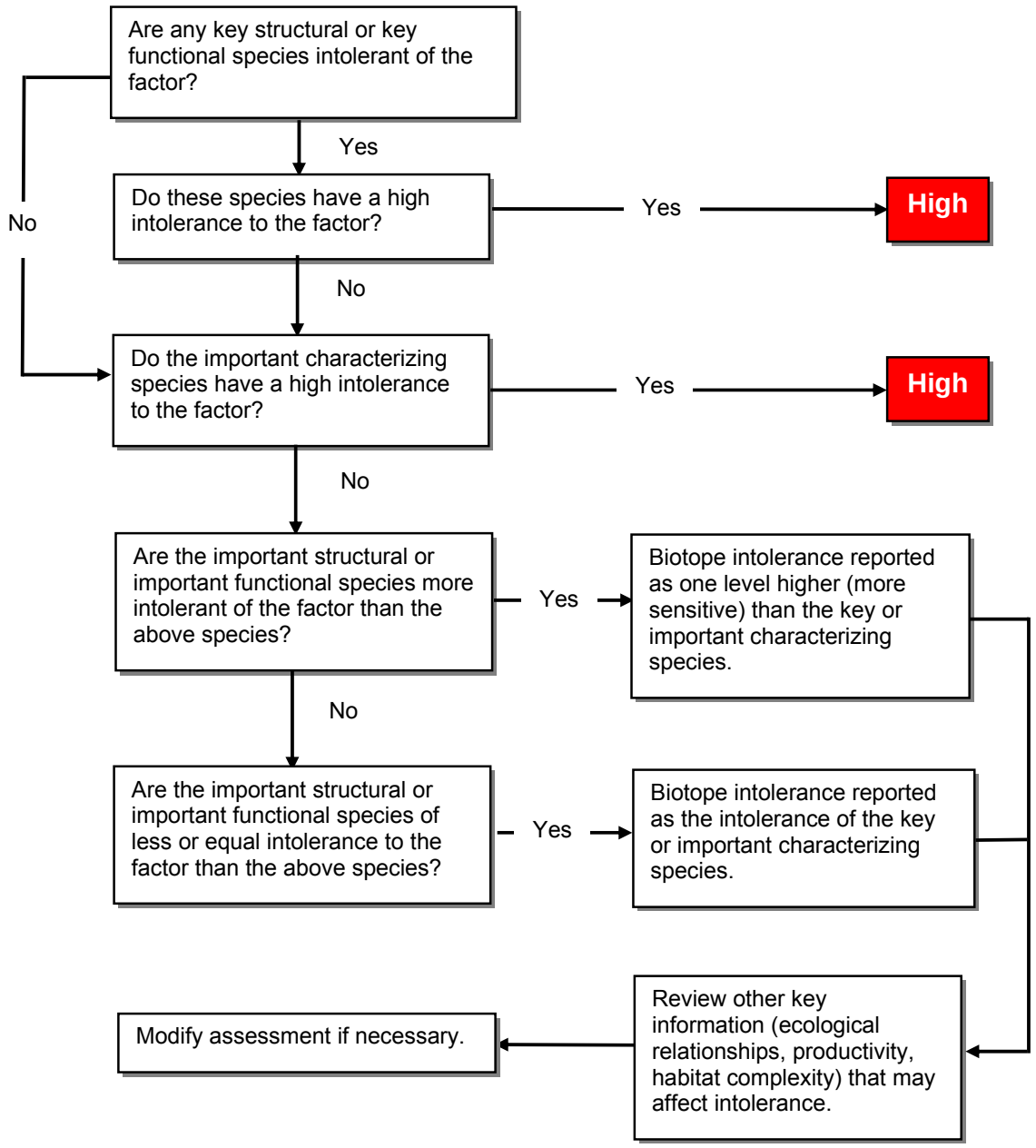

Figure A4.1. Biotope 'intolerance' assessment rationale.

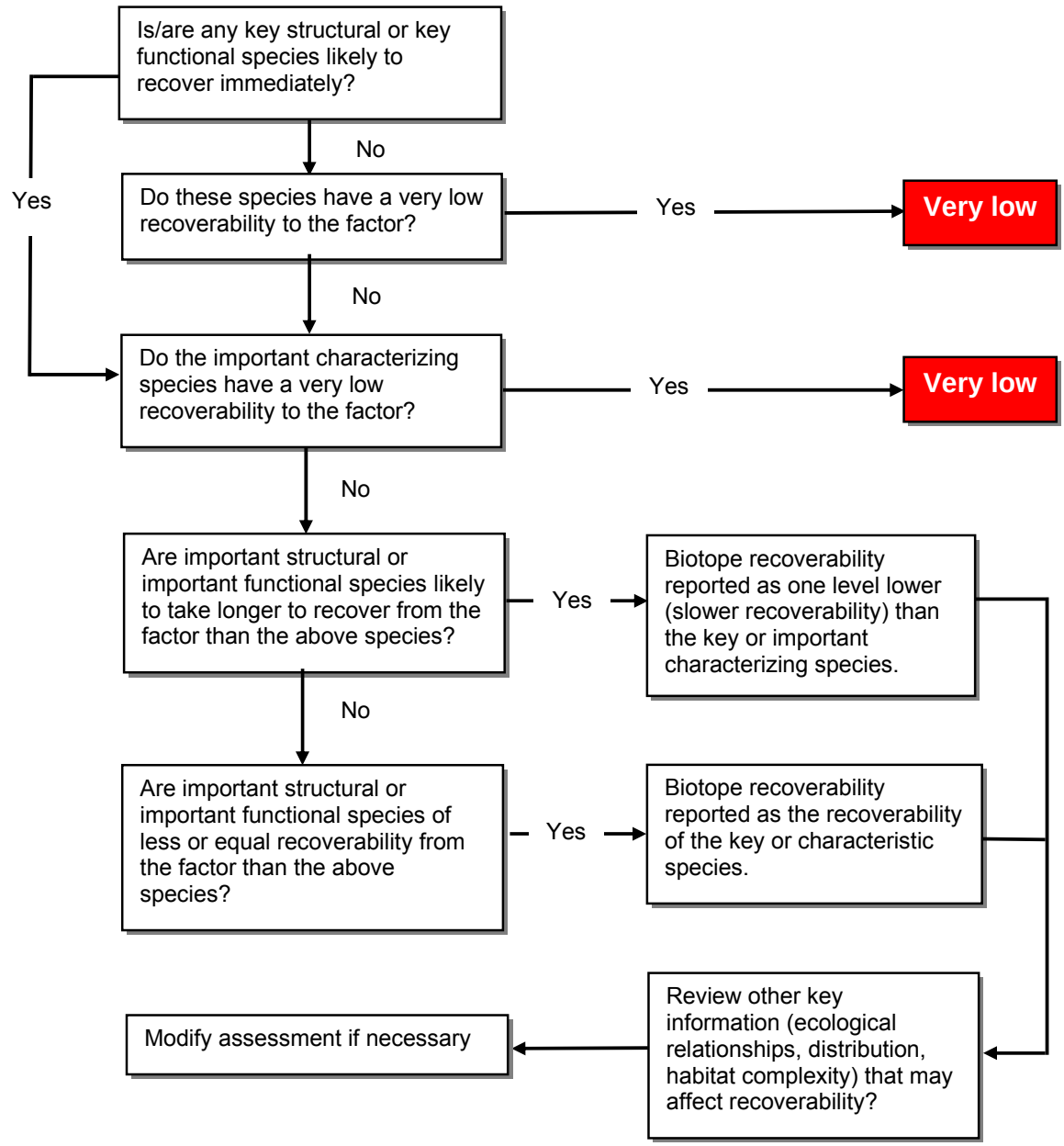

Figure A4.2. Biotope recoverability assessment rationale.

Appendix 5. Relative sensitivity (combined scale) of species within the Biology and Sensitivity Key Information database (VH= VH; H= High; M= Moderate; L= L; VL= Very L; NS= Not sensitive; NS*= Not sensitive*; NR= Not relevant, and INS= Insufficient Information).

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
A bivalve mollusc	*Abra alba*	M	NS	NS*	NS	L	VL	VL	VL	L	M	L	VL	NS*	NR	NS	L	VL	NR	L
A red seaweed	*Ahnfeltia plicata*	M	L	L	NS	L	L	VL	L	L	M	INS	M	L	NR	INS	L	M	NR	INS
Dabberlocks	*Alaria esculenta*	M	L	L	M	L	L	M	L	M	L	L	NS	L	M	INS	L	M	L	M
Dead man's fingers	*Alcyonium digitatum*	M	L	VL	NR	NR	NS*	L	VL	NS	L	INS	L	L	L	M	L	M	NR	L
Tentacled lagoon worm	*Alkmaria romijni*	VH	H	L	L	L	H	NS	NS	H	INS	INS	INS	INS	L	L	H	H	INS	INS
Sea fan anemone	*Amphianthus dohrnii*	VH	NS	VL	NR	NR	L	L	NS	L	INS	INS	INS	INS	L	L	H	H	NR	NR
A brittlestar	*Amphiura chiajei*	M	NS	NS*	L	NR	M	L	NR	M	INS	INS	M	NS	NR	VL	VL	NS	NR	L
A brittlestar	*Amphiura filiformis*	M	VL	VL	VL	VL	M	L	VL	M	M	L	M	NS*	M	VL	VL	NS	NR	NS
Rosy feather-star	*Antedon bifida*	M	M	NS	M	M	M	L	VL	M	M	L	M	INS	M	L	M	NS	L	NS
A bristleworm	*Aphelochaeta marioni*	M	NS	NS*	NR	L	L	VL	VL	M	M	VL	NS*	L	NS	VL	L	NS	NR	L
Sea mouse	*Aphrodita aculeata*	M	NS	NS	NR	VL	L	NS	NS	L	INS	INS	INS	INS	M	INS	L	NS	NR	M
Icelandic cyprine	*Arctica islandica*	H	M	NS	NR	M	VL	H	NR	M	INS	VL	INS	VL	INS	VL	M	M	M	M
Blow lug	*Arenicola marina*	M	NS	NS	NR	L	L	L	NS	L	M	VL	L	L	NS	NS	L	NS	L	L
Lagoon sandworm	*Armandia cirrhosa*	VH	NS	NS	INS	INS	H	INS	NS	VH	INS	INS	INS	INS	VH	INS	M	NS	INS	INS
A sea squirt	*Ascidiella scabra*	L	NS	NS	L	L	NS	NS	NS	L	L	INS	INS	INS	NS	NS	L	L	NR	NR
Knotted wrack	*Ascophyllum nodosum*	H	H	NS	M	H	H	L	NS	H	H	L	L	L	L	INS	H	H	H	NS
Common starfish	*Asterias rubens*	M	VL	L	M	NS	L	M	VL	L	L	L	M	L	M	M	L	NS	NR	L
Fan mussel	*Atrina fragilis*	VH	H	VL	NR	NR	H	H	NS	H	INS	M	INS	M	VL	INS	VH	VH	H	INS
A branching sponge	*Axinella dissimilis*	H	H	H	H	H	M	H	NS	H	INS	INS	INS	INS	H	H	H	H	NR	NS
An acorn barnacle	*Balanus crenatus*	M	M	L	M	M	VL	M	VL	VL	M	L	L	L	VL	M	L	M	NR	NR
A sand digger shrimp	*Bathyporeia pelagica*	L	L	VL	NS	VL	M	L	NS	M	M	M	M	M	M	M	NS	NS	NR	L
Star ascidian	*Botryllus schlosseri*	M	M	M	L	L	L	VL	NS	M	INS	INS	INS	L	L	L	L	M	NR	M

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
A heart urchin	*Brissopsis lyrifera*	M	NS	NS*	NR	NR	L	L	NS*	L	M	INS	L	NS*	NR	M	L	NS	NR	L
An erect bryozoan	*Bugula turbinata*	M	M	L	M	L	L	NS	NS	L	M	NS	M	NS	NR	INS	L	M	NR	NR
DeFolin's lagoon snail	*Caecum armoricum*	VH	INS	INS	H	H	INS	INS	INS	INS	INS	INS	INS	INS	INS	INS	H	INS	INS	INS
A burrowing mud shrimp	*Callianassa subterranea*	M	NS	NS	VL	VL	L	L	NS	L	M	L	M	VL	M	VL	NR	NS	L	NS
Edible crab	*Cancer pagurus*	M	VL	L	NS	NS	NS	L	NS*	VL	M	L	L	NS	INS	NS	L	NS	L	VL
Gallery worm	*Capitella capitata*	L	L	VL	VL	L	NS	VL	NS	INS	L	VL	NS*	NS*	NS	VL	L	L	NS	NS
Common shore crab	*Carcinus maenas*	L	NS	NS	NS	VL	VL	NS*	NR	L	L	VL	M	NS	NS	NS	L	NS	L	NS
A red seaweed	*Ceramium virgatum*	L	L	L	L	L	L	VL	NS	L	L	INS	L	NS*	NR	INS	L	L	NR	NR
Common cockle	*Cerastoderma edule*	M	L	NS	L	L	L	L	NS	L	L	L	L	L	VL	M	L	L	L	M
Lagoon cockle	*Cerastoderma glaucum*	H	H	NS	H	H	H	L	L	H	INS	INS	INS	H	L	H	M	NS	INS	INS
Carrageen	*Chondrus crispus*	M	L	L	L	L	L	VL	VL	L	M	INS	VL	L	NS	INS	VL	M	L	INS
Sea lace or Dead man's rope	*Chorda filum*	M	L	NS	M	M	L	L	NS	M	INS	INS	INS	L	L	INS	L	M	L	INS
Montagu's stellate barnacle	*Chthamalus montagui*	M	L	VL	VL	L	L	NS*	M	NS	M	L	L	L	NS	M	L	M	NR	L
Poli's stellate barnacle	*Chthamalus stellatus*	M	L	VL	VL	L	VL	NS*	VL	NS	M	L	L	L	NS	M	L	M	NR	L
A sea squirt	*Ciona intestinalis*	M	L	NS	L	M	NS	L	NS	L	INS	INS	INS	NS*	NS	NS	M	M	NR	NS
A bristleworm	*Cirratulus cirratus*	H	H	NS*	NR	L	L	NS	NS	L	H	INS	L	NS*	INS	L	L	INS	INS	INS
A green seaweed	*Cladophora rupestris*	L	L	NS	L	L	NS	NS	VL	VL	L	INS	L	NS*	NS	INS	NS	L	L	VL
Light bulb sea squirt	*Clavelina lepadiformis*	M	M	L	M	M	VL	L	NS	L	INS	INS	INS	INS	NS	NS	M	M	NR	NS
A hydroid	*Clavopsella navis*	VH	H	H	VH	VH	NS	INS	L	NS	INS	INS	INS	INS	INS	INS	H	VH	INS	INS
An encrusting bryozoan	*Conopeum reticulum*	L	L	NS	L	L	L	NS	NS	L	L	NS	L	INS	INS	NS	L	L	NR	NR
Coral weed	*Corallina officinalis*	M	L	L	M	L	VL	L	NS	VL	L	INS	VL	VL	L	INS	L	L	L	L

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Basket shell	*Corbula gibba*	M	NS	NS*	VL	L	L	NS	VL	L	L	L	INS	NS*	NS	VL	L	L	NR	L
A hydroid	*Cordylophora caspia*	M	NS	NS	M	L	VL	NS	NS	M	NS	NS	NS	NS*	L	NS	L	L	NR	NR
A mud shrimp	*Corophium volutator*	M	M	L	NS	L	M	VL	NS	L	L	M	M	L	NS	L	L	NS	NR	L
Brown shrimp	*Crangon crangon*	L	L	NS	L	NR	NS	NS	NS*	NS	L	L	L	L	NS	NR	VL	NS	L	NS*
Slipper limpet	*Crepidula fornicata*	M	VL	VL	VL	L	L	VL	VL	M	M	L	L	INS	NS	L	L	L	M	NS*
Sea beech	*Delesseria sanguinea*	M	L	NS	M	L	L	NS	NS	NS	M	VL	M	NS	NS	M	L	M	NR	NS*
Common Skate	*Dipturus batis*	L	L	NR	NR	NR	L	M	NS	NS	INS	INS	INS	INS	L	INS	M	L	H	INS
Sea potato	*Echinocardium cordatum*	M	NS	L	L	L	L	L	L	L	M	L	M	M	L	M	M	L	L	L
Edible sea urchin	*Echinus esculentus*	M	L	VL	L	VL	VL	L	VL	VL	M	M	M	NS*	L	L	L	VL	L	VL
Ivell's sea anemone	*Edwardsia ivelli*	H	H	M	H	H	H	M	NS	H	INS	INS	INS	INS	M	M	H	NS	NR	NR
A sea mat	*Electra pilosa*	L	L	NS	L	L	NS	NS	NS	L	L	NS	L	INS	NR	INS	L	L	NR	L
Razor shell	*Ensis spp.*	M	NS	L	M	M	L	L	L	L	M	L	M	L	L	L	M	L	L	NR
Pink sea fan	*Eunicella verrucosa*	VH	M	VL	NR	NR	M	NS*	NS	M	INS	INS	INS	NS	NR	VH	M	M	M	NR
Speckled sea louse	*Eurydice pulchra*	L	M	NS	NS	L	L	L	NS*	L	L	M	M	M	L	M	NS	NS	NR	NR
Bean-like tellin	*Fabulina fabula*	M	NS	NS*	VL	L	L	VL	VL	L	M	L	M	L	NS	L	L	L	NR	INS
Hornwrack	*Flustra foliacea*	M	NS	NS*	NR	NR	NS	NS	NS	L	M	VL	INS	INS	NR	INS	L	M	NR	M
Horned wrack	*Fucus ceranoides*	M	M	NS	M	M	M	L	NS	M	INS	VL	INS	M	M	INS	M	M	INS	INS
A brown seaweed	*Fucus distichus*	M	M	VL	M	M	L	M	VL	L	INS	VL	INS	INS	L	INS	L	M	L	INS
Toothed wrack	*Fucus serratus*	M	M	VL	L	L	L	NS	VL	M	M	L	L	L	VL	VL	L	M	L	NS
Spiral wrack	*Fucus spiralis*	M	M	VL	M	M	L	NR	L	M	INS	L	M	L	L	INS	L	M	L	INS
Bladder wrack	*Fucus vesiculosus*	M	M	NS	L	L	L	NS	NS	M	L	L	L	L	L	INS	L	M	L	INS
The tall sea pen	*Funiculina quadrangularis*	H	NS	NS	NR	NR	H	M	NS	H	INS	INS	INS	L	NR	M	M	NS	NR	H
A red seaweed	*Furcellaria lumbricalis*	M	M	M	M	M	M	VL	NS	M	M	INS	M	M	VL	INS	M	VL	M	M
Lagoon sand shrimp	*Gammarus insensibilis*	H	L	L	M	M	M	L	H	H	H	INS	H	INS	L	INS	M	H	INS	INS
A gammarid shrimp	*Gammarus salinus*	L	L	NS	NS	NS	L	NS	VL	M	VL	VL	M	NS*	NS	NS	NS	NR	NR	INS

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Giant goby	*Gobius cobitis*	L	L	L	M	NS	VL	L	L	NS	L	M	L	L	L	NS	NR	L	L	NS*
Couch's goby	*Gobius couchi*	L	L	L	M	NS	VL	L	L	NS	L	M	L	L	L	L	NR	L	M	NS
Bowerbank's halichondria	*Halichondria bowerbanki*	M	L	NS	L	M	L	NS	NS	L	INS	INS	L	INS	L	L	L	M	NR	NR
Breadcrumb sponge	*Halichondria panicea*	M	M	NS	L	L	L	VL	NS	L	INS	INS	L	INS	L	L	L	M	NR	M
Sea oak	*Halidrys siliquosa*	M	L	VL	L	L	M	NS	L	M	L	VL	VL	NS*	VL	INS	L	M	NR	NS*
Ragworm	*Hediste diversicolor*	M	NS	NS*	L	L	L	L	NS	L	M	M	L	NS*	L	L	L	VL	L	L
Blue-rayed limpet	*Helcion pellucidum*	L	L	L	L	NS	L	L	L	NS	L	INS	INS	L	L	L	L	NS	NR	L
Bloody Henry starfish	*Henricia oculata*	M	L	VL	L	NS	VL	M	NS	L	INS	INS	INS	INS	M	M	VL	NS	NR	NR
Thongweed	*Himanthalia elongata*	M	M	M	M	L	L	L	VL	M	L	INS	L	L	M	INS	L	M	L	NS*
Short snouted seahorse	*Hippocampus hippocampus*	M	VL	VL	NR	VL	M	NS*	VL	M	INS	INS	INS	INS	INS	INS	M	NS	M	M
An amphipod	*Hyale prevostii*	M	L	L	L	L	L	L	L	L	L	L	M	L	L	M	L	L	L	L
Laver spire shell	*Hydrobia ulvae*	M	L	NS	NS	NS	L	VL	NS	M	NS	INS	L	NS	NS	L	VL	NS	NR	NS
An amphipod	*Jassa falcata*	M	M	L	L	L	L	M	L	L	M	M	VH	INS	INS	M	L	L	L	L
Banded chink shell	*Lacuna vincta*	M	L	NS	L	L	L	L	VL	L	INS	INS	L	NS	NS	L	M	NS	NR	L
Oarweed	*Laminaria digitata*	M	L	L	L	L	L	L	L	L	L	L	L	L	L	INS	L	M	L	L
Tangle or cuvie	*Laminaria hyperborea*	M	NS	NS	M	M	M	M	M	M	NS	VL	NS	M	M	INS	M	M	M	M
Sugar kelp	*Laminaria saccharina*	M	M	L	M	L	L	L	L	M	L	L	L	L	M	INS	L	L	L	INS
Sand mason	*Lanice conchilega*	M	L	NS	L	L	L	L	NS	M	M	L	L	M	NR	L	L	L	NR	M
Sunset cup coral	*Leptopsammia pruvoti*	VH	VH	H	VH	VH	VL	H	NS	H	INS	INS	INS	VL	VH	H	VH	VH	NR	NR
Harbour crab	*Liocarcinus depurator*	L	NS	NS	NR	NR	L	L	NS	L	INS	L	INS	INS	L	M	M	NS	L	NS
An encrusting coralline alga	*Lithophyllum incrustans*	H	VL	VL	H	H	VL	NS	VL	NS	H	INS	M	L	INS	INS	L	VL	NR	L
Maerl	*Lithothamnion corallioides*	VH	VH	VH	VH	VH	M	M	M	M	INS	INS	INS	VL	VH	NS	VH	NS	M	M

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Maerl	*Lithothamnion glaciale*	VH	VH	H	VH	VH	H	H	H	H	INS	INS	INS	H	VL	VL	VH	H	H	H
Common periwinkle	*Littorina littorea*	M	M	L	NS	NS	L	NS	VL	L	VL	L	M	NS	NS	VL	L	NS	L	NS
Baltic tellin	*Macoma balthica*	M	NS	NS*	NS	VL	L	VL	VL	L	M	M	M	NS*	VL	VL	L	L	NR	L
A bristleworm	*Magelona mirabilis*	M	NS	NS*	L	L	L	INS	VL	L	INS	INS	INS	L	NS	NS	L	L	NR	INS
Plumose anemone	*Metridium senile*	M	NS	NS	L	M	L	NS	NS*	NS	VL	INS	NS	NS*	NS	NS	L	VL	M	M
Horse mussel	*Modiolus modiolus*	H	H	NS	H	H	H	H	VL	H	H	VL	VL	VL	NR	VL	H	VL	H	H
Sea grapes	*Molgula manhattensis*	L	VL	NS	L	L	NS	NS	NS	L	NS	INS	INS	INS	NS	NS	L	L	NR	NR
A colonial sea squirt	*Morchellium argus*	M	M	L	M	L	L	VL	L	L	INS	INS	INS	NS	L	INS	L	M	L	L
Sand gaper	*Mya arenaria*	M	L	L	L	L	L	VL	NS	L	L	L	M	L	NS	NS	L	L	L	M
Common mussel	*Mytilus edulis*	M	L	NS	NS	VL	VL	VL	NS	L	L	L	L	L	VL	VL	L	L	L	VL
Starlet sea anemone	*Nematostella vectensis*	VH	L	NS	VH	VH	VH	L	NS	VH	INS	INS	INS	L	NS	L	VH	NS	NR	L
A hydroid	*Nemertesia ramosa*	M	L	VL	M	M	L	INS	NS	M	INS	INS	INS	INS	INS	INS	L	M	NR	NS
A brachiopod	*Neocrania anomala*	M	M	VL	NR	NR	M	L	NS	M	INS	INS	INS	INS	NS	VL	L	M	NR	NS
An opossum shrimp	*Neomysis integer*	NS	NS	NS*	NR	NR	L	L	NS*	L	L	L	L	NS*	L	NR	NR	NR	NR	INS
Gravel sea cucumber	*Neopentadactyla mixta*	H	M	H	H	H	H	H	NS	H	INS	INS	INS	INS	H	M	H	NS	NR	H
Norway lobster	*Nephrops norvegicus*	M	NS	NS	NR	NR	L	VL	NS*	L	INS	L	INS	NS	NS	M	L	VL	L	L
A catworm	*Nephtys hombergii*	L	NS	NS	NR	NR	VL	NS	NR	L	L	L	M	VL	VL	NS	L	NS	L	L
Dog whelk	*Nucella lapillus*	H	NS	NS	L	L	VL	L	NS	L	H	VL	L	H	VL	L	NS	L	NR	VL
A bivalve mollusc	*Nucula nitidosa*	M	VL	NS*	L	L	L	NS	NR	M	INS	INS	INS	NS*	INS	L	L	L	NR	L
A hydroid	*Obelia longissima*	L	L	L	L	L	L	L	NS	NS	L	L	INS	NS*	INS	NS	L	L	NR	NR
Common octopus	*Octopus vulgaris*	NS	NS	NS	NR	NR	NS	L	NS	NS	INS	VL	INS	INS	L	INS	L	NS	L	NS
Common brittlestar	*Ophiothrix fragilis*	M	M	VL	L	NR	VL	L	VL	VL	INS	INS	M	L	L	M	L	NS	NR	NS
Thick top shell	*Osilinus lineatus*	M	M	L	L	L	L	NS*	L	L	INS	INS	L	L	L	M	L	L	L	L
Native oyster	*Ostrea edulis*	VH	VH	VL	H	H	VL	VL	VL	H	VH	H	VL	NS*	VL	H	H	VL	VH	NR
A tubeworm	*Owenia fusiformis*	M	L	NS*	NR	M	NS	L	NS	L	INS	NS	INS	NS*	INS	NS	L	M	NR	VL

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Dulse	*Palmaria palmata*	M	L	L	L	L	L	L	VL	L	M	L	M	L	L	NS	L	M	L	L
Lagoon snail	*Paludinella litorina*	H	H	M	H	L	L	M	NS	H	INS	INS	INS	INS	M	INS	VH	H	NR	H
China limpet	*Patella ulyssiponensis*	M	M	VL	M	L	NS	NS	NS	NS	M	L	M	NS*	L		L	L	L	INS
Common limpet	*Patella vulgata*	M	M	L	L	L	L	L	VL	L	M	L	M	L	L	L	VL	L	L	L
Great scallop	*Pecten maximus*	M	L	L	L	NR	NS	L	NS	L	L	L	L	L	NR	VL	L	NS	M	NR
Channelled wrack	*Pelvetia canaliculata*	M	M	NS	M	M	M	L	NS	M	INS	L	M	M	VL	INS	M	M	M	NR
Ross	*Pentapora fascialis*	M	M	L	M	M	VL	L	NS	L	INS	INS	INS	INS	M	L	M	M	NR	NS
Lobe shell	*Philine aperta*	M	NS	NS	NR	NR	M	L	NS	M	INS	INS	INS	INS	INS	INS	L	NS	NR	NS
Common piddock	*Pholas dactylus*	M	L	L	L	L	VL	L	NS	L	M	L	INS	INS	L	L	L	M	L	NS
Maerl	*Phymatolithon calcareum*	VH	VH	VH	VH	VH	M	M	M	M	INS	INS	INS	VL	NR	NS	VH	NS	M	NR
Long clawed porcelain crab	*Pisidia longicornis*	L	L	NS	M	VL	L	NS	L	L	L	L	L	NS	L	L	M	VL	M	INS
A bristleworm	*Polydora ciliata*	M	NS	NS	L	L	L	L	NS	L	L	L	L	L	L	L	L	L	L	NR
A tubeworm	*Pomatoceros triqueter*	M	M	L	L	L	NS*	NS*	NS	L	INS	INS	INS	INS	NS	INS	VL	L	NR	NR
Common goby	*Pomatoschistus microps*	L	L	VL	NR	NR	VL	L	VL	VL	L	M	L	INS	VL	VL	NR	VL	NR	VL
Sand goby	*Pomatoschistus minutus*	L	L	L	L	NS	VL	L	L	NS	L	M	L	NS	L	L	NR	L	L	VL
Sealoch anemone	*Protanthea simplex*	M	M	VL	M	M	L	M	NS	M	INS	INS	INS	INS	L	L	M	VL	NR	L
Green sea urchin	*Psammechinus miliaris*	M	M	VL	M	M	VL	M	VL	L	M	L	M	VL	L	L	M	NS	L	L
A red seaweed	*Rhodothamniella floridula*	M	M	L	L	L	NS	VL	L	L	M	INS	M	L	NR	INS	L	M	NR	INS
Honeycomb worm	*Sabellaria alveolata*	M	NS	VL	L	L	L	L	NS	L	INS	INS	INS	INS	L	L	L	M	L	L
Ross worm	*Sabellaria spinulosa*	M	NS	NS	NS	L	L	L	NS	L	NS*	INS	INS	INS	INS	L	L	M	NR	L
Furbelows	*Saccorhiza polyschides*	M	NS	L	M	M	L	L	L	NS	L	L	L	L	M	L	L	VL	L	NS*
An acorn barnacle	*Semibalanus balanoides*	M	L	VL	L	M	VL	L	VL	L	M	L	M	L	L	L	L	M	NR	L
A tubeworm	*Serpula vermicularis*	M	M	L	L	L	M	L	VL	L	INS	VL	INS	L	M	L	M	M	L	NS
A bristleworm	*Spio filicornis*	M	VL	NS*	L	L	L	VL	NS	L	M	VL	VL	VL	NR	L	L	VL	NR	VL

Common Name	Scientific name	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
A bristleworm	*Spiophanes bombyx*	M	L	NS	L	L	M	VL	NS	M	M	L	L	L	NR	L	L	VL	INS	L
A surf clam	*Spisula solida*	M	L	VL	L	L	L	NS	VL	L	L	L	NR	L	M	VH	L	L	L	L
A sand hopper	*Talitrus saltator*	L	VL	NR	NR	NS	NR	NS	NR	NR	M	INS	L	INS	NR	NR	L	NR	NR	NR
Lagoon sea slug	*Tenellia adspersa*	VH	VH	L	VH	VH	NS	L	NS	H	INS	INS	INS	INS	L	INS	M	L	INS	INS
Northern hatchet shell	*Thyasira gouldi*	VH	VL	VL	VH	VH	VL	VH	NS	VH	INS	INS	INS	VH	M	M	VH	VL	NR	NR
Looping snail	*Truncatella subcylindrica*	H	H	NS*	L	L	L	M	NS	H	VH	INS	INS	INS	M	INS	VH	H	NR	H
Gut weed	*Ulva intestinalis*	L	L	L	VL	NS*	L	NS*	VL	VL	L	VL	L	NS*	NS	INS	L	NS	L	NR
An encrusting bryozoan	*Umbonula littoralis*	M	L	L	L	L	L	L	L	L	INS	INS	L	INS	M	L	L	L	NR	M
Dahlia anemone	*Urticina felina*	M	VL	VL	M	M	NS	L	NS	NS	M	INS	VL	INS	NR	L	M	NS	M	NS
Pullet carpet shell	*Venerupis senegalensis*	M	L	VL	VL	L	L	VL	VL	L	M	M	L	L	NS	L	L	L	L	L
Slender sea pen	*Virgularia mirabilis*	M	NS	NS	NR	NR	M	M	NS	M	INS	INS	INS	L	M	M	M	NS	L	NS
Common eelgrass	*Zostera marina*	VH	VH	M	L	L	M	NS	VH	VH	M	VL	VL	VH	VL	VL	M	H	M	M
Dwarf eelgrass	*Zostera noltii*	H	H	L	VL	L	L	NS	L	H	L	VL	L	L	VL	VL	L	L	L	H

Appendix 6. Relative sensitivity (combined scale) of biotopes within the Biology and Sensitivity Key Information database (VH= Very high; H= H; M= Moderate; L= Low; VL= Very Low; NS= Not sensitive; NS*= Not sensitive*; NR= Not relevant, and INS= Insufficient Information).

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Ostrea edulis beds on shallow sublittoral muddy sediment	IMX.Ost	VH	VH	VL	L	L	H	L	VL	VH	VH	H	M	NS*	NR	L	M	VL	VH	NR
Zostera marina/*angustifolia* beds in lower shore or infralittoral clean or muddy sand	IMS.Zmar	VH	VH	M	L	L	M	VL	VH	VH	M	L	L	VH	VL	L	M	H	M	M
Phymatolithon calcareum maerl beds with hydroids and echinoderms in deeper infralittoral clean gravel or coarse sand	IGS.Phy.HEc	VH	VH	VH	VH	VH	M	M	H	M	INS	INS	INS	VL	VH	VH	VH	M	M	M
Erect sponges, *Eunicella verrucosa* and *Pentapora fascialis* on slightly tide-swept moderately exposed circalittoral rock.	MCR.ErSEun	VH	M	VL	NR	NR	L	NS*	VL	H	INS	INS	INS	INS	VH	H	VH	VH	VH	H
Lithothamnion glaciale maerl beds in tide-swept variable salinity infralittoral gravel	IGS.Lgla	VH	VH	H	VH	VH	H	H	VL	H	M	INS	L	H	L	M	VH	NS	VH	VH
Caves and overhangs (deep)	CR.Cv	VH	H	NS	NR	NR	NS	NS*	NS	H	INS	INS	INS	INS	NR	H	VH	VH	H	M
Serpula vermicularis reefs on very sheltered circalittoral muddy sand	CMS.Ser	VH	L	NS	NR	NR	VH	L	VL	VH	INS	INS	INS	INS	VH	L	M	VH	L	L
Modiolus modiolus beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata	MCR.ModT	VH	H	VL	NR	NR	H	H	L	H	VH	L	L	VL	NR	L	H	H	VH	VH
Yellow and grey lichens on supralittoral rock	LR.YG	VH	VL	NR	H	NS*	NR	NS	NR	NS*	VH	NS	VH	H	NS*	NR	H	VH	H	NR
Ceramium sp. and piddocks on	MLR.RPid	VH	L	NS*	L	VL	L	NS	NS	L	M	INS	M	NS*	NR	INS	L	M	NR	NR

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
eulittoral fossilised peat																				
Lophelia reefs	COR.Lop	VH	VL	VL	NR	NR	VL	VH	NS	NR	INS	INS	VL	INS	NR	INS	VH	H	H	VH
Zostera noltii beds in upper to mid shore muddy sand	LMS.Znol	H	H	M	M	M	M	VL	M	VH	M	L	M	VH	VL	L	M	VH	L	VH
Ascophyllum nodosum on very sheltered mid eulittoral rock.	SLR.Asc	H	L	VL	M	M	VL	L	NS	H	M	L	L	M	H	L	H	H	M	L
Ascophyllum nodosum ecad *mackaii* beds on extremely sheltered mid eulittoral mixed substrata	SLR.AscX.mac	H	H	NS	M	M	H	VL	NS	H	L	L	M	H	H	INS	M	NS	M	NS
Ascophyllum nodosum with epiphytic sponges and ascidians on variable salinity infralittoral rock	SIR.AscSAs	H	VL	VL	L	L	VL	L	VL	H	H	L	L	L	L	VL	H	H	M	L
Halcampa chrysanthellum and *Edwardsia timida* on sublittoral clean stone gravel	IGS.HalEdw	H	L	NS	NR	NR	VH	NS	L	VH	INS	INS	INS	INS	NR	L	M	NS	NR	NR
Limaria hians beds in tide-swept sublittoral muddy mixed sediment	IMX.Lim	H	L	VL	NR	NR	H	VL	VL	H	H	VL	INS	L	NR	INS	H	VL	H	NR
Chrysophyceae on vertical upper littoral fringe soft rock	LR.Chr	M	NR	NR	M	L	NR	L	NR	NS*	L	L	INS	INS	NS	NR	L	M	NR	NR
Venerid bivalves in circalittoral coarse sand or gravel	CGS.Ven	M	VL	VL	NR	NR	L	NS	VL	L	M	M	M	L	NR	VL	L	L	INS	NR
Hediste diversicolor and *Macoma balthica* in sandy mud shores	LMU.HedMac	M	VL	NS*	VL	VL	L	VL	VL	L	M	M	M	L	NS	VL	L	L	L	NR
Ruppia maritima in reduced salinity infralittoral muddy sand	IMS.Rup	M	L	L	M	L	M	NS	M	M	M	VL	M	L	VL	VL	L	L	L	L
Puccinellia maritima salt marsh community	LMU.NVC_SM13	M	VL	L	L	L	M	VL	NR	L	M	VL	M	NS	NS*	VL	L	M	NS*	NR

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Mytilus edulis beds on reduced salinity tide-swept infralittoral rock	SIR.MytT	M	L	NS	VL	VL	NS	L	VL	L	L	L	L	NS*	M	L	L	L	L	NR
Polyides rotundus and/or *Furcellaria lumbricalis* on reduced salinity infralittoral rock	SIR.PolFur	M	M	L	M	L	L	VL	NS	L	M	INS	M	L	VL	VL	L	M	M	NR
Semi-permanent tube-building amphipods and polychaetes in sublittoral mud or muddy sand	IMU.TubeAP	M	L	VL	NR	NR	L	L	VL	M	M	M	H	NS	NR	M	L	VL	NR	NR
Mytilus edulis beds on variable salinity infralittoral mixed sediment	IMX.MytV	M	L	NS	NS	L	M	VL	NS	M	L	L	M	NS*	NS*	L	L	L	L	NR
Fabulina fabula and *Magelona mirabilis* with venerid bivalves in infralittoral compacted fine sand	IGS.FabMag	M	VL	VL	VL	L	M	VL	VL	M	M	M	L	L	NR	NS	L	L	NR	NR
Laminaria saccharina and/or *Saccorhiza polyschides* on exposed infralittoral rock	EIR.LsacSac	M	L	NS	M	L	NS*	L	L	M	VL	VL	L	NS*	NR	L	L	M	M	M
Brissopsis lyrifera and *Amphiura chiajei* in circalittoral mud	CMU.BriAchi	M	NS	NS*	NR	NR	M	L	VL	VH	M	M	M	NS*	NR	M	L	NS	NR	M
Musculus discors beds on moderately exposed circalittoral rock	MCR.Mus	M	M	L	NR	NR	L	L	L	L	L	INS	VL	NS*	NR	L	L	L	NR	L
Polyides rotundus, *Ahnfeltia plicata* and *Chondrus crispus* on sand-covered infralittoral rock	MIR.PolAhn	M	L	L	M	NR	L	VL	VL	L	M	INS	M	L	NR	VL	L	M	M	NR
Halidrys siliquosa and mixed kelps on tide-swept infralittoral rock with coarse sediment.	MIR.HalXK	M	L	VL	L	L	M	VL	L	H	L	VL	L	L	NR	INS	L	VL	NS*	M
Burrowing amphipods and *Eurydice*	LGS.AEur	M	L	NS	L	L	M	L	NS	L	M	M	M	M	VL	M	L	NS	NR	L

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
pulchra in well-drained clean sand shores																				
Sponge crusts and anemones on wave-surged vertical infralittoral rock	EIR.SCAn	M	L	VL	L	M	NR	NS	NS	NS*	L	INS	L	NS*	NR	M	M	M	NR	NR
Macoma balthica and *Abra alba* in infralittoral muddy sand or mud	IMS.MacAbr	M	NS	NS*	NR	NR	M	NS	VL	L	M	L	M	NS*	NR	L	L	VL	L	NR
Cordylophora caspia and *Electra crustulenta* on reduced salinity infralittoral rock	SIR.CorEle	M	L	NS	L	L	L	NS	NS	M	L	NS	L	NS	L	NS	L	L	NR	NS*
Hartlaubella gelatinosa and *Conopeum reticulum* on low salinity infralittoral mixed substrata	SIR.HarCon	M	L	NS	L	L	L	L	NS	L	L	NS	L	NS	L	L	L	M	NR	NR
Alaria esculenta on exposed sublittoral fringe bedrock	EIR.Ala	M	L	L	M	L	L	M	L	M	L	VL	M	L	M	INS	L	M	L	NR
Laminaria hyperborea with dense foliose red seaweeds on exposed infralittoral rock.	EIR.LhypR	M	L	L	M	M	M	M	M	M	L	L	L	M	M	L	M	M	M	M
Sabellaria alveolata reefs on sand-abraded eulittoral rock	MLR.Salv	M	L	L	M	M	L	L	VL	M	VL	L	L	VL	L	L	L	M	L	L
Under-boulder communities	MLR.Fser.Fser.Bo	M	M	L	M	L	L	L	L	M	L	INS	L	NS	L	L	M	M	L	L
Overhangs and caves	LR.Ov	M	M	L	L	L	L	L	L	L	H	INS	L	NS	L	M	M	M	L	L
Neocrania anomala and *Protanthea simplex* on very sheltered circalittoral rock	SCR.NeoPro	M	M	VL	NR	NR	M	M	NS	NR	INS	INS	INS	NS	L	L	M	M	NR	NR
Muddy sand shores	LMS.MS	M	L	M	NS	M	M	L	NS	H	VH	VH	VH	M	M	M	L	M	M	M
Pioneer saltmarsh.	LMU.Sm	M	L	M	L	M	M	VL	NS	M	M	L	H	L	VL	VL	L	M	L	L

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Sabellaria spinulosa crusts on silty turbid circalittoral rock	MCR.Sspi	M	L	VL	VL	L	NS	VL	VL	L	L	INS	INS	VL	INS	INS	L	M	NR	VL
Barnacles and fucoids (moderately exposed shores)	MLR.BF	M	L	L	L	L	L	L	L	M	M	L	L	L	L	L	M	M	M	L
Virgularia mirabilis and *Ophiura* spp. on circalittoral sandy or shelly mud	CMS.VirOph	M	VL	NS	NR	NR	M	L	VL	M	M	L	L	L	NS	NS	VL	NS	NR	NR
Laminaria saccharina park on very sheltered lower infralittoral rock	SIR.Lsac.Pk	M	L	L	L	M	L	VL	L	M	M	L	L	L	NS	M	L	L	L	L
Laminaria digitata on moderately exposed sublittoral fringe rock	MIR.Ldig.Ldig	M	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	M	L	L
Laminaria saccharina, foliose red seaweeds, sponges and ascidians on tide-swept infralittoral rock	SIR.Lsac.T	M	L	VL	L	M	L	VL	L	M	M	INS	L	L	NS	L	M	L	L	L
Sea pens and burrowing megafauna in circalittoral soft mud	CMU.SpMeg	M	NS	NS	NR	NR	M	L	VL	M	M	L	M	L	M	NS	L	NS	L	L
Philine aperta and *Virgularia mirabilis* in soft stable infralittoral mud	IMU.PhiVir	M	M	VL	NR	NR	M	INS	NS	VL	INS	INS	INS	INS	M	L	M	VL	L	L
Laminaria digitata and piddocks on sublittoral fringe soft rock	MIR.Ldig.Pid	M	L	L	L	L	L	L	L	L	M	L	L	L	L	L	L	M	L	M
Piddocks with a sparse associated fauna in upward-facing circalittoral very soft chalk or clay	MCR.Pid	M	L	L	L	L	L	L	L	L	INS	INS	INS	INS	L	L	L	M	NR	L
Sabellaria spinulosa with kelp and red seaweeds on sand-influenced infralittoral rock	MIR.SabKR	M	VL	NS	L	L	NS	L	L	L	VL	L	INS	L	M	VL	L	M	M	L
Echinocardium cordatum and *Ensis* spp. in lower shore or shallow	IMS.EcorEns	M	NS	L	L	L	M	L	VL	L	M	L	M	L	L	M	M	L	L	L

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
sublittoral muddy fine sand.																				
Polydora sp. tubes on upward-facing circalittoral soft rock	MCR.Pol	M	NS	NS	NR	NR	L	VL	VL	L	L	L	L	VL	M	L	L	L	L	NR
Amphiura filiformis and *Echinocardium cordatum* in circalittoral clean or slightly muddy sand	CMS.AfilEcor	M	NS	NS	NR	NR	M	L	VL	M	M	L	M	L	M	M	L	NS	L	L
Ophiothrix fragilis and/or *Ophiocomina nigra* beds on slightly tide-swept circalittoral rock or mixed substrata	MCR.Oph	M	M	VL	NR	NR	M	L	VL	M	INS	L	L	L	M	L	L	NS	L	NS*
Mytilus edulis beds with hydroids and ascidians on tide-swept moderately exposed circalittoral rock	MCR.MytHAs	M	L	NS	NR	NR	NS	VL	NS	L	L	L	L	NS*	NR	L	L	L	L	NR
Barnacles and *Patella* spp. on exposed or moderately exposed, or vertical sheltered, eulittoral rock	ELR.BPat	M	M	VL	L	L	L	VL	NS	M	M	VL	M	L	M	NS	M	M	L	L
Antedon spp., solitary ascidians and fine hydroids on sheltered circalittoral rock	SCR.AntAsH	M	M	NS	NR	NR	M	L	NS	M	M	L	M	L	M	L	M	M	NS	NR
Fucus distichus and *Fucus spiralis* f. *nana* on extremely exposed upper shore rock	ELR.Fdis	M	VL	VL	L	VL	VL	L	VL	M	M	VL	L	VL	M	NS	M	M	L	L
Mixed fucoids, *Chorda filum* and green seaweeds on reduced salinity infralittoral rock	SIR.FChoG	M	M	VL	L	L	VL	VL	VL	L	M	VL	L	L	L	L	L	M	L	L
Burrowing anemones in sublittoral muddy gravel	IMX.An	M	M	NS	NR	NR	M	M	NS	M	INS	INS	INS	L	M	NS	M	NS	M	NR
Ampharete falcata turf with	COS.AmpPar	M	M	VL	NR	NR	M	VL	VL	M	INS	INS	INS	VL	M	L	L	L	L	L

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Parvicardium ovale on cohesive muddy very fine sand near margins of deep stratified seas																				
Laminaria saccharina, *Chorda filum* and dense red seaweeds on shallow unstable infralittoral boulders or cobbles	MIR.LsacChoR	M	L	NS	L	M	VL	L	L	L	L	L	L	L	NR	L	L	M	NR	NR
Laminaria saccharina, *Chorda filum* and filamentous red seaweeds on sheltered infralittoral sediment	IMX.LsacX	M	L	NS	L	L	L	L	L	L	L	L	L	VL	NR	L	L	L	NR	NR
Alcyonium digitatum with a bryozoan, hydroid and ascidian turf on moderately exposed vertical infralittoral rock	IR.AlcByH	M	L	VL	L	M	NS*	NS*	NS	L	L	L	L	NS*	NR	M	M	M	NR	NR
Crepidula fornicata and *Aphelochaeta marioni* in variable salinity infralittoral mixed sediment	IMX.CreAph	M	VL	VL	VL	L	L	VL	VL	M	M	L	M	L	NS	L	L	L	M	NR
Laminaria hyperborea forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock	EIR.LhypFa	M	L	NS	NR	M	NS	VL	VL	M	M	VL	VL	NS	NR	M	M	M	L	L
Arenicola marina and synaptid holothurians in extremely shallow soft mud.	IMU.AreSyn	M	VL	NS*	NR	M	M	L	NS	M	L	L	L	L	NR	NS	L	NS	L	NR
Venerupis senegalensis and *Mya truncata* in lower shore or infralittoral muddy gravel	IMX.VsenMtru	M	L	VL	VL	L	L	VL	VL	M	M	M	M	L	NS	L	L	L	L	NR
Foliose red seaweeds on exposed or	EIR.FoR	M	L	L	NR	NR	M	L	VL	L	M	M	L	M	NR	M	L	M	L	NR

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
moderately exposed lower infralittoral rock																				
Mytilus edulis and *Fucus vesiculosus* on moderately exposed mid eulittoral rock	MLR.MytFves	M	M	VL	L	L	NS	VL	VL	M	L	L	M	L	NR	NR	L	M	L	NS
Himanthalia elongata and red seaweeds on exposed lower eulittoral rock	ELR.Him	M	M	L	L	L	NS	L	VL	M	M	L	M	L	NR	L	L	M	L	NR
Mytilus edulis and barnacles on very exposed eulittoral rock	ELR.MytB	M	M	VL	L	L	NS	VL	VL	NS	M	L	M	L	NR	NR	L	M	L	VL
Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand	IGS.Lcon	M	NS	NS	L	NS	M	VL	VL	M	M	L	L	M	NR	L	L	VL	NR	L
Fucus ceranoides on reduced salinity eulittoral rock	SLR.Fcer	M	L	L	L	NS	L	VL	NS	L	L	L	M	M	M	VL	L	M	NR	M
Fucus vesiculosus on mid eulittoral mixed substrata	SLR.FvesX	M	L	VL	L	L	L	VL	VL	M	L	L	M	L	NR	NS	L	M	L	NR
Suberites spp. and other sponges with solitary ascidians on very sheltered circalittoral rock	SCR.SubSoAs	M	M	NS	NR	NR	M	NS	NS	M	L	INS	INS	NS*	NR	M	M	M	NR	NR
Molgula manhattensis and *Polycarpa* spp. with erect sponges on tide-swept moderately exposed circalittoral rock	MCR.MolPol	M	L	VL	NR	NR	M	NS	VL	M	M	M	L	NS	NR	M	M	M	NR	NR
Flustra foliacea and other hydroid/bryozoan turf species on slightly scoured circalittoral rock or mixed substrata	MCR.Flu	M	L	VL	NR	NR	M	NS	VL	L	L	VL	L	VL	NR	NR	L	M	NR	L

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Bugula spp. and other bryozoans on vertical moderately exposed circalittoral rock	CR.Bug	M	M	VL	NR	NR	L	VL	VL	L	M	VL	M	L	NR	L	L	M	NR	L
Polydora ciliata, *Mya truncata* and solitary ascidians in variable salinity infralittoral mixed sediment.	IMX.PolMtru	M	L	VL	VL	L	M	NS	VL	M	L	M	L	M	NR	NS	L	M	NR	NR
Aphelochaeta marioni and *Tubificoides* spp. in variable salinity infralittoral mud	IMU.AphTub	M	L	NS*	NR	VL	M	VL	VL	M	L	L	L	NS	NR	L	L	M	NR	NR
Dense *Lanice conchilega* in tide-swept lower shore sand	LGS.Lan	M	L	VL	L	L	M	L	VL	M	M	L	M	M	NR	L	L	VL	L	NR
Potamogeton pectinatus community	IMU.NVC_A12	M	VL	VL	L	L	VL	NS*	L	L	M	L	M	NS*	M	VL	L	M	L	NR
Halichondria bowerbanki, *Eudendrium arbusculum* and *Eucratea loricata* on reduced salinity tide-swept circalittoral mixed substrata	ECR.HbowEud	M	L	NS	NR	NR	M	NS	NS	M	L	VL	L	VL	M	L	L	M	NR	NR
Rhodothamniella floridula on sand-scoured lower eulittoral rock	MLR.Rho	M	M	M	L	L	NS	VL	L	M	M	L	M	L	NS	L	L	M	L	INS
Foraminiferans and *Thyasira* sp. in deep circalittoral soft mud	COS.ForThy	M	M	VL	NR	NR	L	H	VL	NS	INS	INS	INS	NS	NR	M	L	L	INS	L
Rhodothamniella floridula in upper littoral fringe soft rock caves	LR.RhoCv	M	L	NS	L	L	NS	L	VL	M	M	L	M	L	L	L	L	M	NR	INS
Phragmites australis swamp and reed beds	IMU.NVC_S4	M	NS	NS	NS	L	L	NS*	NS	L	L	L	L	NS*	L	NS	L	M	NS	NR
Urticina felina on sand-affected circalittoral rock	MCR.Urt	M	L	VL	NR	NR	M	NS*	VL	L	L	INS	L	VL	NR	NR	L	M	NR	NR
Ocnus planci aggregations on sheltered sublittoral muddy sediment	IMU.Ocn	M	L	VL	NR	NS	M	VL	NS	M	L	L	M	L	NR	M	L	VL	NR	NR

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Limnodrilus hoffmeisteri, *Tubifex tubifex* and *Gammarus* spp. in low salinity infralittoral muddy sediment	IMU.LimTtub	M	NS	NS*	L	VL	L	VL	NS	M	M	L	L	NS*	M	VL	L	NS	NR	NR
Faunal and algal crusts, *Echinus esculentus*, sparse *Alcyonium digitatum* and grazing-tolerant fauna on moderately exposed circalittoral rock	MCR.FaAlC	M	L	VL	NR	NR	M	L	NS	L	M	M	L	M	NR	M	L	L	L	NR
Styela gelatinosa and other solitary ascidians on very sheltered deep circalittoral muddy sediment	COS.Sty	M	L	VL	NR	NR	L	VH	NS	NS	M	INS	INS	NS	NR	L	L	L	NR	NR
Abra alba, *Nucula nitida* and *Corbula gibba* in circalittoral muddy sand or slightly mixed sediment	CMS.AbrNucCor	M	NS	NS*	NR	NR	M	NS	VL	M	M	L	M	NS*	NR	L	L	L	NR	NR
Laminaria saccharina on reduced or low salinity infralittoral rock	SIR.LsacRS	M	L	VL	L	M	L	VL	L	M	L	VL	L	VL	M	L	M	L	M	NR
Barnacles and *Littorina littorea* on unstable eulittoral mixed substrata	SLR.BLlit	M	M	NS	L	L	L	VL	NS	L	L	VL	M	VL	NR	NS	L	M	L	M
Polydora ciliata in variable salinity infralittoral firm mud or clay	IMU.PolVS	M	NS	NS	NR	NR	L	VL	VL	L	L	L	L	NS*	M	NS*	L	L	L	NR
Corallina officinalis on very exposed lower eulittoral rock	ELR.Coff	M	L	L	M	L	NS	L	NS	NR	M	NS	M	NS	NS	NR	L	M	L	NR
Grazed *Laminaria hyperborea* with coralline crusts on infralittoral rock	MIR.LhypGz	M	L	L	L	M	M	VL	VL	M	M	NS	L	NS	NR	L	L	M	M	NR
Corallina officinalis and coralline crusts in shallow eulittoral rockpools.	LR.Cor	M	L	L	L	L	NR	L	NS	NS	M	L	M	VL	NS	VL	L	M	L	NR
Mytilus edulis and piddocks on eulittoral firm clay	MLR.MytPid	M	M	VL	L	L	NS	NS	VL	M	L	L	M	L	NS	NS	M	M	NR	NR

Habitat Name	Code	Substratum loss	Smothering	Siltation	Desiccation	Emergence	Water Flow	Temperature	Turbidity	Wave exposure	Synthetic chemicals	Heavy metals	Hydrocarbons	Nutrients	Salinity	Oxygenation	Physical disturbance	Displacement	Extraction	Extraction other species
Neomysis integer and *Gammarus* spp. in low salinity infralittoral mobile sand	IGS.NeoGam	L	NR	NS	NR	NR	L	L	NS	M	L	L	L	NS*	VL	VL	NS	NR	NR	NR
Barren coarse sand shores	LGS.BarSnd	L	NS	NR	NR	M	L	NR	NR	L	NR	NR	NR	NR	NR	NR	VL	NR	NR	NR
Beggiatoa spp. on anoxic sublittoral mud	CMU.Beg	L	INS	NS	NR	NR	M	NS	NS	L	INS	INS	NS	NS*	VL	NS*	NS	NS	NR	NR
Filamentous green seaweeds on low salinity infralittoral mixed sediment or rock	IMX.FiG	L	L	VL	L	L	M	L	L	M	L	VL	M	L	M	L	L	L	VL	VL
Nephtys cirrosa and *Bathyporeia* spp. in infralittoral sand	IGS.NcirBat	L	NS	NS	NR	NR	L	VL	VL	L	L	L	M	NS*	NR	VL	VL	NS	NR	NR
Talitrid amphipods in decomposing seaweed on the strand-line	LGS.Tal	L	NS	NR	NR	NS	NR	NS	NR	NS*	M	INS	M	NR	NR	NR	NS	NS	NR	NR
Pectenogammarus planicrurus in mid shore well-sorted gravel or coarse sand	LGS.Pec	L	L	NR	NR	NS	NS*	NS	NR	L	L	L	L	NS*	NR	NR	NS	NR	NR	NR
Ulva spp. on freshwater-influenced or unstable upper eulittoral rock	MLR.Ent	L	L	NS	VL	VL	NS	NS*	NS	VL	L	VL	L	NS*	NR	INS	L	L	L	NR
Pomatoceros triqueter, *Balanus crenatus* and bryozoan crusts on mobile circalittoral cobbles and pebbles	ECR.PomByC	L	L	NS	NR	NR	L	NS	NS	L	NS	NS	NS	NS	NR	NR	NS	L	NR	NR
Green seaweeds (*Ulva* spp. and *Cladophora* spp.) in upper shore rockpools	LR.G	L	L	NR	L	NS	NR	NS	NS	VL	L	L	L	NS*	NS	NS	L	L	NR	NR
Capitella capitata in enriched sublittoral muddy sediments	IMS.Cap	L	NS	NS	VL	L	L	VL	VL	L	VL	VL	NS*	NS*	NR	VL	L	VL	VL	NR

Appendix 7. Sublittoral sediment biotope complexes (2004) versus 1997 codes and intolerance, recoverability and sensitivity to physical disturbance. Biotope complexes and higher scales are greyed. Estuarine and lagoonal biotope complexes are omitted.

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SCS	**SUBLITTORAL COARSE SEDIMENT (UNSTABLE COBBLES AND PEBBLES, GRAVELS AND COARSE SANDS)**						
SS.SCS.ICS	**Infralittoral coarse sediment**			**?**	**?**	**?**	**?**
SS.SCS.ICS.MoeVen	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand	IGS.Sell	IGS.FabMag	Intermediate	High	Low	Moderate
SS.SCS.ICS.HeloMsim	*Hesionura elongata* and *Microphthalmus similis* with other interstitial polychaetes in infralittoral mobile coarse sand						
SS.SCS.ICS.Glap	*Glycera lapidum* in impoverished infralittoral mobile gravel and sand	IMS.SpiSpi					
SS.SCS.ICS.CumCset	Cumaceans and *Chaetozone setosa* in infralittoral gravelly sand						
SS.SCS.ICS.SLan	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand	IGS.Lcon	IGS.Lcon	Intermediate	High	Low	Moderate
SS.SCS.ICS.SSh	Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)						
SS.SCS.ICS.HchrEdw	*Halcampa chrysanthellum* and *Edwardsia timida* on sublittoral clean stone gravel	IGS.HalEdw	IGS.HalEdw	High	High	Moderate	Moderate
SS.SCS.CCS	**Circalittoral coarse sediment**			**Intermediate**	**High**	**Low**	**Low**
SS.SCS.CCS.MedLumVen	*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel	CGS.Ven	CGS.Ven	Intermediate	High	Low	Moderate
SS.SCS.CCS.Nmix	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand	CGS.Ven.Neo	CGS.Ven	Intermediate	High	Low	Moderate
SS.SCS.CCS.BLan	*Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel	CGS.Ven.Bra	CGS.Ven	Intermediate	High	Low	Moderate
SS.SCS.CCS.PomB	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	ECR.PomByC[3]	ECR.PomByC	Tolerant	Not relevant	Not sensitive	High
SS.SCS.CCS.Pkef	*Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand						

[3] SS.SCS.CCS.PomB / ECR.PomByC are ephemeral communities, differing significantly form others in biotope complex. Therefore, sensitivity to be assessed and plotted separately.

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SCS.OCS	**Offshore circalittoral coarse sediment**			**?**	**?**	**?**	**?**
SS.SCS.OCS.GlapThyAmy	*Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand						
SS.SCS.OCS.HeloPkef	*Hesionura elongata* and *Protodorvillea kefersteini* in offshore coarse sand						
SS.SSa	**SUBLITTORAL SANDS AND MUDDY SANDS**						
SS.SSa.IFiSa	**Infralittoral fine sand**			**Intermediate**	**High**	**Low**	**Low**
SS.SSa.IFiSa.IMoSa	Infralittoral mobile clean sand with sparse fauna	IGS.Mob	IGS.NcirBat	Low	Very high	Very Low	Moderate
SS.SSa.IFiSa.NcirBat	*Nephtys cirrhosa* and *Bathyporeia* spp. in infralittoral sand	IGS.NcirBat	IGS.NcirBat	Low	Very high	Very Low	Moderate
SS.SSa.IFiSa.ScupHyd	*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles	IGS.ScupHyd	MCR.Flu	Intermediate	High	Low	Moderate
SS.SSa.IFiSa.TbAmPo	Semi-permanent tube-building amphipods and polychaetes in sublittoral sand	IMU.TubeAP	IMU.TubeAP	Intermediate	High	Low	Low
SS.SSa.IMuSa	**Infralittoral muddy sand**			**?**	**?**	**?**	**?**
SS.SSa.IMuSa.ArelSa	*Arenicola marina* in infralittoral fine sand or muddy sand						
SS.SSa.IMuSa.FfabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	IGS.FabMag	IGS.FabMag	Intermediate	High	Low	Moderate
SS.SSa.IMuSa.EcorEns	*Echinocardium cordatum* and *Ensis* spp. in lower shore and shallow sublittoral slightly muddy fine sand	IMS.EcorEns	IMS.EcorEns	High	Moderate	Moderate	Moderate
SS.SSa.IMuSa.ScubNhom	Unknown						
SS.SSa.CFiSa	**Circalittoral fine sand**			**?**	**?**	**?**	**?**
SS.SSa.CFiSa.Epus .Obor.Apri	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand						
SS.SSa.CFiSa.ApriBatPo	*Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand						
SS.SSa.CMuSa	**Circalittoral muddy sand**			**?**	**?**	**?**	**?**
SS.SSa.CMuSa.AalbNuc	*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	CMS.AbrNucCor	CMS.AbrNucCor	Intermediate	High	Low	Moderate
SS.SSa.CMuSa.AbraAirr	*Amphiura brachiata* with *Astropecten irregularis* and other echinoderms in circalittoral muddy sand						

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SSa.OSa	**Offshore circalittoral sand & muddy sand**			**?**	**?**	**?**	**?**
SS.SSa.OSa.MalEdef	Maldanid polychaetes and *Eudorellopsis deformis* in offshore circalittoral sand or muddy sand						
SS.SSa.OSa.OfusAfil	*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand	CMS.AfilEcor	CMS.AfilEcor	Intermediate	High	Low	Moderate
SS.SMu	**SUBLITTORAL COHESIVE MUD AND SANDY MUD COMMUNITIES**						
SS.SMu.ISaMu	**Infralittoral sandy mud**			**?**	**?**	**?**	**?**
SS.SMu.ISaMu.SundAasp	*Sagartiogeton undatus* and *Ascidiella aspersa* on infralittoral sandy mud						
SS.SMu.ISaMu.MelMagThy	*Melinna palmata* with *Magelona* spp. and *Thyasira* spp. in infralittoral muddy sand or sandy mud	IMS.SpiSpi					
SS.SMu.ISaMu.MysAbr	*Mysella bidentata* and *Abra* spp. in infralittoral sandy mud						
SS.SMu.ISaMu.NhomMac	*Nephtys hombergii* and *Macoma balthica* in infralittoral muddy sand or sandy mud	IMS.MacAbr	IMS.MacAbr	Intermediate	High	Low	Moderate
SS.SMu.ISaMu.AmpPlon	*Ampelisca* spp., *Photis longicaudata* and other tube-building amphipods and polychaetes in infralittoral muddy sand or sandy mud	IMS.TubeAP	IMU.TubeAP	Intermediate	High	Low	Low
SS.SMu.ISaMu.Cap	*Capitella capitata* in enriched sublittoral muddy sediments	IMS.Cap	IMS.Cap	Intermediate	Very high	Low	Moderate
SS.SMu.IFiMu	**Infralittoral fine mud**			**Intermediate**	**High**	**Low**	**Low**
SS.SMu.IFiMu.CerAnit	*Cerastoderma edule* with *Abra nitida* in infralittoral mud						
SS.SMu.IFiMu.Are	*Arenicola marina* in infralittoral mud	IMU.AreSyn	IMU.AreSyn	Intermediate	High	Low	Low
SS.SMu.IFiMu.PhiVir	*Philine aperta* and *Virgularia mirabilis* in soft stable infralittoral mud	IMU.PhiVir	IMU.PhiVir[4]	Intermediate	Moderate	Moderate	Low
SS.SMu.IFiMu.Ocn	*Ocnus planci* aggregations on sheltered sublittoral muddy sediment	IMU.Ocn	IMU.Ocn	Intermediate	High	Low	Low
SS.SMu.IFiMu.Beg	*Beggiatoa* spp. on anoxic sublittoral mud	CMU.Beg	CMU.Beg[5]	Low	Immediate	Not sensitive	High

[4] IMU.PhiVir biotopes, characterised *by Virgularia mirabilis* are likely to have prolonged recoverabilities and therefore, should be assessed and plotted separately.

[5] *Beggiatoa* biotopes are characteristic of anoxic, often abiotic, habitats, and therefore, should be assessed and plotted separately.

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SMu.CsaMu	**Circalittoral sandy mud**			**Intermediate**	**High**	**Low**	**Low**
SS.SMu.CSaMu .AfilMysAnit	*Amphiura filiformis*, *Mysella bidentata* and *Abra nitida* in circalittoral muddy sand or sandy mud	CMS.AfilEcor	CMS.AfilEcor	Intermediate	High	Low	Moderate
SS.SMu.CsaMu.ThyNten	*Thyasira* spp. and *Nuculoma tenuis* in circalittoral sandy mud						
SS.SMu.CSaMu. VirOphPmax	*Virgularia mirabilis* and *Ophiura* spp. with *Pecten maximus* on circalittoral sandy or shelly mud	CMS.VirOph	CMS.VirOph	Low	Very high	Very Low	Moderate
SS.SMu.CSaMu. VirOphPmax.HAs	*Virgularia mirabilis* and *Ophiura* spp. with *Pecten maximus*, hydroids and ascidians on circalittoral sandy or shelly mud with shells or stones	CMS.VirOph.HAs	CMS.VirOph	Low	Very high	Very Low	Moderate
SS.SMu.CsaMu.LkorPpel	*Lagis koreni* and *Phaxas pellucidus* in circalittoral muddy sand or sandy mud						
SS.SMu.CSaMu.AfilNten	*Amphiura filiformis* and *Nuculoma tenuis* in circalittoral and offshore muddy sand	CMS.AfilEcor	CMS.AfilEcor	Intermediate	High	Low	Moderate
SS.SMu.CFiMu	**Circalittoral fine mud**			**Intermediate**	**High**	**Low**	**Low**
SS.SMu.CFiMu.SpnMeg	Seapens and burrowing megafauna in circalittoral fine mud	CMU.SpMeg	CMU.SpMeg	Intermediate	High	Low	Moderate
SS.SMu.CFiMu.SpnMeg .Fun	Seapens, including *Funiculina quadrangularis*, and burrowing megafauna in undisturbed circalittoral fine mud	CMU.SpMeg.Fun	CMU.SpMeg	Intermediate	High	Low	Moderate
SS.SMu.CFiMu.MegMax	Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud						
SS.SMu.CFiMu.BlyrAchi	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud	CMU.BriAchi	CMU.BriAchi	Intermediate	High	Low	High
SS.SMu.OMu	**Offshore circalittoral mud & sandy mud**			**?**	**?**	**?**	**?**
SS.SMu.OMu.AfalPove	*Ampharete falcata* turf with *Parvicardium ovale* on cohesive muddy sediment near margins of deep stratified seas	COS.AmpPar	COS.AmpPar	Intermediate	High	Low	Low
SS.SMu.OMu.ForThy	Foraminiferans and *Thyasira* sp. in deep circalittoral fine mud	COS.ForThy	COS.ForThy	Intermediate	High	Low	High
SS.SMu.OMu.StyPse	*Styela gelatinosa*, *Pseudamussium septemradiatum* and solitary ascidians on sheltered deep circalittoral muddy sediment	COS.Sty	COS.Sty	Intermediate	High	Low	Moderate

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SMu.OMu.CapThy	*Capitella capitata* and *Thyasira* spp. in organically-enriched offshore circalittoral mud and sandy mud						
SS.SMu.OMu.CapThy.Odu b	*Capitella capitata*, *Thyasira* spp. and *Ophryotrocha dubia* in organically-enriched offshore circalittoral mud or sandy mud						
SS.SMu.OMu.LevHet	*Levinsenia gracilis* and *Heteromastus filifirmis* in offshore circalittoral mud and sandy mud						
SS.SMu.OMu.PjefThyAfil	*Paramphinome jeffreysii*, *Thyasira* spp. and *Amphiura filiformis* in offshore circalittoral muddy sand and sandy mud						
SS.SMu.OMu.MyrPo	*Myrtea spinifera* and polychaetes in offshore circalittoral muddy sand and sandy mud						
SS.SMx	**SUBLITTORAL MIXED SEDIMENT**						
SS.SMx.IMx	**Infralittoral mixed sediment**			**Intermediate**	**High**	**Low**	**Low**
SS.SMx.IMx.SpavSpAn	*Sabella pavonina* with sponges and anemones on infralittoral mixed sediment						
SS.SMx.IMx.VsenAsquAps	*Venerupis senegalensis*, *Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	IMX.VsenMtru	IMX.VsenMtru	Intermediate	High	Low	Low
SS.SMx.IMx.CreAsAn	*Crepidula fornicata* with ascidians and anenomes on infralittoral coarse mixed sediment	IMX.CreAph	IMX.CreAph	Intermediate	High	Low	Low
SS.SMx.IMx.Lim	*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	IMX.Lim[6]	IMX.Lim	High	Low	High	High
SS.SMx.IMx.Ost	*Ostrea edulis* beds on shallow sublittoral muddy mixed sediment	IMX.Ost[7]	IMX.Ost	Intermediate	Moderate	Moderate	Low
SS.SMx.CMx	**Circalittoral mixed sediment**			**Intermediate**	**Moderate**	**Moderate**	**Low**
SS.SMx.CMx.ClloMx	*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment	IMX.An	IMX.An	Intermediate	Moderate	Moderate	Moderate
SS.SMx.CMx.ClloMx.Nem	*Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment with cobbles and pebbles	IMX.An	IMX.An	Intermediate	Moderate	Moderate	Moderate

[6] IMX.Lim represents a distinct epifaunal rather than infaunal community. Therefore, where present this biotope should be assessed and plotted separately from the biotope complex.

[7] IMX.Ost is a distinct epifaunal community, with prolonged recovery. Therefore, where present this biotope should be assessed and plotted separately from the biotope complex.

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SMx.CMx.ClloModHo	Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment	CMX.ModHo[8]					
SS.SMx.CMx.MysThyMx	*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment						
SS.SMx.CMx.FluHyd	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral cobbles and pebbles in sediment	MCR.Flu.SerHyd	MCR.Flu	Intermediate	High	Low	Moderate
SS.SMx.CMx.OphMx	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	MCR.Oph	MCR.Oph	Intermediate	High	Low	Moderate
SS.SMx.OMx	**Offshore circalittoral mixed sediment**			**Intermediate**	**High**	**Low**	**Moderate**
SS.SMx.OMx.PoVen	Polychaete-rich deep *Venus* community in offshore gravelly muddy sand	CGS.Ven	CGS.Ven	Intermediate	High	Low	Moderate
SS.SMp	**SUBLITTORAL MACROPHYTE-DOMINATED COMMUNITIES ON SEDIMENTS**						
SS.SMp.Mrl	**Maerl beds**			**High**	**Very low**	**Very High**	**Moderate**
SS.SMP.Mrl.Pcal	*Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand	IGS.Phy	IGS.Phy.HEc	High	Very low	Very High	Moderate
SS.SMP.Mrl.Pcal.R	*Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand	IGS.Phy.R	IGS.Phy.HEc	High	Very low	Very High	Moderate
SS.SMP.Mrl.Pcal.Nmix	*Phymatolithon calcareum* maerl beds with *Neopentadactyla mixta* and other echinoderms in deeper infralittoral clean gravel or coarse sand	IGS.Phy.HEc	IGS.Phy.HEc	High	Very low	Very High	Moderate
SS.SMP.Mrl.Lgla	*Lithothamnion glaciale* maerl beds in tide-swept variable salinity infralittoral gravel	IGS.Lgla	IGS.Lgla	High	Very low	Very High	High
SS.SMP.Mrl.Lcor	*Lithothamnion corallioides* maerl beds on infralittoral muddy gravel	IMX.Lcor	IGS.Phy.HEc	High	Very low	Very High	Moderate
SS.SMP.Mrl.Lfas	*Lithophyllum fasciculatum* maerl beds on infralittoral sandy mud or mud	IMX.Lfas	IGS.Phy.HEc	High	Very low	Very High	Moderate
SS.SMp.KSwSS	**Kelp and seaweed communities on sublittoral sediment**			**?**	**?**	**?**	**?**
SS.SMp.KSwSS.LsacR	*Laminaria saccharina* and red seaweeds on infralittoral sediments	IMX.LsacX	IMX.LsacX	Intermediate	High	Low	Moderate
SS.SMp.KSwSS.LsacR	*Laminaria saccharina* and red seaweeds on infralittoral sediments	MIR.EphR	MIR.LsacChoR	Intermediate	High	Low	Moderate

[8] *Modiolus modiolus* beds are distinct communities with prolonged recovery rates. Therefore, where present this biotope should be assessed and plotted separately from the biotope complex.

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SMp.KSwSS.LsacR.CbPb	Red seaweeds and kelps on tide-swept mobile infralittoral cobbles and pebbles						
SS.SMp.KSwSS.LsacR.Gv	*Laminaria saccharina* and robust red algae on infralittoral gravel and pebble						
SS.SMp.KSwSS.LsacR.Sa	*Laminaria saccharina* and filamentous red algae on infralittoral sand						
SS.SMp.KSwSS.LsacR.Mu	*Laminaria saccharina* with red and brown seaweeds on lower infralittoral muddy mixed sediment						
SS.SMp.KSwSS.LsacCho	*Laminaria saccharina* and *Chorda filum* on sheltered upper infralittoral muddy sediment	IMX.LsacX	IMX.LsacX	Intermediate	High	Low	Moderate
SS.SMp.KSwSS.LsacRGraFS	*Laminaria saccharina*, *Gracilaria gracilis* and brown seaweeds on full salinity infralittoral sediment						
SS.SMp.KSwSS.LsacRGraVS	*Laminaria saccharina*, *Gracilaria gracilis* and brown seaweeds on full salinity infralittoral sediment						
SS.SMp.KSwSS.LsacMxVS	*Laminaria saccharina* and *Gracilaria gracilis* with sponges and ascidians on variable salinity infralittoral sediment						
SS.SMp.KSwSS.Tra	Mats of *Trailliella* on infralittoral muddy gravel	IMX.Tra	IMX.LsacX	Intermediate	High	Low	Moderate
SS.SMp.KSwSS.Pcri	Loose-lying mats of *Phyllophora crispa* on infralittoral muddy sediment	IMX.Pcri	IMX.LsacX	Intermediate	High	Low	Moderate
SS.SMp.KSwSS.FilG	Filamentous green seaweeds on low salinity infralittoral mixed sediment or rock	IMX.FiG	IMX.FiG	Intermediate	Very high	Low	High
SS.SMp.SSgr	**Sublittoral seagrass beds**			**Intermediate**	**Moderate**	**Moderate**	**Low**
SS.SMP.SSgr.Zmar	*Zostera marina*/*angustifolia* beds on lower shore or infralittoral clean or muddy sand	IMS.Zmar	IMS.Zmar	Intermediate	Moderate	Moderate	Low
SS.SMP.SSgr.Rup	*Ruppia maritima* in reduced salinity infralittoral muddy sand	IMS.Rup	IMS.Rup	Intermediate	Very high	Low	Low
SS.SMp.Ang	**Angiosperm communities in brackish conditions**			**Intermediate**	**High**	**Low**	**Low**
SS.SMp.Ang.NVC_A12	*Potamogeton pectinatus* community	IMU.NVC_A12	IMU.NVC_A12	Intermediate	High	Low	Low
SS.SMp.Ang.NVC_S4	*Phragmites australis* swamp and reed beds	IMU.NVC_S4	IMU.NVC_S4	Intermediate	High	Low	Low
SS.SMp.Ang.Cha	*Chara* community						
SS.SBR	**SUBLITTORAL BIOGENIC REEFS ON SEDIMENT**						
SS.SBR.PoR	**Polychaete worm reefs (on sublittoral sediment)**			**?**	**?**	**?**	**?**
SS.SBR.PoR.SspiMx	*Sabellaria spinulosa* on stable circalittoral mixed sediment	CMX.SspiMx					
SS.SBR.PoR.SalvMx	*Sabellaria alveolata* on variable salinity sublittoral mixed sediment						

Biotope code 2004	Biotope name 2004	Represented	Representative	Intolerance	Recover-ability	Sensitivity	Confidence
SS.SBR.PoR.Ser	*Serpula vermicularis* reefs on very sheltered circalittoral muddy sand	CMS.Ser	CMS.Ser	High	High	Moderate	High
SS.SBR.SMus	**Sublittoral mussel beds (on sublittoral sediment)[9]**			**Intermediate / High**	**High / Low**	**Low / High**	**Low**
SS.SBR.SMus.ModT	*Modiolus modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata	MCR.ModT	MCR.ModT	High	Low	High	Moderate
SS.SBR.SMus.ModMx	*Modiolus modiolus* beds on open coast circalittoral mixed sediment	CMX.ModMx	MCR.ModT	High	Low	High	Moderate
SS.SBR.SMus.ModHas	*Modiolus modiolus* beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata	SCR.ModHas	MCR.ModT	High	Low	High	Moderate
SS.SBR.SMus.MocCvar	*Modiolus modiolus* beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata	SCR.ModCvar	MCR.ModT	High	Low	High	Moderate
SS.SBR.SMus.MytSS	*Mytilus edulis* beds on sublittoral sediment	IMX.MytV	IMX.MytV	Intermediate	High	Low	Moderate
SS.SBR.Crl	**Coral reefs**			**High**	**Very low**	**Very high**	**High**
SS.SBR.Crl.Lop	*Lophelia* reefs	COR.Lop	COR.Lop	High	Very low	Very high	High

[9] Biotope complex sensitivity is evidently dependent on the presence of absence of *Modiolus modiolus.* Therefore, in absence of *M. modiolus* use sensitivity of MytV, otherwise report *Modiolus* bed sensitivity.

Appendix 8. Notes for interpretation of sensitivity assessments and the benchmarks used.

The following is a short summary of the key assumptions involved in *MarLIN* sensitivity assessments and notes on their interpretation. Information on the development of the sensitivity assessment approach is detailed in Hiscock *et al.* (1999) and Tyler-Walters & Jackson (1999), the full approach is outlined in Tyler-Walters *et al.* (2001) and, as revised in 2003, on the *MarLIN* Web site.

Introduction

Marine organisms may be affected by a number of human activities and natural events. The magnitude or scale of the effect of an activity (or event) is dependent on the receiving environment. The same activity (or event) in different locations may have different effects. For example, an activity that markedly increased siltation may have little effect in a turbid estuary whereas it would probably have significant effects in a sheltered embayment. Therefore, the effects of an activity and the resultant change in environmental factors are site specific and cannot be generalised.

In addition, any one activity (or event) may change one or more environmental factors (see 'effects of specified marine and coastal activities or natural events'). Similarly, it is not possible to take into account every set of environmental conditions to which a species or biotope are exposed throughout their range.

In order to achieve a practical, systematic, and transparent approach, the assessment of intolerance, recoverability, and sensitivity required a standard set of definitions and scales (see Tyler-Walters *et al.,* 2001, *MarLIN*, 2004). The assessment of intolerance required a specified level of environmental perturbation. Therefore, the *MarLIN* programme developed a set of 'benchmark' levels of environmental change in the environmental factors against which to assess sensitivity. The benchmarks also allow intolerance and hence sensitivity to be compared against the predicted effects of planned projects or proposals (see (see Tyler-Walters *et al.,* 2001, *MarLIN*, 2004).

Sensitivity assessments

Sensitivity assessments and key information reviews are designed to provide the information required to make scientifically based environmental management decisions. It is not possible for sensitivity assessments to consider every possible outcome and are indicative. *MarLIN* sensitivity assessments are indicative qualitative judgements based on the best available scientific information. *They do not allow quantitative analysis.* The sensitivity assessments represent the most likely (or probable) result of a given change in an environmental factor on a species population or biotope.

Sensitivity assessments require expert interpretation on a site-by-site or activity-by activity basis. *MarLIN* sensitivity assessments should be read in conjunction with the explanation and key information provided, together with the relevant benchmark. In all cases, an explanation of each intolerance, recoverability and hence sensitivity assessment is provided, together with a summary of the relevant key information, and references highlighted.

Assumptions

The following decisions and assumptions are inherent in the *MarLIN* approach to sensitivity assessment.

- The intolerance, recoverability, and sensitivity of a species or biotope to a specified level of environmental perturbation are dependent on the biology of the species or ecology of the biotope.

- Intolerance, and hence sensitivity, depends on the magnitude, duration, or frequency of change in a specific environmental factor.
- The effects of an activity or natural event and the resultant change in environmental factors are site specific and cannot be generalised. Therefore, a series of standard level of effect or change in each environmental factor are used for assessment (the benchmarks).
- *MarLIN* sensitivity assessments are not site specific. The intolerance of a hypothetical 'average' species population is assessed, representing a population in the middle of its range or habitat preferences. Populations at the limits of their environmental preferences are likely to be more intolerant of environmental perturbation.
- Recoverability assumes that the impacting factor has been removed or stopped and the habitat returned to a state capable of supporting the species or biotope in question. *The time taken for the habitat to return to a state capable of supporting the species or biotope is not assessed.*
- Where the collated key information and other evidence suggests a range of intolerances or recoverabilities, a precautionary approach is taken, and the 'worst case' scenario, i.e. the higher sensitivity, is reported.
- In all cases, the explanation behind each sensitivity assessment, the relevant key information and references are highlighted.

Interpretation of sensitivity assessments

Sensitivity is based on the assessment of intolerance against a benchmark level of change in an environmental factor, and the likely recoverability of the species population or biotope.

- The benchmarks are intended to be pragmatic guidance values for sensitivity assessment, to allow comparison of sensitivities between species, and to allow comparison with the predicted effects of project proposals.
- Species or biotopes are likely to be more intolerant, and hence potentially more sensitive, to any activity or natural event that causes a change in a specific environmental factor of greater magnitude and/or longer duration and/or greater frequency than the benchmark. For example:
    - if the predicted change in an environmental factor has a greater magnitude than that used in the benchmark, then it is likely that the species population / biotope will have a greater sensitivity to this change;
    - if the predicted change in an environmental factor has a longer duration than that used in the benchmark, then it is likely that the species population / biotope will have a greater sensitivity to this change;
    - if the predicted change in an environmental factor is likely to occur at higher frequency than used in the benchmark, then it is also likely that the species or community will exhibit a higher sensitivity;
    - if the frequency of the predicted change in an environmental factor is greater than the time required for recover then the species or community will probably exhibit a higher sensitivity,
    - while if the species or community is likely to recover between the impacting events then it may not exhibit an increased sensitivity.
- Similarly, if a species population is isolated from sources of recruitment, for instance in isolated water bodies (e.g. sea lochs or lagoons) or by hydrography, then the recoverability may lower, and hence the population may exhibit a higher sensitivity.

Isolation is already factored into the recoverability assessments for relevant biotopes and lagoonal species.

Activities that result in incremental long term change, such as climate change, are difficult to assess since the given level of change varies with time. Synergistic and antagonistic effects are also difficult to predict and are poorly understood, especially for pollutants. *These effects have not been addressed within the sensitivity assessments.* However, benchmarks could be compared to the predicted level of change at specific time intervals.