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

Review of Biodiversity for Marine Spatial Planning within the Firth of Clyde

Report to:

The SSMEI Clyde Pilot from the Marine Life Information Network (MarLIN).

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List of Abbreviations

BAP	Biodiversity Action Plan
BGS	British Geological Survey
BODC	British Oceanographic Data Centre
Cefas	Centre for Environment, Fisheries and Aquaculture Sciences
COAST	Community of Arran Seabed Trust
DASSH	Data Archive for Seabed Species and Habitats
EUNIS	European Nature Information System
ESRI	Environmental Systems Research Institute
FRS	Fisheries Research Services
GIS	Geographic Information System
IACMST	Inter-Agency Committee on Marine Science and Technology
UKHO	UK Hydrographic Office
JNCC	Joint Nature Conservation Committee
LRC	Local Record Centre
MarClim	Marine Biodiversity and Climate Change
MarLIN	Marine Life Information Network
MBA	Marine Biological Association
MCS	Marine Conservation Society
mDAC	Marine Data Archive Centre
MDIP	Marine Data Information Partnership
MEDAG	Marine Environmental Data Advisory Group
MEDIN	Marine Environmental Data Information Network
MESH	Mapping European Seabed Habitats
MNCR	Marine Nature Conservation Review
NIMF	Nationally Important Marine Feature
NMBL	National Marine Biological Library
NTS (Scotland)	National Trust for Scotland
OS	Ordnance Survey
QA	Quality Assessment
SAMS	Scottish Association for Marine Science
SEPA	Scottish Environmental Protection Agency
SNH	Scottish Natural Heritage
SMRU	Sea Mammal Research Unit
SSMEI	Scottish Sustainable Marine Environment Initiative
WoRMS	World Register of Marine Species

Marine Life Information Network (MarLIN)

The Review of Biodiversity for Marine Spatial Planning within the Firth of Clyde

Executive summary

The SSMEI Clyde Pilot is aimed at the development and delivery of more integrated and sustainable management of the marine and coastal areas of the Firth of Clyde. This will be achieved through an effective and integrated stakeholder regulator partnership, the development of a Marine Spatial Plan, together with improved decision support mechanisms and integrated decision making.

Aims

The aim of this report was to collect, collate and review the existing marine biodiversity knowledge on the Firth of Clyde and use this to identify areas of biodiversity interest and gaps in current knowledge. This comprised four key objectives.

1. Collate data on the occurrence, distribution and extent of intertidal and subtidal species (excluding birds) and habitats (biotopes) within the Firth of Clyde.
2. Review existing criteria relating to the identification of important marine biodiversity and define how this can be applied at the local level of the Firth of Clyde.
3. Assess the extent to which the available data may be used to identify areas of biodiversity interest and undertake an analysis for the Firth of Clyde.
4. Produce a project GIS and final report including an analysis of data gaps.

Data collection, collation and database construction

An extensive literature review of the biodiversity of the Firth of Clyde was carried out. The results of the literature review were combined with expert knowledge and online metadata catalogues to identify relevant data holders. Data holders were contacted, and key organizations were visited where possible. Written permission to use the data was obtained, together with permission to archive the datasets in a national archive where possible.

The resulting data collation constitutes the most comprehensive analysis of biodiversity for this region to date. A total of ca 133,000 data records were collated into an ESRI geodatabase to allow the spatial representation and analyses of species and habitat data, based on predictive seabed habitat types and 5 km diameter hexagons.

Identification of important marine biodiversity: criteria and approaches

Existing criteria for the identification of important marine biodiversity were reviewed.

These included:

1. national (UK-wide) criteria for identifying candidate Nationally Important Marine Features (cNIMF) (species and habitats), UK Biodiversity Action Plan (BAP) species and habitats, nationally rare and scarce species;
2. criteria specific to devolved national and local levels, such as the Scottish Biodiversity List for marine species and habitats and local Biodiversity Action Plan species and habitats; and
3. international criteria such as the OSPAR selection criteria for species and habitats that spans the North East Atlantic biogeographic region.

Overlap between criteria was identified, and key differences between criteria discussed.

Approaches to identifying areas of important marine biodiversity were outlined and included approaches based on:

1. priority species and habitats;
2. ecosystem structure and functioning;
3. sensitivity of species/habitats to specific pressures arising from anthropogenic activities; and
4. biodiversity hotspots.

Records of conservation priority species are distributed unevenly through the Firth of Clyde. They are mostly aggregated in the sea lochs and in coastal areas, indicating a strong relationship between recorded biodiversity and sampling effort. An even more exaggerated pattern can be seen for recorded priority habitats, which are all coastal and almost entirely restricted to the sea lochs.

Combined hotspot approach

Six measures of diversity were analysed in this study to provide information about diversity at two levels of ecological organization: a) the species composition of communities and b) the diversity of biotopes (which includes aspects of the physical environment). The measures were 1) species richness, 2) average taxonomic distinctness (this was calculated for the six dominant invertebrate phyla not the entire species dataset for comparability), 3) number of priority species, 4) biotope richness, 5) average biotope distinctness and 6) the number of priority biotopes.

The results of the analysis allowed not only the identification of biodiversity hotspots for species and habitats but gave an overall picture of the recorded distribution of other "important" locations for biodiversity. These areas included BAP, LBAP and nationally rare and scare species, OSPAR and Annex I Habitats and candidate NIMFs.

Ninety of the 435 5km diameter hexagons within the Firth of Clyde had sufficient data to inform our measures of species hotpots. Of these, five key areas were identified as species hotpots: Northern Loch Fyne and Loch Shira; Irvine Bay; East of Dunoon in the upper Firth of Clyde; East of Rothesay, Bute; and the Kyle of Bute and Loch Striven. Eleven areas were identified as species "cold spots" in the analysis, scoring low for all of the measures (e.g. north of Ardmore point, Turnberry Bay, Troon point and the deeper parts of Irvine Bay and Lunderston Bay in the Upper Firth of Clyde).

Biotope information was mostly confined to the sea lochs apart from a few areas in the south east of the Firth (areas off Irvine, Turnberry Bay, Ballantrae Bay). This was because biotope information was taken from Marine Nature conservation Review (MNCR) data, which was limited to the coastal regions. Ten biotope hotspots were identified, including an area in the northern part of Loch Fyne, Loch Goil, in the mouth of Holy Loch and Ardlamont Point.

Only 38 hexagons had enough data to combine hotspot measures for species and biotopes and were confined almost entirely to the sea lochs (with the exception of two areas, near Troon and Girvan).

The mouth of Loch Shira was categorised as a hotspot for both species and biotopes, with nine further locations scoring highly including Loch Goil, the mouth of Holy Loch, the north of Loch Striven, Kyles of Bute, Ardlamont Point and Loch Fyne, near Tarbert.

Conclusions and recommendations

In conclusion, the study was limited by the availability of quality data. Hence, it was only possible to map the distribution of priority species, priority biotopes and hotspots in restricted areas of the Firth of Clyde. The issue of data coverage had implications for each stage of this project; from data collection to setting of spatial resolution, analyses, and the application of existing criteria for the identification of areas of important marine biodiversity.

The following recommendations are made.

- The time take to acquire data from disparate organizations should not be underestimated.
- Visiting data holders was an extremely productive way of mobilizing their data, as it gave the authors the opportunity to explain the importance of the study and its data needs. It also allowed data to be collected *in situ*.
- Data acquisition was promoted by the projects connection with a defined project, the SSMEI and the Firth of Clyde pilot. Data providers 'bought in' to the project's aims and could see clear advantages in being associated with a Scottish project.
- Data providers should be made aware of the projects time frame and clear deadlines set for data acquisition.
- Data standardization (from multiple formats) and quality control are a major time constraint that should not be underestimated.
- Data collation should be undertaken in liaison with the relevant national marine Data Archive Centres.
- Using a standard scale of unit across the study area removes any spatial bias and allows a comparison of the relative importance of different areas in terms of biodiversity.
- No single measure of biodiversity is appropriate and a combination of approaches (biodiversity measures, biodiversity hotspot analysis, representativeness of all features, sensitivity assessments) should be used in the MSP.

Predictive seabed habitat type was not a good surrogate for biotope richness. Therefore, it could not be used to compensate for poor spatial coverage of survey data.

- An examination of the relationships between recorded habitats and predicted habitats would allow the confidence in using the predictive seabed maps as a surrogate to be assessed but was beyond the scope of the current study.

The maps produced for this study must be considered within the context of expert knowledge of this study area. They are based on the data available but this may miss important sites that have not been formally surveyed. Hotspots reflect data availability but may not be a definitive representation of regional patterns of biodiversity. As a result, it was not possible to apply national criteria for the identification of important marine features at a local level. In particular, estimates of 'decline' and 'threat' are dependant on long-term data series (which are very limited in the study area), and expert knowledge of the locality. The next stage of this project, stakeholder review, is vital to the refinement of the diversity hotspot maps.

Marine Life Information Network (MarLIN)

Review of Biodiversity for Marine Spatial Planning within the Firth of Clyde

1. Introduction

The Firth of Clyde hosts a wide variety of marine habitats and species along its 620 km coastline and within the 3,650 km^2 of its sea and seabed (Figure 1). Human activities have already had a great effect on those habitats and species (e.g. heavy industry and fisheries) and, as seas become increasingly well used, there is an urgent requirement to manage local marine resources and protect biodiversity. Protection is required both to ensure the continued provision of marine ecosystem goods and services and also to safeguard areas to protect our marine natural history legacy for future generations.

1.1 Marine Spatial Planning

The currently disjointed nature of marine management is well documented (Ducrotoy & Pullen, 1999, Crowder *et al.*, 2006). Marine Spatial Planning (MSP), delivered through Marine Spatial Plans (MSPs), is a means to bring integrated sustainable management and development of local marine resources to overcome this often sectoral or issue-based piecemeal approach.

Marine Spatial Planning is defined as *"strategic, forward-looking planning for regulating, managing and protecting the marine environment, including through allocation of space, that addresses the multiple, cumulative, and potentially conflicting uses of the sea*" (Defra, 2005).

MSP is seen as a way of improving decision making and delivering a more Ecosystem-Based Approach to managing marine activities. In essence, it is a planning tool that enables integrated, forward-looking and consistent decision making on the use of the sea. The main elements of MSP include an interlinked system of plans, policies and regulations; the components of environmental management systems (e.g. setting objectives, initial assessment, implementation, monitoring, audit and review); and some of the many tools that are already used for land use planning. Whatever the building blocks, the essential consideration is that they need to work across sectors and give a geographic context in which to make decisions about the use of resources, development, conservation and the management of activities in the marine environment. In addition, MSPs may also enable integration of policies that do not have a spatial dimension and can play a key role in coordinating policies with a marine dimension and aligning priorities. A central principle of MSP is The Ecosystem Approach (or Ecosystem-Based Approach), which is realized in part through recording the current situation in order to build an understanding of the patterns of biodiversity distribution. This is key to identifying important areas for marine biodiversity that require safeguarding; and the process is driven by national and international obligations and policies.

1.1.1 *Ecosystem Approach*

The guiding principle for the development of MSPs is the 'Ecosystem Approach' to sustainable development (see Box 1). This is a holistic method for the management of human activities; it looks at all the links among living and non-living resources, rather than considering single issues in isolation. Ecosystem based plans focus on the multiple activities occurring within specific areas that are defined by an ecosystem, rather than by artificial boundaries.

Box 1. The Ecosystem Approach

"The Ecosystem Approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The application of the Ecosystem Approach will help to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources." Convention on Biological Diversity, 2000.

"The Ecosystem Approach is the comprehensive integrated management of human activities, based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity." EU Marine Strategy Stakeholder Workshop, Denmark, 4-6 December 2002.

1.1.2 *Recording the Current Situation*

The importance of MSP is to bring together all the relevant strategies and policies into one place and where possible integrate these to provide a framework for consistent decision making. Building an understanding of the patterns of biodiversity distribution, and in particular identifying the location of important areas for marine biodiversity that may require safeguarding, is one key element in the wider process of documenting and recording the current situation. It is also important for highlighting gaps in our knowledge and targeting future monitoring efforts.

1.1.3 *National and International obligations and policy drivers*

National (Scottish and UK-wide) policy drivers leading the present interest in MSP follow.

1. The Scottish Executive Strategic Framework for Scotland's Marine Environment.
2. The commitment in the Labour Party General Election Manifesto, through a Marine Act, to introduce a new framework for the seas, based on marine spatial planning, balancing conservation, energy and resource needs.
3. The Government's vision for the marine environment as set out in the first Marine Stewardship Report.
4. The Government's Review of Marine Nature Conservation, particularly the Irish Sea Pilot Project.
5. The Government's Regulatory Review of Development in Coastal and Marine Waters.
6. The UK's Sustainable Development Strategy: Securing the Future.

At an international level, the policy drivers include the following.

1. The Bergen Declaration of the 5th North Sea Conference formally endorses ecosystem based management and includes commitments on spatial planning in the North Sea.
2. OSPAR commitments on the Ecosystem Approach and consideration of spatial planning.

3. The development of the Thematic Strategy for the Protection and Conservation of the European Marine Environment (European Marine Strategy) that identified Strategic Goals including:

- to protect, allow recovery and, where practicable, restore the function and structure of marine ecosystems in order to achieve and maintain good environmental status of these ecosystems;
- to control the use of marine services and goods and other activities in marine areas that have or may have a negative impact on status of the marine environment to levels that are sustainable and that do not compromise uses and activities of future generations nor the capacity of marine ecosystems to respond to changes; and
- to apply the principles of good governance, both within Europe and globally.

1.2 Scottish Sustainable Marine Environment Initiative

The Scottish Sustainable Marine Environment Initiative (SSMEI) is a unique and innovative approach to develop an overall marine planning framework for Scotland. The SSMEI aims to develop and then test the benefits of possible new management framework options for the sustainable development of Scotland's marine resources through the establishment of a number of pilot projects. The Scottish Sustainable Marine Environment Initiative (SSMEI) was instigated by the Scottish Government in November 2002. The framework options should embrace the concept of the Ecosystem-Based Approach to protection measures, and will be tested through the implementation of a number of pilot management schemes. An important aspect of the project is that it runs across several government agencies within Scotland and links directly with other relevant UK initiatives.

The Pilot projects are an important step forward in MSP. A significant aspect of the SSMEI process, unlike other MSP projects that have gone before, is that these plans are intended to be implemented by the relevant bodies as a material consideration in planning consents and inform the development of future terrestrial development plans.

1.2.1 *SSMEI Clyde Pilot*

The SSMEI Clyde Pilot is aimed at the development and delivery of more integrated and sustainable management of the marine and coastal areas of the Firth of Clyde (Figure 1). This will be achieved through an effective and integrated stakeholder regulator partnership, the development of a Marine Spatial Plan, together with improved decision support mechanisms and integrated decision making.

The MSP will include a voluntary approach to solutions that can be achieved through co-operation and compromise rather than the implementation of new legislation, a novel approach. An example of such an approach has been the creation of the Community Marine Conservation Area in Lamlash Bay, which was formerly a voluntary agreement between the local community and fishermen but has recently been designated as Scotland’s first No-Take Zone. Local Coastal Partnerships have been recognised by stakeholders as an important mechanism for the delivery of such voluntary agreements.

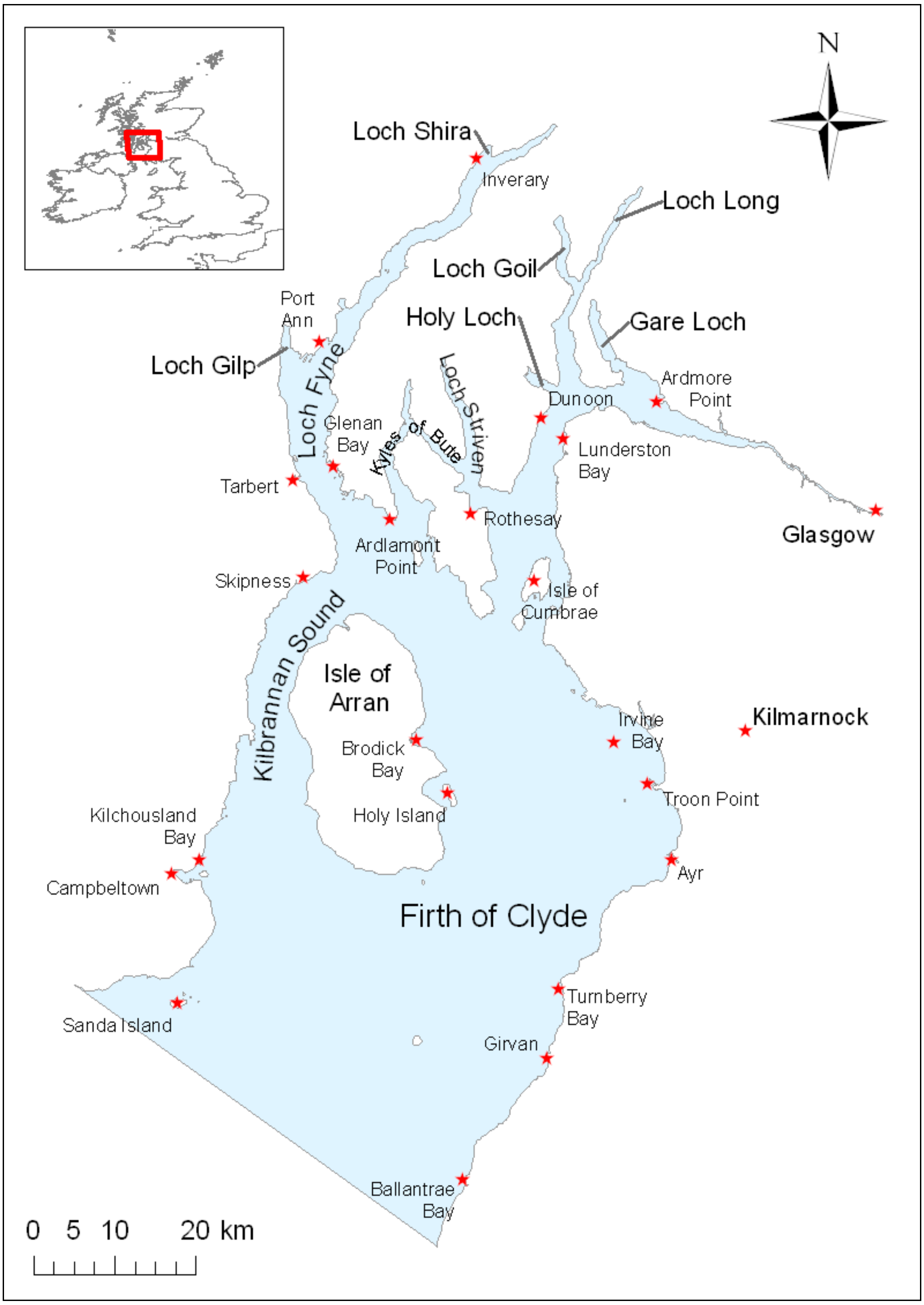


Figure 1. The Scottish Sustainable Marine Environment Initiative Clyde Pilot study area.

2. Aims

The aim of the project reported on here was to collect, collate and review the existing marine biodiversity knowledge on the Firth of Clyde and use this to identify areas of biodiversity interest and gaps in current knowledge.

This comprised four key objectives.

1. Collate data on the occurrence, distribution and extent of intertidal and subtidal species (excluding birds) and habitats (biotopes) within the Firth of Clyde.
2. Review existing criteria relating to the identification of important marine biodiversity and define how this can be applied at the local level of the Firth of Clyde.
3. Assess the extent to which the available data may be used to identify areas of biodiversity interest and undertake and analysis for the Firth of Clyde.
4. Produce a project GIS and final report including an analysis of data gaps.

3. Methodology

The study involved an intense period of data collection and collation, followed by quality assurance. Subsequent data analysis examined the distribution of priority and important species and habitats, and the examination of biodiversity hotspots.

3.1 Data collection, collation and database construction

A search of the electronic resources maintained and managed by the National Marine Biological Library (NMBL) (over 240,000 articles in the peer-reviewed and grey literature) was completed prior to commencing the data collation exercise. This yielded published data that were used directly and it also indicated organizations collecting or holding data within the Firth of Clyde study area. The SSMEI team had previously undertaken a similar search and the lists were compared to ensure all potential data sources had been identified.

Key data holders were also identified from initial discussions with the SSMEI team and SNH, in addition to the expert knowledge of the project team. The following online data and metadata catalogues were also queried to return data within the study area.

- Marine Life Information Network (MarLIN).
- Mapping European Seabed Habitats (MESH).
- Marine Environmental Data Information Network (MEDIN) Metadata Discovery Portal.

Additionally, data collected as part of the MarClim (Marine Biodiversity and Climate Change) project (2001-2005), co-ordinated by the Marine Biological Association (MBA), were included in the data catalogue.

Site visits were arranged to key organizations and individuals identified as holding data relevant to the study area. Visits allowed a level of engagement with the data providers and provided an opportunity to discuss the aims of the project and the mechanisms by which the data would be captured, transformed and utilized. Visits also identified other relevant data holders and allowed the capture of anecdotal and non-published information regarding important species and habitats within the Firth of Clyde. It was not possible to visit all relevant parties during the time scheduled in the region and a number of contacts were made via phone and email.

The lengthy mobilization time for certain data prevented their use in the study (e.g. seal haul out data (SMRU), harbour porpoise and basking shark data (University of

Plymouth), basking shark data (MCS)). Other data were discarded due to their coarse resolution, such as the JNCC cetacean data.

Data holders were informally consulted regarding their specific local knowledge of the region and additional local experts were identified for their knowledge of the Firth of Clyde and contacted. Consultees included representatives of the angling industry, dive industry, local recreational divers and conservationists. Stakeholder opinions were used to identify locally important marine sites for education, research and recreation. A detailed list of all contacts and outcomes is provided in Appendix 1.

A project data catalogue was established for the storage and management of data captured during the duration of the project. Metadata for each dataset was completed at the time of data capture and entered into an ISO 19115 and UK GEMINI compatible metadata catalogue (Appendix 2). For each dataset, an assessment was made on the quality of the data based on criteria set out in the ISO 19115 standard for geospatial metadata (ISO, 2006) and using guidelines set out in Rackham & Walker (2006) (Table 1).

Table 1. Quality assessment (QA) criteria.

	Overall QA	**Spatial accuracy**	**Taxonomic accuracy**	**Methodological accuracy**	**QA procedure**
High	Good quality data, internally quality assessed, high confidence of accuracy of position and species identification	Accurate positioning system used i.e. GPS	Surveyors with expert knowledge or data verified by taxonomic expert, few errors expected	Standard methodology used and documented in detail	Rigorous internal (and possibly external) QA procedures documented
Medium	Good quality data, may lack internal QA, full documentation or may have some spatial/ taxonomic ambiguity	Positions estimated from charts or OS maps by surveyor	Surveyors with good natural history background potential errors in difficult to identify groups	Standard methodology used but not supported by documentation	Some internal (or external) QA on a more ad hoc basis not necessarily documented or standardized
Low	Data with spatial/ taxonomic ambiguities and/or little documentation and/or no internal QA	Positions estimated from charts or OS maps by DASSH[1]	Volunteer/ other non-expert surveyors errors possible for non-common and easy to identify species	Little information on methodology or indications that no set methodology was used	No QA procedures documented
Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Data were also graded on survey quality using the following three categories with respect to field surveyors:

- professional and academic;

[1] Data Archive for Seabed Species and Habitats (DASSH)

- volunteer with expert ID; and
- volunteer.

The spatial distribution of data by quality across the study area can be seen for species in Figure 2, and for habitats in Figure 3. There were no low quality habitat data. Figure 4 and Figure 5 show the spread of data quality (species and habitat data combined) at a finer resolution (1 km diameter hexagons).

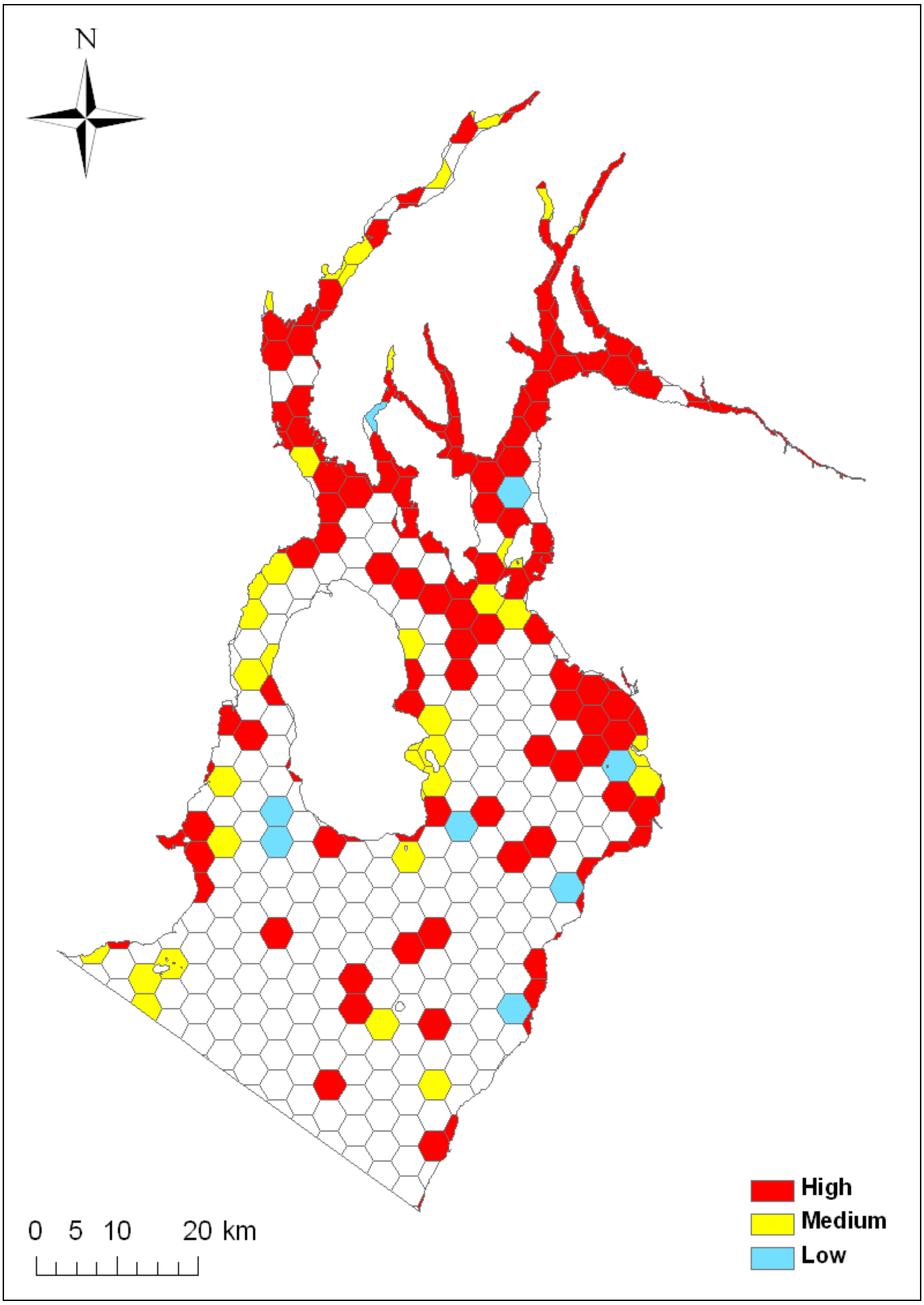


Figure 2. The spatial distribution of data by quality across the Firth of Clyde for species sample data.

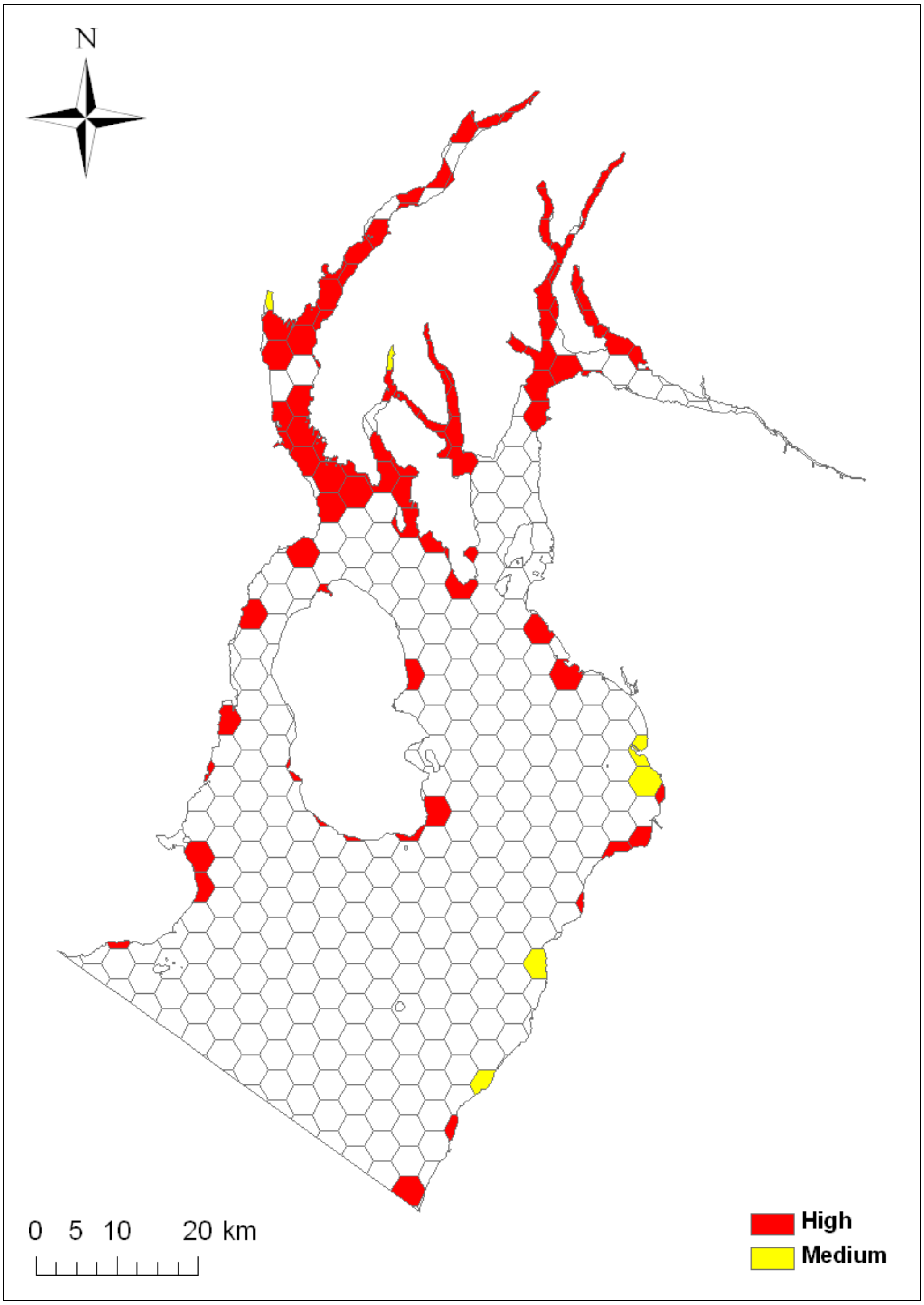


Figure 3. The spatial distribution of data by quality across the Firth of Clyde for habitat sample data.

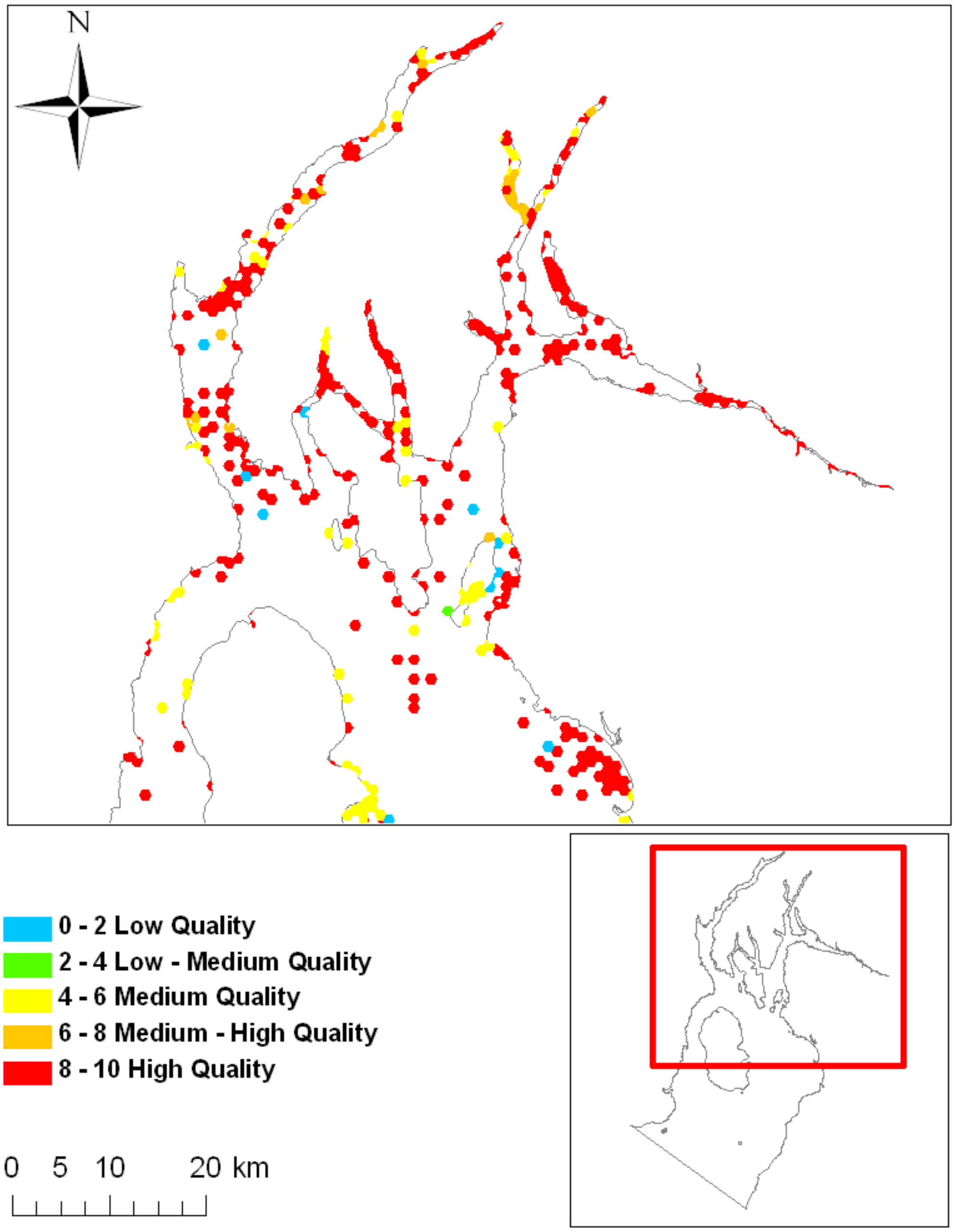


Figure 4. The detailed (1 km resolution) spatial distribution of data by quality across the northern part of the Firth of Clyde for species and habitat data combined.

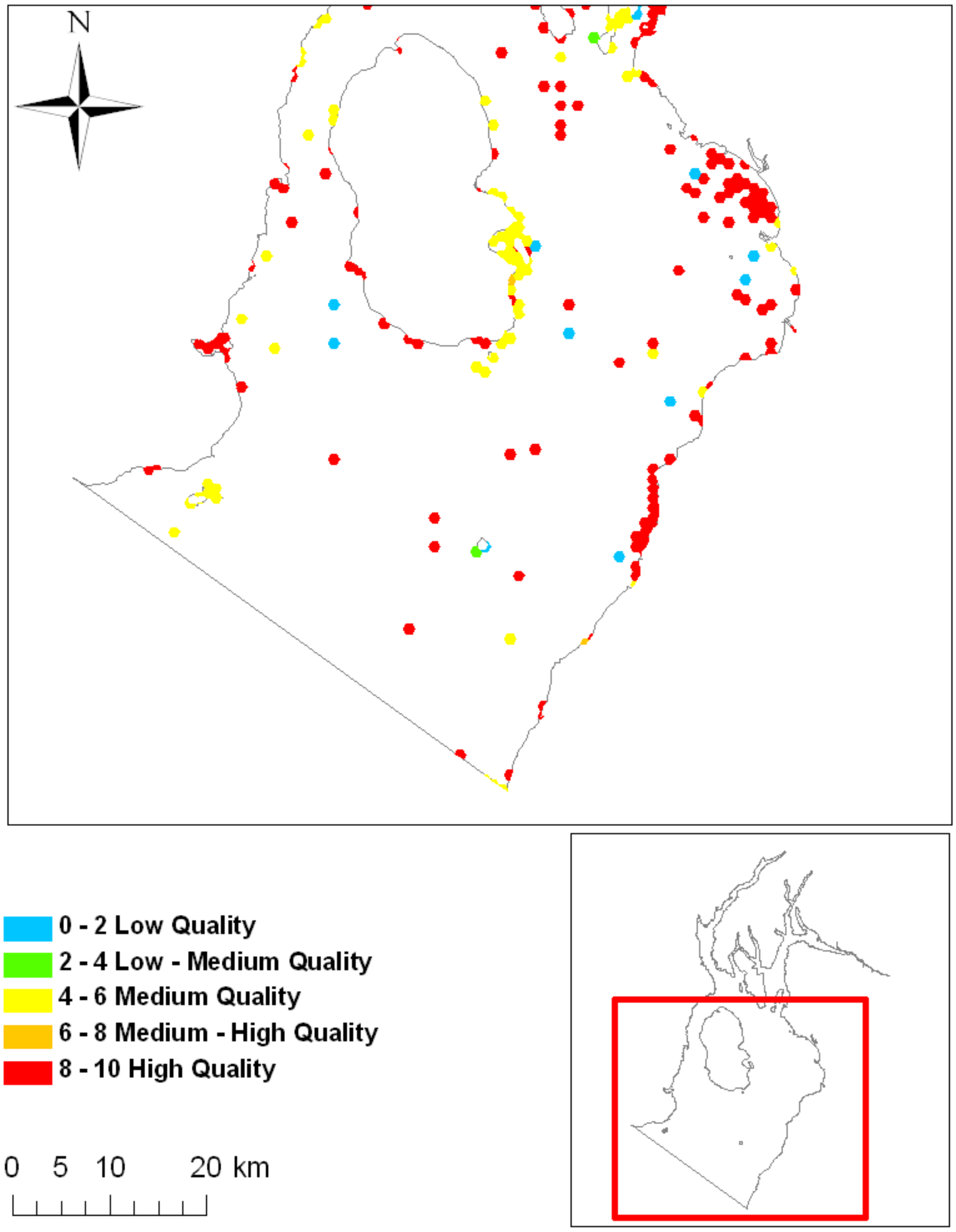


Figure 5. The detailed (1 km resolution) spatial distribution of data by quality across the southern part of the Firth of Clyde for species and habitat data combined.

3.2 Data Archiving

The Marine Environmental Data Information Network (MEDIN) provides guidance and best practice information on the archiving, management and dissemination of data in the marine sector. MEDIN was established in April 2008 by the merger of MEDAG (Marine Environmental Data Advisory Group) and MDIP (Marine Data Information Partnership) under the auspices of IACMST (Inter-Agency Committee on Marine Science and Technology).

A key mechanism for the delivery and management of data within the MEDIN framework is the network of marine Data Archive Centres (mDACs, Table 2).

Table 2. Marine Data Archive Centres (mDACs); role, remit and status.

Data archive centre	Role/remit	Status
British Geological Survey (BGS)	Sea floor geophysics and geology	MEDIN accredited mDAC
British Oceanographic Data Centre (BODC)	Water column oceanography	MEDIN accredited mDAC
Data Archive for Seabed Species and Habitats (DASSH)	Benthic marine life	MEDIN accredited mDAC
UK Hydrographic Office (UKHO)	Hydrography and navigation data	MEDIN accreditation pending

During the data collation exercise data providers were requested to provide written permission to allow any data used by the project to be archived at the appropriate MEDIN mDAC (metadata schema can be found in Appendix 2 and the permission form in Appendix 3). By archiving the data within the MEDIN framework of mDACs, the long-term storage and availability of the data can be assured. Additionally, permission was sought to progress relevant biodiversity data to the National Biodiversity Network.

3.3 Project GIS

All GIS work undertaken was carried out using ESRI ArcGIS 9.2. A geodatabase was established to manage the spatial information collated during the project. Initial layers were created to display the distribution of species and habitats within the study area. This was achieved by plotting records by latitudinal and longitudinal coordinates (using the WGS84 coordinate system[2]) onto a base map of the Firth of Clyde (Figure 1). Information about each taxa or habitat record was then overlaid for each location. The locations of all the species and habitat datasets collated are shown in Figure 6. To ensure the project geodatabase was compatible with the version used by the SSMEI team (ArcGIS 9.1), an ArcGIS 9.1 geodatabase was created with the spatial data and layers generated.

[2] The World Geodetic System defines a reference frame for the Earth, for use in geodesy and navigation. The latest revision is WGS 84 dating from 1984 (last revised in 2004), which will be valid up to about 2010.

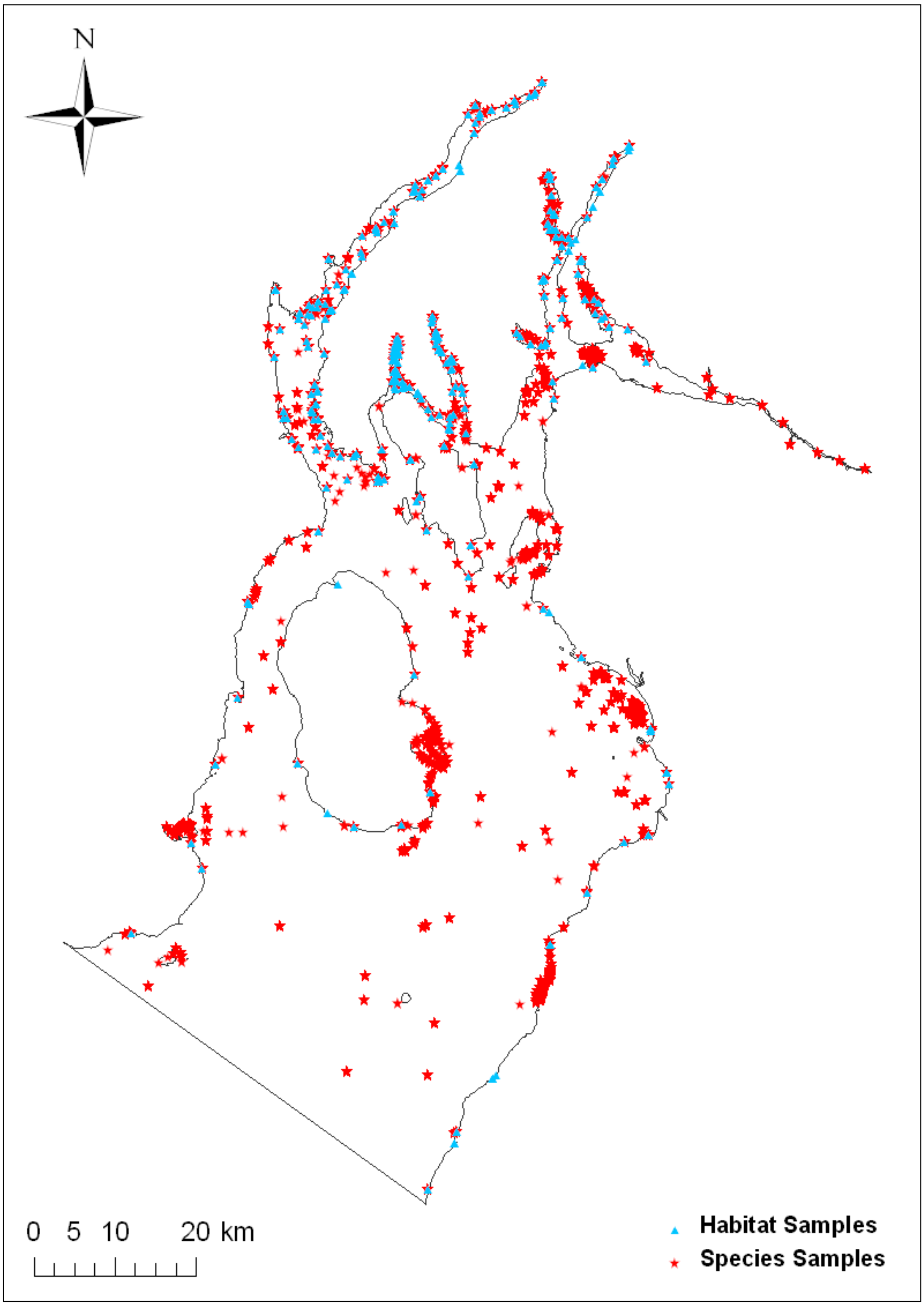


Figure 6. Locations of datasets collated for species and habitats.

3.4 Data Analysis and Quality Control

Once the data were compiled into the geodatabase, a series of procedures were carried out to establish the spatial resolution for analyses and filter the data to remove low quality data, after which analyses were carried out.

3.4.1 *Spatial resolution*

The identification of suitable spatial units is governed by the sampling coverage at a particular study area. For the Firth of Clyde, a GIS layer containing a 5 km diameter hexagonal grid was generated using the Jenness Enterprises repeating shapes tool (Jenness, 2005). In total, 435 hexagons were generated for the Firth of Clyde study area. Hexagonal units were chosen because these are most commonly used for spatial planning (Bassett & Edwards, 2003, Worm *et al.*, 2003, Oetting *et al.*, 2006), and because they offered the best alignment to complex features, such as the UK coastline, ensuring a better level of coverage. A 5 km hexagon was selected as the optimal unit since lower resolution would mean samples[3] were so sparse that many spatial units were empty or had low (<3) samples. Larger units would have lost resolution in the data and also meant that greater areas of the Firth of Clyde would not have been used in the analysis (see Figure 7 and Figure 8).

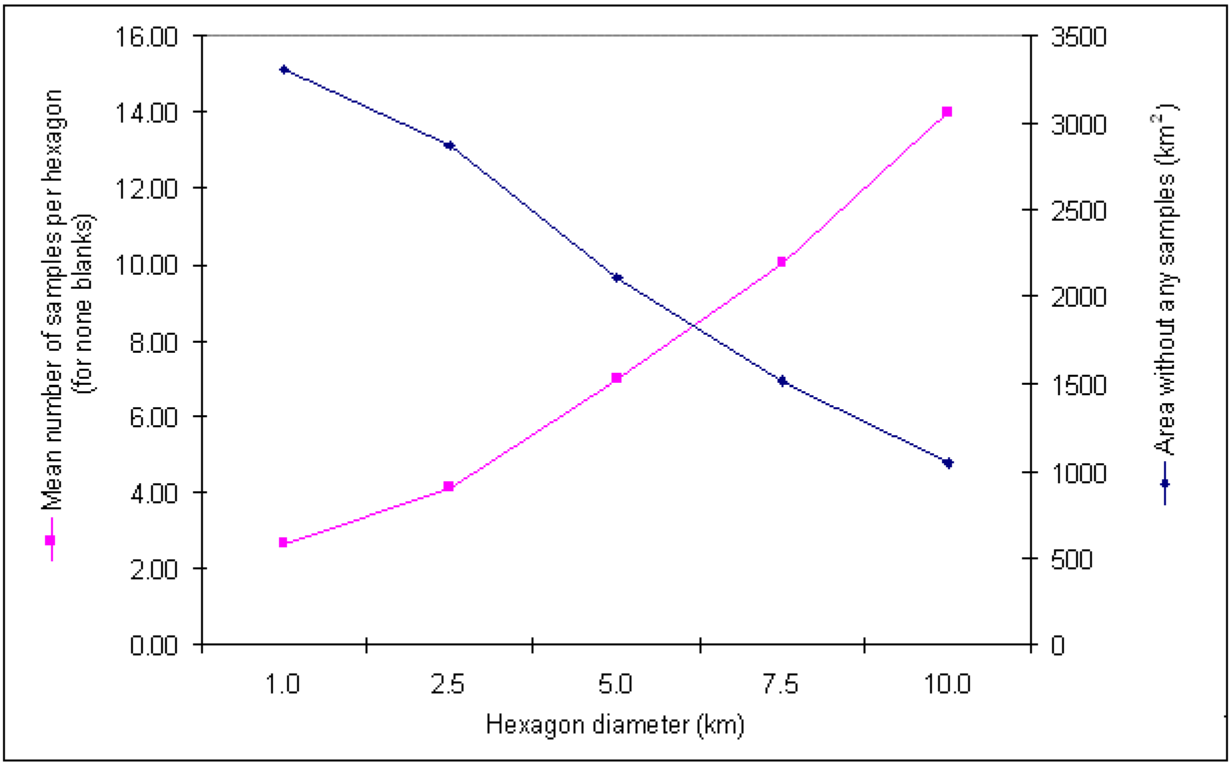


Figure 7. The mean number of samples for hexagons of different size and the area of the Firth of Clyde not covered by hexagons with sample data.

[3] For the purposes of this work, a 'sample' is defined as a data collection unit that is unique in space and time, i.e. one sediment core sample replicate, one whale watching cruise, one video survey transect.

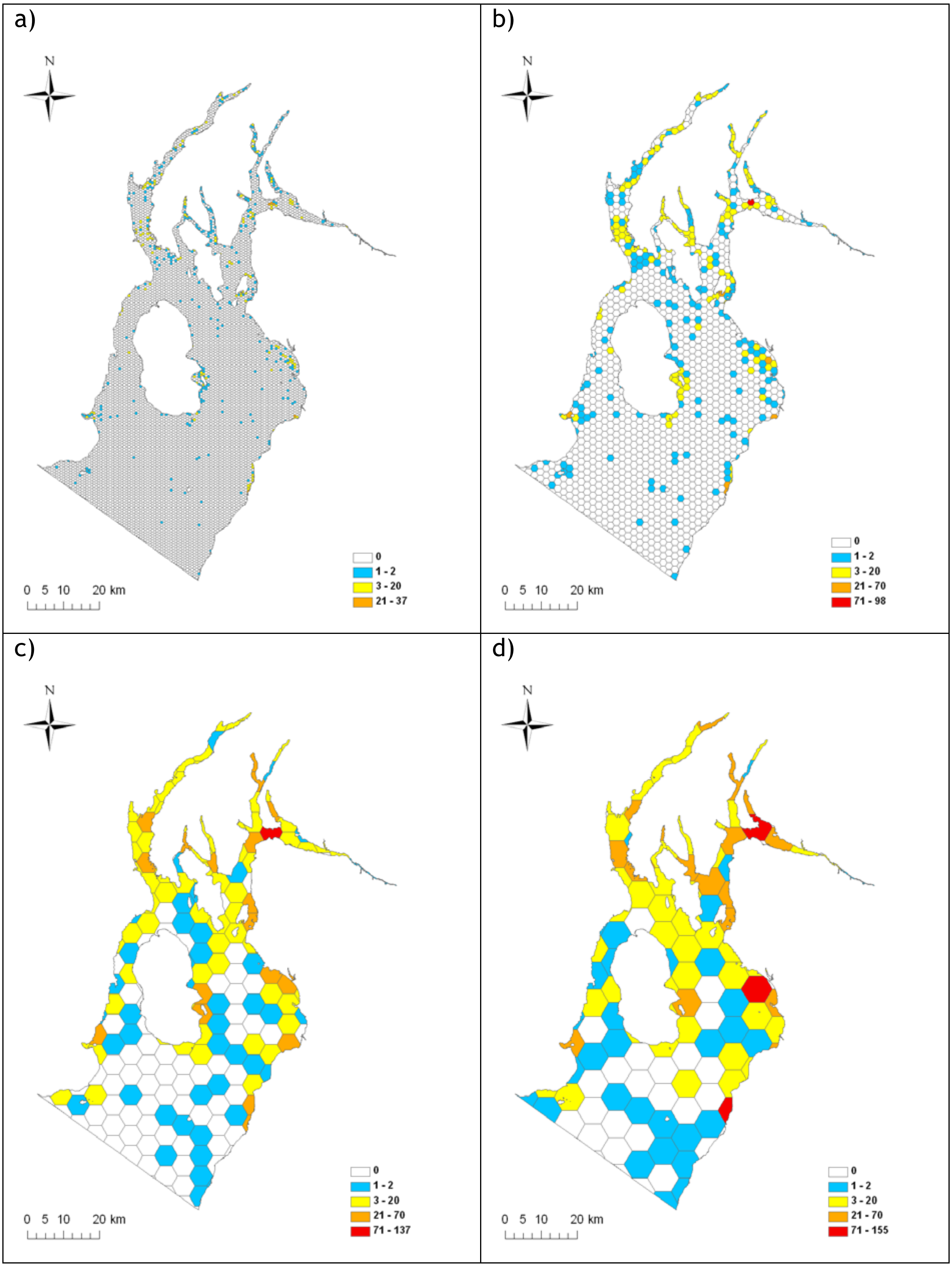


Figure 8. Number of samples encompassed by hexagon units of a) 1 km diameter, b) 2.5 km diameter, c) 7.5 km diameter and d) 10 km diameter.

3.4.2 *Data filtering*

The data were subjected to a series of temporal and spatial filters to remove low quality or inadequate information. For species datasets the procedure outlined in Table 3 was applied.

1. For monitoring data, only the most recent surveys at each location were included in analyses. Much of these data orignate from impact assessments and the survey sites may have changed over the course of the monitoring period, becoming degraded or recovering. For this reason, only the most up to date information for each site was included (the temporal cut-off varied by location). The removal of older surveys in the filtering process removed approximately 35% of the total records for species) (Table 3).
2. Data points that fell outside of the Firth of Clyde study area were removed from analyses (approximately 3.5% of the total species dataset (Table 3).
3. Many of the species records were only accurate to genus level, which can cause artificial inflation of species richness because, for example, a database query would identify *Gibbula* sp. and *Gibbula umbilicalis* as two different species from the genus *Gibbula* when only one may be present in a sample. Therefore, only records accurate to species level were included in the analysis. Recorded species names were checked against the World Register of Marine Species database (WoRMS, 2007) to ensure all species names were standardized in terms of spelling and synonyms. This step in the filtering process removed almost 14% of the total number of species records (Table 3).

Table 3. Filtering process for species data: proportion of records discarded at each stage.

Filter stage	Number of records		% of total records	
	No. remaining in analyses	No. discarded from analyses	% remaining in analyses	% discarded at each stage
Initial database	130,865	-	100	-
1) Removal of all repeat survey data apart from most recent at each location	84,481	46,384	64.56	35.44
2) Removal of any data points that fell outside the Firth of Clyde study area	79,883	4,598	61.04	3.51
3) Species matched to WoRMS lists and invalid/lower than species level names were discarded	61,733	18,150	47.17	13.87
4) Samples discarded where less than 3 occurred in a hexagon	57,466	4,267	43.91	3.26
5) Data filtered to retain the 6 benthic invertebrate phyla for taxonomic distinctness analyses	52,373	5,093	40.02	3.89

4. Finally, 5 km diameter hexagons with less than three samples were removed from analyses due to the high levels of uncertainty associated with such sparse sampling (approximately 3.26% of the total species dataset). The only exception to this was when scoring occurrences of priority species, where a

significant number of the records came from *ad hoc* sightings and surveys focusing on individual groups or species (for example cetaceans). Therefore in the case of priority species, all records were included (a total of 61,733 samples, or 47% of the total species dataset; Table 3).

5. For calculation of taxonomic distinctness, only species from six benthic invertebrate phyla were included in analyses (Cnidaria, Crustacea, Annelida, Mollusca, Bryozoa and Echinodermata after Hiscock & Breckels (2007)). This analysis used approximately 40% of the original dataset.

For biotope datasets, the following procedure was applied (Table 4).

1. Biotope codes that could not be matched to MNCR lists were removed (almost 59% of the biotope dataset (Table 4). These data were almost exclusively Marine Conservation Society (MCS) SeaSearch records from the Joint Nature Conservation Committee (JNCC) snapshot.

SeaSearch data includes a habitat classification, but it is not possible to convert this into the European Nature Information System (EUNIS) habitat classification (see Box 2). MCS has researched the conversion of SeaSearch surveys into EUNIS classifications and concluded that, due to the large differences in the classification systems and lack of correspondence with some categories, conversion is not viable (Chris Wood, MCS, pers. comm.). The classification of EUNIS habitats is reliant on physical factors such as wave exposure, which are not included in SeaSearch surveys; without this information it is not possible to reclassify accurately SeaSearch records into EUNIS habitats. Therefore, SeaSearch records had to be removed from analyses (for further discussions and possible solutions for retaining such data, see section 5). All remaining biotope codes above EUNIS level 4 were removed from analyses to prevent double counting and enable calculation of biotope distinctness.

Table 4. Filtering process for biotope data: proportion of records discarded at each stage.

Filter stage	Number of records		% of total records	
	No. remaining in analyses	No. discarded from analyses	% remaining in analyses	% discarded at each stage
Initial database	1,758	-	100	100
1) Matched to biotope codes and invalid/low levels discarded	722	1,036	41.07	58.93
2) Surveys discarded where less than 3 samples in hexagon	642	80	36.52	11.08

2. Finally, 5 km diameter hexagons with less than three surveys were removed from analyses due to the high levels of uncertainty associated with such sparse sampling (approximately 11% of the total species dataset).

The filtered data (to stage 3, see above) were plotted by temporal scale increments (5 years) to show the spread of the data temporally (Figure 9). It can be clearly seen that there is an uneven sampling effort across the study area through time (Figure 9), with areas such as the SE Isle of Arran having a disproportionate amount of recent samples, while other areas such as Loch Striven, were intensively sampled in the late 1980s.

The distribution of the number of samples in each 5 km diameter hexagon is uneven for both species and habitats (Figure 10). For species records, there are 15 5 km diameter hexagons (out of a total of 435, or 3.4%) with high densities of samples (>21-70) and five (1.15%) with very high densities of samples. More than half of the hexagons (239, or 55%) had no species records in them.

Box 2. EUNIS classification system

The EUNIS classification was developed for the European Environment Agency to standardize the description of habitat types across Europe. It allows for harmonization of a number of classification schemes (including the Marine Biotope Classification for Britain and Ireland). The classification allows the identification of both artificial and natural habitats in the terrestrial, marine and freshwater environments. For the purpose of the EUNIS classification a habitat is described as "plant and animal communities as the characterizing elements of the biotic environment, together with abiotic factors operating together at a particular scale" [http://eunis.eea.europa.eu/about.jsp].

As a hierarchical classification it can be used at various levels of detail (see below). The JNCC have produced translation tables that match habitat types in the EUNIS habitat classification to the following schemes:

- the marine habitat classification for Britain and Ireland (v04.05);
- EC Habitats Directive Annex I types;
- OSPAR priority habitat types; and
- UK Biodiversity Action Plan priority habitat types (Source: Joint Nature Conservation Committee, 2007)

Description of EUNIS classification levels

Level	Description
1	***Environment (marine):*** a single category is defined within EUNIS to distinguish the marine environment from terrestrial and freshwater habitats.
2	***Broad physical habitats:*** based on depth and broad substrata (e.g. rock or sediment) or water column e.g. littoral sediment.
3	***Main habitats:*** mainly physical based on energy regime but with some general description of biogenic habitat e.g. 'Littoral sediments dominated by aquatic Angiosperms', and 'Sublittoral macrophyte dominated sediment'.
4	***Dominant community type:*** community type described without specific reference to conspicuous species e.g. 'Fuciods in tide swept conditions'.
5	***Community:*** distinguished by their different dominant species or suites of conspicuous species e.g. '*Chthamalus* spp. on exposed upper eulittoral rock'.

Most hexagons did not contain habitats records (332 out of a total of 435 hexagons, or 76%). Where data were available, they tended to be in low numbers per hexagon (10% of hexagons had either 1 or 2 records, and 12% of hexagons had between 3 and 20 records). Just 1% of hexagons had high sampling effort (more than 20 samples).

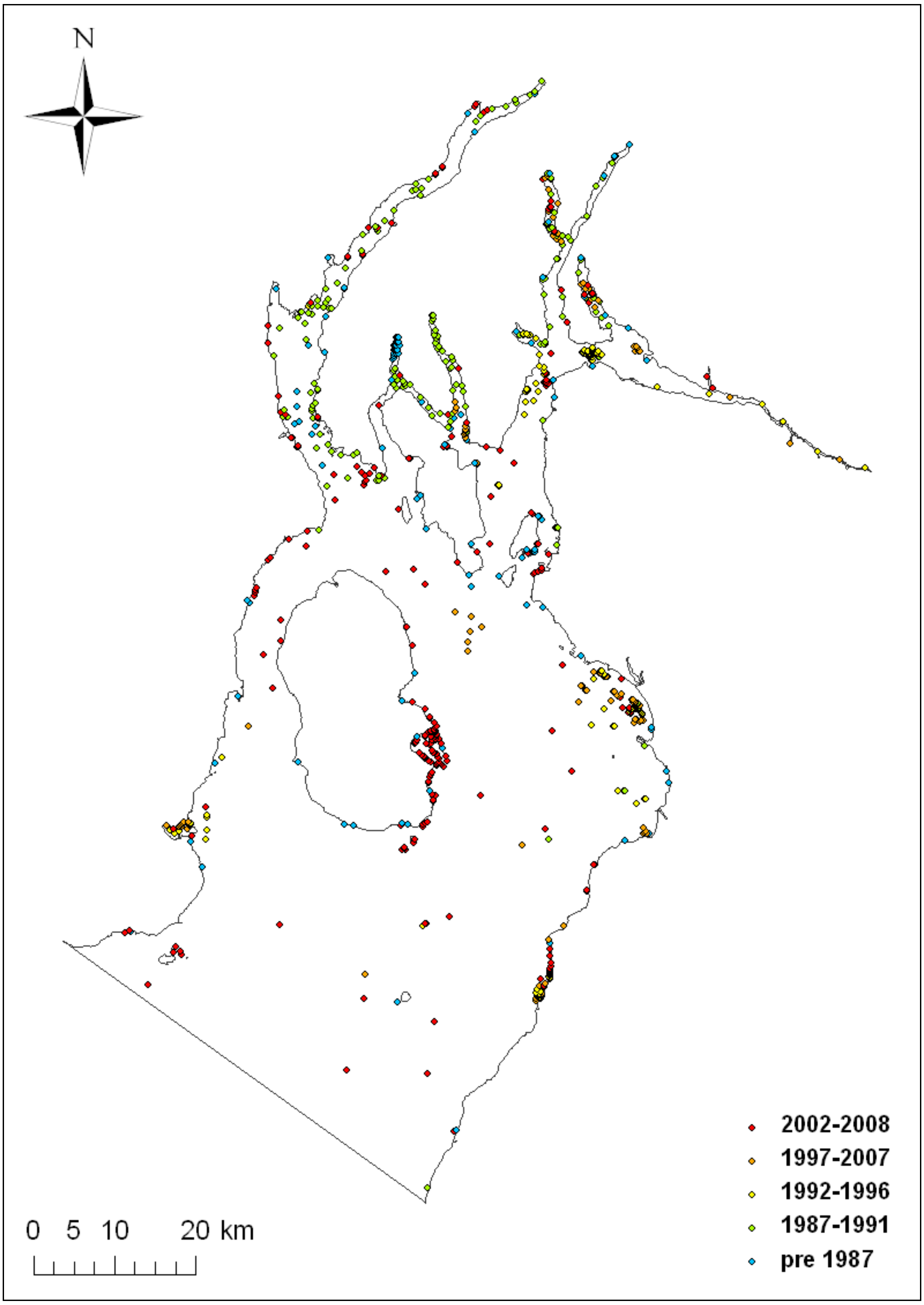


Figure 9. Spatio-temporal spread of species data, plotted by sample year (aggregated at 5 year intervals).

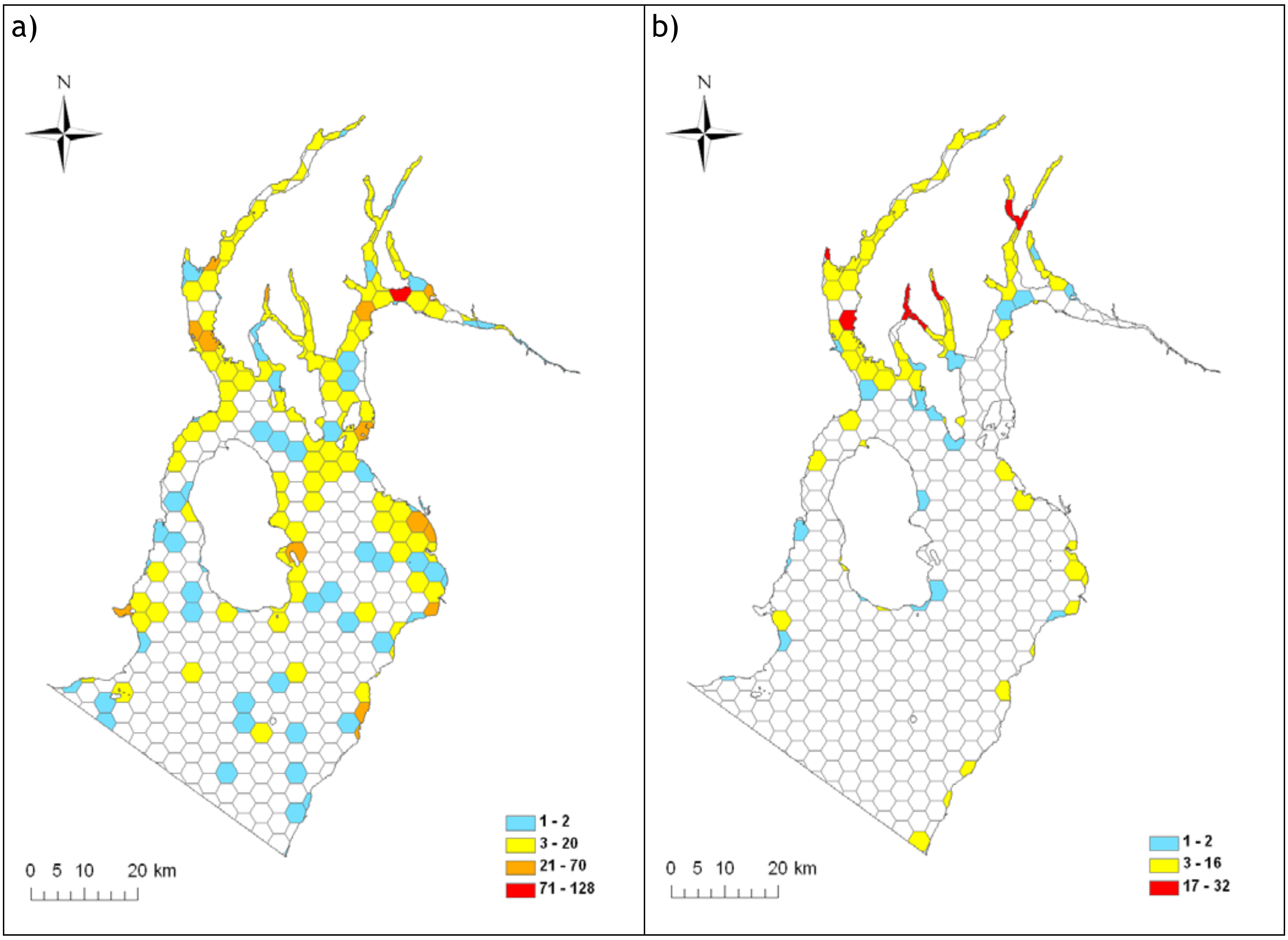


Figure 10. Spatial distribution of a) species and b) habitat records (number of samples per 5 km diameter hexagon).

3.4.3 *Predictive seabed habitat types*

Terrestrial habitat mapping techniques are often difficult to apply to the marine environment given the higher costs associated with direct surveys. Therefore, an alternative approach was developed (JNCC, 2004). The approach involves the creation of a model of the environment based on observed correlations between habitats and environmental data, such as depth or current speed. This technique has been used for broad scale national and international projects such as UKSeaMap (Connor *et al.*, 2006) and MESH[4].

A fine scale study was carried out to map modelled habitats for the Firth of Clyde study area (Tresadern, 2008). Cartographic modelling was used and the following environmental characteristics were incorporated: 1) height and bathymetry, 2) seabed type, 3) biology, 4) energy regime and 5) salinity. While the resultant maps broadly agreed with the coarser scale UKSeaMap and MESH outputs, no ground-truthing has yet taken place so overall accuracy is unknown. Furthermore, the quality of the predictive seabed habitat map (or model that underpins it) is related to the data used to construct it, which in most cases are not ideally fit for this purpose. However, the predictive seabed type map (Figure 11) represents the best knowledge

[4] Mapping European Seabed Habitats (MESH) - http://www.searchmesh.net/

available on seabed habitat types in the Firth of Clyde at present. Hence, it was used in the design of the analysis.

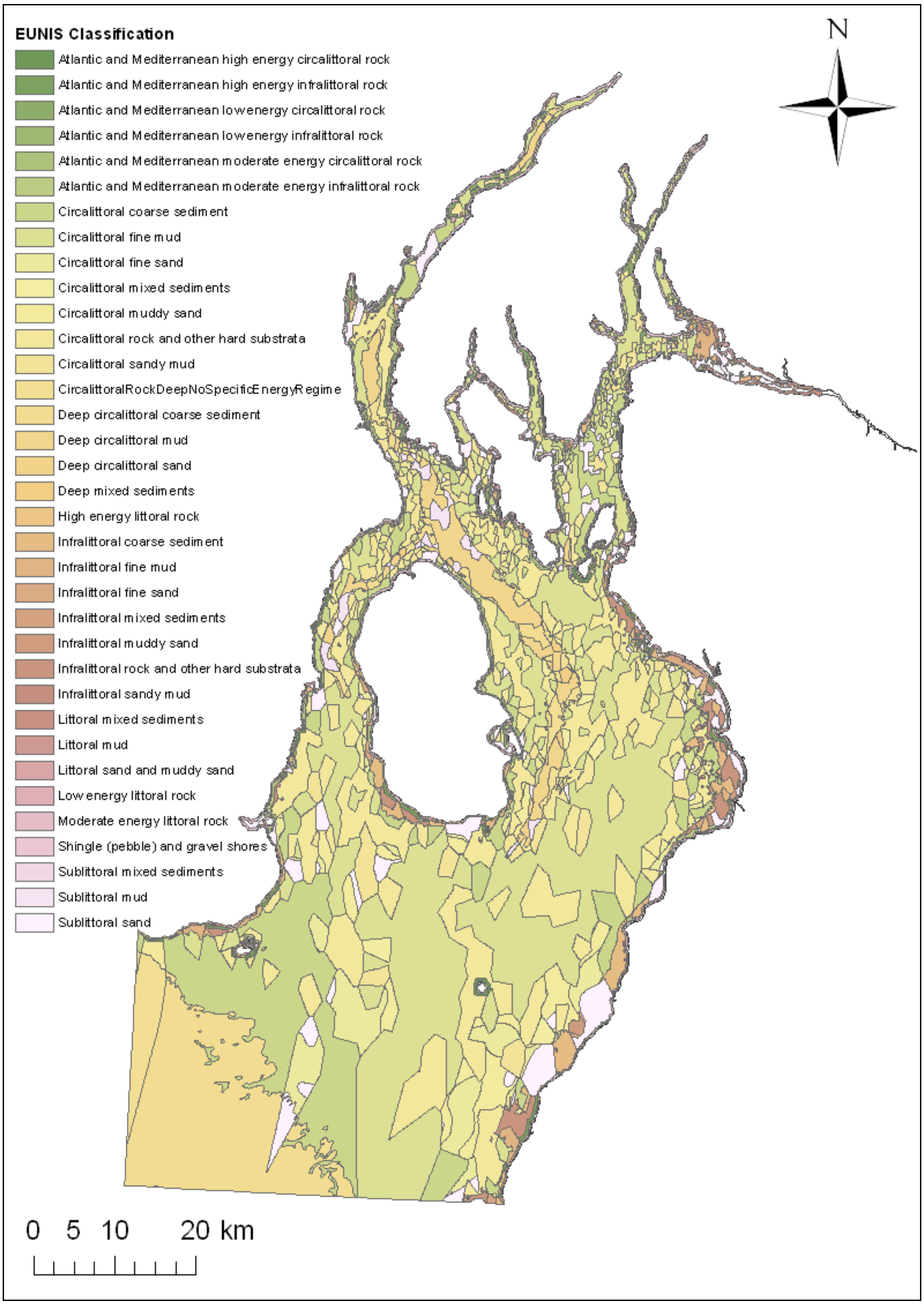


Figure 11. Map of predictive seabed habitat types for the Firth of Clyde.

GIS layers of the predictive seabed habitat type provided by SSMEI (Tresadern, 2008) were imported into the project geodatabase. These predicted seabed habitats were aggregated to EUNIS level 2 (see Box 2) for all subsequent analyses to reduce the number of types and allow greater data coverage and improve confidence.

3.5 Identification of important areas for marine biodiversity

The priority species and habitats lists for the Firth of Clyde are given in Appendix 4 and the original national and international source lists are shown in Appendix 5.

3.5.1 *Nationally Important Marine Feature (NIMF) criteria*

The criteria to identify Nationally Important Marine Features (NIMF) (species and habitats) were identified by the Review of Marine Nature Conservation (Connor *et al.*, 2003). Within the context of NIMF, national refer to the UK, rather than Scotland. The criteria (Box 3) include proportional importance, rarity, decline and threat of decline. Under the guidance of the Marine Priority List Review Group of the UK Priority Species and Habitats Review Working Group, a final set of criteria for NIMF species and habitats were developed together with guidelines for their application.

Box 3. Nationally Important Marine Features (NIMF) criteria.

CRITERION 1: Proportional Importance

A high proportion of the populations of a species (at any time of its life cycle) occurs within the UK. This may be related to either global or regional extent of the feature. Species are categorised as follows:

Global importance: a high proportion of the global population of a species (at any time of its life cycle) occurs within the UK. 'High proportion' is considered to be more than 25%.

Regional importance: a high proportion of the regional population of a species (at any time of its life cycle) occurs within the UK. 'Regional' refers to the north-east Atlantic (OSPAR) area. 'High proportion' is considered to be more than 30%.

CRITERION 2: Rarity

Marine species that are sessile or of restricted mobility (at any time in their life cycle) are considered nationally rare if distribution is restricted to a limited number of locations. For pragmatic reasons, species are considered rare if recorded in eight or less 10 km squares (0.5%) within the 3 mile territorial seas limit of UK waters. The figure is calculated for the UK as a whole and with the Isle of Man so that rarity is assessed in a relevant geographical area and for a distance offshore that includes most of the variable habitats before the level sediment plain is reached (see Sanderson *et al.*, 1996 for explanation.)

NB. A mobile species qualifies as nationally rare if the total population size is known, inferred or suspected to be fewer than 250 mature individuals. Vagrant species should not be considered under this criterion.

CRITERION 3: Decline

An observed, estimated, inferred or suspected significant decline (exceeding expected or known natural fluctuations) in numbers, extent or quality of a marine species in the UK (quality refers to life history parameters). The decline may be historic, recent or current. Alternatively, a decline at a global or regional level, where there is cause for concern that the proportional importance criteria will be met within the foreseeable future. Decline in extent and quality of species at different scales should be assessed as follows:

Extent: Within the UK population of the species:

- There has been a recent significant decline in numbers of individuals/geographical range, OR
- Numbers of individuals/geographical range are presently in marked decline, OR
- The present population is at significantly lower levels than in the past as a result of human activity.

Box 3. Nationally Important Marine Features (NIMF) criteria (continued).
Quality: The species has suffered a significant decline in one of more of the following:
• Loss of genetic diversity
• Loss of fecundity
• Reduction in the numbers of mature individuals
• Fragmentation of the population
CRITERION 4: Threat of decline
It is estimated, inferred or suspected that a species will suffer a significant decline (as defined under the "decline" criterion) in the foreseeable future as a result of human activity. This assessment will need to take into account inherent sensitivity, and expected degree of exposure to the effects of human activity. A species may also qualify under this criterion if there is real cause for concern that it would fulfil the proportional importance criterion in the near future due to threat of global or regional decline.

NIMF were identified in the exercise undertaken by Hiscock *et al*. (2006). However, it should be noted that the list of NIMF species and habitats is currently a candidate list only.

The current list of candidate NIMF species is not definitive and there are gaps in coverage across the major taxonomic groups (Hiscock *et al*., 2006). Some specialists approached to review groups indicated that they did not believe in the relevant concepts; polychaetes are not represented for this reason. For other groups, relevant specialists were too busy and, whilst some obvious candidates could be included, a proper analysis was not undertaken (e.g. sponges). Nevertheless, the candidate list provides the best current indication of species to be protected.

3.5.2 *UK Biodiversity Action Plan (BAP) criteria*

The UK Biodiversity Action Plan (BAP) criteria for marine species and habitats (Box 4) originated in terrestrial systems and the development of these criteria were purposefully designed for compatibility with the existing terrestrial and freshwater criteria. Like NIMF, this is also a UK wide listing.

Box 4. UK Biodiversity Action Plan criteria (BAP).
CRITERION 1: International threat
Assess the species' status in either a global or a European context.
i) Use the best available knowledge e.g.
• IUCN global Red Lists
• Red Lists from individual European countries
• other (specified) authoritative sources that assess threat or decline.
ii) Where possible, use the new IUCN categories (CR, EN, VU): if Red Lists use the old IUCN criteria, treat the Rare category with caution.
iii) Red listing in >50% of countries with adequate data within the biogeographic or European range of the species, would qualify a species as internationally threatened. If this evidence is cited, please indicate the range of the species and list the countries that include it in a Red List.
iv) The revised IUCN Red List Categories and Criteria (version 3.1, published in 2001) and guidelines on their application at global and national levels are available electronically at: www.iucn.org/themes/ssc/red-lists.htm. See www.redlist.org for lists of globally threatened species.

CRITERION 2: International responsibility + moderate decline in the UK

Under this criterion, a species that has declined by more than 25% in the last 25 years in the UK may qualify if the UK supports 25% or more of the global or European population. Please quantify your answer as far as possible and provide all supporting information

i) The European or global proportion can be measured in terms of grid square records, sites, numbers of individuals etc. Please provide as much data as possible.

ii) Make a special note if the species is endemic or near-endemic.

iii) The species needs to have declined by 25% or more over the past 25 years.

Box 4. UK Biodiversity Action Plan criteria (BAP) (continued).

CRITERION 3: Marked decline in the UK

A species that has declined by 50% or more over the past 25 years qualifies under this criterion.

i) Decline may have been measured or may be deduced from other evidence.

ii) If no direct evidence exists, deterioration or loss of habitat; threat to a food plant; or other relevant factors may be used as surrogates (i.e. inferred decline).

iii) Decline can be expressed in a number of possible ways, for instance as population size, range or number of occupied sites.

iv) In the absence of a 25-year run of data, decline rate will be automatically extrapolated from a shorter (or longer) period.

v) Evidence and sound reasoning must be given in support of the claim.

vi) Please give the types of record (e.g. 10 km square, 1 km square, site data) and time-span of the supporting data.

In relation to the run of data available, please provide a judgement on how appropriate the extrapolation to 25 years is, and how able the data are to be used in this context. Equally, if you have used an alternative means of measuring rate of decline, please provide the working and outline its usage in this context. If some data were ignored, or discontinuous or more than one data set was used (covering different time periods) this should be highlighted.

CRITERION 4: Other important factor(s)

Even if a species does not qualify under Criteria 1, 2 or 3 there may still be a case for listing it as Priority. However, evidence of extreme threat is required. Justifications may include reasons such as those listed below.

1. It is predicted that the species will decline by 50% in a current 25 year period, or in the next 25 years.

2. The species is believed to be long-lived (>25 years) with a low recovery potential and if action is not taken to reverse current trends then the species is likely to become extinct in the next 100 years.

3. The species is declining and is a good 'indicator' that represents an issue causing the decline of a range of less easily incorporated species. The species may represent a unique or favoured habitat or food source for an established or proposed BAP species.

4. The species is known to have been more abundant and widespread (i.e. population or extent twice as large+) in the recent past and, whilst the species is recovering, the factors that caused the original decline are still operating or the species' population has not recovered to a point where it is likely to be viable in the long term.

5. The species is threatened globally or in the European seas so that the UK could become a future 'stronghold'.

The key difference between the cNIMF criteria and BAP criteria is that the latter require quantitative measures of decline and extreme threat (supported by evidence). This is a major constraint on the number of species and habitats included since data to support these measures is often not widely available for many marine species.

The criteria for identifying candidate NIMF species and habitats do not require the same quantitative rigour that proved so difficult to apply in identifying marine BAP species and habitats. The NIMF list is therefore a much better representation of marine species and habitats that are rare, in decline or threatened with decline. However, all of the BAP species and habitats are also NIMF and so the candidate NIMF list provides the most suitable measure to address the criterion 'Area important for a priority marine feature'.

3.5.3 *Nationally Rare and Scarce criteria*

In addition to NIMFs and BAPs there is a list of Nationally Rare and Scarce species (Sanderson, 1996). Again, national in this context refers to UK-wide, rather than Scottish. The rare species are included as NIMFs since these criteria constitute one of the NIMF criteria but the scarce species are outside of the NIMF criteria (Box 5).

Box 5. Nationally Rare and Scarce Criteria.

NATIONALLY RARE:

Benthic marine species that are native and occur in eight or fewer of the 10 x 10 km squares (of the Ordnance Survey national grid) containing sea within the 3 mile territorial limit for Great Britain.

NATIONALLY SCARCE:

Species that occur in nine to 55 of the above squares.

In addition to these UK-wide criteria, there are also national criteria e.g. Scottish Biodiversity List and criteria at a finer scale, namely Local BAPs.

3.5.4 *Scottish Biodiversity List criteria*

The Scottish Biodiversity List comprises species and habitats considered to be of principal importance for the purpose of conservation of biodiversity in Scotland (Box 6). The Scottish Biodiversity List has been developed to meet the requirements of Section 2 (4) of the Nature Conservation (Scotland) 2004 Act for the conservation of biodiversity.

Box 6. Scottish Biodiversity List criteria (marine species and habitats).

CRITERION 1: Importance

All marine habitats and species included on the priority list for the UK, and which are present in Scotland.

CRITERION 2: Rarity

Species that are rare in Scottish waters, where rarity is assessed as species that occur in less than six (c. 1%) of the total number of ten km squares or less than three (c. 5%) of the ICES rectangles. A mobile species qualifies as nationally rare if the total population size is known, inferred or suspected to be fewer than 250 mature individuals. Vagrant species should not be included under this criterion.

Rare habitats are those that occur in six or fewer locations in Scottish waters.

CRITERION 3: Data deficient

Habitats that are known to be particularly important for supporting marine plant and animal assemblages that are data deficient.

CRITERION 4: Decline

An observed, estimated, inferred or suspected significant decline (exceeding expected or known natural fluctuations) in numbers, extent or quality of a marine habitat or species in Scotland (for species, quality relates to life history parameters). Significant decline should be assessed as 25% reduction of area or numbers, or other appropriate threshold (which must be stated and justified).

3.5.5 *Local Biodiversity Action Plan (LBAP) criteria*

The criteria used to select Local Biodiversity Action Plan (LBAP) LBAP habitats and species is based on the BAP criteria (Box 7). This is implemented at a local scale; if a BAP species is present then it is automatically included on the LBAP list. LBAPS were proposed as a way of stimulating effective local action for national priorities identified in the UK Biodiversity Action Plan, as well as for species and habitats which are particularly cherished or valued in local areas of Scotland. It was envisaged as a way of refocusing the conservation work that was already underway within local authority areas but with new nationally agreed objectives.

Box 7. LBAP criteria for habitats and species.
Species criteria
CRITERION 1: Decline – species that have undergone a locally dramatic decline.
CRITERION 2: Rarity – species that are locally rare.
CRITERION 3: Threatened – species that are locally under threat.
CRITERION 4: Importance – species that have a significant number of their UK population in the locality.
CRITERION 5: Sentinel species – species that have a high profile and will therefore illustrate wider environmental issues.
CRITERION 6: Indicator species – species that can be used as indicators of habitat quality.
CRITERION 7: Characteristic species – species that are characteristic of the locality.
Habitats criteria
CRITERION 1: Decline - habitats that have a high rate of local decline.
CRITERION 2: Importance - where the local area has a high proportion of the UK resource.
CRITERION 3: Rarity - habitats that are locally rare.
CRITERION 4: Threatened - habitats that are locally under threat.
CRITERION 5: Fragmented - habitats that are locally fragmented but with the potential for repair.
CRITERION 6: Distinctive - are important for key species; and are locally distinctive.

3.5.6 *Internationally important species and habitats*

The UK has obligations to protect internationally important species and habitats that are listed on a variety of directives and conventions and mainly include vertebrate species. These include the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR). This was adopted in Paris, France in September 1992 and entered into force in March 1998. These criteria (Box 8 and Box 9) were developed to identify an initial list of species and habitats that are considered to be under immediate threat or subject to rapid decline, and were formally adopted by OSPAR in 2003.

Box 8. OSPAR selection criteria for species.

CRITERION 1: Global importance

Global importance of the OSPAR area for a species. Importance on a global scale, of the OSPAR Area, for the species is when a high proportion of a species at any time of the life cycle occurs in the OSPAR Area. 'High proportion' is considered to be more than 75%, when known.

CRITERION 2: Local importance

Importance within the OSPAR Area, of the regions for the species where a high proportion of the total population of a species within the OSPAR Area for any part of its life cycle is restricted to a small number of locations in the OSPAR Area. 'High proportion' is considered to be 90% of the population in a small number of locations of 50 km x 50 km grid squares. This is dependent on scientific judgement regarding natural abundance, range or extent and adequacy of recording. A different scale may be needed for different taxa.

CRITERION 3: Rarity

A species is rare if the total population size is small. In case of a species that is sessile or of restricted mobility at any time of its life cycle, a species is rare if it occurs in a limited number of locations in the OSPAR Area, and in relatively low numbers. In case of a highly mobile species, the total population size will determine rarity.

'A limited number of locations' could be in a small number of 50 km x 50 km grid squares, but a different scale may be needed for different taxa. This is dependent on scientific judgement regarding natural abundance, range or extent and adequacy of recording Species which are present in high abundance outside of the OSPAR Area and only occur at the edges of the OSPAR Area will not generally qualify as 'rare' species.

CRITERION 4: Sensitivity

A 'very sensitive' species is one if very easily adversely affected by a human activity, and/or if affected is expected to only recover over a very long period, or not at all. A 'sensitive' species is one if easily adversely affected by a human activity, and/or if affected is expected to recover in a long period.

A 'very long period' may be considered to be more than 25 years and 'long period' in the range of 5 to 25 years. The time frame should be on an appropriate scale for that species.

Sensitivity to human activities is measured by

a. life history characteristics

b. dependence on other specific ecological attributes e.g. restricted / specific habitats requirements.

CRITERION 5: Keystone species

A species that has a controlling influence on a community.

CRITERION 6: Decline

Decline means an observed or indicated significant decline in numbers, extent or quality (quality refers to life history parameters). The decline may be historic, recent or current. 'Significant' need not be in a statistical sense.

'Decline' is divided into the following categories:

1. Extirpated (extinct within the OSPAR Area): a population of a species formerly occurring in the maritime area is defined as extirpated:

- if it was still occurring in the area at any time during the last 100 years
- and if there is a high probability, or it has been proved, that the last individuals have since died or moved away.
- or if surveys in the area have repeatedly failed to record a living individual in its former range and / or known or expected habitats at appropriate times (taking into account diurnal, seasonal, annual patterns of behaviour) for at least 10 years.

Box 8. OSPAR selection criteria for species (continued).

2. Severely declined: a population of species occurring in the maritime area is defined as severely declined

- if individual numbers show an extremely high and rapid decline in the area over an appropriate time frame, or the species has already disappeared from the major part of its former range in the area.
- or if individual numbers are at a severely low level due to a long continuous and distinct general decline in the past.

3. Significantly declined: means a considerable decline in number, extent or quality beyond the natural variability and in an appropriate time frame for that species.

4. High probability of a significant decline in number, extent or quality in the future.

Box 9. OSPAR selection criteria for habitats.

CRITERION 1: Global importance (importance of the OSPAR Area for the habitat in a global context

A high proportion of the habitat occurs in the OSPAR Area. 'High proportion' is considered to be more than 75%, when known. This criterion may require knowledge of the distribution of habitats at a global scale.

CRITERION 2: Regional importance (importance of the sub-regions of the OSPAR Area for the habitat)

A high proportion of the habitat occurs within a specific biogeographic region and/or region of national responsibility within the OSPAR Area. 'High proportion' is considered to be more than 75%, when known.

CRITERION 3: Rarity

A habitat is assessed as being rare if it is restricted to a limited number of locations or to small, few and scattered locations in the OSPAR area.

'The 'limited number of locations' is set at 2% of the 50 km x 50 km grid squares for each of the following three bathymetric zones:

a. littoral (intertidal zone and splash zone)

b. sublittoral (down to 200 m depth)

c. bathyal / abyssal (below 200 m depth)

The assessment is dependent on scientific judgement regarding natural abundance, range or extent and adequacy of recording.

CRITERION 4: Sensitivity

A 'very sensitive' habitat is one that is very easily adversely affected by a human activity and/or would be expected to, recover only over a very long period, or not at all. A 'sensitive' habitat is one that is easily adversely affected by a human activity and would be expected to recover only over a long period.

Sensitivity will be expressed in terms of:

a. impact of human activities (resistance)

b. capacity to recover (resilience), including a reflection of its degree of isolation or confinement to a small area.

A 'very long period' is considered to be more than 25 years and a 'long period' in the range of 5 to 25 years, dependent on the habitat. It is considered that the sensitivity of a habitat differs according to specific impacts of different human activities and, as such, should be applied at the end of the selection process with respect to the specific impacts of human activities.

Box 9. OSPAR selection criteria for habitats (continued).

CRITERION 5: Ecological significance

The habitat is very important for the wider significance of the ecological processes, functions and species that it supports.

Example habitats could be: spawning, breeding, reproduction, or nursery areas for fish, mammals or birds, resting and feeding areas, areas with a high natural productivity or diversity, areas with a high proportion of endemic species, and areas important as migratory routes.

CRITERION 6: Status of decline

Decline means a significant decline in extent or quality. The decline may be historic, recent of current. The decline can occur in the whole OSPAR maritime area or regionally.

'Decline' is assessed for both decline in extent and quality, recognising the following descriptions:

a. Extent – based on distributional coverage or areal extent.

b. Quality – judgement of decline in quality should be based on change from natural condition caused by human activities. Such judgement is likely to include aspects of biodiversity, species composition, age composition, productivity, biomass per area, reproductive ability, non-native species and the abiotic character of the habitat.

There is a degree of overlap between the above biodiversity lists since many OSPAR species are also BAP species (Table 5). All BAPs are also cNIMFs, but as discussed above, the NIMF criteria are broader and encompass features for which there are less quantitative data available. The nationally rare and scarce list (Sanderson, 1996) includes features that are NIMFs (rare being one of the criteria) but scarce features are not included. National and local lists (Scottish Biodiversity List and LBAP species and habitats respectively) encompass all UK-wide priority species and habitats but also include those of importance smaller spatial scales.

Table 5. Comparison of the criteria for international, national and local species and habitats priority lists.

Criterion	NIMF	BAP	NR&S[5]	SBL[6]	OSPAR[7]	LBAP	Comments
Proportional importance/ Importance/ Global importance/ Local importance	✓			✓	✓	✓	NIMF species are categorised at global and regional (NE Atlantic) scales, with high proportion considered to be >25% and >30% of the population respectively. SBL includes all marine habitats and species on the priority list for the UK that are present in Scotland. OSPAR has two importance criteria: global (with high proportion >75% of the population of a species in the OSPAR area) and local (where high proportion is considered to be 90% of the population in a small number of locations of 50 km x 50 km grid squares).
Rarity	✓		✓	✓	✓	✓	NIMF and NR&S species are considered rare if they occur in <0.5% of 10 km squares within the 3 mile territorial seas limit of UK waters. SBL species are considered rare if they occur in <6 (c. 1%) of the total number of ten km squares or <3 (c. 5%) of the ICES rectangles. A mobile species qualifies as nationally rare if the total population size is known, inferred or suspected to be fewer than 250 mature individuals. Rare habitats are those that occur in 6 or fewer locations in Scottish waters. OSPAR species are considered rare if the total population size is small. For sessile species or those of restricted mobility at any time of its life cycle, a species is rare if it occurs in a limited number of locations in the OSPAR Area, and in relatively low numbers. In case of a highly mobile species, the total population size will determine rarity.
Scarcity			✓				Species are considered scarce if they occur in 0.5-3.4% of 10 km squares (9-55 squares) within the 3 mile territorial seas limit of UK waters.

[5] Nationally Rare and Scarce
[6] Scottish Biodiversity List
[7] OSPAR criteria for species is given, which is slightly different from habitats criteria

Criterion	NIMF	BAP	NR&S[5]	SBL[6]	OSPAR[7]	LBAP	Comments
Decline/International responsibility and moderate decline in the UK/Marked decline in the UK	✓	✓		✓	✓	✓	The key difference is that for NIMFs, significant decline is 'observed, estimated, inferred or suspected'. For BAP species, moderate decline relates to a 25% decrease where the UK supports 25% or more of the global or European population, and marked decline, a 50% decrease over the last 25 years. SBL considers decline as an observed, estimated, inferred or suspected significant decline (exceeding expected or known natural fluctuations) in numbers, extent or quality of a marine habitat or species in Scotland. A significant decline is assessed as 25% reduction of area or numbers, or other appropriate threshold. OSPAR considers decline in 4 categories: 1) extirpated (extinct), 2) severely declined (high and rapid decline or major range reduction or low number of individuals due to long continuous decline), 3) significantly declined (considerable decline in number, extent or quality) and 4) high probability of a significant decline in number, extent or quality in the future.
Threat of decline	✓	✓				✓	NIMFs are 'estimated, inferred or suspected' to suffer a significant decline in the foreseeable future as a result of human activity'. For BAPS, this threat is encompassed in Criterion 4, under 1. 'it is predicted that the species will decline by 50% in a current 25 year period'; 2. 'it is likely to become extinct in the next 100 years'; and 4. 'the species was known to have been more abundant and widespread in the recent past…'.
International threat		✓					BAP species are assessed in either global or European context using IUCN global Red Lists and Red Lists from individual European countries and other sources.
Data deficient				✓			SBL habitats that are known to be particularly important for supporting marine plant and animal assemblages that are data deficient.
Sensitivity					✓		A very sensitive species is one if very easily adversely affected by a human activity, and/or if affected is expected to only recover over a very long period, or not at all. A 'sensitive' species is one if easily adversely affected by a human activity, and/or if affected is expected to recover in a long period.
Keystone species					✓		A species that has a controlling influence on a community.
Sentinel species						✓	A species that has a high profile and will therefore illustrate wider environmental issues.
Indicator species						✓	A species that can be used as an indicator of habitat quality.
Characteristic species						✓	A species that is characteristic of the locality.

3.5.7 *Approaches to identifying areas of important marine biodiversity*

There are various ways in which marine biodiversity can be analysed, mapped and incorporated into Marine Spatial Planning. These include:

- identification of areas containing local, regional, national or international priority species;
- identification of areas, habitats or species of particular importance for ecosystem structure and functioning;
- identification of species and habitats likely to be sensitive to human activities and natural events; and
- identification of biodiversity hotspots.

Priority species and habitats - areas containing species or habitats of local, national and international importance can be identified to allow biodiversity to be protected at each of these scales. At a local scale, in addition to identifying areas where "important" species and habitats occur, biodiversity can be measured as species diversity and habitat diversity, both of which can be calculated in a number of ways (for example species richness, an index of diversity or taxonomic distinctness).

Regardless of the statistic or score used, measures of biodiversity are scale dependent, limited by extent (i.e. area of search, whether measured at a local, national or international scale) and resolution (the size of the sample unit, for example diversity could be examined within one sediment core, or within a planning unit, for example the 5 km diameter hexagonal units used here). In practice, both extent and resolution are defined according to conservation and management objectives or by survey limitations and methodologies, rather than by scales driven by ecosystem function.

Ecosystem structure and functioning - an Ecosystem Approach to representing marine biodiversity requires all species and habitats to be represented within protected areas and in sufficient amounts (area and population size) to allow the ecosystem to function "normally". Despite gaps in data coverage, it may be possible to use the available data to identify areas (using predefined units such as the 5 km diameter hexagons) that allow a certain proportion of each of the habitats and species to be included in protected areas within the MSP.

Decision support software such as Marxan (Ball & Possingham, 2000) can be used to identify a number of possible areas. However, accurate targets for the proportions of each species and habitats ideally should be identified using a panel of experts who understand the minimum requirements. Such information often does not exist and arbitrary targets are chosen. Frequently, areas are identified by algorithms used in software such as Marxan based on targets but which also incorporate weightings and "locked-in" regions. These may include regions already designated for protection (e.g. Sites of Special Scientific Interest, Special Areas for Conservation) and areas identified through interviews with local scientists and managers as of high conservation importance (Beck & Odaya, 2001).

Sensitivity – another approach to incorporating important marine biodiversity into a MSP is based on sensitivity. This involves mapping landscapes, biotopes and/or species sensitive to specific pressures arising from anthropogenic activities within an area (Tyler-Walters & Hiscock, 2005). The information collated (in its entirety) during the course of this study and provided to SSMEI in the form of GIS layers could potentially be used in conjunction with sensitivity information available on MarLIN web pages to produce sensitivity maps.

Biodiversity hotspots - prioritising areas for protection comes down to cost effectiveness of the protection, in essence protecting the highest number of important species and habitats for the least cost (the exact species and habitats depend on which criteria are applied, see section 3.4). This idea drives the identification of "hotspots". The definition of "hotpots" in the literature is variable, again reflecting management and conservation objectives, as illustrated in Table 6. Some studies focus on areas where the number of rare or declining species or habitats (or other priority species and habitats) is high. This may be because it is assumed that by focusing on priority species there will be an effective umbrella for overall species richness of an area, which is not always the case (Bonn *et al.*, 2002). However, protecting structural or ecosystem engineer species may be effective. Some studies may use the term hotspots to describe species or habitat richness or diversity measured using specific indices (e.g. Shannon Wiener Index or Taxonomic distinctness) (see Box 10). Other studies combine a number of different measures (Reid, 1998), for example, the number of endemic species in combination with areas of threatened or declining habitats (Myers *et al.*, 2000). A further approach is to score areas based on a number of measures (Hiscock & Breckels, 2007) to help identify locations which would protect the greatest diversity for minimum cost.

Table 6. Examples of the measures used identify "hotspots"

Measure	References
Endemic species	Myers *et al.* (2000), Phillips (2001), Hughes *et al.* (2002)
Species richness	Hughes *et al.* (2002), Myers *et al.* (2000), Phillips (2001), Price (2002), Worm *et al.* (2003)
Priority species	Hiscock & Breckels (2007)
Priority habitats	Hiscock & Breckels (2007), Myers *et al.* (2000)
Habitat richness	Hiscock & Breckels (2007)
Taxonomic Distinctness	Hiscock & Breckels (2007), Price (2002)
Biotope distinctness	Hiscock & Breckels (2007)
α-diversity	Hooper *et al.* (2002), Price (2002), Worm *et al.* (2003)
β-diversity	Hooper *et al.* (2002), Vanderklift *et al.* (1998)
γ-diversity	Hooper *et al.* (2002), Vanderklift *et al.* (1998)

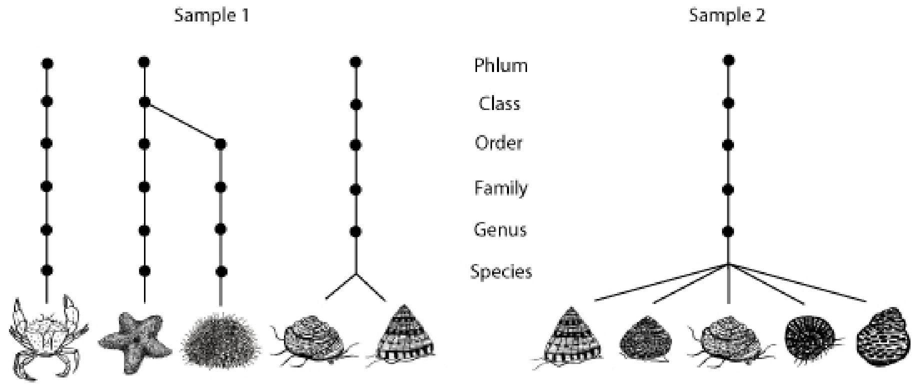
3.6 A combined hotspot approach

In the current study, six measures of diversity were analysed to provide information about diversity at two levels of ecological organization: a) the species composition of communities and b) the diversity of biotopes (which includes aspects of the physical environment). The measures were:

1. species richness;
2. average taxonomic distinctness (see Box);
3. number of priority species (see section 3.5);
4. biotope richness;
5. average biotope distinctness; and
6. number of priority biotopes (see section 3.5).

Box 10. Average taxonomic distinctness

Average taxonomic distinctness calculates the average taxonomic distance apart of all the pairs of species in a sample, based on branch lengths of a hierarchical Linnaean taxonomic tree (Warwick & Clarke, 2001). The illustration below shows the principle of average taxonomic distinctness. Both samples have the same species richness with five species present. However, sample 2 has five species from the same genus, whilst sample 1 has five species from four different genera and three different phyla. Therefore species from sample 1 are separated by longer branch lengths in the taxonomic tree and have a greater average taxonomic distinctness.



The reason a combined measure was used to describe biodiversity hotspots rather than simply using species richness is that species richness alone does not provide a complete picture of the pattern of biodiversity (Purvis & Hector, 2000). The analysis in this study built on work initiated for a UK wide study (Hiscock & Breckels, 2007), and represents the first attempt at applying this approach to a smaller spatial scale. The overall process is shown in Figure 12.

The range of different taxonomic groups represented in an area (phylogenetic diversity, see Box 10) is not addressed by species richness measures. Therefore, average taxonomic distinctness was included in the analytical design. Average taxonomic distinctness is a diversity measure that reflects how different the species are from each other at any given location (Warwick & Clarke, 2001). For example, a sample consisting of ten species from the same genus should be seen as much less biodiverse than another sample of ten species, all of which are from different families. Unlike measures of species richness, the level of taxonomic relatedness is robust to variations in sampling effort.

The third measure, number of priority species, gives an indication of the importance of a location in terms of whether it is a habitat for species of recognised conservation priority (see section 3.5).

Species richness or number of species in a given area is strongly influenced by sampling effort (see Box 11). To overcome this bias, in this study, differences in sampling intensity at the spatial unit level were standardized by using regression analysis to identify and score deviations away from expected levels of diversity (either hotspots or coldspots). In this way it was possible to obtain semi-quantitative measures of species richness and numbers of priority species.

Furthermore, since the type of habitat also plays a strong role in the species richness of a given area, this was factored into the design of the analysis (using EUNIS level 2 categories, see Box 2). So rather than calculating the overall richness for any particular location, it was calculated for each predictive seabed habitat type and these were aggregated to give a final score. Hence, the diversity of a circalittoral rock and other hard substrata site was never compared with sublittoral sediment for example, instead data were interrogated to determine if the biodiversity of that circalittoral rock and other hard substrata was greater, equal or less than the expected level of diversity for all circalittoral rock and other hard substrata areas.

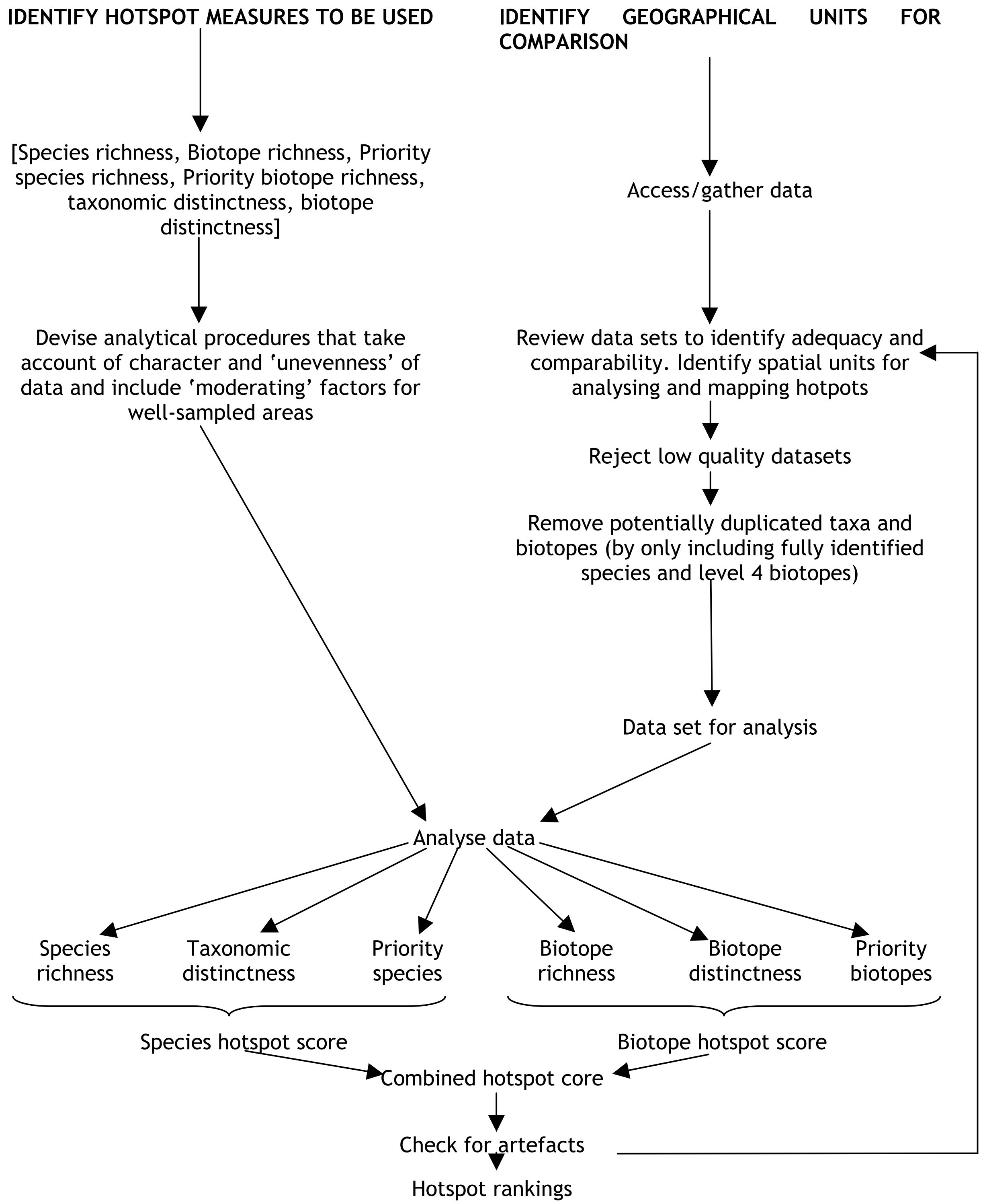
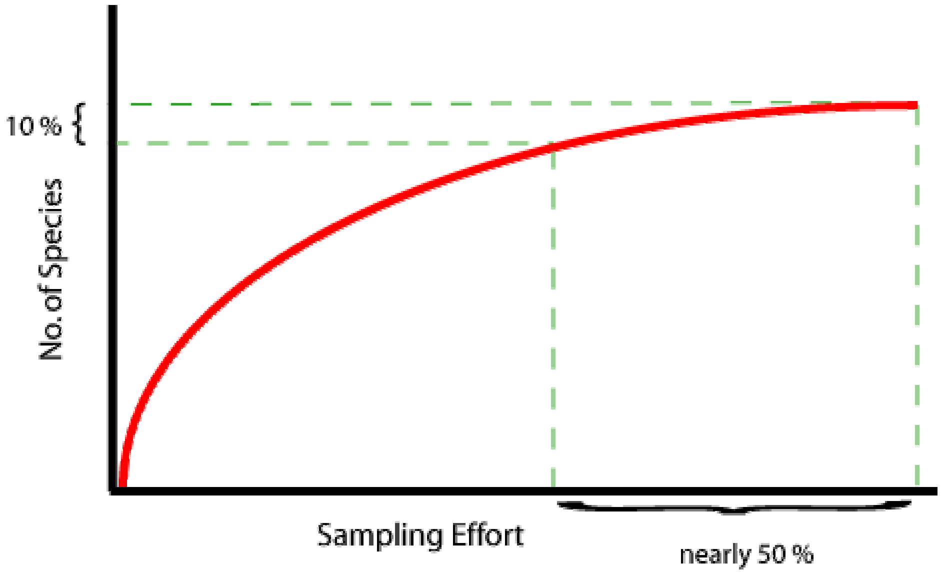


Figure 12. Procedure for identifying marine biodiversity hotspots from survey data

The same three criteria were also applied to biotopes. Biotope richness, biotope distinctness, and the number of priority biotopes were included in analyses at each spatial unit.

Box 11. Sample size and biodiversity measures

Measures of diversity are closely related to sample size (Magurran, 1996). In nearly all marine contexts, it is not possible to collect exhaustive census data, and classic species accumulation curves (see below) illustrate how the number of different species detected increases with sample size. "The harder you look, the more species you find" is fundamental to much biological sampling and the asymptote of accumulation curves is rarely reached. Thus observed species richness and other diversity measures, are highly sensitive to sample size and hence fundamentally not comparable across studies involving unknown levels of sampling.



A species accumulation curve for a hypothetical location, showing that initially species number increases rapidly with each additional sample but then begins to plateau. In this example for the final 10% increase in number of observed species a near doubling of sampling effort is required.

Biotope distinctness is a novel measure (Hiscock & Breckels, 2007) but is fundamentally similar to taxonomic distinctness since biotopes are classified according to a hierarchy and locations with biotopes from completely different habitat types can considered more diverse than locations with biotopes that are similar (i.e. from the same biotope complex). Taken with the species indices, the location of diversity hotspots can be broadly identified.

Considered together these six measures give an extremely comprehensive picture of ecological diversity, and enable assessment of one aspect of the conservation value of the site. However, low diversity areas can be functionally important and consequentially of high conservation value.

3.6.1 *Species richness*

Within each 5 km diameter hexagon, species lists were compiled for each predictive seabed habitat type (see section 3.4.3), and the total number of samples that yielded these lists were summed. Then for each seabed habitat type, species richness was plotted against sampling effort. Sampling effort was subject to a logarithmic (log_{10}) transformation (as fewer species are added to the overall list with increasing sampling effort) and a simple linear regression was performed to allow species richness to be correlated to sampling intensity (see Appendix 6). A regression plot was generated for each predictive seabed habitat type, together with its 95% confidence intervals (see Appendix 6). These indicated the range where 95% of the data would fall if measurements were repeated. Each hexagon was scored from 1-3 depending on its position relative to these confidence intervals. If a location fell within the confidence intervals, it was assigned a score of 2, if it fell below the lower confidence limit, it was considered to be poor for that richness measure and assigned a score of 1. Locations that fell above the 95 % confidence limits were considered to have high values for the particular richness measure and were assigned a score of 3. Finally, to obtain one species richness score per hexagon, the median score was calculated from all the scores for each predictive seabed habitat types present. The median was used rather than the mean to aggregate scores within a hexagon since the scores were organized on a categorical scale (low = 1, expected = 2 and high = 3). Thus it was intuitive to maintain this organization and use the median (mid-point) of the scores rather than artificially create a continuous scale using the mean and lose the original significance of the numbers. Sample size was accounted for in the scoring for each predictive habitat type within a given hexagon unit (section 3.6.1). On the assumption that sample size is a function of spatial extent of each habitat, this method was not biased by different relative spatial extents of each habitat within a given hexagon.

3.6.2 *Average taxonomic distinctness*

Not all the species data were used in this part of the analysis as different sampling methods can result in different species being observed at different locations. Therefore, only species from six phyla were analysed (annelids, bryozoans, crustaceans, cnidarians, echinoderms and molluscs), as these phyla are widely distributed and have full taxonomic classifications.

Species lists for these six phyla were compiled for each predictive seabed habitat type (aggregated to EUNIS level 2) occurring within each 5 km diameter hexagon. The habitat type specific species lists were then used to calculate the average taxonomic distinctness, using PRIMER version 6. The analysis generated a funnel plot for each predictive seabed habitat type indicating the 95% confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of species from a master list for each predictive seabed habitat type (i.e. all the species from the Firth of Clyde found in that predictive seabed habitat type). An example is shown in Figure 13, and all plots are shown in Appendix 6. Data points outside the 95% confidence interval departed significantly from random expectation (Clarke & Warwick, 1998). Hexagons with deviations below the funnel were assigned a score of 1, as these show below expected levels of taxonomic distinctness, while those above the funnel were scored 3, being higher than expected. The hexagons that fell within the area of the 95% confidence intervals (funnel area) were scored 2.

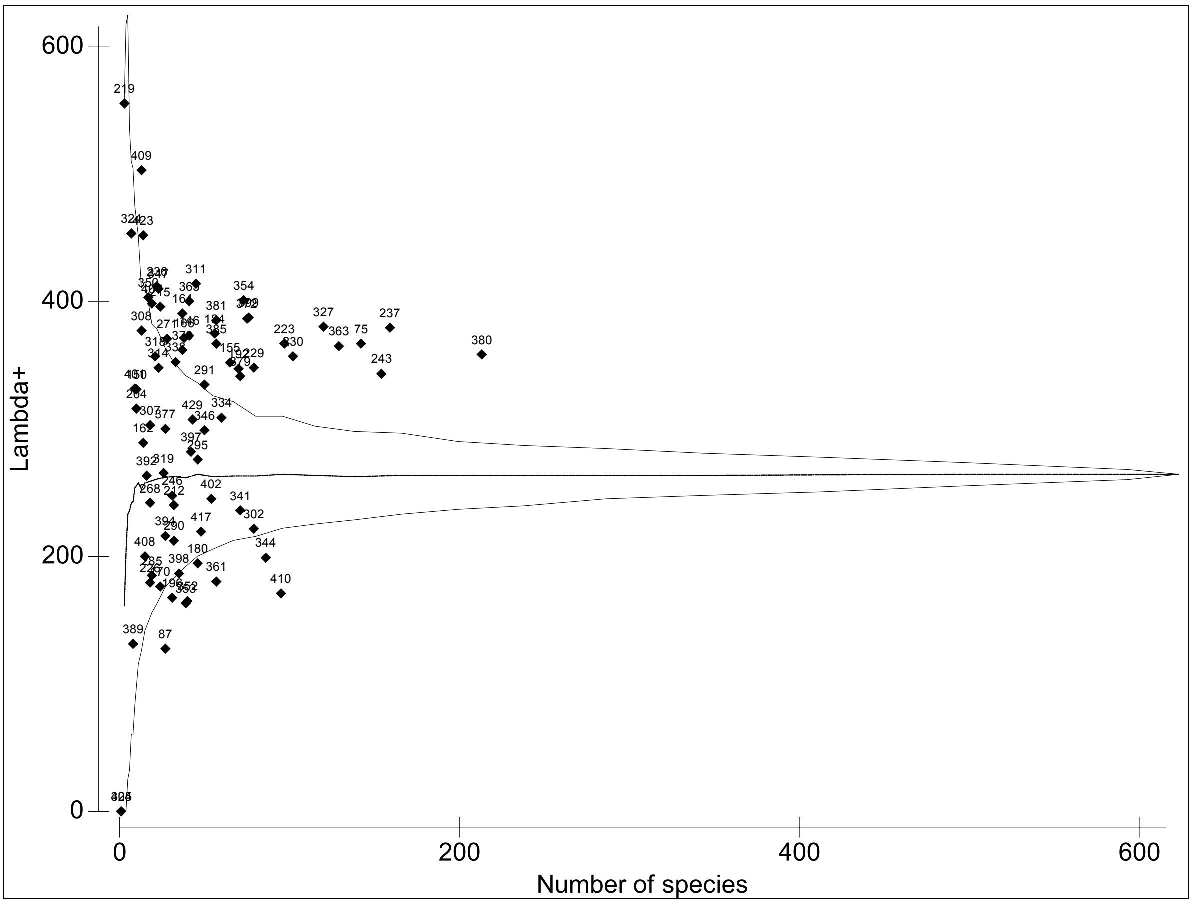


Figure 13. Average species distinctness (Δ+) funnel plot showing data points within predictive seabed habitat type A1 (littoral rock and other hard substrata) for each hexagon[8].

3.6.3 *Priority species*

The species lists from each 5 km diameter hexagon were compared to the master priority species list for the Firth of Clyde, and the total number of priority species found in each hexagon recorded.

Some consideration was taken with the final species list, especially where records did not exist for the Firth of Clyde in the dataset compiled during this project. The mobile species amongst this list (i.e. the short beaked common dolphin *Delphinus delphinus,* Allis shad *Alosa alosa*) may not have been recorded due to the nature of the available data (i.e. mostly benthic and shore surveys). In addition to these restrictions, the timescale of the data collation phase of the project did not allow for species specific searches to be performed with some organizations. The ribbon worms *Cerebratulus fuscus and Tetrastemma robertianae* and the bryozoan *Arachnidium fibrosum* are only listed under the Scottish Biodiversity List, which is currently under review. Therefore, there is some doubt over the whether such species should be prioritised for the Firth of Clyde.

[8] The plotted funnel indicates the 95 % confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of species from a predictive seabed habitat type A1 master list. Data points outside this area depart significantly from random expectation (Clarke & Warwick, 1998). Deviations below the funnel were assigned a score of 1, as these show below expected levels of taxonomic distinctness, while those above the funnel were scored 3, being higher than expected. The hexagons that fell within the area of the 95 % confidence intervals (funnel area) were scored 2.

Structural biogenic species such as horse mussels (*Modiolus modiolus*) and seagrass (*Zostera marina*) may be recorded as either habitats or species. This poses a problem, since a species record does not necessarily mean that there is a horse mussel or seagrass bed. Rather this indicates that at least one individual was encountered. For this reason only recorded observations of species and habitats were used and no inferences were made from species to habitats.

In the case of *Beggiatoa* habitat, this was flagged on priority lists but removed from analyses, since this is an indicator of extreme organic enrichment and a very impoverished benthic community. While it is rare, and appears on the LBAP list, it is not a biodiverse or even desirable condition.

For analyses, no restriction was placed on the number of records in each hexagon to allow all records to be included. This was particularly important to ensure the inclusion of mobile species sightings that often occurred as single records in locations with little other sampling effort. However, not all data could be included, for example it was not possible to use the JNCC cetaceans atlas since the resolution of these data are too coarse (Appendix 7).

A regression analysis was conducted on priority species (see section 3.6.1) and each hexagon was scored by setting 10 and 90 percentile limits to the regression. Hexagons at or below the 10^{th} percentile were scored 1, hexagons above the 90^{th} percentile were scored 3 and the remaining hexagons were scored 2 (Figure A6.10, Appendix 6).

3.6.4 *Biotope richness*

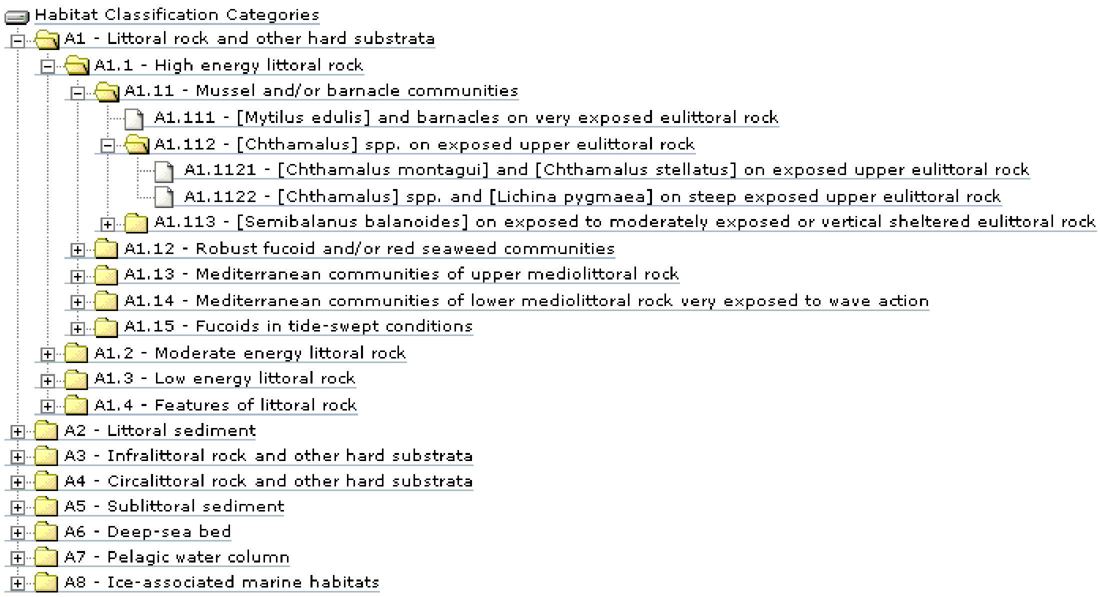
A biotope is the smallest geographical unit of the biosphere or of a habitat that can be delimited by convenient boundaries and is characterized by its biota (Lincoln *et al.*, 1998). Biotope recording did not occur during all surveys and there are fewer biotope records than survey stations in the database. However, all the biotope data available were plotted on GIS and the number of biotopes recorded at each location established. Biotope richness was standardized for sampling intensity and allocated a score from 1-3 using the same method used for species richness (Figure A6.13, Appendix 6).

3.6.5 *Average biotope distinctness*

This method works in the same way as average taxonomic distinctness and allows insights into the variety of biotopes present at any particular location. Using the EUNIS habitat classification, all biotopes fit within a hierarchical system (Box 2 and Box 12) similar in principle to the Linnaean tree for species taxonomy. Therefore it is possible to determine how distantly related two biotopes are by determining the branch lengths between them as you can for species (Box). It may be preferable to target conservation on locations with a high level of different habitat types as well as being highly species rich or taxonomically distinct. Locations were given a score from 1-3 for average biotope distinctness under the same selection criteria as for average taxonomic distinctness.

This analysis was carried out by compiling lists of biotopes occurring in each 5 km diameter hexagon and translating them to level 4 of the EUNIS classification. A master biotope aggregation file was prepared that included all the biotopes recorded in the Firth of Clyde and their hierarchical classification. The analysis generated a funnel plot indicating the 95% confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of biotopes from the master Firth of Clyde biotope list. Data points outside this area departed significantly from random expectation (Clarke & Warwick, 1998). Deviations below the funnel were assigned a score of 1, as these show below expected levels of biotope distinctness, while those above the funnel were scored 3, being higher than expected. The hexagons that fell within the area of the 95% confidence intervals (funnel area) were scored 2 (Figure A6.12, Appendix 6).

Box 12. EUNIS hierarchical habitat classification system.



3.6.6 *Priority biotopes*

The biotope lists from each hexagon were compared to the master priority biotope list for the Firth of Clyde (see section 3.5), and the total number of priority biotopes found in each hexagon recorded, together with the total sampling effort that generated this list. Each hexagon was scored using the same regression technique as species richness (Figure A6.13, Appendix 6) with higher than expected numbers of priority biotopes scoring 3, below expected, 1 and within the 95% confidence intervals, 2.

3.6.7 *Data output*

The 5 km diameter hexagonal grid was spatially joined to the sample locations to produce a sample count per hexagon. Species and habitat data were then spatially joined to the predictive seabed habitat map polygons and the hexagonal grid to determine the seabed habitat type and hexagon each data point fell within. Finally, these layers containing the species/habitats with seabed habitat type and hexagon were joined to the sample counts. For the richness and taxonomic distinctiveness analysis all hexagons with less than three samples were removed (but no restrictions on the number of samples were imposed on priority species for reasons outlined in section 3.6.3). Once the analysis was complete the results (richness scores, taxonomic distinctiveness scores, priority species/biotope scores and hotspot scores) were imported into the GIS and spatially joined to the hexagonal grid to output the individual scores per hexagon.

3.6.8 *Combining the measure for hotspot identification*

The species hotspot scores were calculated by taking the median of the species richness, priority species number and taxonomic distinctness scores. Similarly, the biotope hotspot scores were calculated by taking the median of the biotope richness, priority biotope number and biotope distinctness scores (for a discussion on the rationale for using the median, see section 3.6.1). Combined species and biotope hotspots were scored by adding the biotope and species scores and then categorising the sum into six separate 'ranks', with six being the highest score (a 'hotspot'). With the exception of priority species, the measures used to calculate the final hotspot score were standardised by sample size. However, in order to check whether the final score was correlated with sample size we carried out a Spearman rank correlation, which showed no significant correlation.

3.6.9 *Analysis of predictive seabed habitat type data*

Species and habitat data were patchy within the Firth of Clyde and primarily limited to the sea lochs and areas adjacent to the coast. Predictive seabed habitat types within the Firth of Clyde provided full coverage of the region. The ability to identify potential hotspots in biodiversity was explored following the theory that increased habitat diversity leads to increased faunal diversity (Leopold, 1933).

The 5 km diameter hexagonal grid was spatially joined to the predictive seabed habitat map and the areas of each type of seabed were identified for each hexagonal unit. Using area as a proxy for abundance and predictive seabed habitat type instead of species, the diversity (Shannon Wiener H') of predictive seabed habitat types was calculated within each hexagonal unit using PRIMER v6. The results were categorised and a map of predictive seabed habitat type hotspots was constructed. This was compared to the biotope richness analyses in order to assess whether predictive seabed habitat diversity could be used as a surrogate for biotope richness in the absence of survey data coverage.

3.6.10 *Agreement among measures*

An assessment of the agreement between measures of biodiversity was calculated in order to examine how well the combined scores represented their individual parts, and also to identify the potential for redundancy. To examine agreement we utilised Cohen's Kappa statistic. The Kappa coefficient can verify that agreement exceeds chance levels and is calculated using the equation:

$$K = \frac{(O - C)}{(1 - C)}$$

Where *K* is the Kappa coefficient, where *O* is the sum of observed agreements, and *C* is the sum of the products of the proportions of agreements (chance agreement). The Kappa coefficient is always less than or equal to 1. A value of 1 implies perfect agreement and values less than 1 imply less than perfect agreement. A negative value indicates that the two ratings (in this case biodiversity scores) agreed less than would be expected just by chance.

3.6.11 *Confidence*

A confidence rating was calculated for each hexagon based on the quality of the data and the number of samples present, using a three point categorical scale from high to low (Table 1). The quality for each hexagon was calculated by assigning numerical values to each sample (high, medium and low were allocated 3, 2 and 1 respectively) and then the mean for each hexagon was calculated. These values were then represented in the GIS using an equal interval classification to divide results into three categories, high, medium and low. The sample counts per hexagon were also aggregated into high, medium and low, using the natural breaks classification. Once the high, medium and low values were calculated for each hexagon, confidence was calculated using the matrix below (Table 7).

Table 7. Matrix used to calculate confidence rating for each hexagon.

		Average quality		
	Rating	**High**	**Medium**	**Low**
Number of samples	**High**	High	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low

4. Results and interpretation

Significant data gaps, in terms of species and biotopes, exist in the Firth of Clyde, primarily in the outer Firth (this is discussed in detail in the Gap Analysis, section 4.9). Very little data were available for depths greater than 100 m and where data were available the patchy distribution resulted in a significant mismatch between areas with both species and biotope information.

4.1 Locally important species and habitats

There are sites within the study area that are locally important for research, education and recreation even though they might not qualify under national criteria. Some of these are already local nature reserves, Sites of Special Scientific Interest (SSSI) established for marine biology (e.g. Kames Bay, Isle of Cumbrae) and Lamlash Bay on Arran which has been recently designated as a No-Take Zone. Figure 14 shows the distribution of important sites that have already been classified or have been recognised within the Firth of Clyde as important.

At present, there are few areas with formal protection for the marine environment. There are no Special Areas of Conservation (SACs) within the Firth of Clyde (though a number in the surrounding area) and only three small SSSIs that have been notified for their marine features (equating to only 277 km^2).

As well as formally protected areas, there are regions that have been identified as important for marine biodiversity but are yet to receive protection. These include the two Marine Consultation Areas, in Upper Loch Fyne and around the Isles of Cumbrae, as recognised by Scottish Natural Heritage. The results from the local expert consultation also identified these areas as important.

The results from the local expert consultation are shown in Figure 15 and Figure 16, where the responses have been mapped using bounding boxes adapted to coastline and bathymetry. These results show a large number of areas considered important for features of conservation concern, particularly in area of Loch Fyne, around the Isles of Bute, the Isles of Cumbrae, Lamlash Bay and southern Arran and the drop-off. The area from Cumbrae to the mouth of Loch Long is considered particularly important as a fish spawning and nursery area, as are areas to the south of Arran and off Ballantrae. The Kilbrannon Sound has been highlighted as an important feeding area for basking sharks due to locally high densities of krill.

In addition to areas important for biodiversity, local experts highlighted areas important for the activities that utilise them. There are many important dive sites around the Firth of Clyde, particularly in the northern lochs and around the many islands within the Firth. Sea angling is also a major activity in the Firth, particularly in areas in the southern Firth, including sites off Ballantrae, Sanda Island and Lamlash Bay. There are also sites in the Firth that have been restricted for fishing and dredging (Figure 15) mainly due to the presence of military activity as is the case with the area in Loch Fyne and the area off Coalport.

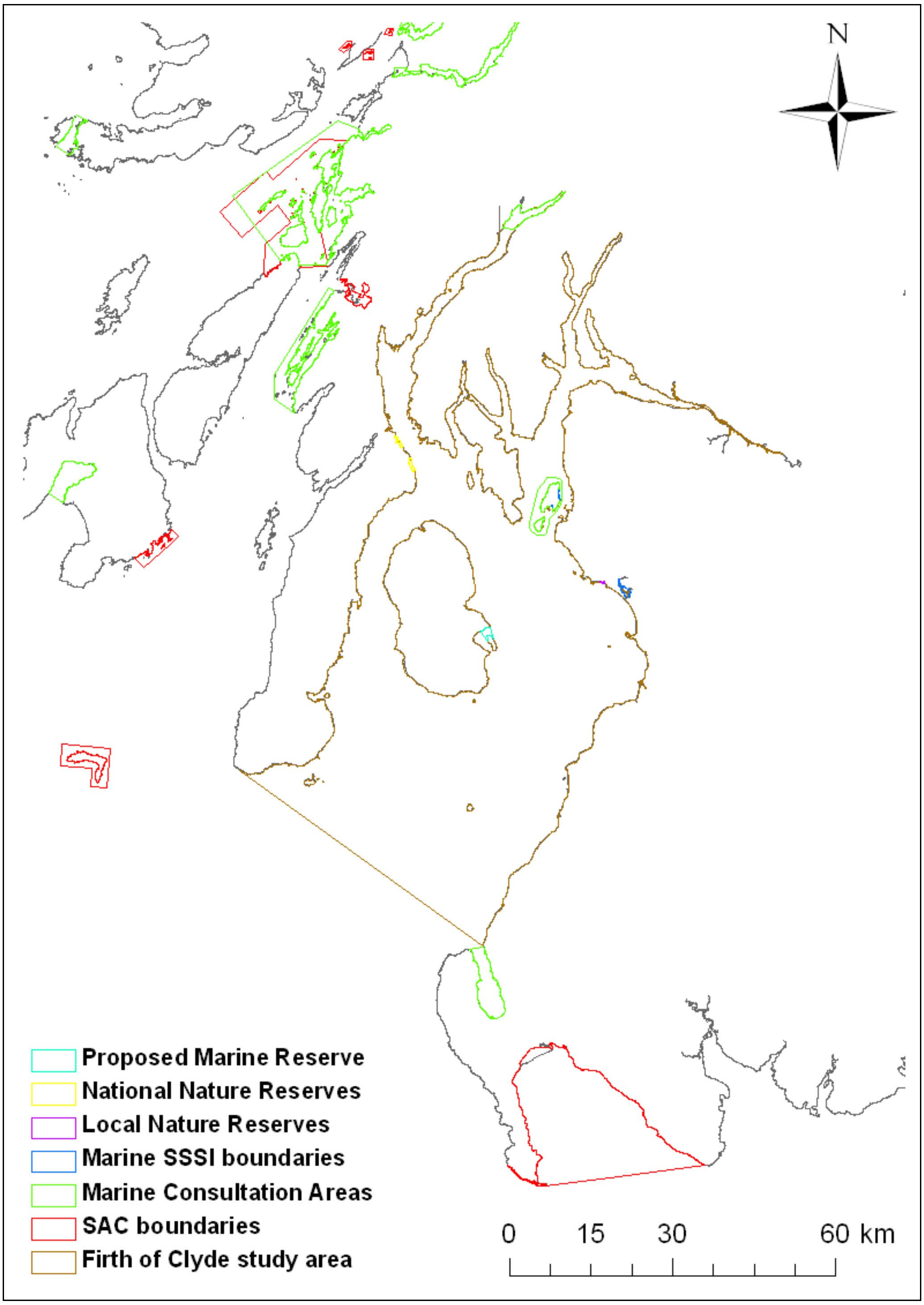


Figure 14. Distribution of protected areas in the region surrounding the Firth of Clyde.

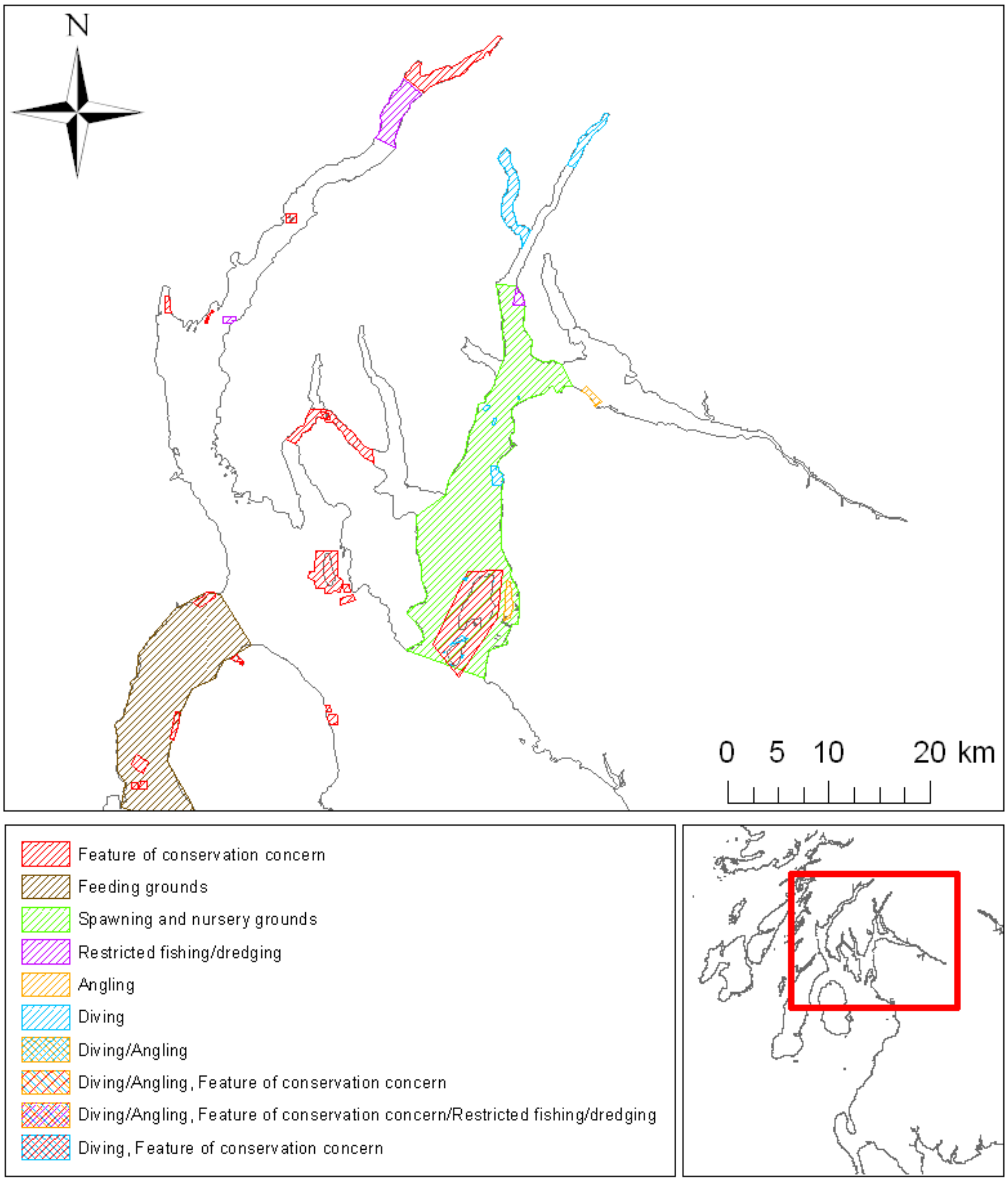


Figure 15. Areas of local importance within the northern Firth of Clyde according to local expert knowledge. Features were mapped at a coarse level and vary widely in size, so this map is only indicative of locations and not the actual boundaries of features.

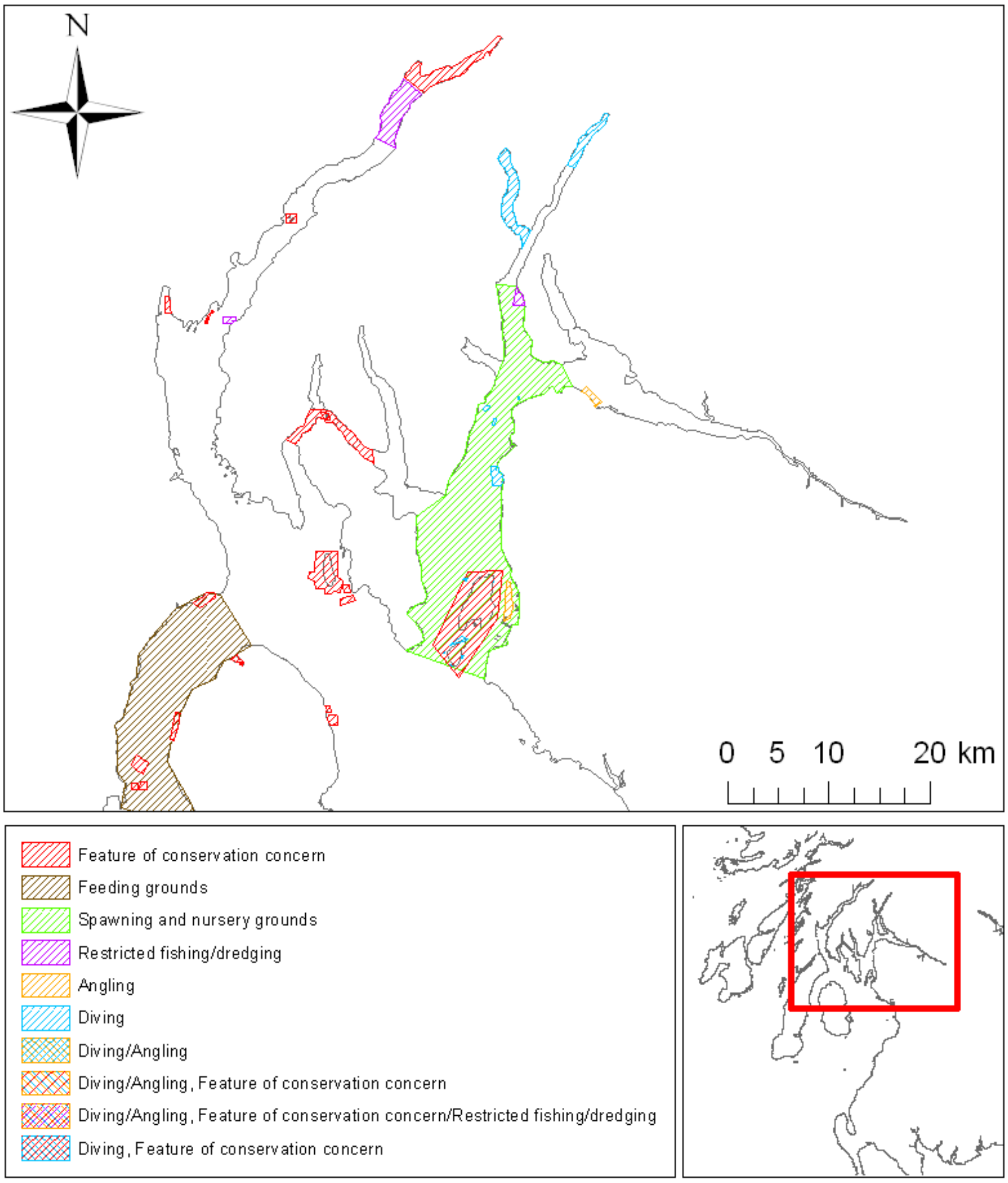


Figure 16. Areas of local importance within the southern Firth of Clyde according to local expert knowledge. Features were mapped at a coarse level and vary widely in size, so this map is only indicative of locations and not the actual boundaries of features.

4.2 Distribution of priority species

The distributions of priority species are shown by category e.g. BAP, LBAP, cNIMF, nationally rare and scarce, Scottish Biodiversity List and OSPAR, in Figure 17-Figure 23.

Biodiversity Action Plan (BAP) species are spread sparsely through the Firth of Clyde study region but there is an aggregation of BAP species records in Loch Goil, the very northernmost part of Loch Fyne and SE Arran (Figure 17).

There are only eight Local Biodiversity Action Plan (LBAP) species recorded in the study area. These are the fan mussel *Atrina fragilis* (6 records), the tall seapen *Funiculina quadrangularis* (1 record) and the sea squirt *Styela gelatinosa* (1 record) and are located in Loch Goil, on the mainland opposite the Isle of Cumbrae, Holy Island, Sanda Island and in the outer Firth of Clyde (Figure 18).

Candidate Nationally Important Marine Features (cNIMF) species are widely distributed through the study area but records are most dense at the following locations: Loch Goil; Gare Loch; Loch Striven; Kyles of Bute; Irvine Bay; SE Arran and Loch Fyne (Figure 19). Their distribution is arranged by the NIMF criteria (see 3.5.1, Figure 20), which again appears to closely reflect sample intensity.

OSPAR species are distributed across the study area (Figure 21) both along the coast and in the outer Firth of Clyde. Aggregations of records correspond to areas of high sampling effort, for example in SE Arran and Loch Goil (Figure 4 and Figure 5).

The distribution of nationally rare and scarce species appears to be restricted to the northern part of the Firth of Clyde (Figure 22). These are comprised of the deeplet sea anemone *Bolocera tuediae*, the spoon worm *Amalosoma eddystonense*, the sea anemone *Gonactinia prolifera*, the brachiopod *Terebratulina retusa*, the red seaweed *Callophyllis cristata*, an amphipod *Austrosyrrhoe fimbriatus* at Loch Fyne, and *Bolocera tuediae* at Loch Long.

Finally the distribution of Scottish Biodiversity List species appears to be fairly well spread across the Firth of Clyde, with species recorded in the sea lochs, around the Isle of Arran as well as in the outer Firth (Figure 23).

When the distributions of these priority species are broken down by taxa, it is apparent that the marine mammal data are sparse (cetaceans and seals, Figure 24). There are a few more records for marine reptiles (loggerhead and leatherback turtles) and these are evenly scattered through the study area, rather than concentrated into specific areas (Figure 25). Priority demersal and benthic fish species however, are mostly concentrated in the sea lochs and around the southwestern coast of Arran (Figure 26).

Priority invertebrates were mapped by phyla, and while some show too few records to gain any insight into their distributions (Annelida, Figure 27; Nemertina, Figure 28; Porifera, Figure 29; Tunicata, Figure 30) others show a patchy distribution (Crustacea, Figure 31; Echinodermata, Figure 32; Mollusca, Figure 33 and Cnidaria, Figure 34) with high densities of records in the sea lochs. Records of priority Rhodophyta species (maerl) are found at few locations, both in the lochs (Loch Fyne and Loch Goil) but also on the coast of the Firth near the Isle of Cumbrae (Figure 35).

The maps for each of the priority species designations illustrate the different spatial distributions for each priority species list and regional patterns of biodiversity at the level of taxonomic groupings but also highlight the strong relationship between biodiversity and sampling effort, which is carefully adjusted for in the hotspot analysis (Box 11).

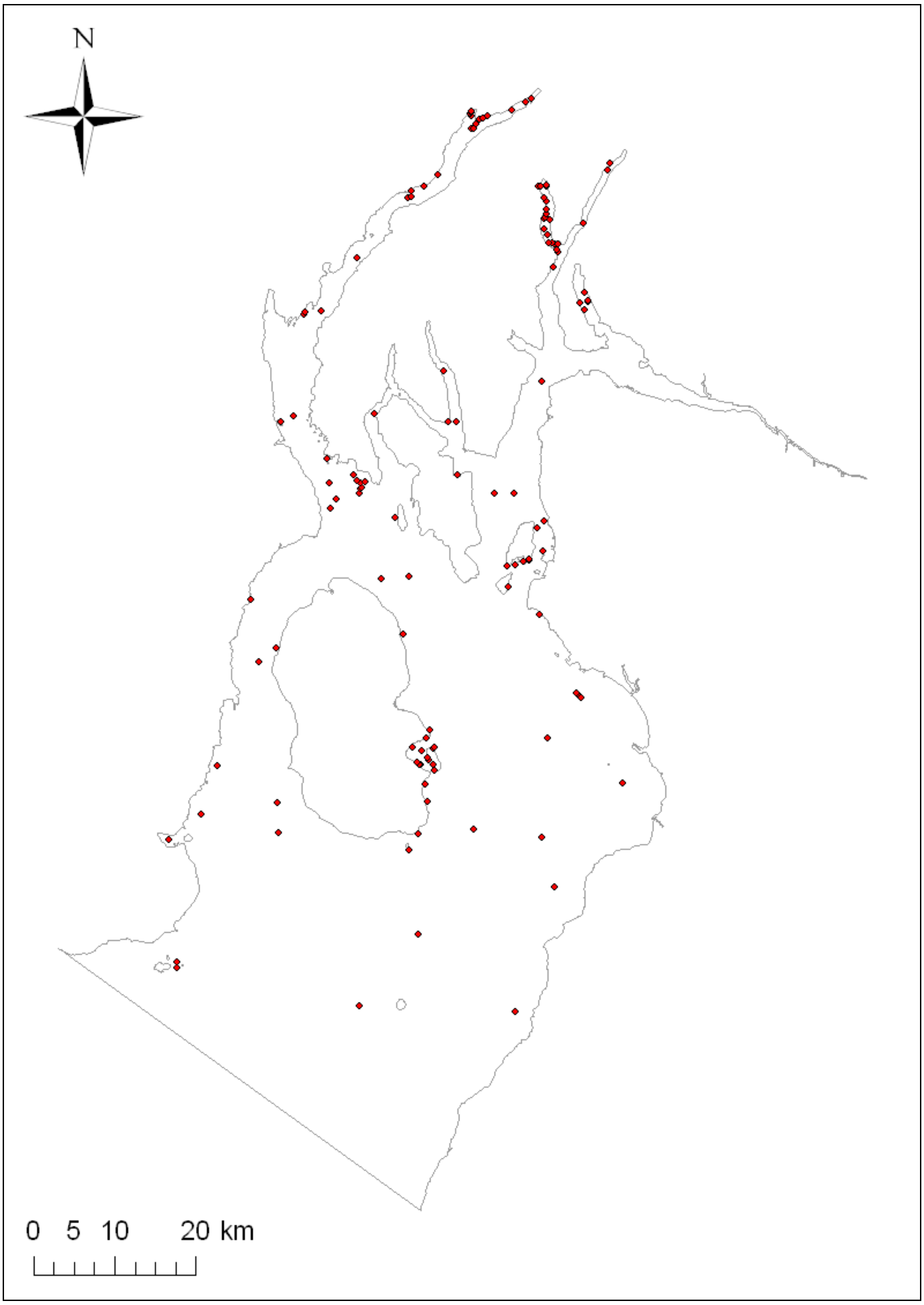


Figure 17. Known distribution of Biodiversity Action Plan (BAP) species in the Firth of Clyde within the data set collated for this project (see section 4.9 and Appendix 4).

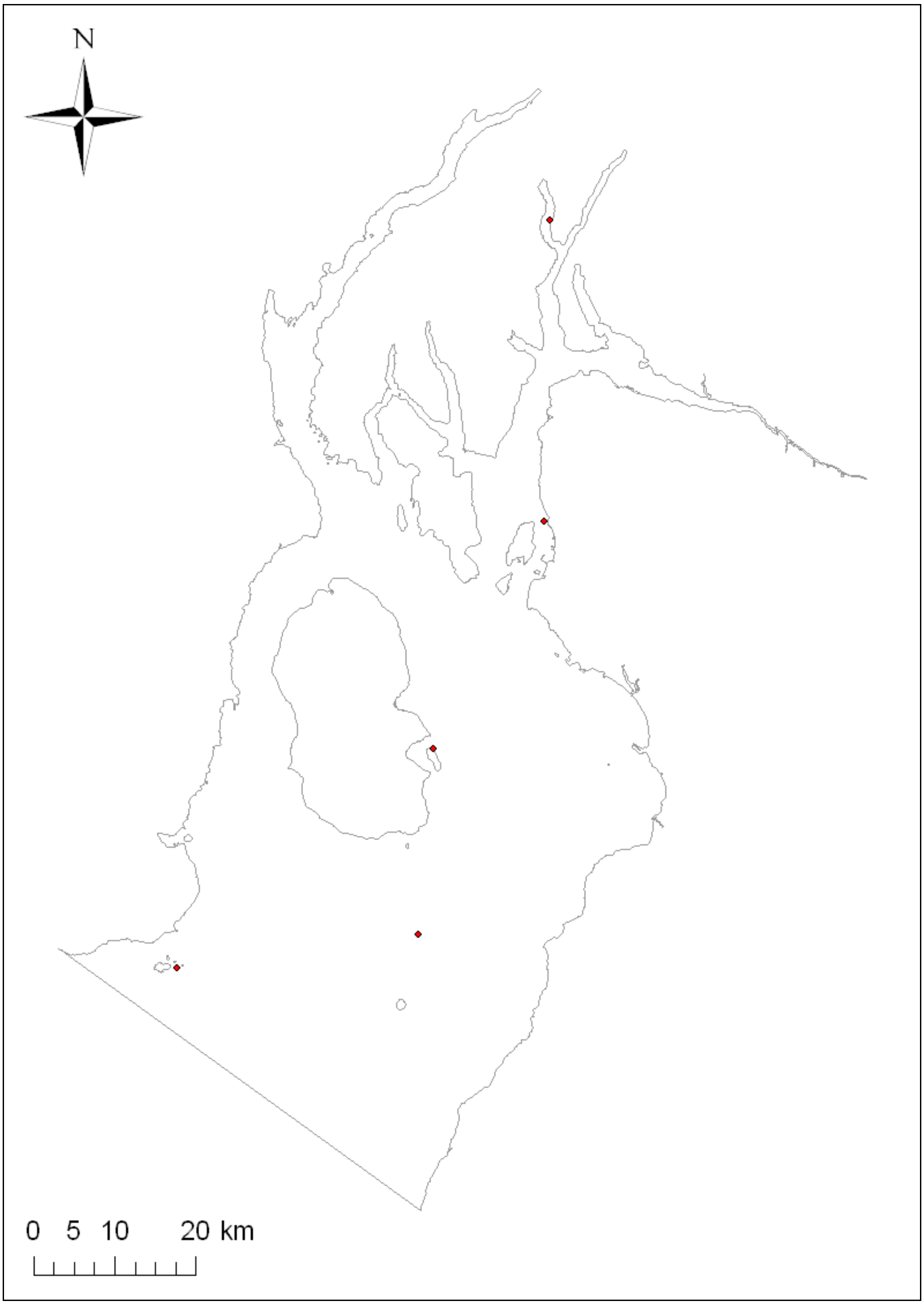


Figure 18. Distribution of Local Biodiversity Action Plan (LBAP) species records in the Firth of Clyde.

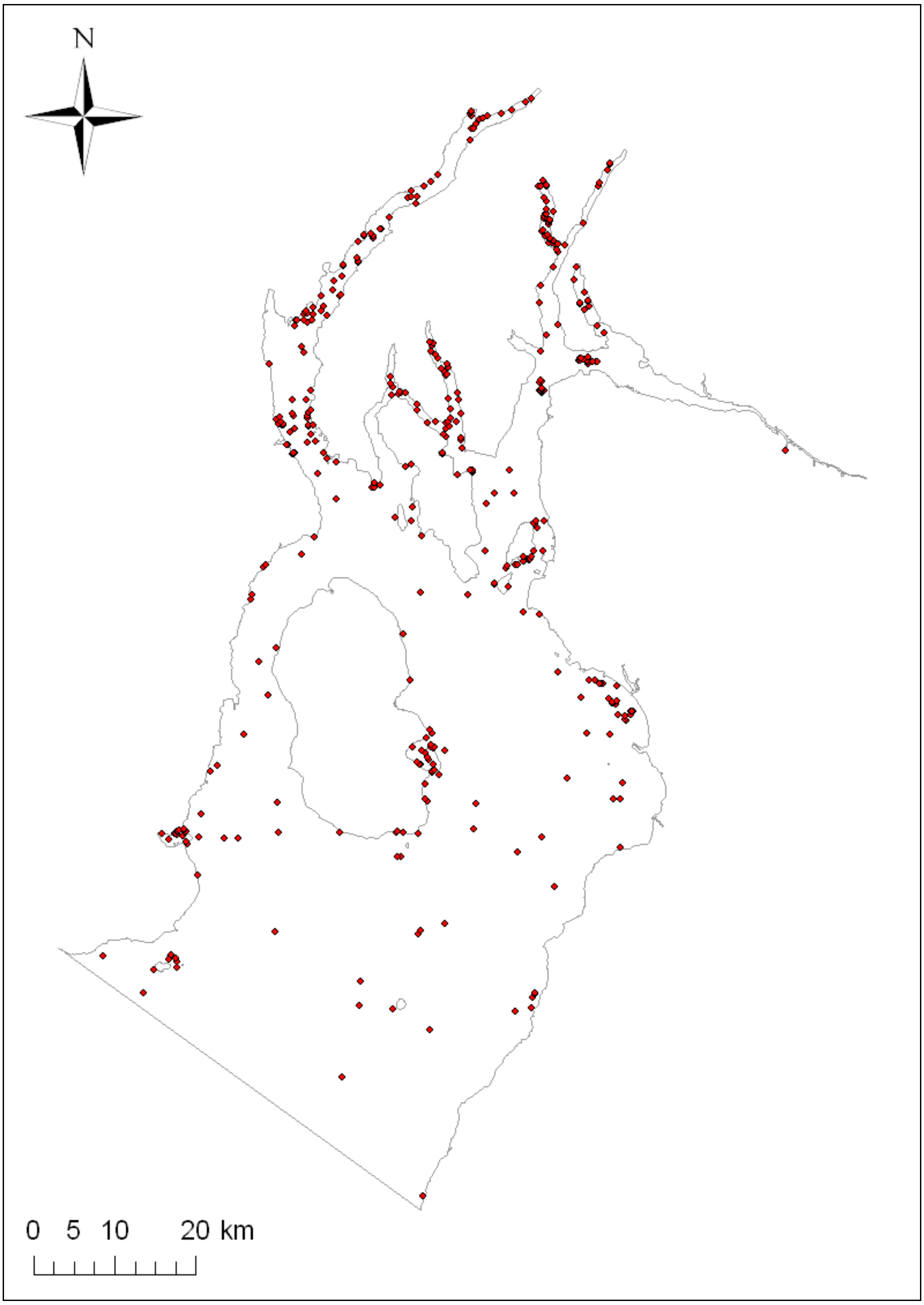


Figure 19. Distribution of candidate Nationally Important Marine Features (cNIMF) species records in the Firth of Clyde.

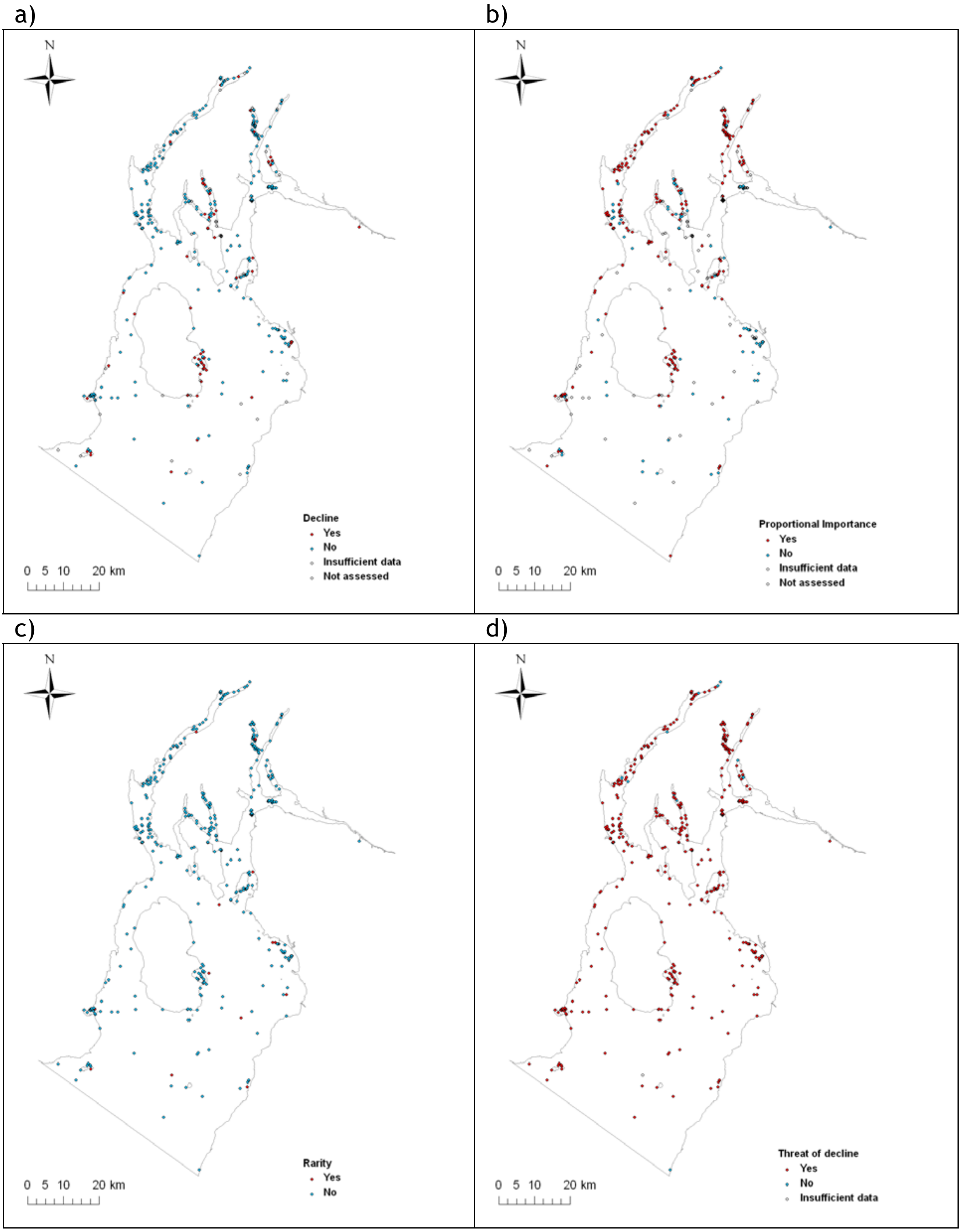


Figure 20. Distribution of candidate Nationally Important Marine Features (cNIMF) species plotted with NIMF designation criteria: a) decline, b) proportional importance, c) rarity and d) threat of decline.

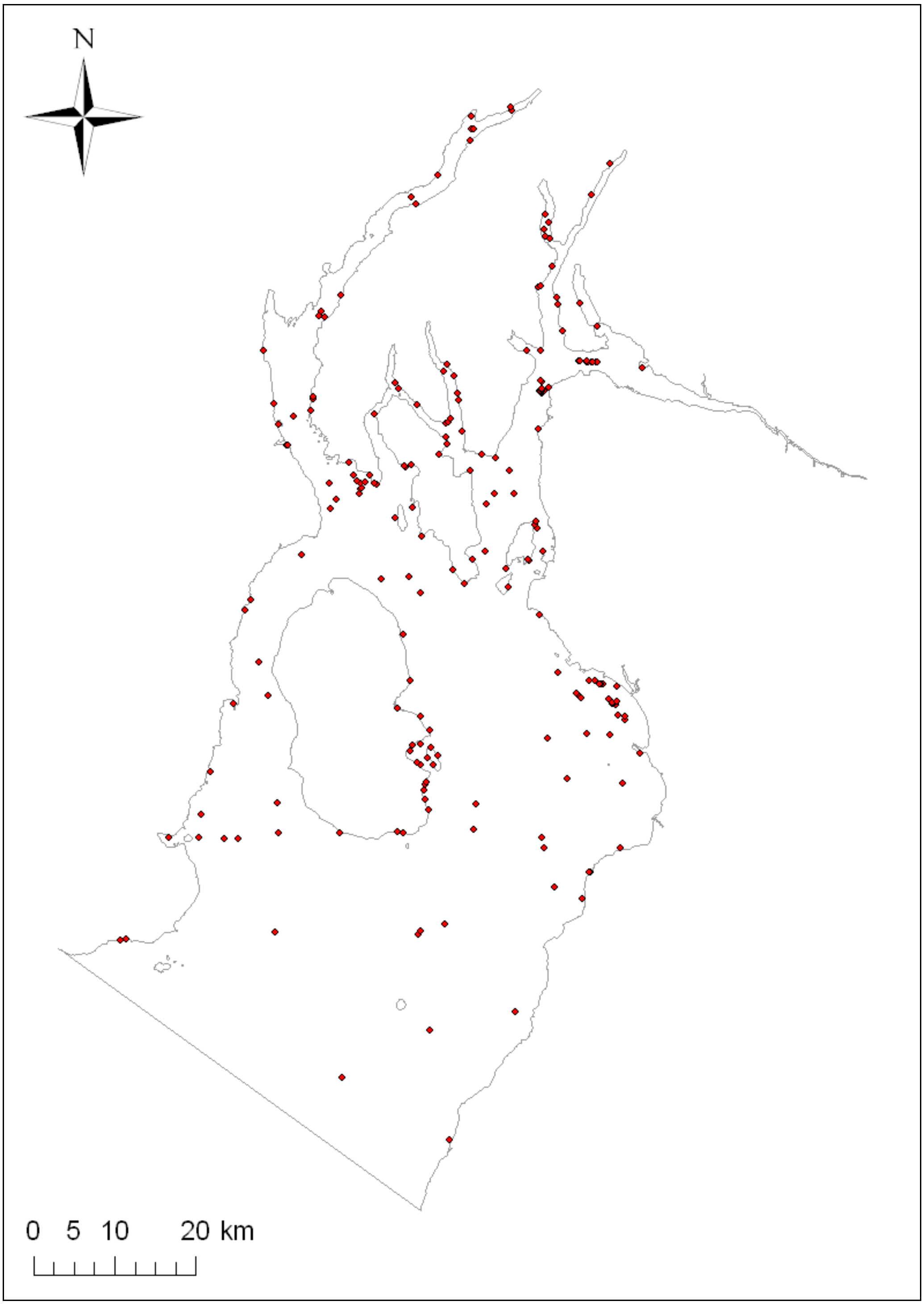


Figure 21. Distribution of OSPAR species records in the Firth of Clyde.

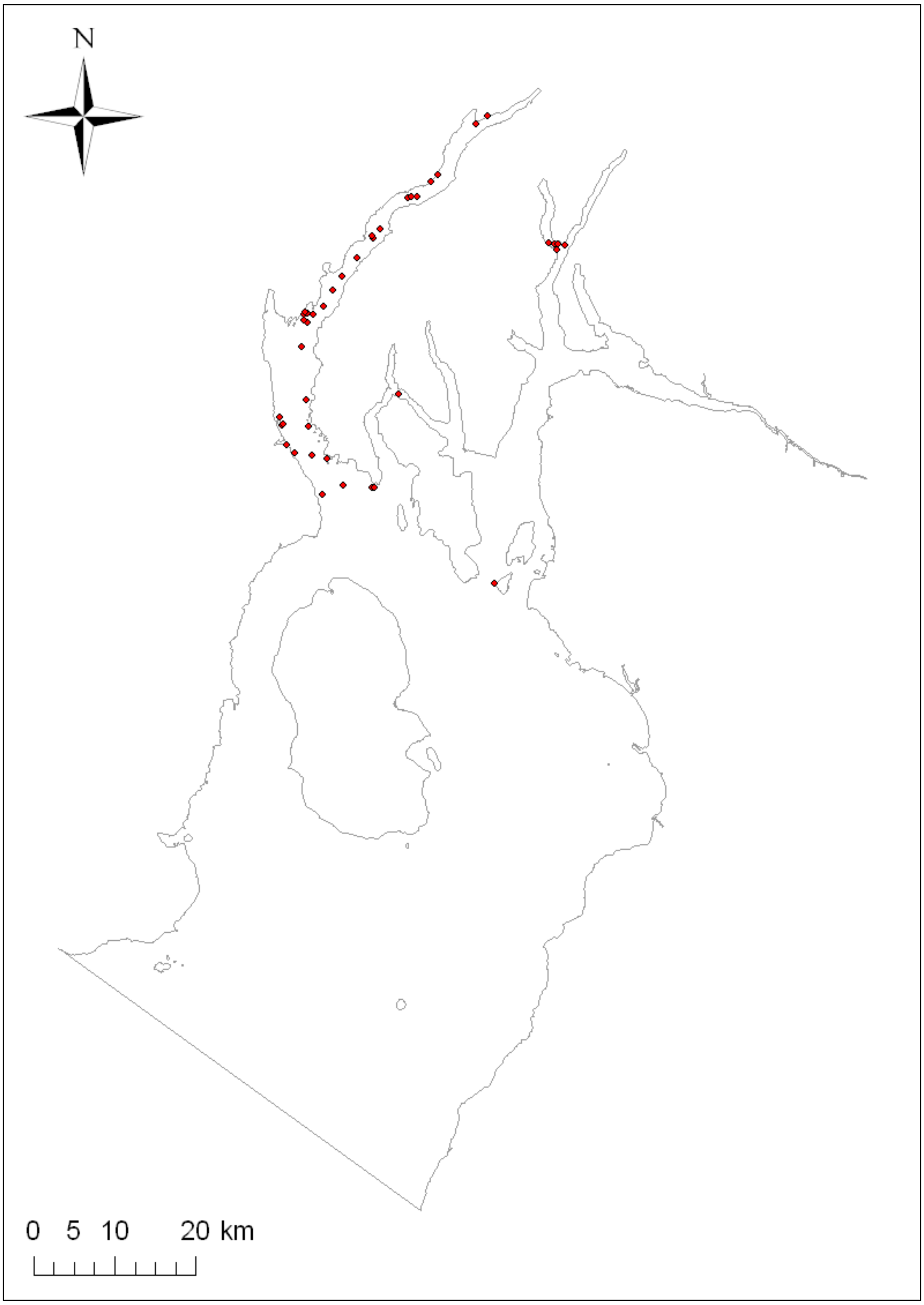


Figure 22. Distribution of nationally rare and scarce species records in the Firth of Clyde.

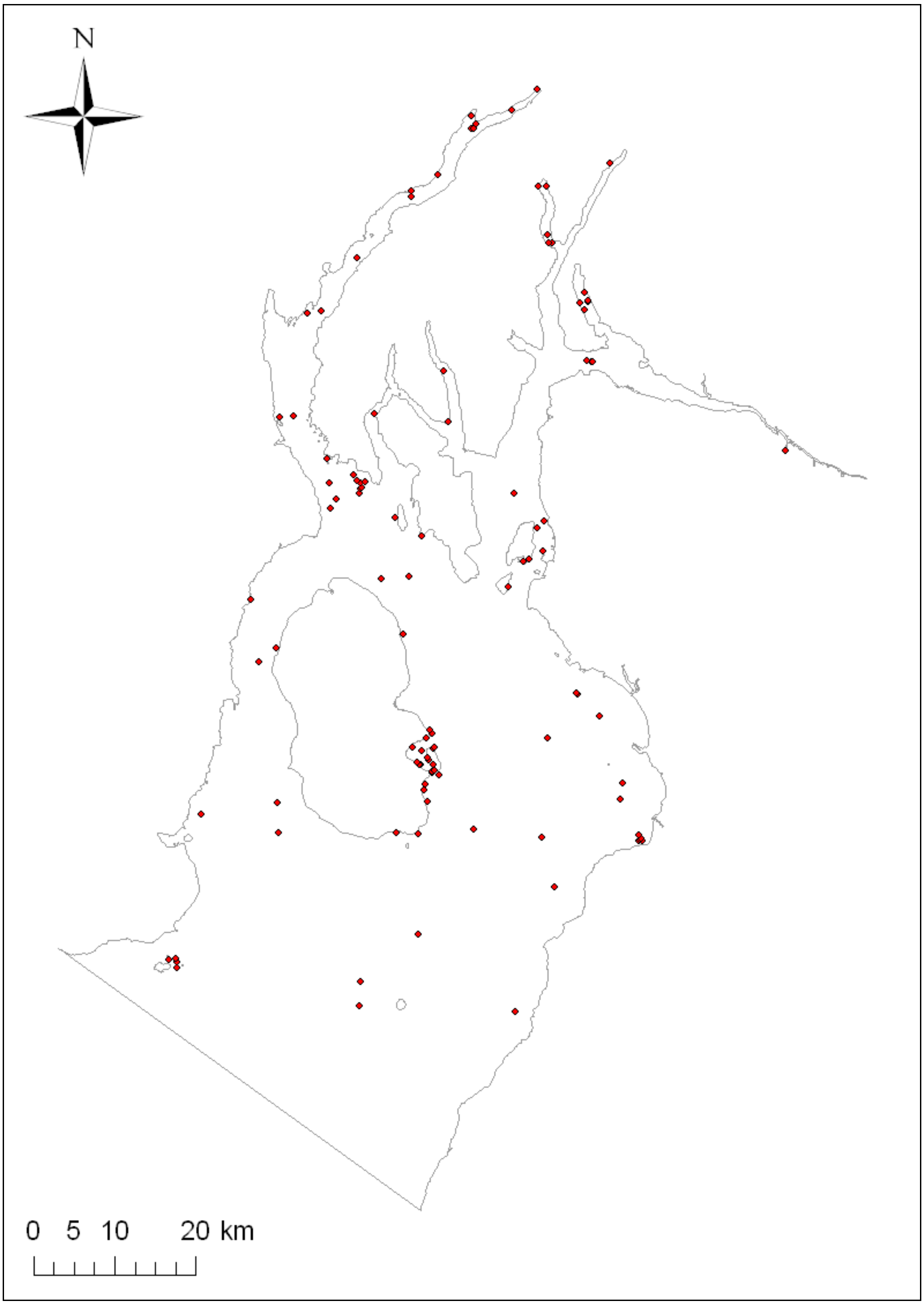


Figure 23. Distribution of Scottish Biodiversity List species records in the Firth of Clyde.

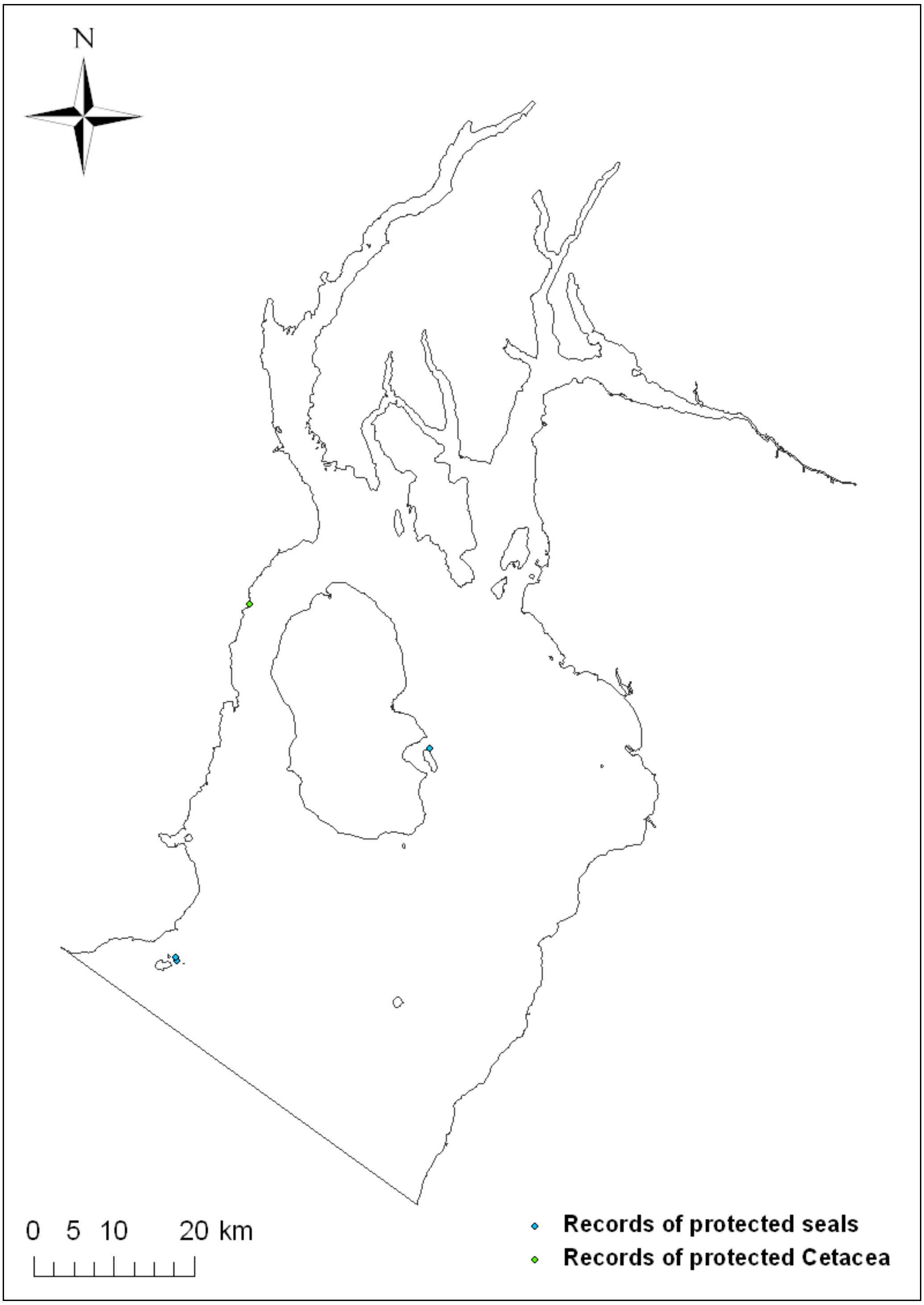


Figure 24. Distribution of cetacean and seal records in the Firth of Clyde.

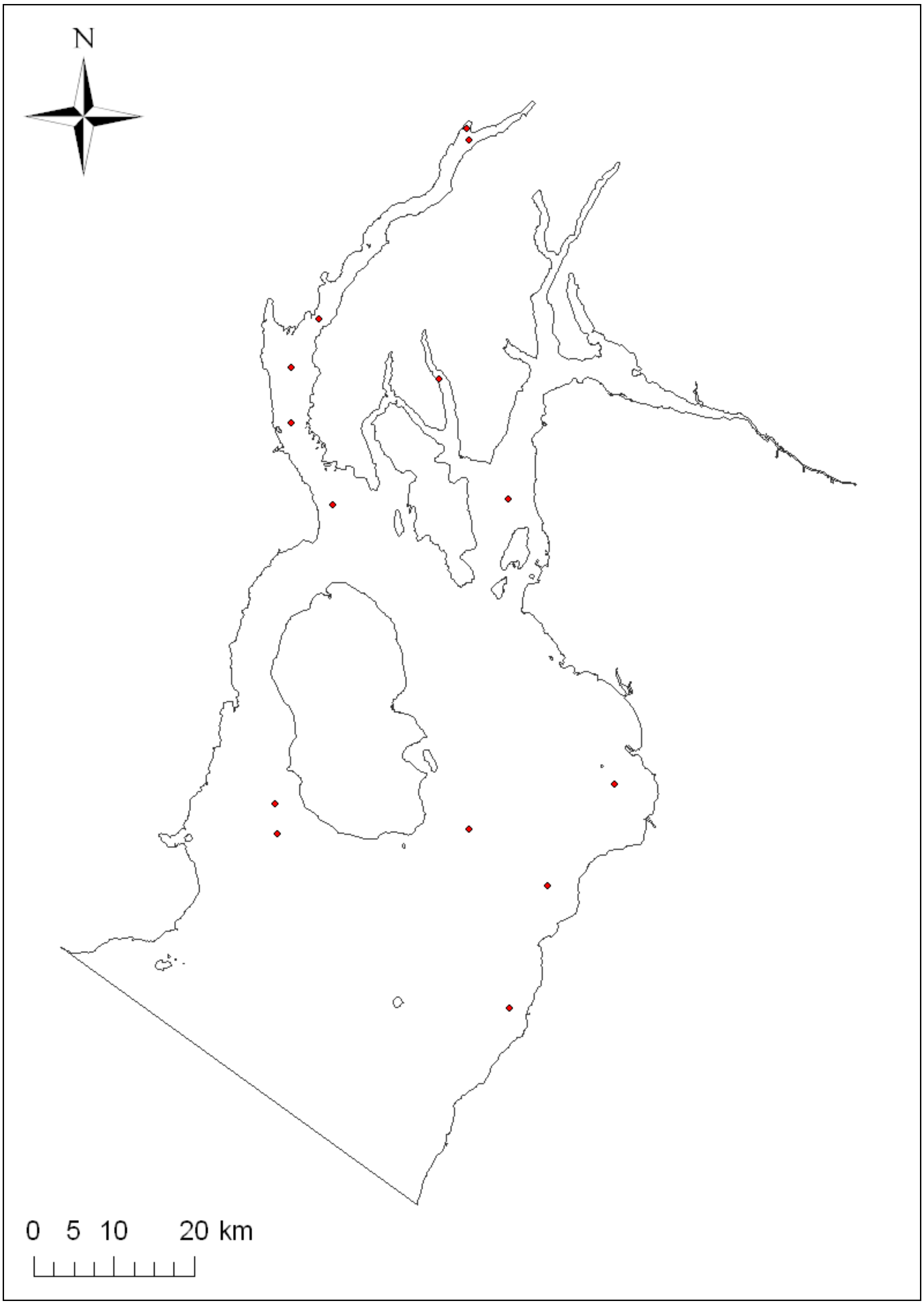


Figure 25. Distribution of marine reptile records (loggerhead and leatherback turtles) in the Firth of Clyde.

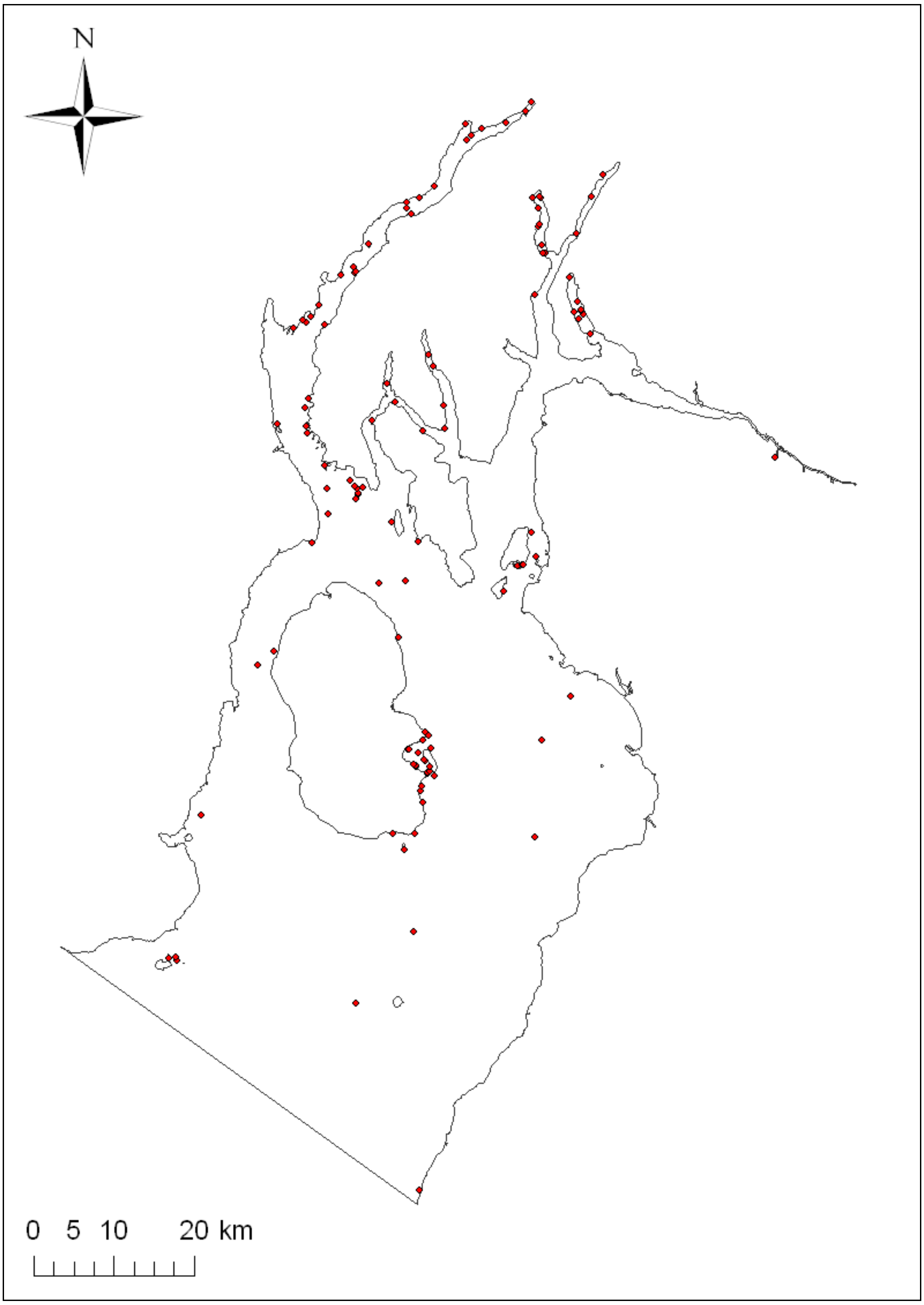


Figure 26. Distribution of priority demersal and benthic fish records in the Firth of Clyde.

Figure 27. Distribution of priority Annelida species records in the Firth of Clyde.

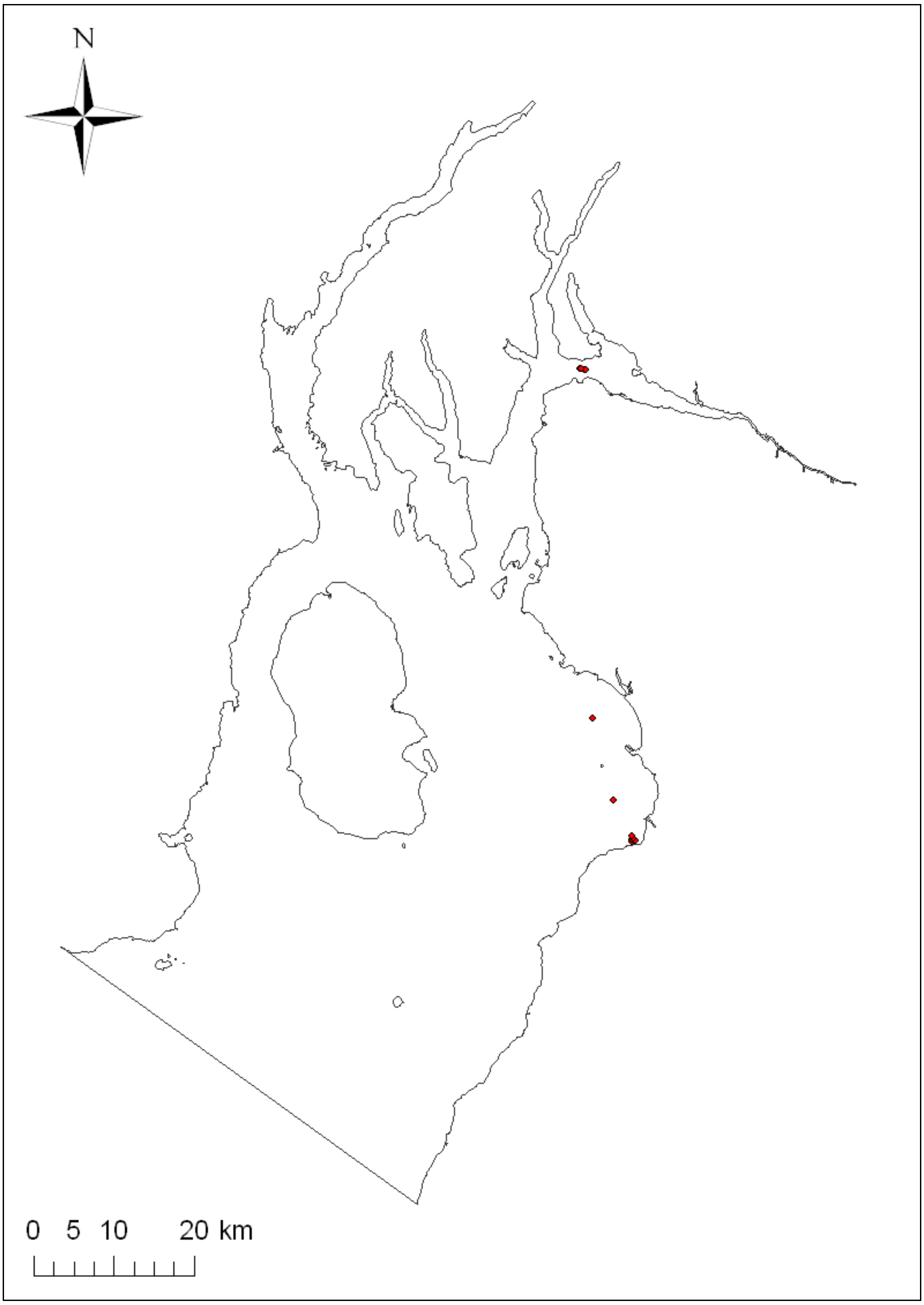


Figure 28. Distribution of priority ribbon worm (Nemertina) species records in the Firth of Clyde.

Figure 29. Distribution of priority sponge (Porifera) species records in the Firth of Clyde.

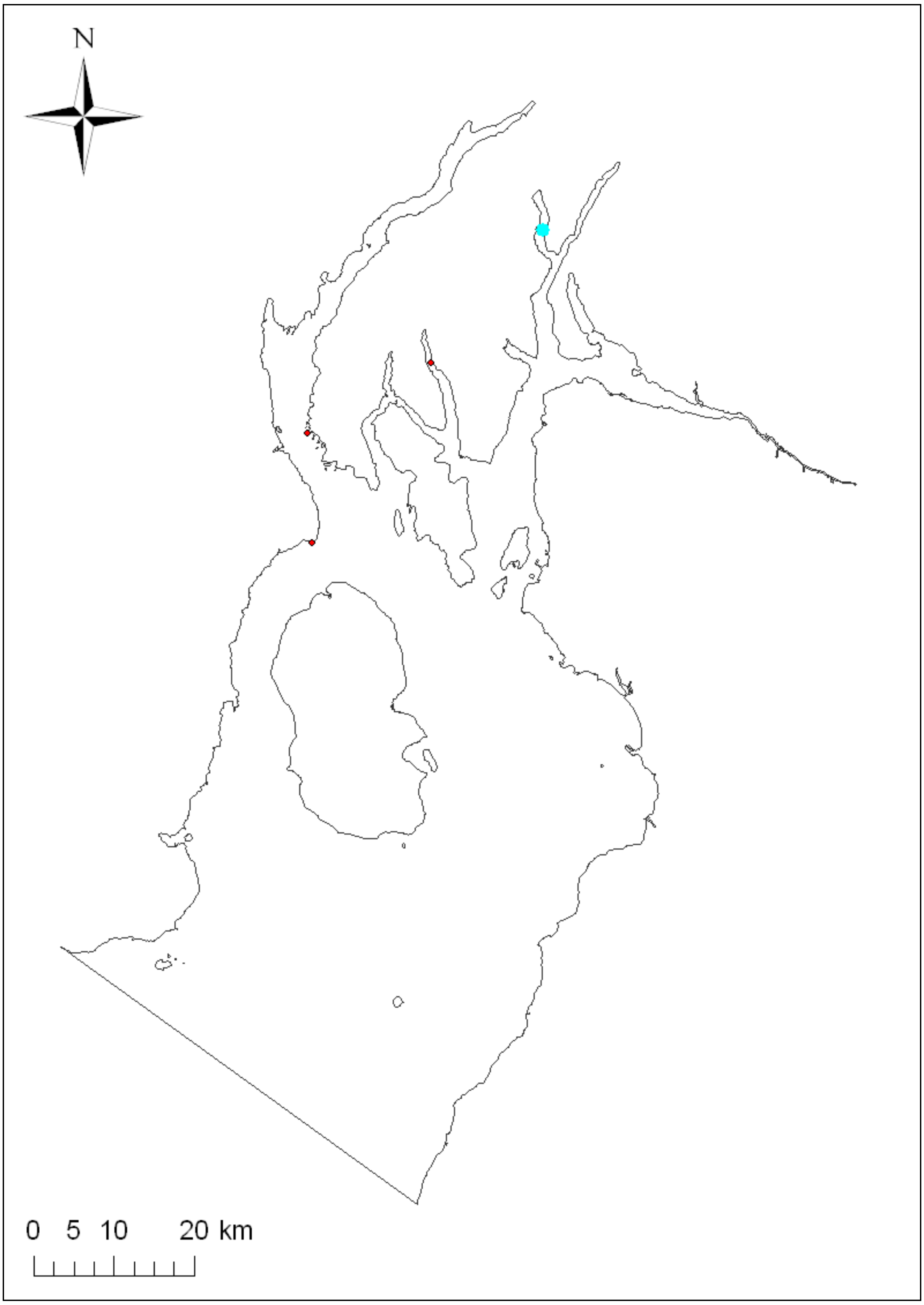


Figure 30. Distribution of priority sea squirt (Tunicata) species records in the Firth of Clyde.

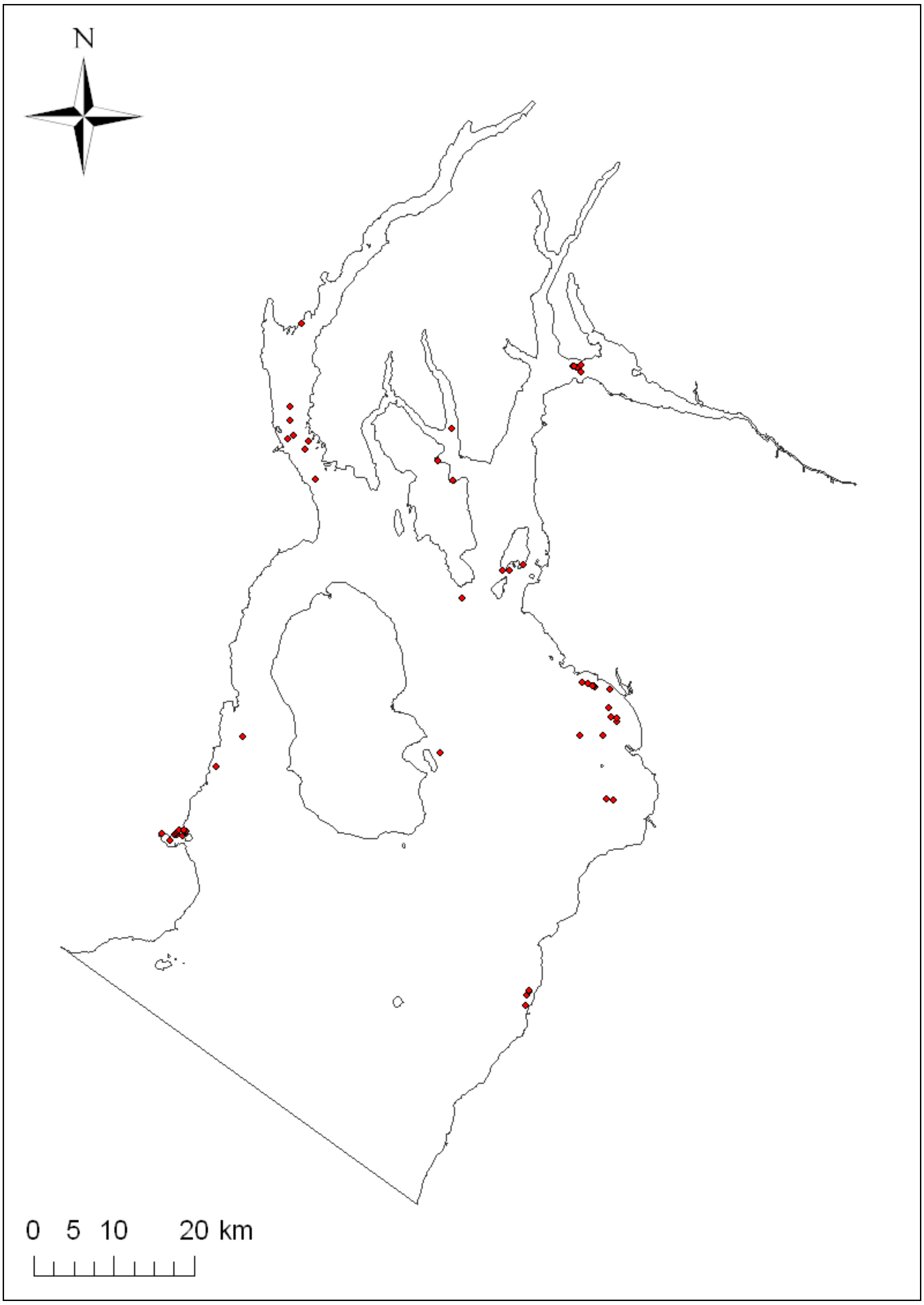


Figure 31. Distribution of priority crustacean (Crustacea) species records in the Firth of Clyde.

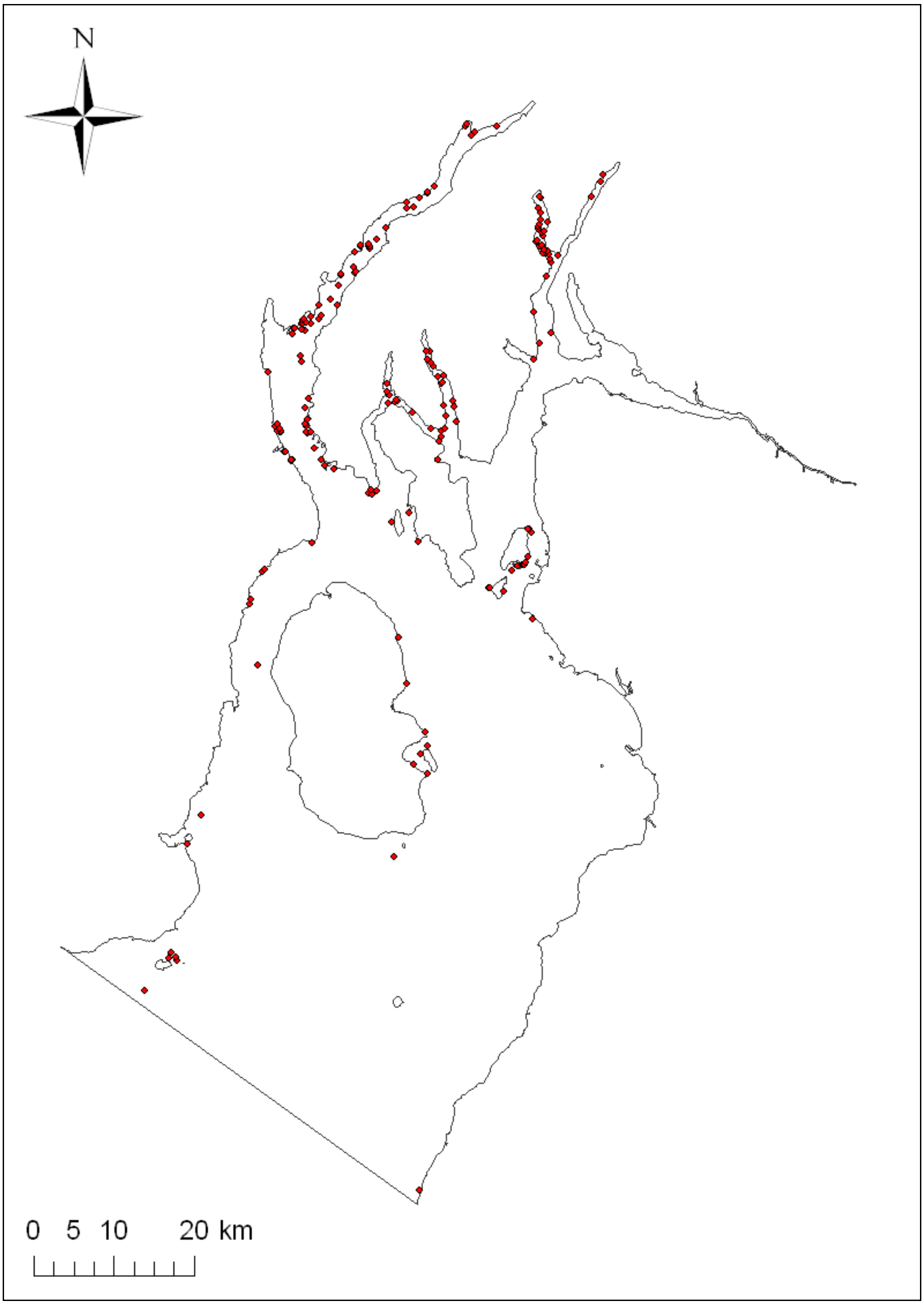


Figure 32. Distribution of priority echinoderm (Echinodermata) species records in the Firth of Clyde.

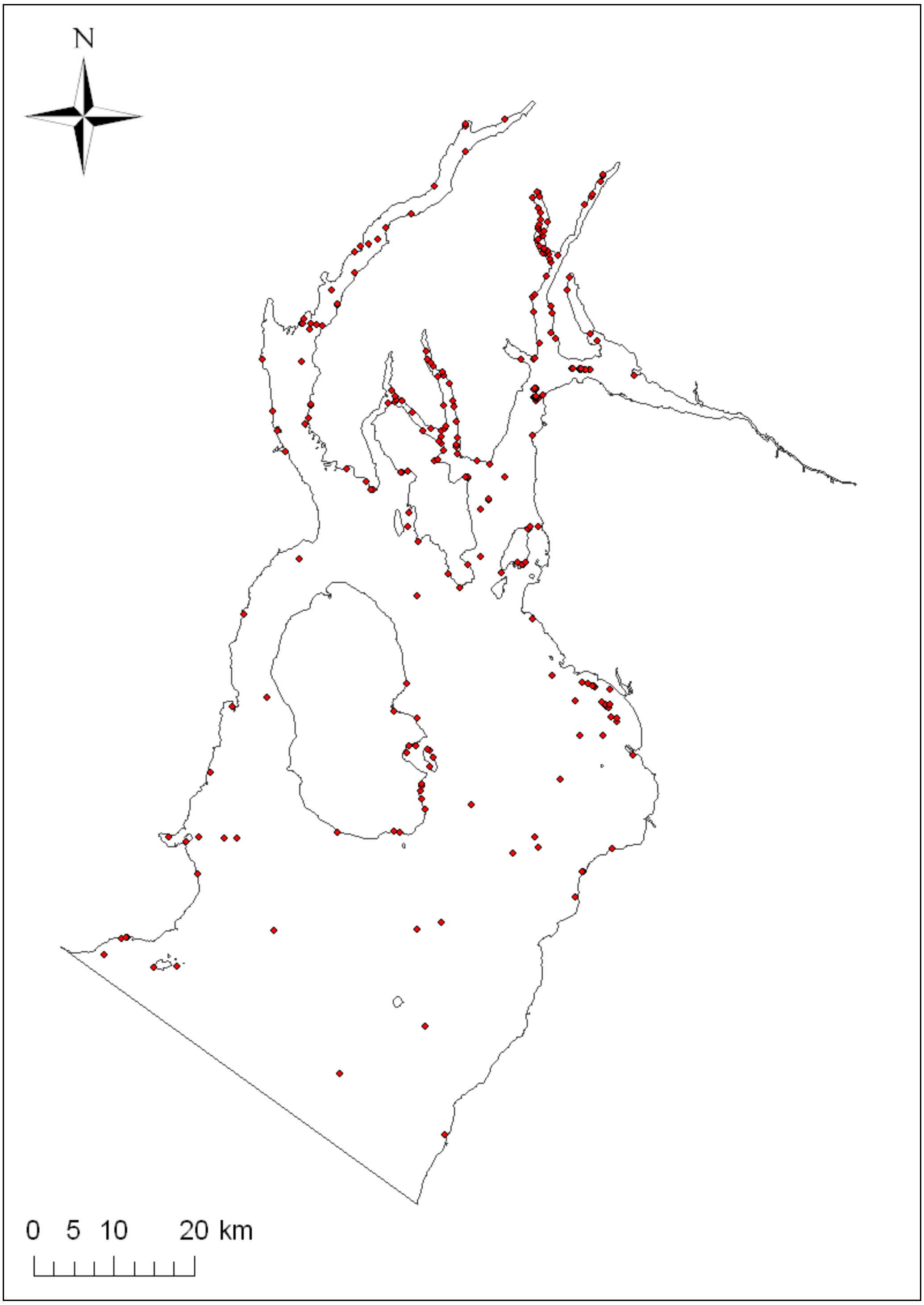


Figure 33. Distribution of priority molluscan (Mollusca) species records in the Firth of Clyde.

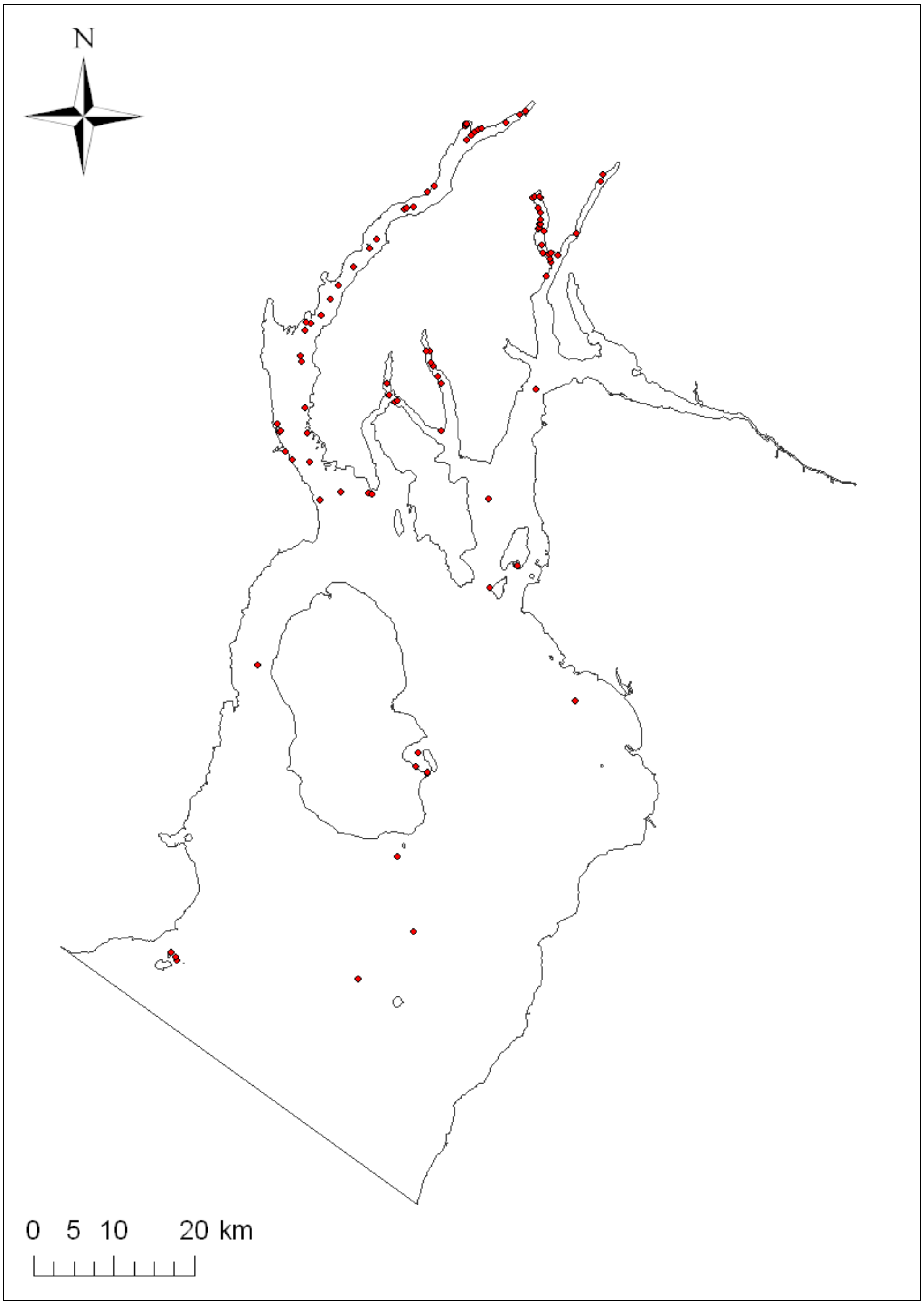


Figure 34. Distribution of priority cnidarian (Cnidaria) species records in the Firth of Clyde.

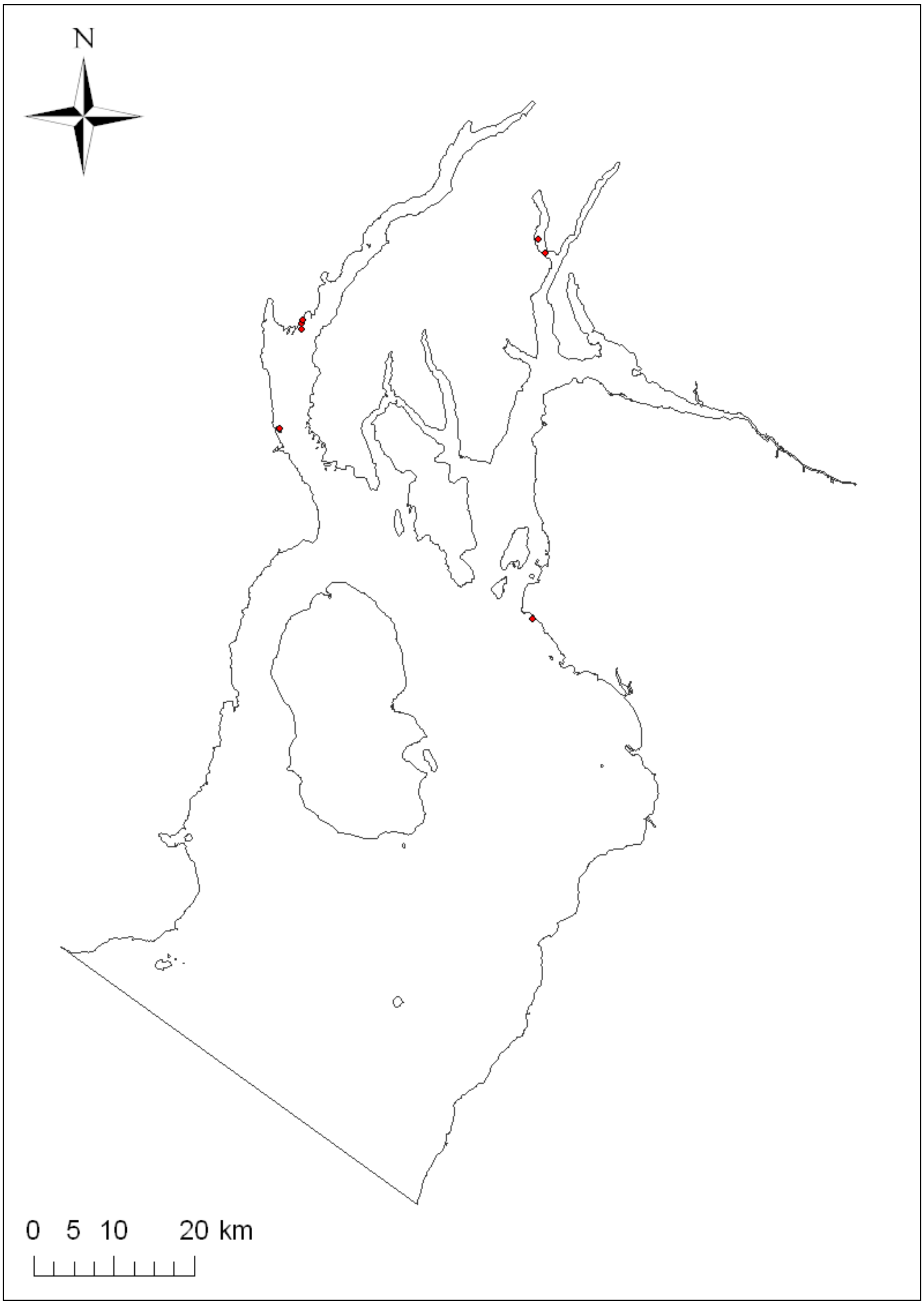


Figure 35. Distribution of priority maerl species records in the Firth of Clyde.

4.3 Distribution of priority habitats

The distribution of habitats of conservation importance (Habitats Directive Annex 1, BAP, LBAP, candidate NIMF, OSPAR, Scottish Biodiversity List) is very uneven across the Firth of Clyde. Almost all priority habitats are located in the sea lochs, which is a strong reflection of the distribution of sampling effort (Figure 4 and Figure 5).

Annex 1 habitats are the most widely distributed around the Firth (Figure 36) but are restricted to coastal areas. High densities of records are found in the Kyles of Bute, Loch Striven, Loch Fyne, Loch Long and Gare Loch. All other coastal areas have fairly sparse numbers of records of Annex 1 habitats.

BAP habitats, LBAP habitats and Scottish Biodiversity List habitats all show a very similar distribution pattern with high densities of records in the Kyles of Bute and Loch Striven, Loch Goil and Gare Loch, with the other sea lochs such as Loch Fyne, and the lower part of Loch Long showing lower densities of records (Figure 37, Figure 38 and Figure 39). Outside of the sea lochs, there are few recorded habitats with these designations; habitats that are listed on all three have been recorded at the most southern point of the Isle of Arran, Ballantrae Bay, and there is a also a BAP and Scottish Biodiversity List habitat at the southern end of Bute.

The pattern for candidate NIMF and OSPAR habitats is similar to the BAP, LBAP and Scottish Biodiversity List habitats in terms of their distribution in the sea lochs but there are just three records for these habitats outside of the sea lochs (Figure 40 and Figure 41). These are at Ballantrae Bay and in the Kilbrannan Sound (cNIMF) and at the southernmost part of the Isle of Arran.

When habitats are broken down into their EUNIS Level 2 types (see Box 2 and Box), the patterns of distribution are revealed. The habitat complex type A1 (littoral rock and other hard substrata) is mostly recorded in the sea lochs but there are some areas around the Isle of Arran and along the western coast of the outer Firth and near Ayr on the eastern coast (Figure 42). Priority habitat A2 (littoral sediment) is also recorded both in the lochs and along the coast of the outer Firth, though distributed more on the eastern coast from near the Isle of Cumbrae to Ballantrae Bay (Figure 43). On the western coast of the outer Firth, records are restricted to near Campbeltown and in the Kilbrannan Sound.

Habitat complex A3 (infralittoral rock and other hard substrata) is predominately recorded in the sea lochs, with isolated records at the southern tip of the Isle of Bute, southwestern Arran and near Ballantrae Bay (Figure 44). By contrast, records of the priority habitat A4 (circalittoral rock and other hard substrata) are entirely restricted in distribution to the sea lochs (Loch Fyne, the northern part of Loch Striven, the Kyles of Bute, Loch Long and Loch Goil, Figure 45), as is priority habitat B3 (rocks, cliffs, ledges and shores including the supralittoral). Similarly priority habitat A5 (sublittoral sediment) is almost restricted to the sea lochs with one record off the southern tip of the Isle of Arran, and another near Ballantrae Bay (Figure 46).

Overall, these patterns of biodiversity must be interpreted with caution. Given their strong dependence on the distribution of sampling effort, the overall patterns represented on these maps (i.e. high densities of priority habitats in the sea lochs) must not be taken as the only areas where priority habitats occur, since the lack of data in other regions means that they have not been recorded but are nevertheless still likely to occur, for example there is a high probability that there will be areas of sublittoral sediment in the outer Firth region.

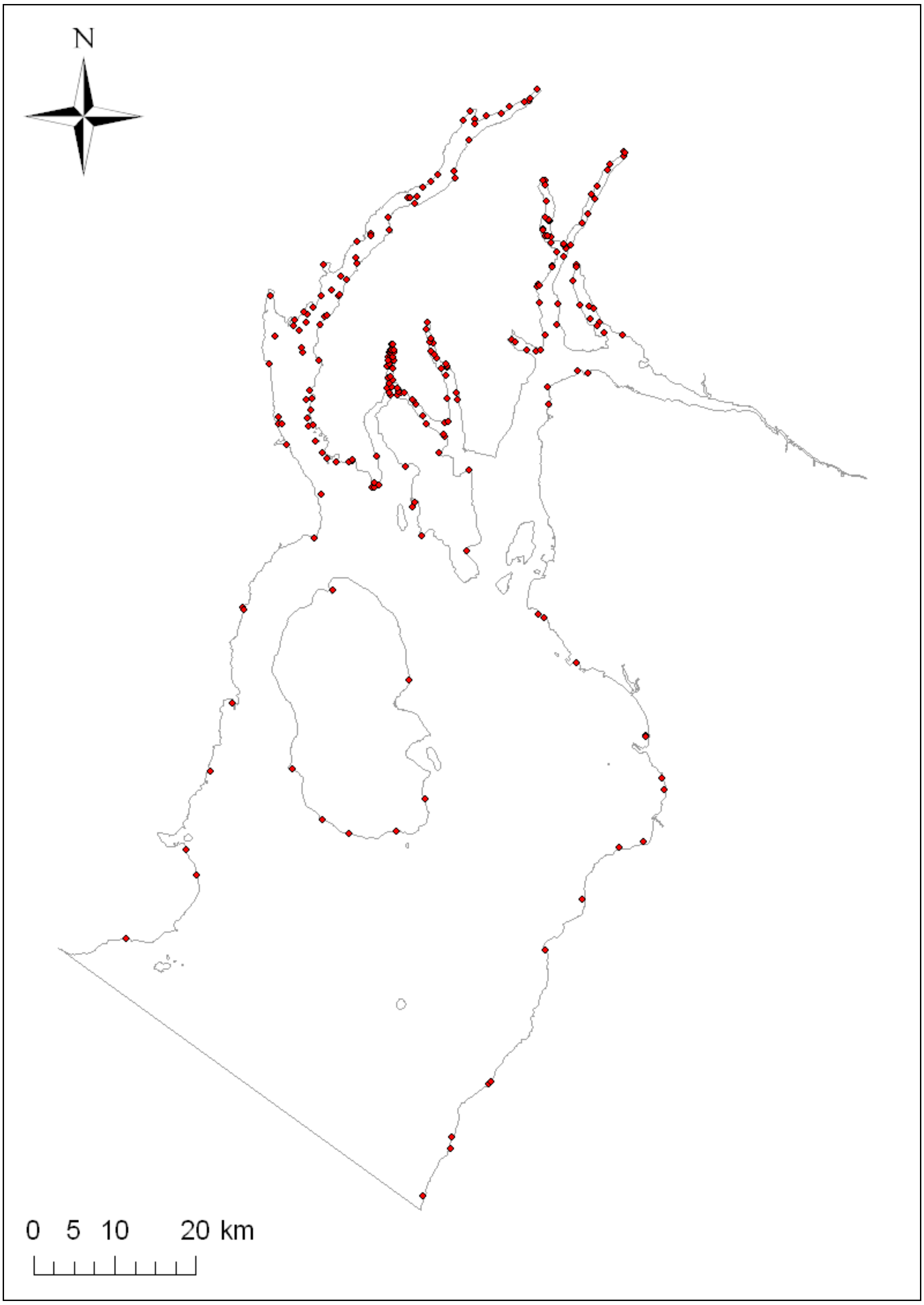


Figure 36. Distribution of Habitats Directive Annex I habitats in the Firth of Clyde area.

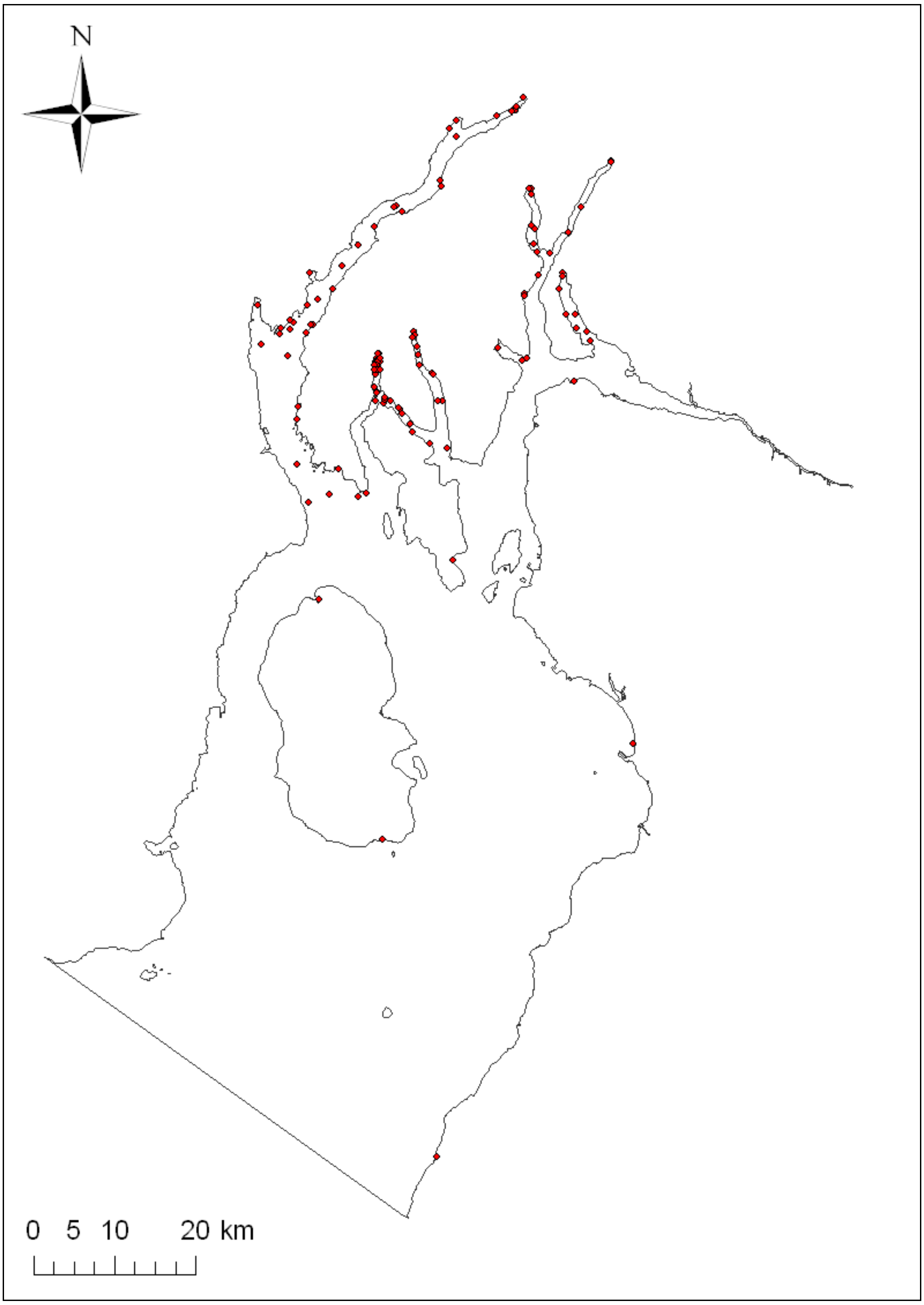


Figure 37. Distribution of Biodiversity Action Plan (BAP) habitats in the Firth of Clyde area.

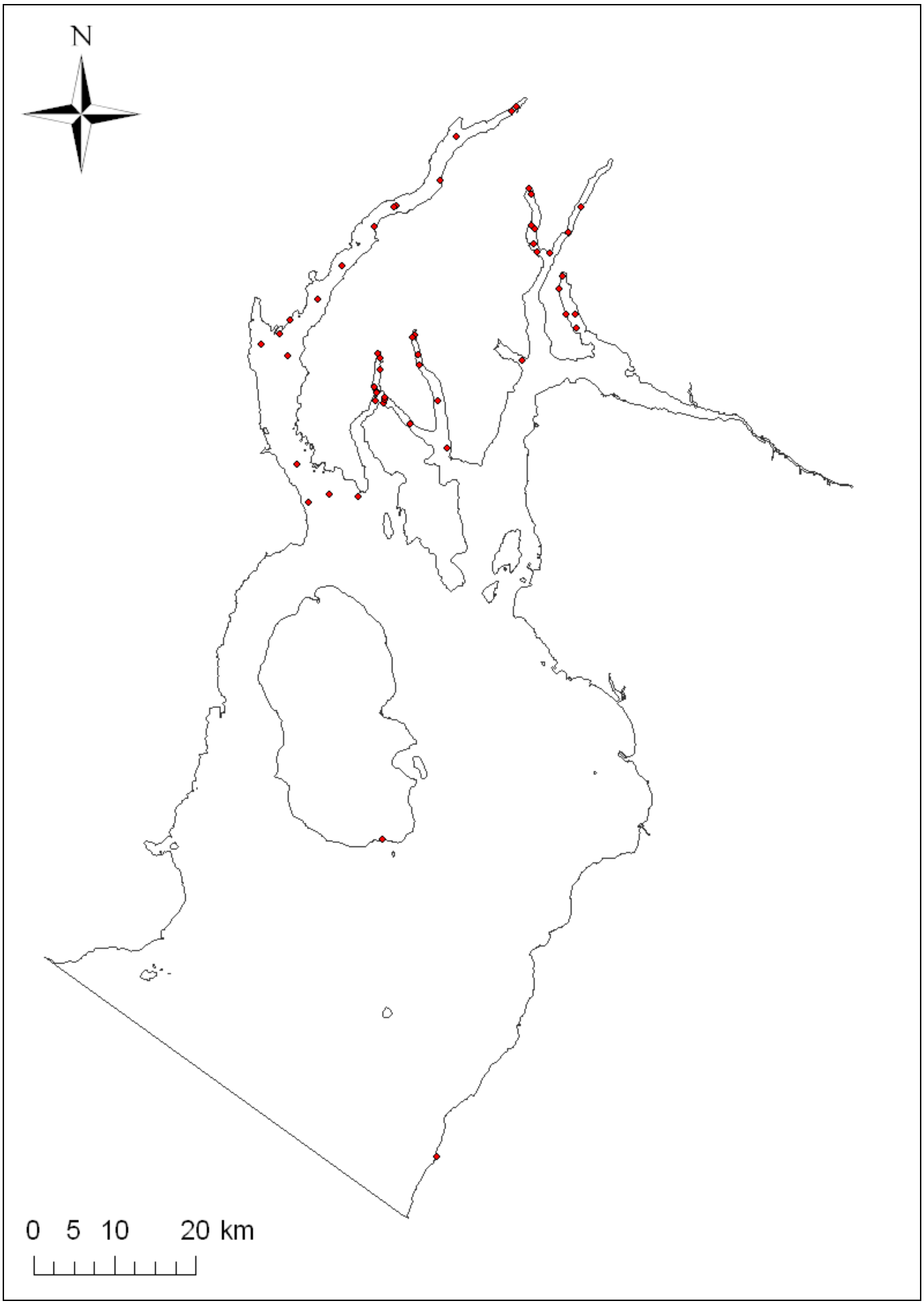


Figure 38. Distribution of local Biodiversity Action Plan (LBAP) habitats in the Firth of Clyde area.

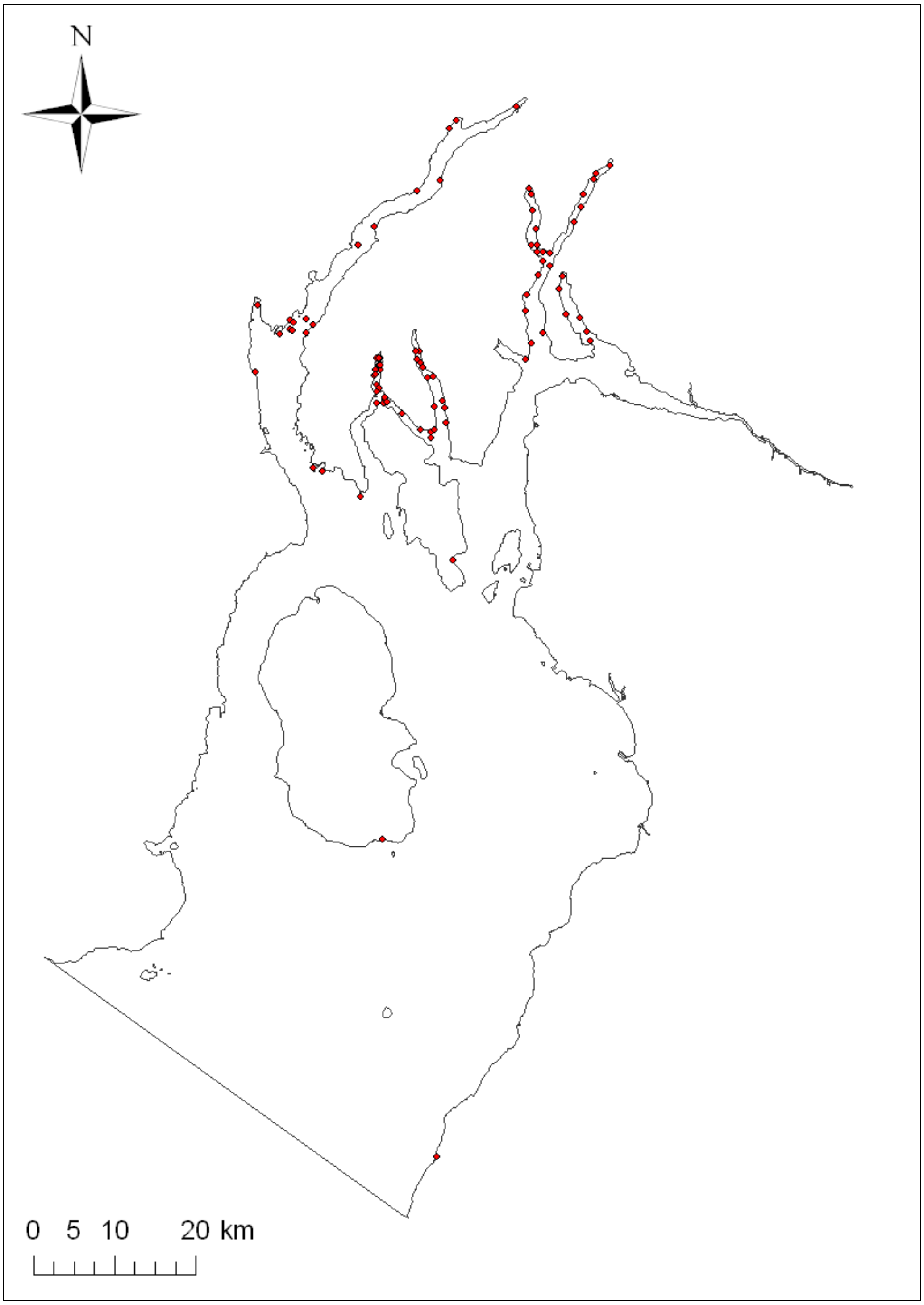


Figure 39. Distribution of Scottish Biodiversity List habitats in the Firth of Clyde area.

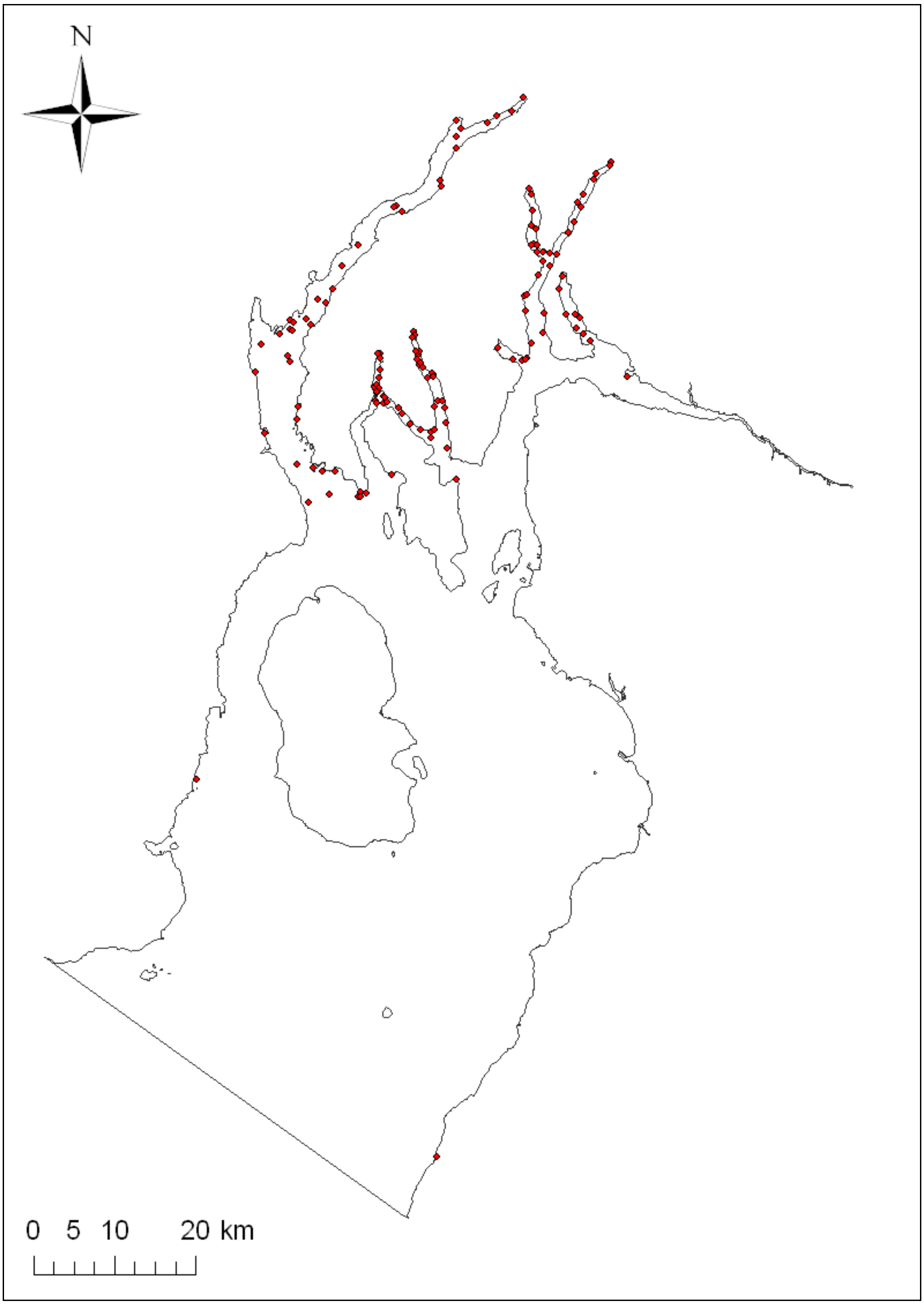


Figure 40. Distribution of candidate Nationally Important Marine Feature (cNIMF) habitats in the Firth of Clyde area.

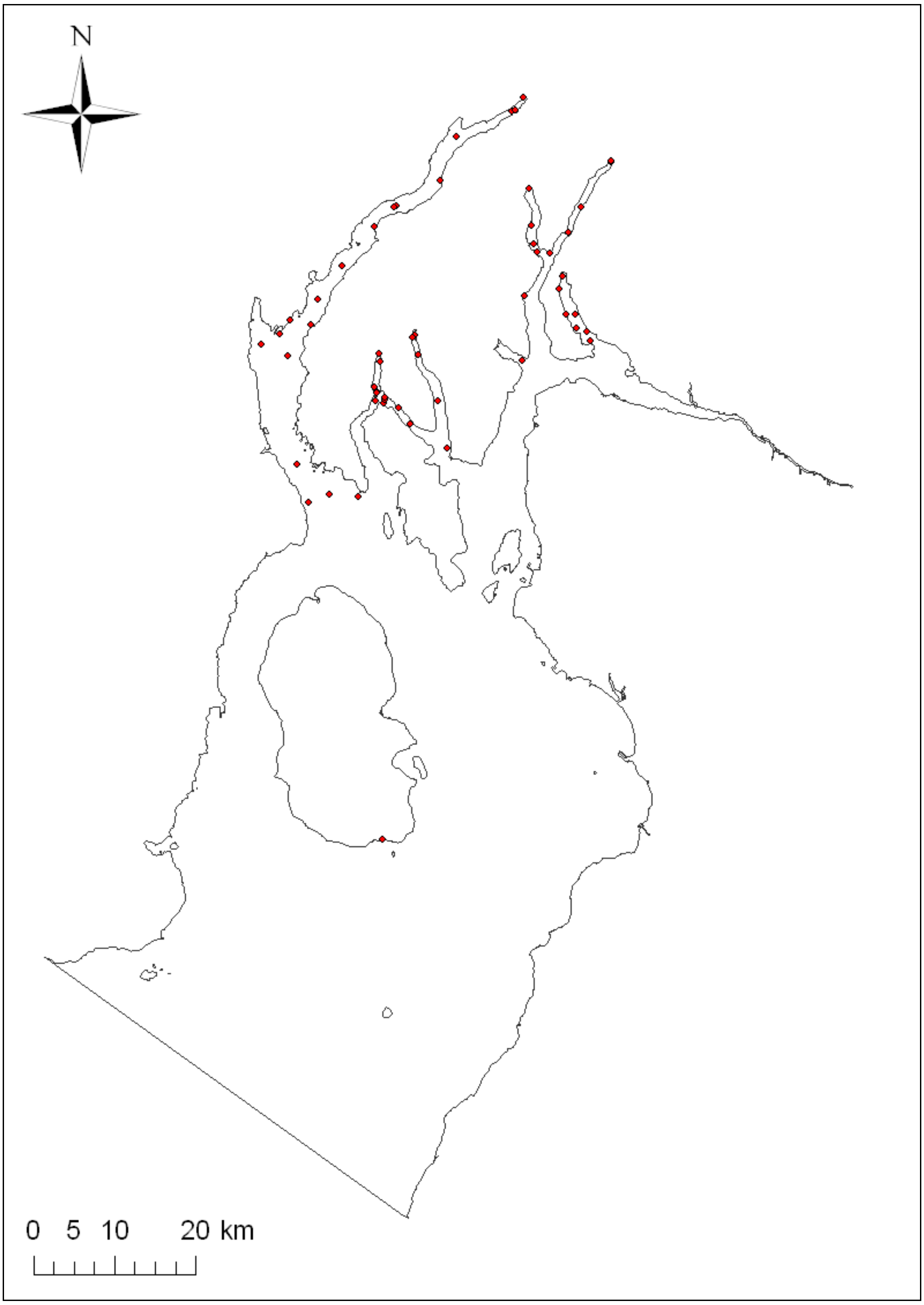


Figure 41. Distribution of OSPAR listed habitat records in the Firth of Clyde.

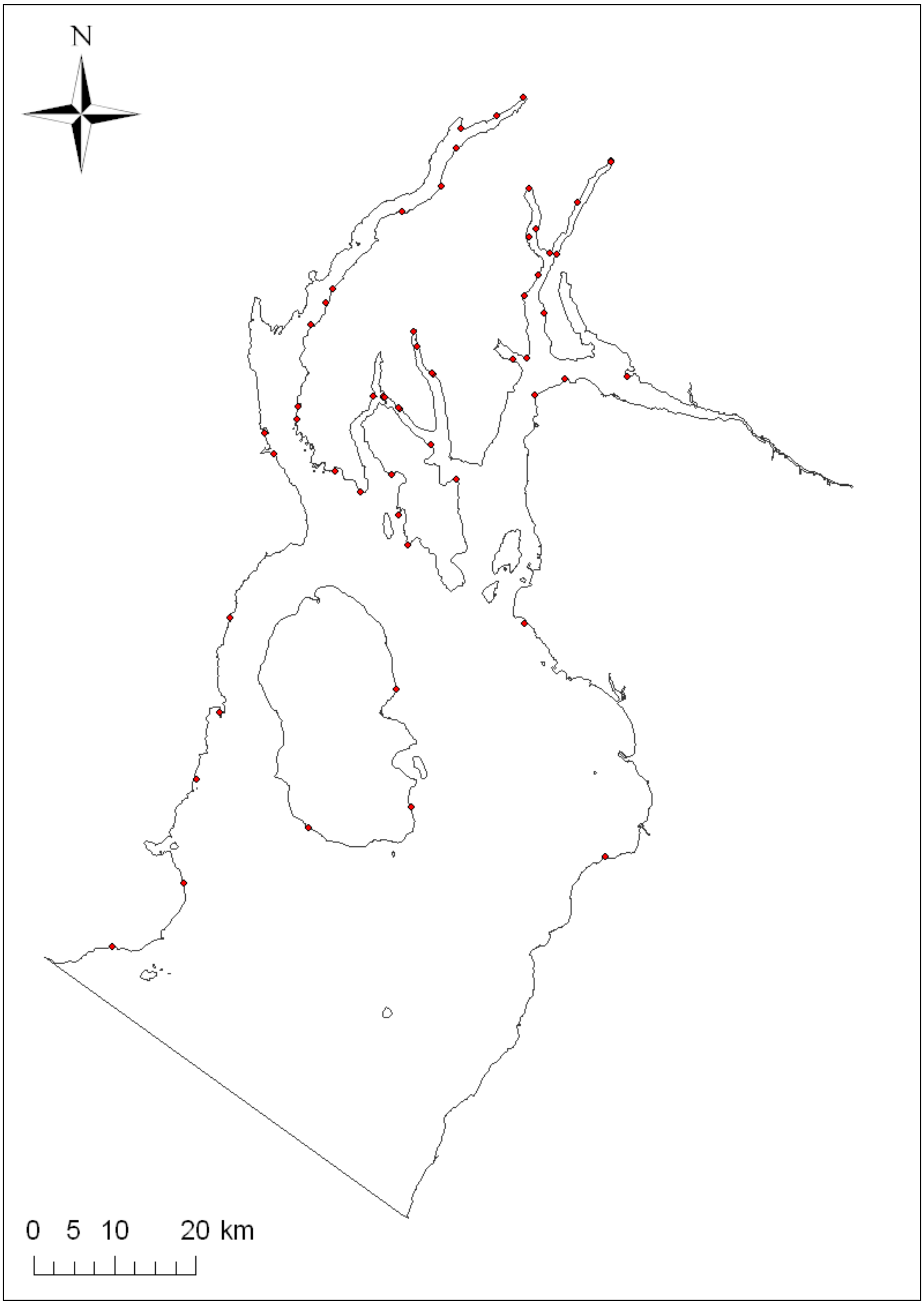


Figure 42. Distribution of priority habitat A1 (littoral rock and other hard substrata) records in the Firth of Clyde.

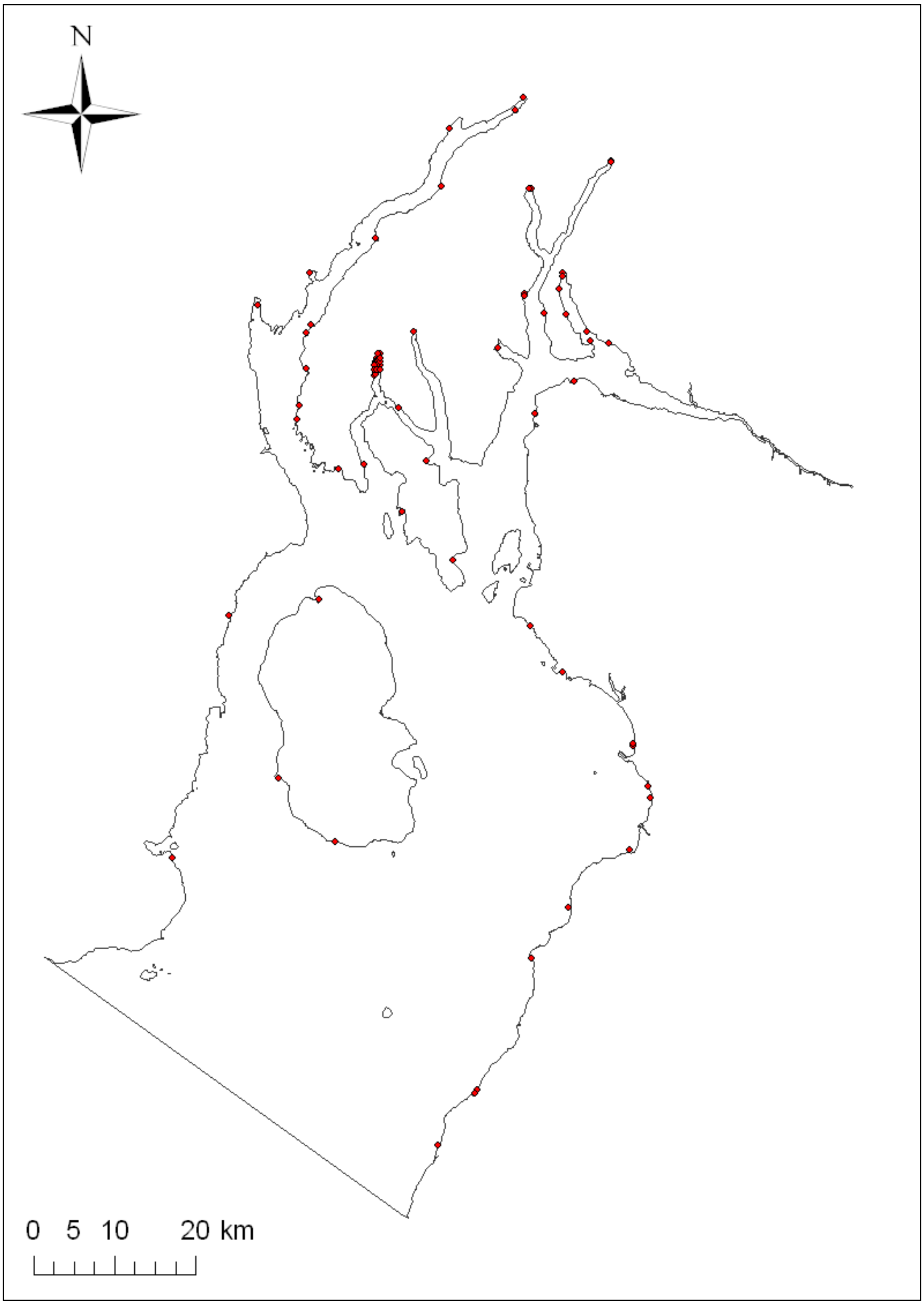


Figure 43. Distribution of priority habitat A2 (littoral sediment) records in the Firth of Clyde.

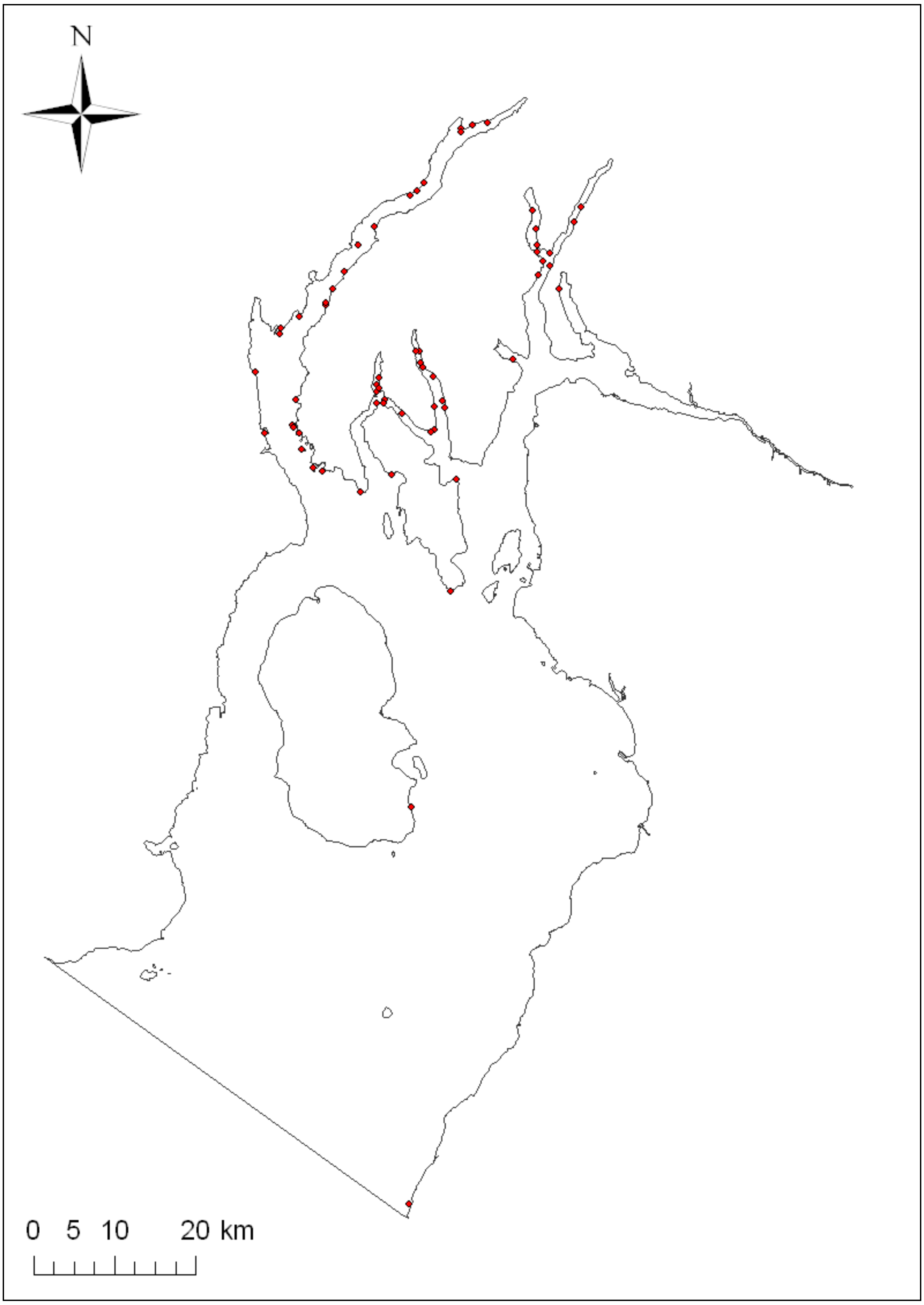


Figure 44. Distribution of priority habitat A3 (infralittoral rock and other hard substrata) records in the Firth of Clyde.

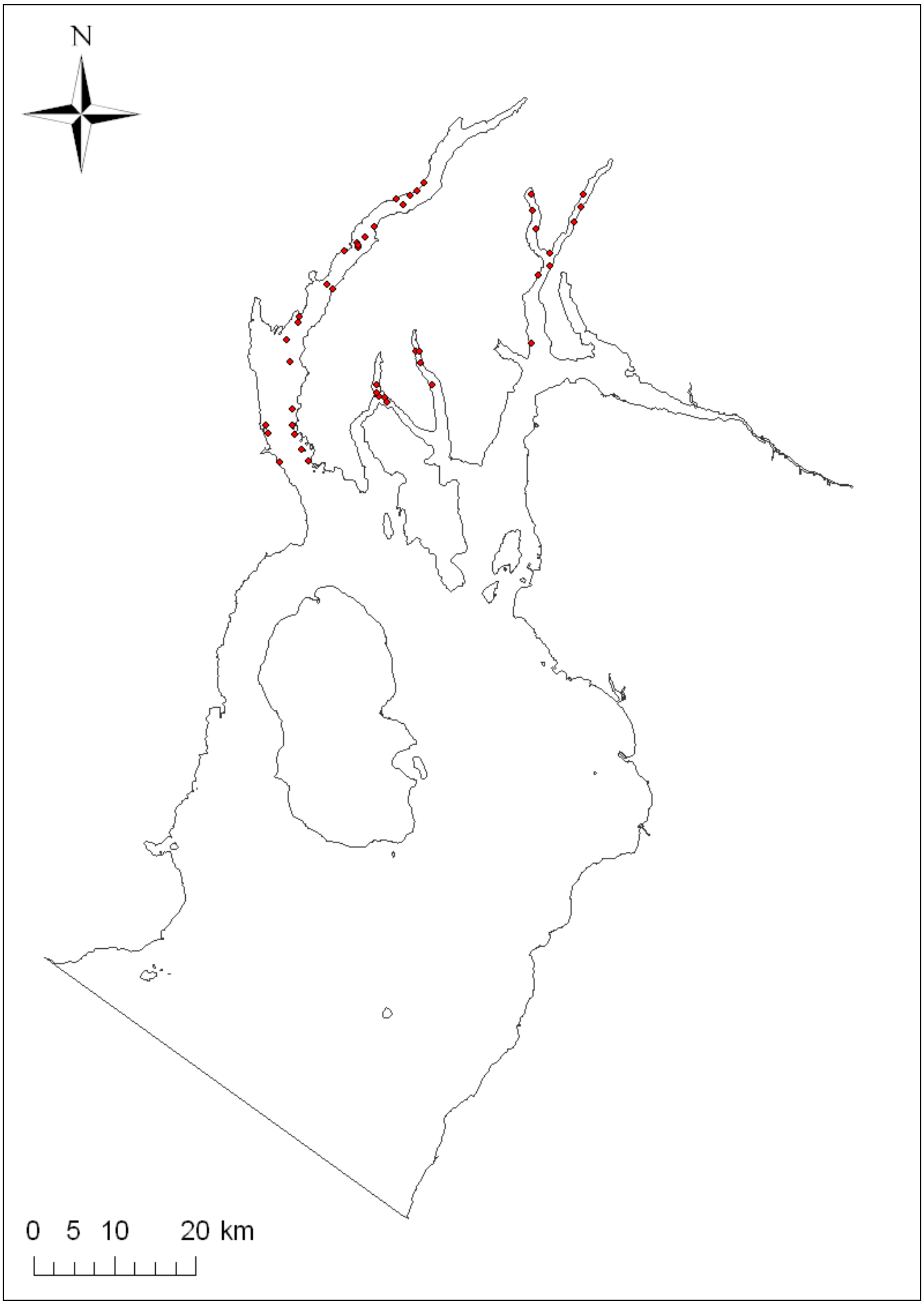


Figure 45. Distribution of priority habitat A4 (circalittoral rock and other hard substrata) records in the Firth of Clyde.

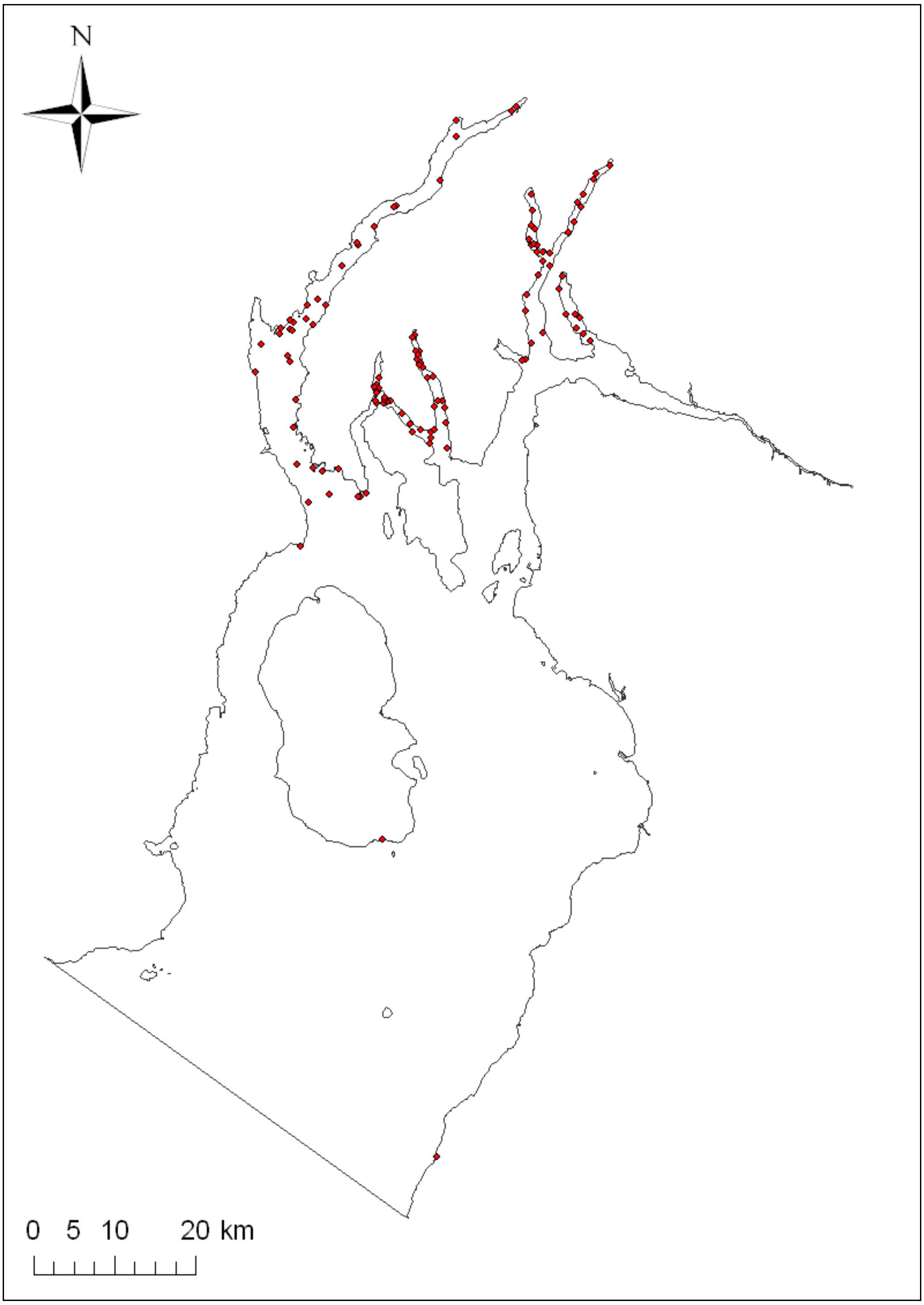


Figure 46. Distribution of priority habitat A5 (sublittoral sediment) records in the Firth of Clyde.

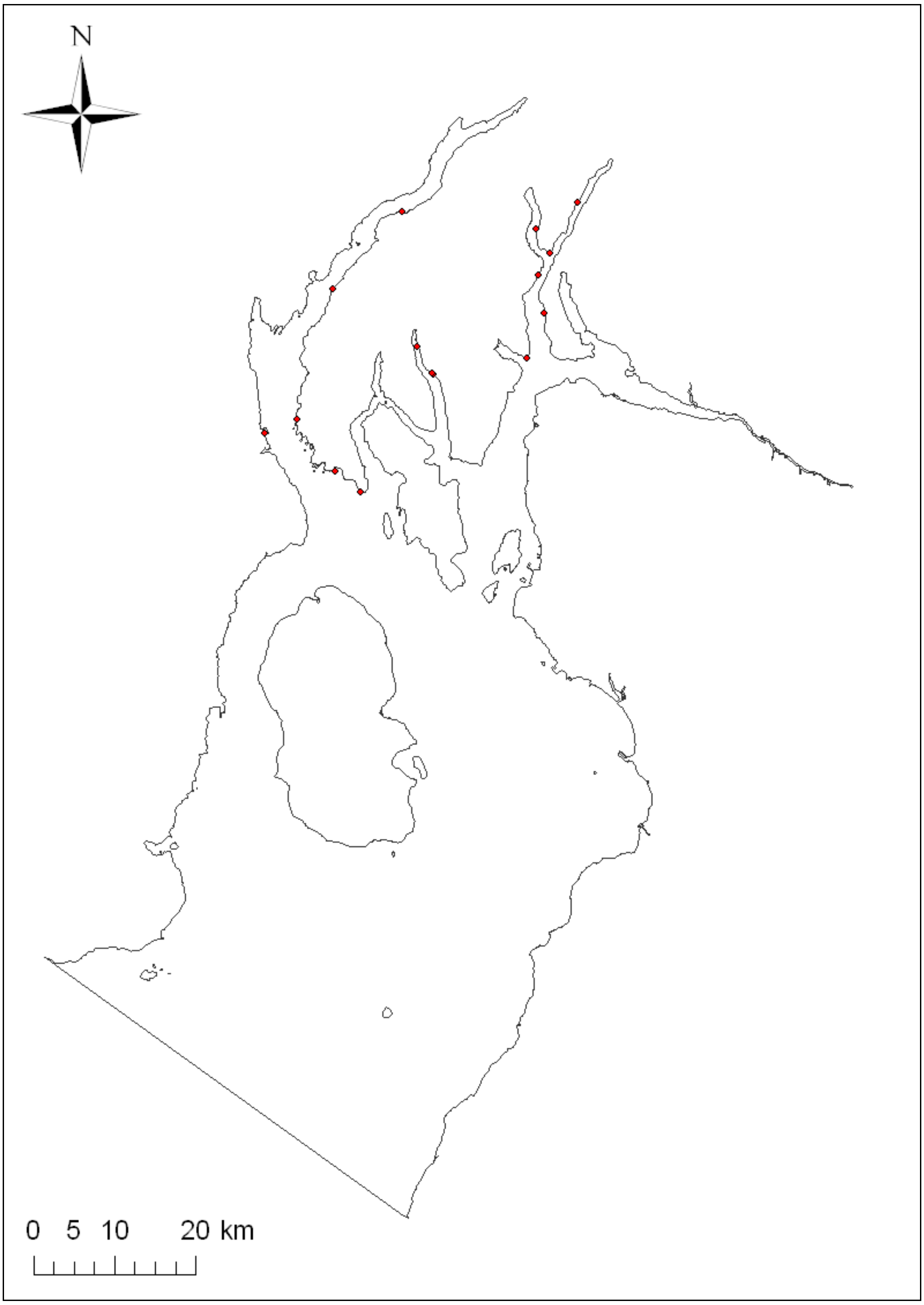


Figure 47. Distribution of priority habitat B3 (rocks, cliffs, ledges and shores including the supralittoral) records in the Firth of Clyde.

4.4 Species Hotspots

Ninety of the 435 5 km diameter hexagons used contained sufficient data to inform our measures of hotpots (see section 3.5.7). Of these, five key areas are identified as species hotpots (see

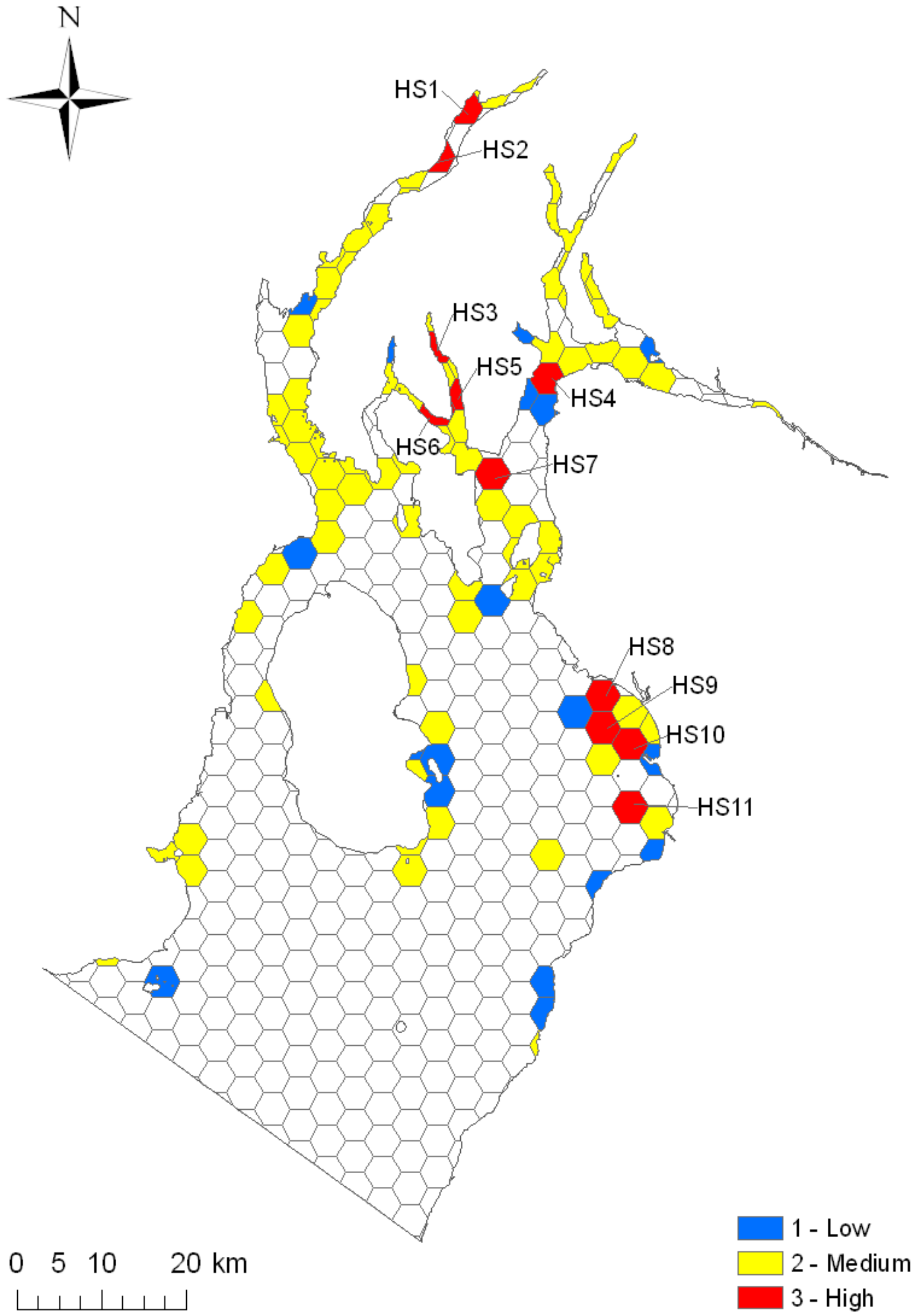


Figure 48 and Appendix 8 for a description of each hotspot):

- Northern Loch Fyne (HS2) and Loch Shira (HS1);
- Irvine Bay (HS8-11);
- East of Dunoon in the upper Firth of Clyde (HS4);
- East of Rothesay, Bute (HS7); and

- The Kyles of Bute (HS6) and Loch Striven (HS3 and 5)

Northern Loch Fyne and Loch Shira have high species richness (Figure 49) and numbers of priority species (Figure 50) but expected levels (i.e. not high) of taxonomic distinctness (Figure 51). This suggests that diversity is not especially high at higher taxonomic levels but is at species level. A similar pattern was found at the Kyles of Bute and Loch Striven, with the taxonomic distinctness of the six invertebrate phyla scoring low while the other biodiversity measures score highly.

A measure of confidence was calculated (see section 3.6.11) for each hexagon to indicate confidence in the data behind the species and biotopes scores. All hotspot areas have high data confidence except northern Loch Fyne (HS2) which has medium confidence (Figure 52, Appendix 8).

Irvine Bay scores highly in terms of species richness (Figure 49) and taxonomic distinctness (Figure 51) but has below expected numbers of priority species (Figure 50). This is likely to be related to the seabed habitat type in this bay, being composed of sandy sediments that are mobile and generally not home to large numbers of rare and/or declining species.

A similar pattern of biodiversity measures is found East of Dunoon in the upper Firth of Clyde and East of Rothesay, Bute where high species richness (Figure 49) and taxonomic distinctness (Figure 51) are contrasted by low to expected numbers of priority species (Figure 50). Since these areas comprise complex seabed habitats, it is not clear why the number of priority species should be low.

Species richness was classed as high in 18 of the 106 hexagon units with sufficient data to analyse (Figure 49). Areas of high species richness additional to the species hotspots identified above included Glenan Bay, East of Loch Tarbert (Loch Fyne), west of Skipness (Tarbert), Kilchousland Bay (near Campbeltown) and North of Brodick Bay on Arran.

Eleven areas were identified as species biodiversity "cold spots" in the analysis, scoring low for all measures (e.g. north of Ardmore point, Turnberry Bay, Troon point and the deeper parts of Irvine Bay and Lunderston Bay in the Upper Firth of Clyde). However, for areas around Sanda Island, Holy island and an area off Port Ann, Loch Fyne, species richness and taxonomic distinctness (Figure 49 and Figure 51 respectively) were low but the number of priority species was high (Figure 50). Interestingly both Sanda Island and Holy island were identified as important areas during consultations with local stakeholders (Figure 16). Caution must be extended when classifying areas as biodiversity "cold spots", since this does not mean that they have low intrinsic conservation value. It cannot be assumed that areas of low biodiversity are functionally less important to the ecosystem.

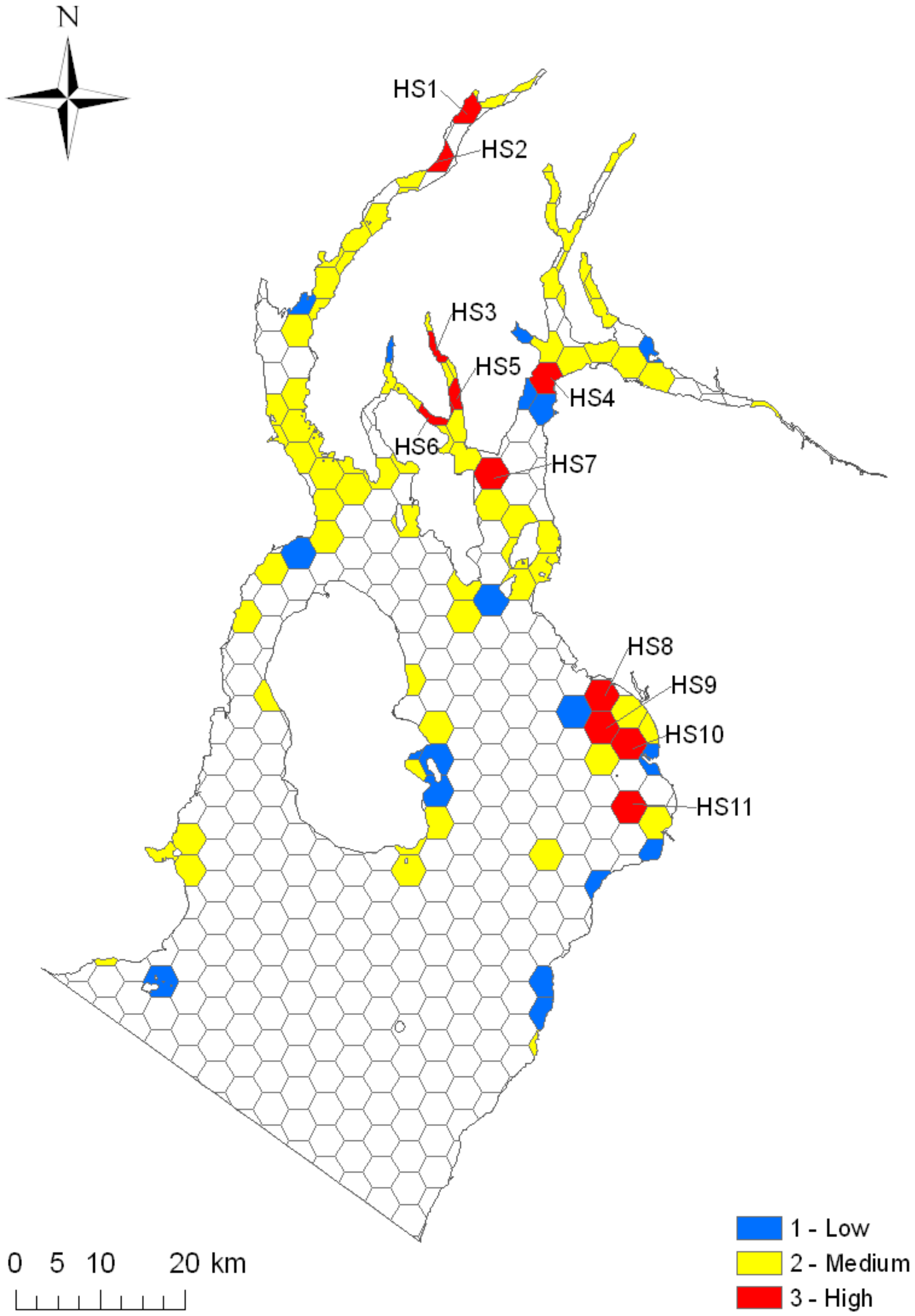


Figure 48. Species hotspot scores for the Firth of Clyde.

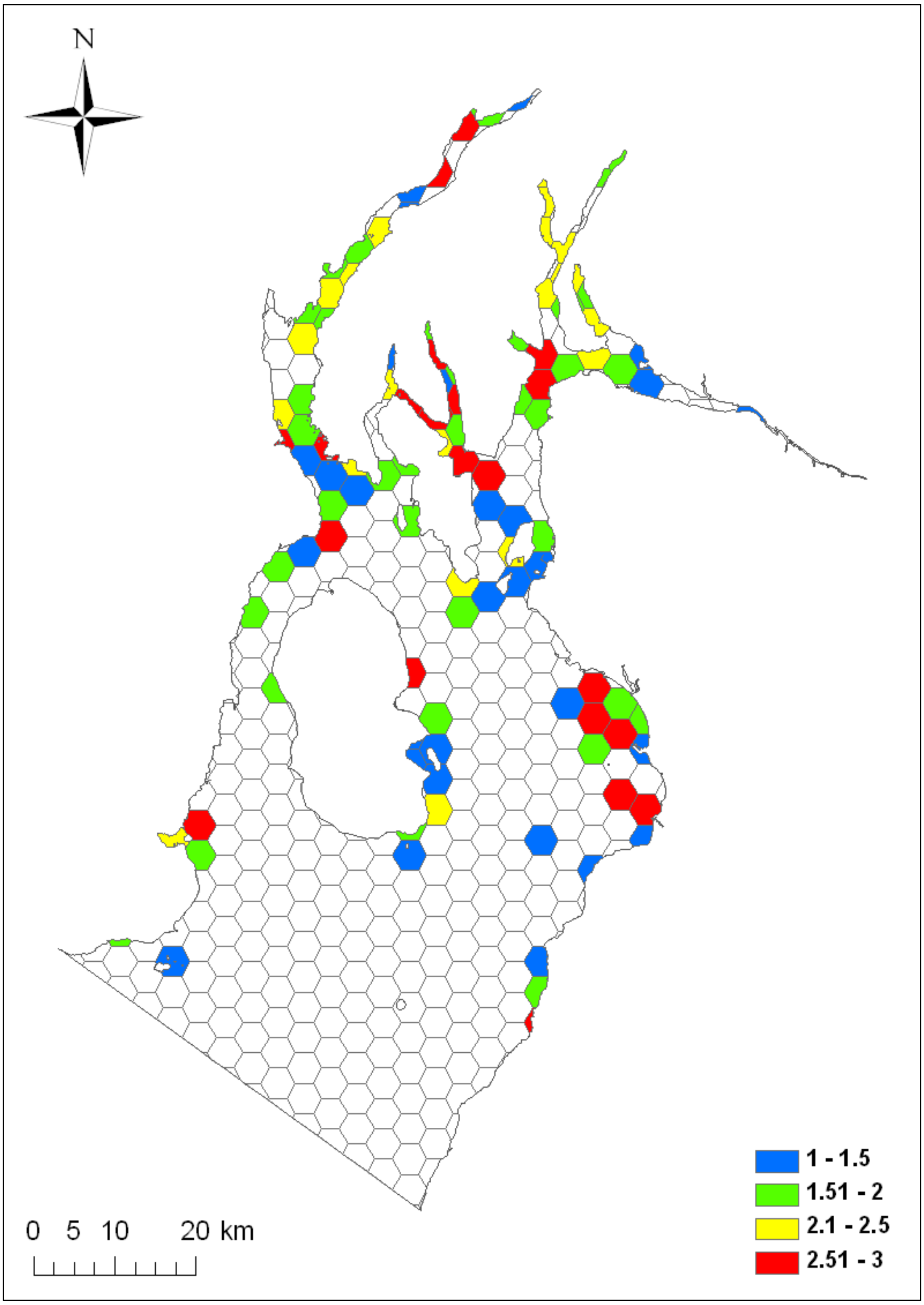


Figure 49. Species richness scores, averaged by seabed habitat type, for the Firth of Clyde (3 = high, 2 = medium, 1 = low).

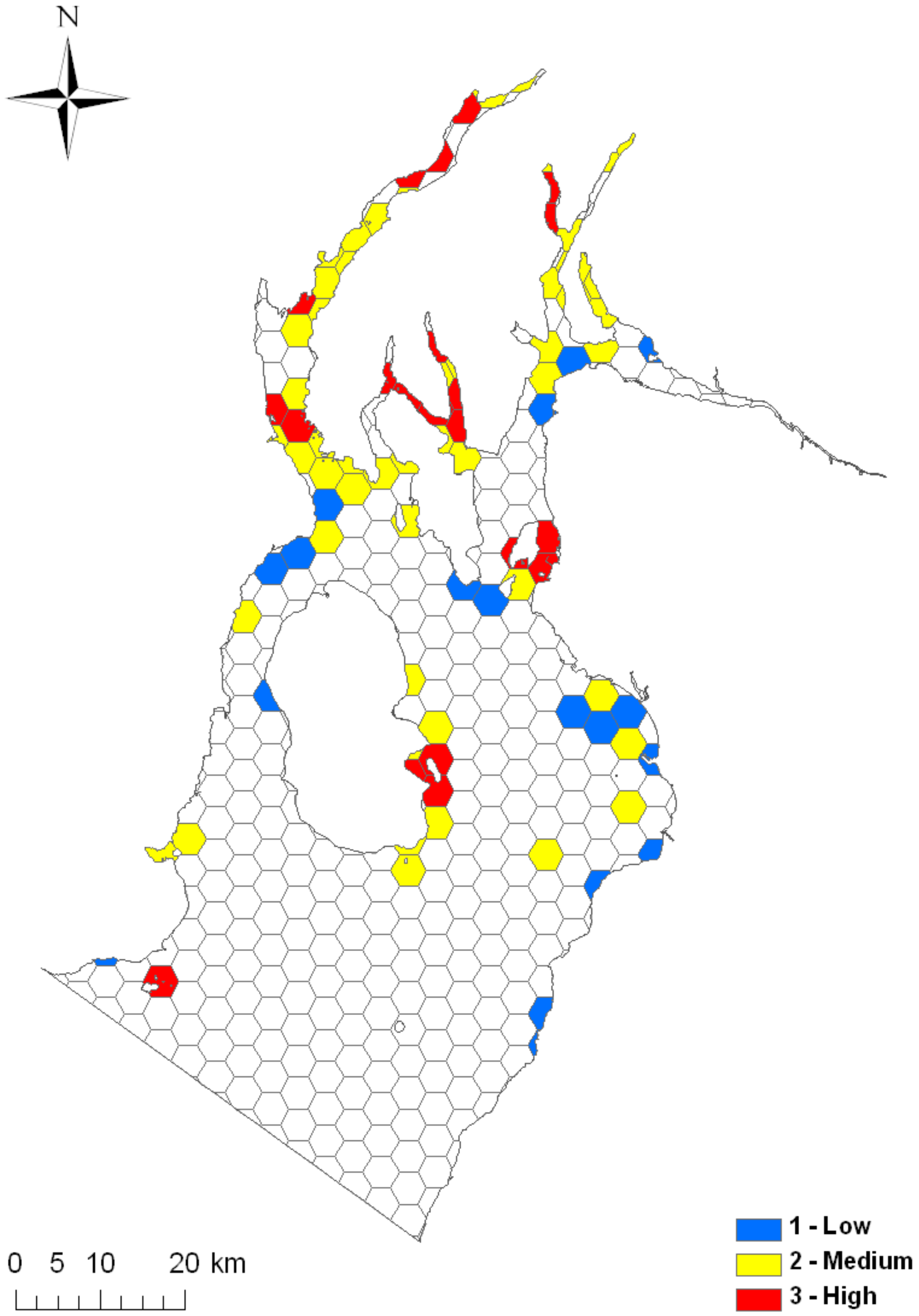


Figure 50. Priority species scores for the Firth of Clyde.

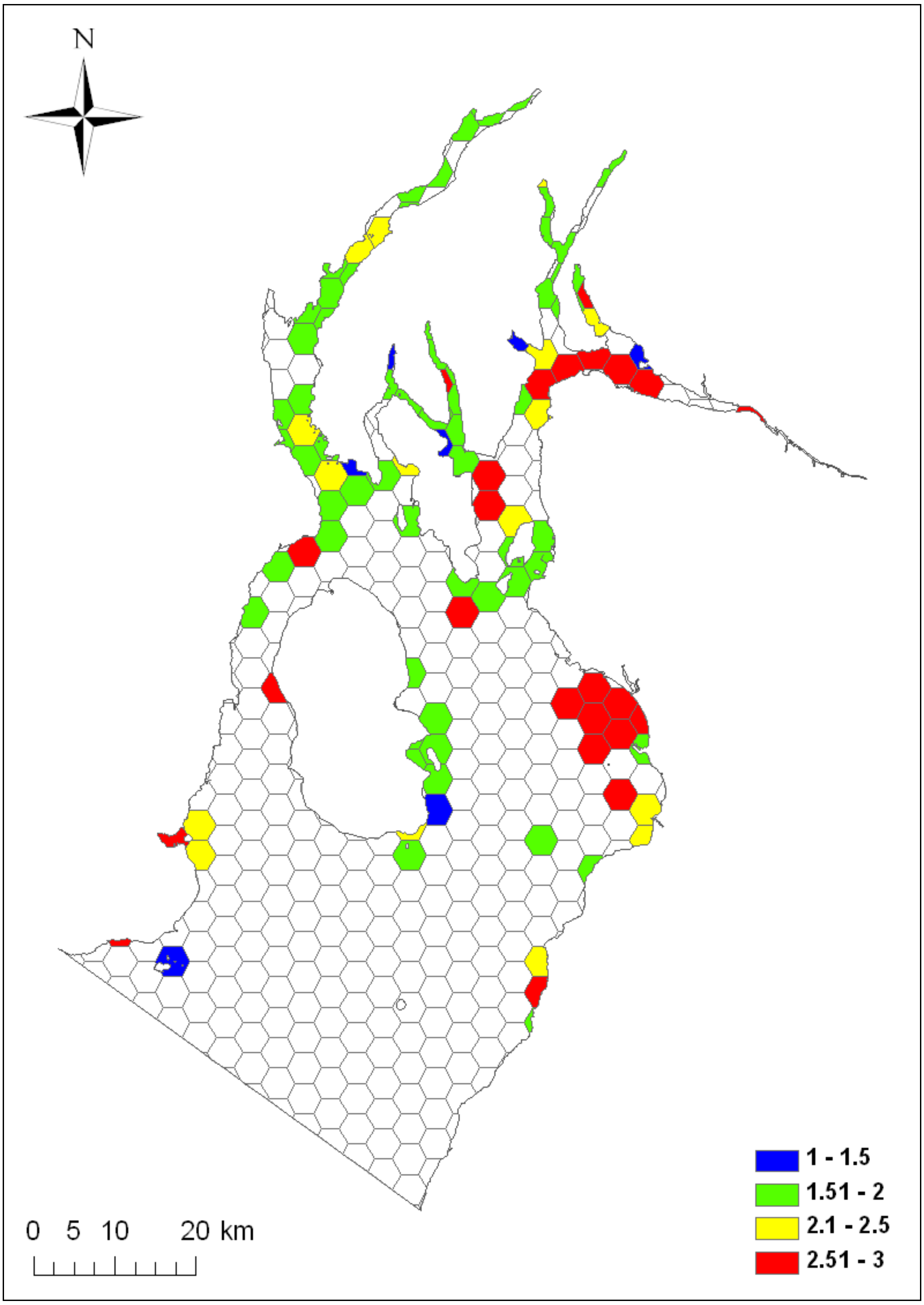


Figure 51. Taxonomic distinctness scores for the Firth of Clyde (3 = high, 2 = medium, 1 = low).

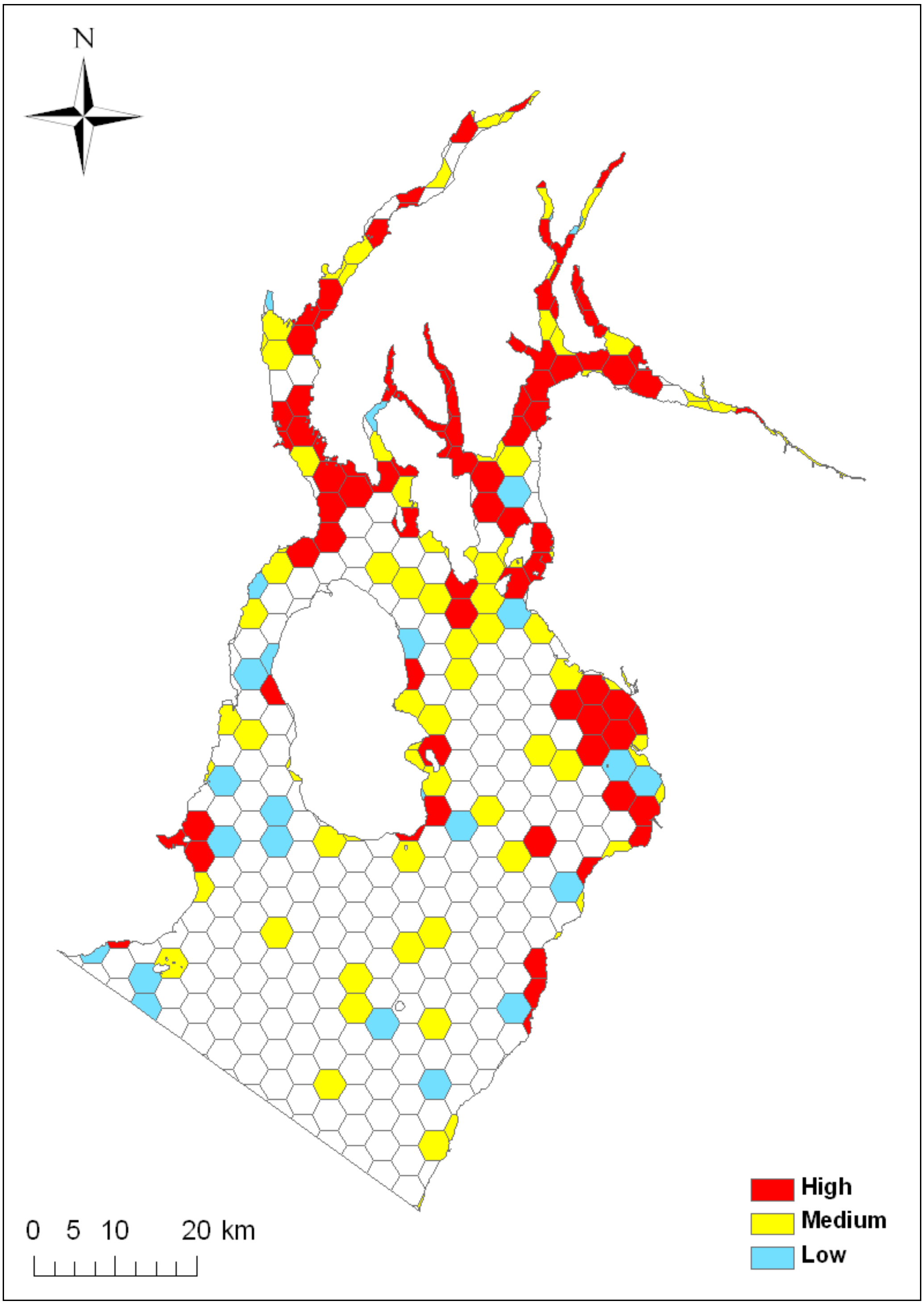


Figure 52. Confidence levels for species data used to identify hotspot measures (see section 3.6.11 for method of assessing confidence).

4.5 Biotope Hotspots

Biotope information was mostly confined to the sea lochs apart from a few areas in the south east of the Firth (areas off Irvine, Turnberry Bay, Ballantrae Bay). This is because biotope information was taken from MNCR data that are limited to coastal regions. Ten biotope hotspots were identified (see Figure 53) including:

- an area in the northern part of Loch Fyne (HS14);
- Loch Goil (HS13);
- in the mouth of Holy Loch (HS17); and
- Ardlamont Point (HS20).

Biotope richness was particularly high in Loch Fyne, around Ardlamont Point, the mouth of Holy Loch, and on the eastern side of Kyles of Bute (Figure 54). Biotope distinctness was particularly high in Loch Goil and in Holy Loch, while all areas outside of the seas lochs scored low (Figure 55). All hotspots had underlying high numbers of priority biotopes driving the final score (Figure 56). Each of the four areas listed above (HS13, HS14, HS17 and HS20) was assigned high data confidence (see Figure 57 and Appendix 8).

Some notable omissions (due to actual data gaps) in terms of areas of potentially high biodiversity (based on priority biotopes) were identified by our consultations with local stakeholders (see Figure 15 and Figure 16). For example an area off Kingscross Point hosts sheer walls and abundant marine life, Whiting Bay hosts seagrass beds, Lamlash Bay has maerl beds, Great and Little Cumbrae have *Modiolus* beds, and the tidal swept reefs around Sanda island and reefs south of Pladda have very high biodiversity (see Appendix 1). However, only anecdotal records were available for these areas and therefore they did not appear in the analyses. However, some biotope hotspots identified here agreed with local knowledge; for example the hotspot off Coulport, Loch Long and areas of Loch Fyne were highlighted for their high biodiversity following fisheries closures in these areas as a result of military activity.

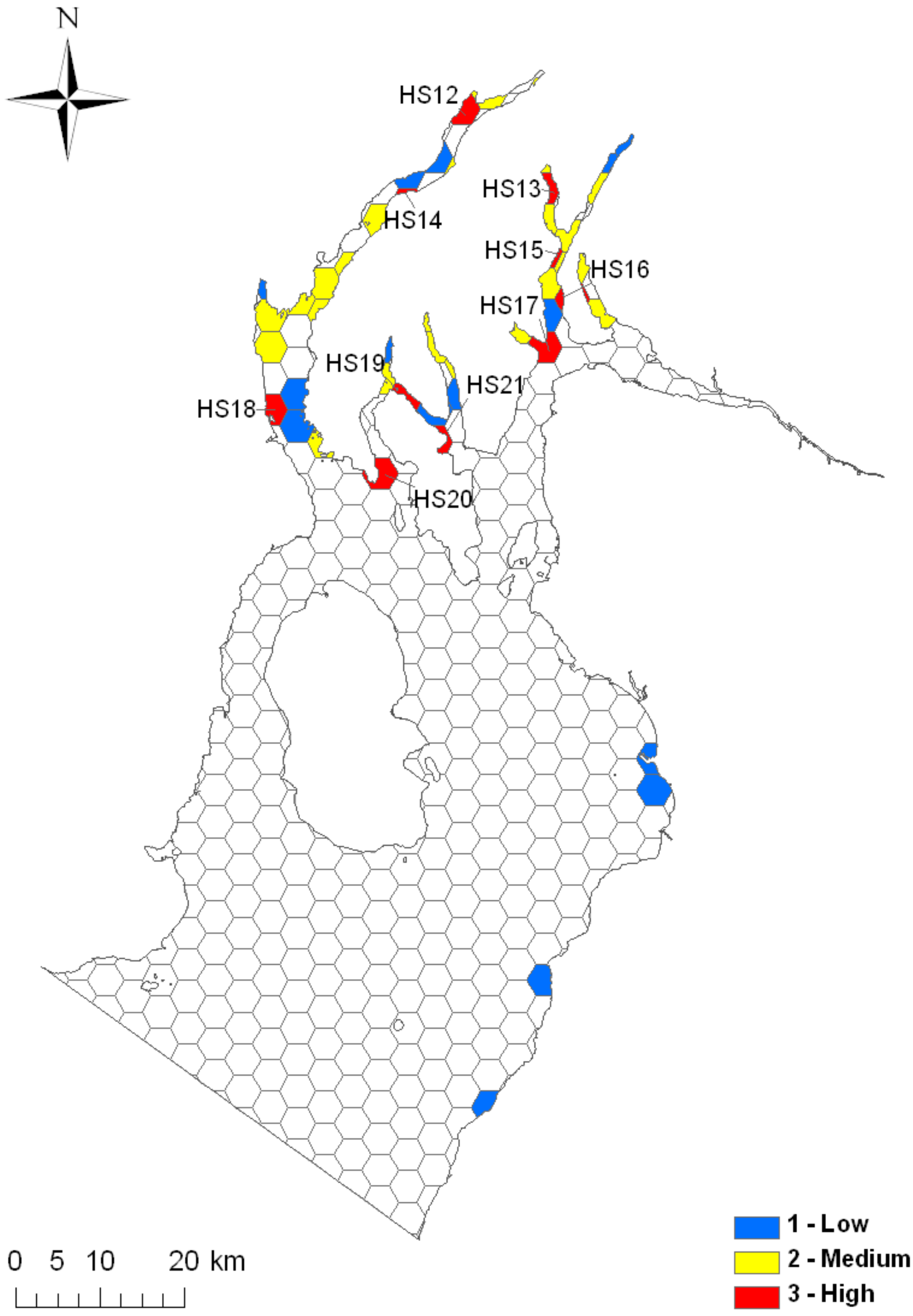


Figure 53. Biotope hotspot scores for the Firth of Clyde.

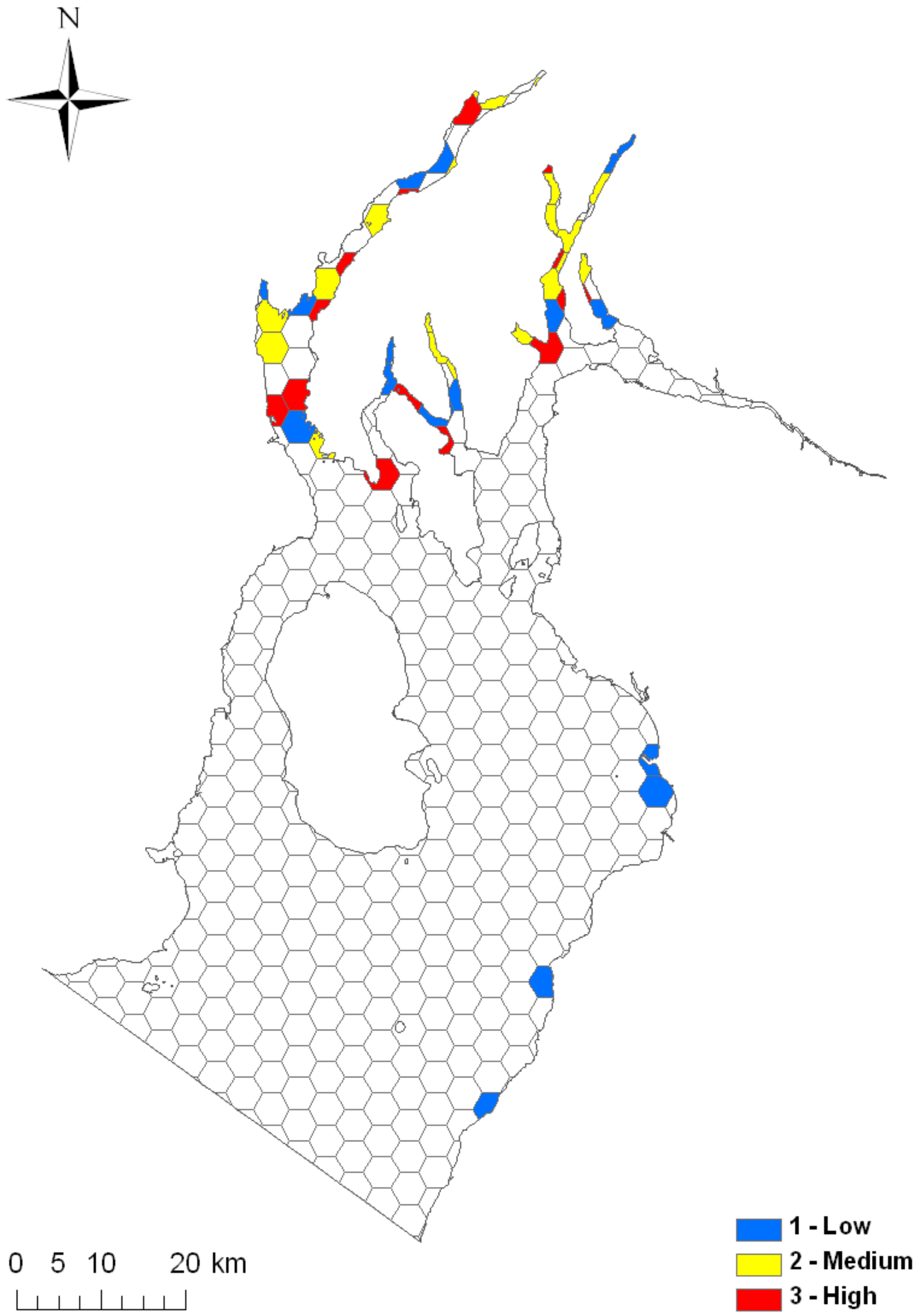


Figure 54. Biotope richness scores for the Firth of Clyde.

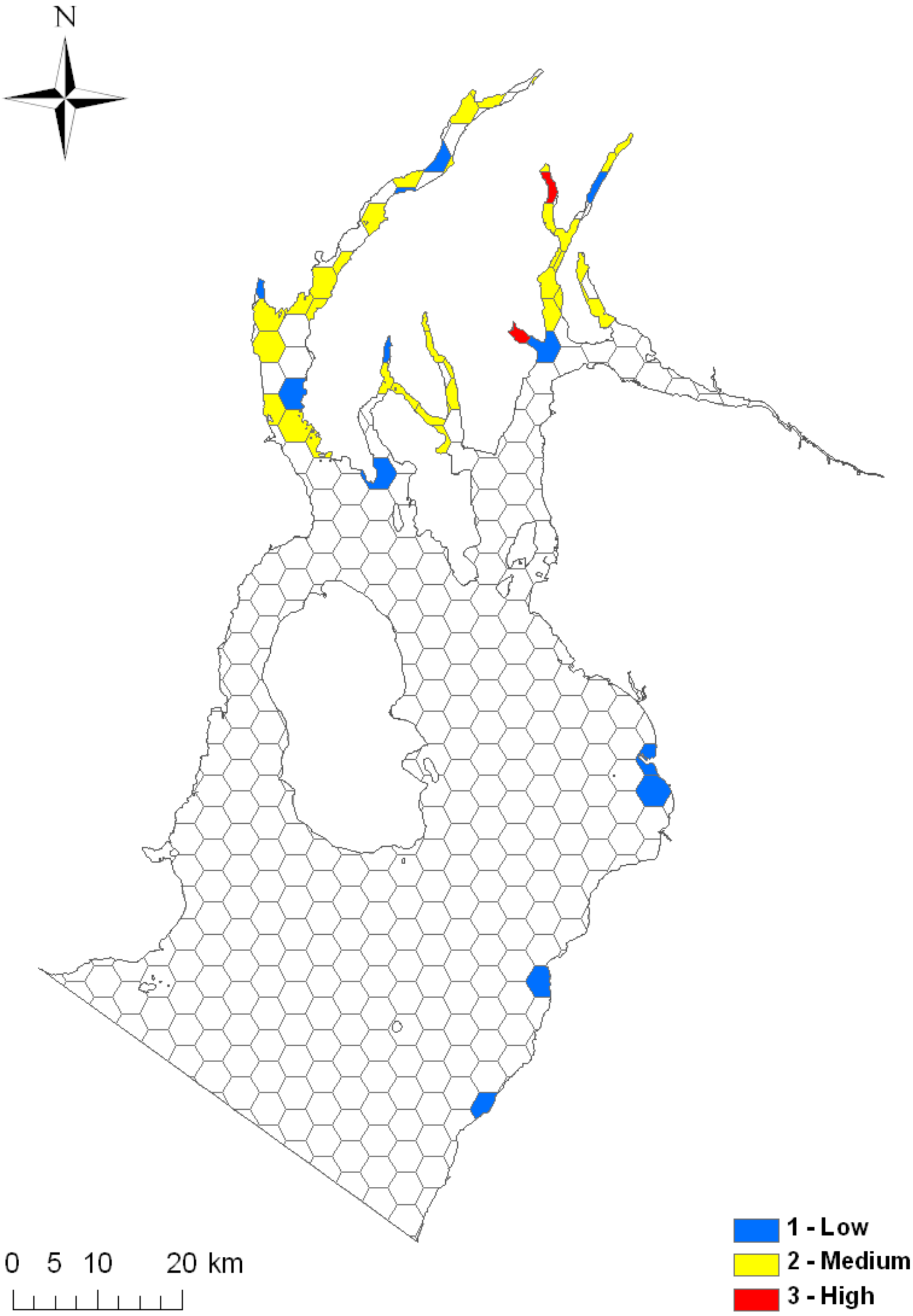


Figure 55. Biotope distinctness scores for the Firth of Clyde.

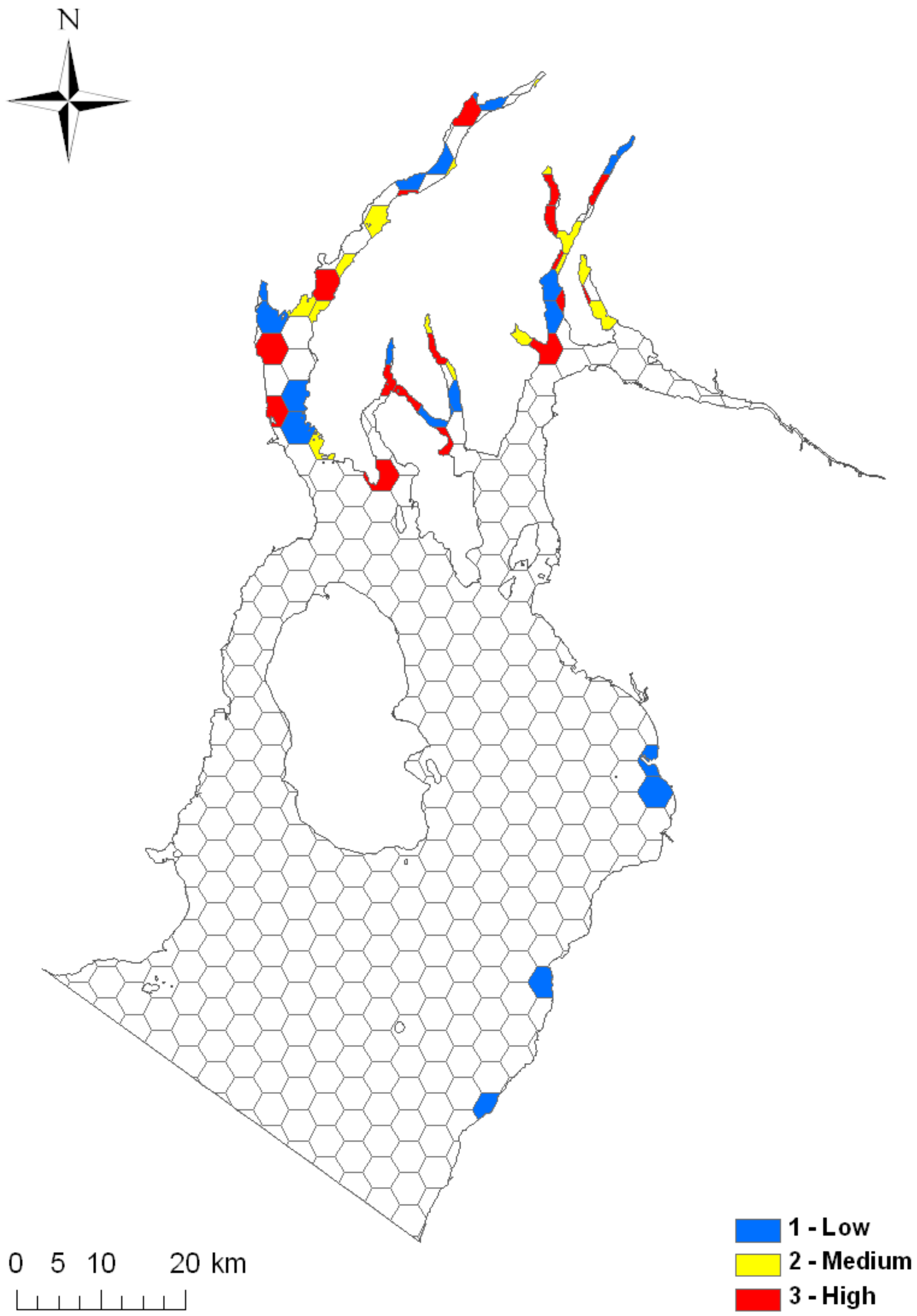


Figure 56. Priority biotope scores for the Firth of Clyde.

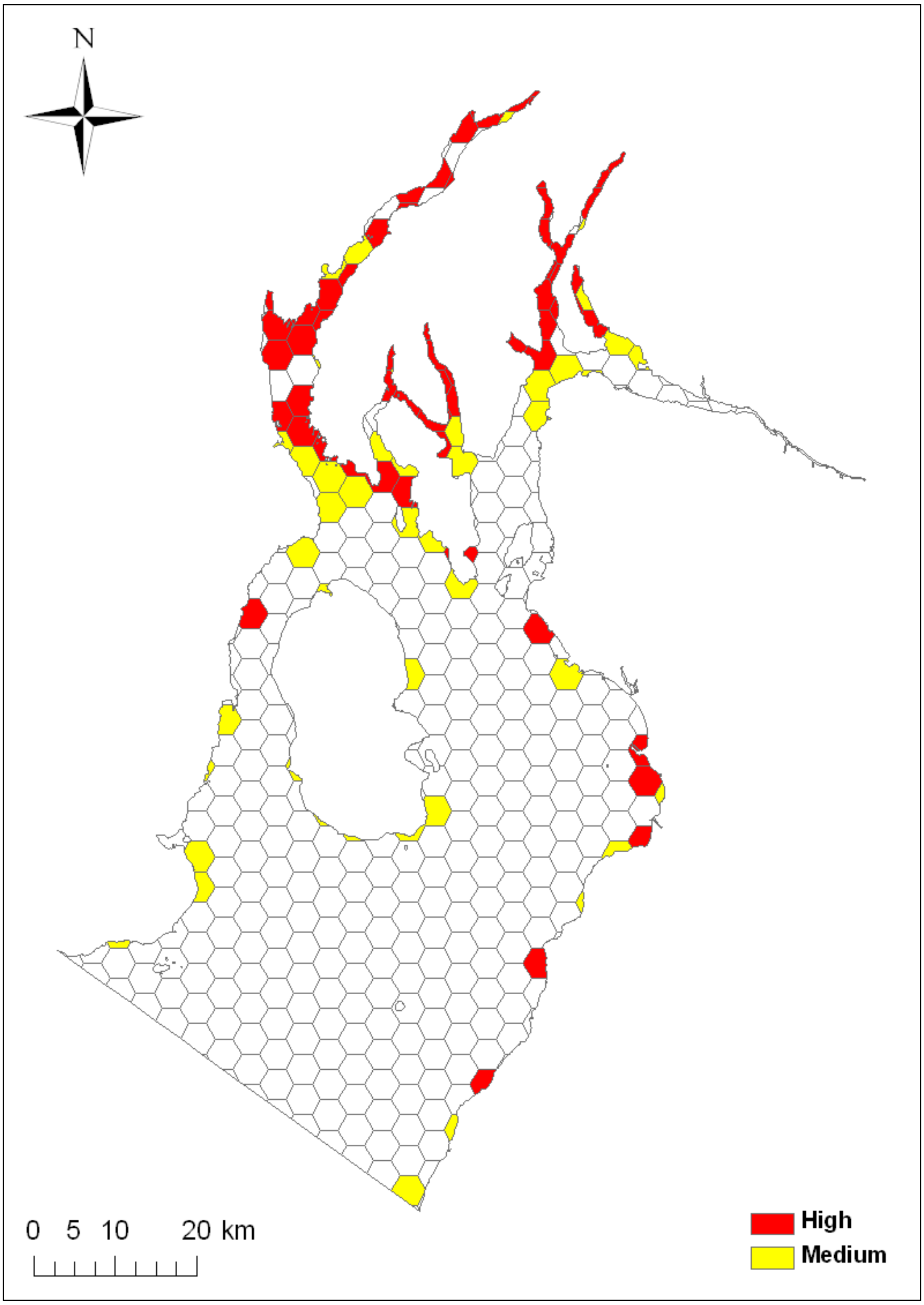


Figure 57. Confidence levels for biotope data used to identify hotspot measures (see section 3.6.11 for method of assessing confidence).

4.6 Combined scores for species and biotopes

Only 38 hexagons out of a total of 435 (8.7%) held enough data to combine hotspot measures for species and biotopes. These were confined almost entirely to the lochs (with the exception of two areas, near Troon and Girvan) (Figure 58; see Figure 59 for confidence).

One site was categorised as a hotspot for both species and biotopes at the mouth of Loch Shira, Loch Fyne HS22 (an area currently with restrictions in place for fishing and dredging due to military activities), with nine further locations scoring highly (including Loch Goil, the mouth of Holy Loch, the north of Loch Striven, Kyles of Bute, Ardlamont Point and Loch Fyne, near Tarbert).

Figure 58 and Figure 60 show the combined hotspots and species hotspots (respectively) compared with the distribution of Scottish Biodiversity List species. There appears to be little correlation between the presence of Scottish Biodiversity List species and either combined or species hotspots. Therefore, the Scottish Biodiversity List was not an appropriate surrogate for biodiversity hotpots (as identified by the measures set out in section 3.6). Figure 61 shows a similar pattern for NIMF. However, if conserving priority species from one or all lists is a key objective of the MSP, then the priority species measure could be given greater weighting in the hotspot analysis.

Areas in the south east of the Firth (off Irvine, Turnberry Bay, Ballantrae Bay) appeared as "cold-spots" for biotopes and for species. However other biotope "cold-spots" were found to be species hotpots (for example in the Kyle of Bute and Loch Striven). Whilst this could represent differences in sampling targets, it could also indicate an area with just one (or two) structurally important biotopes that promote high species diversity. The combined hotspot data identifies areas of relatively high biodiversity within the areas where data are available. Information from local experts and stakeholders identified other potential hotspots where there were no data records that could be used in current analysis; it will be important also to consider these areas within the MSP.

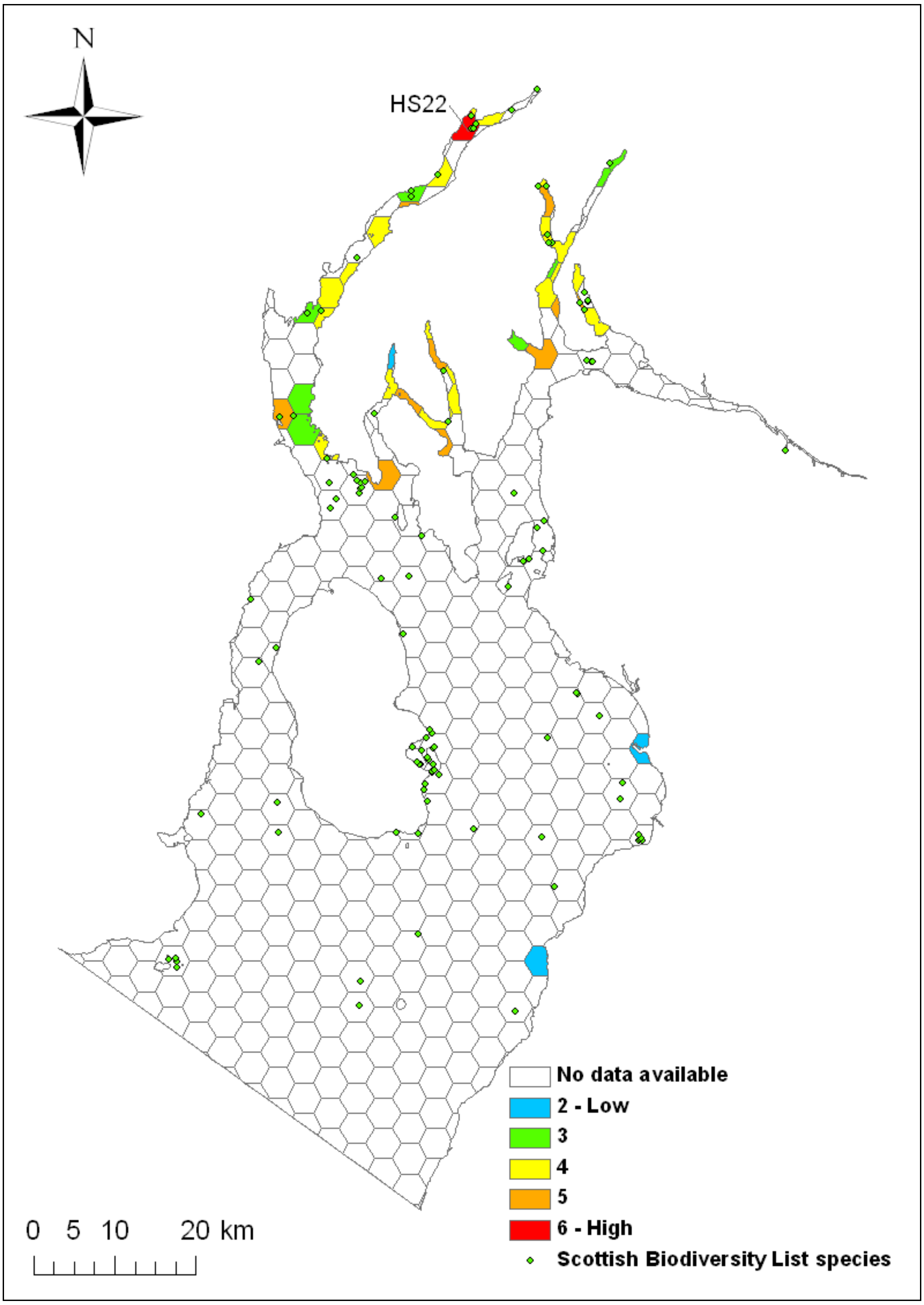


Figure 58. Combined hotspot scores plotted against Scottish Biodiversity List species records.

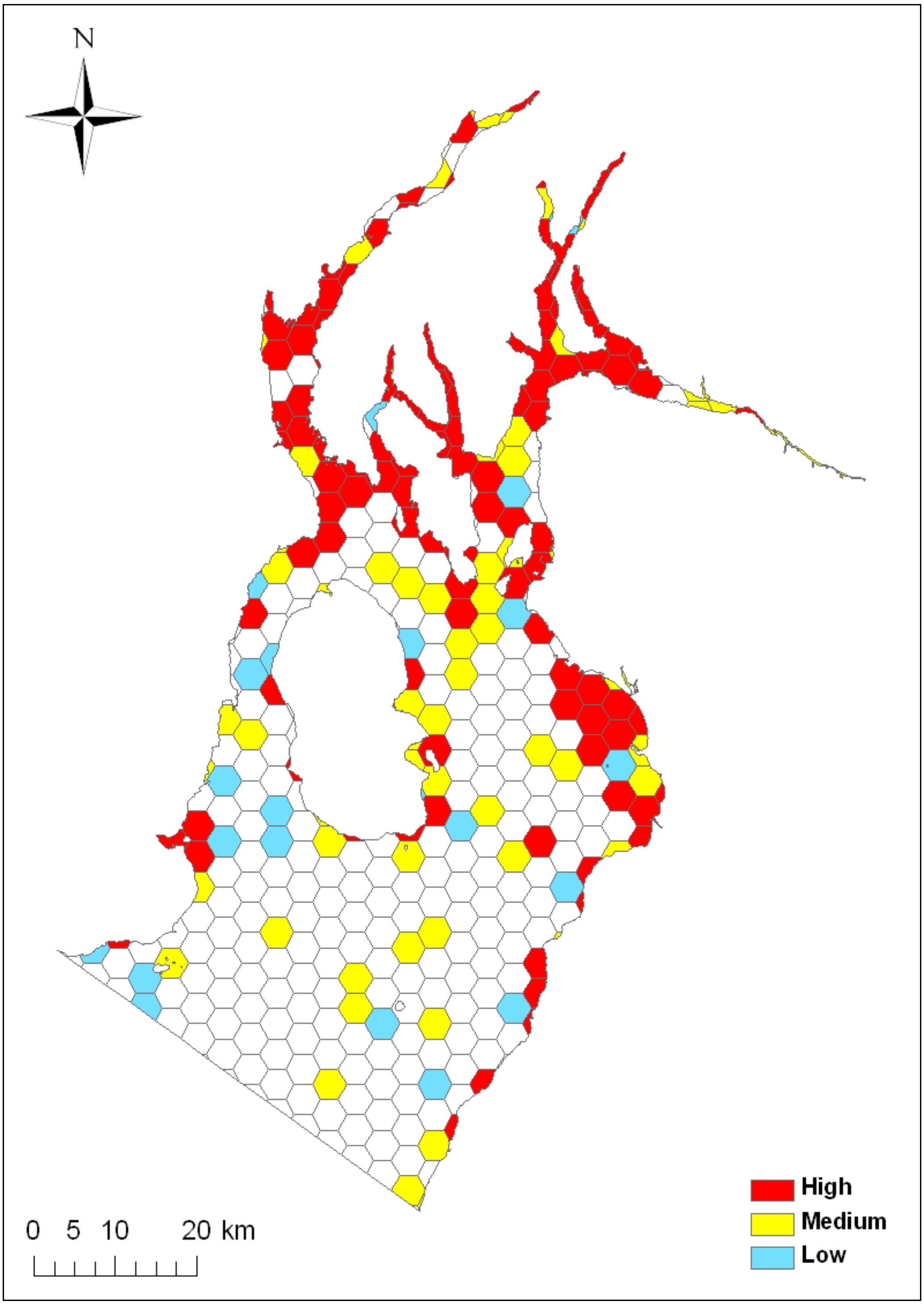


Figure 59. Confidence levels for data used to identify combined hotspot measures (see section 3.6.11 for method of assessing confidence).

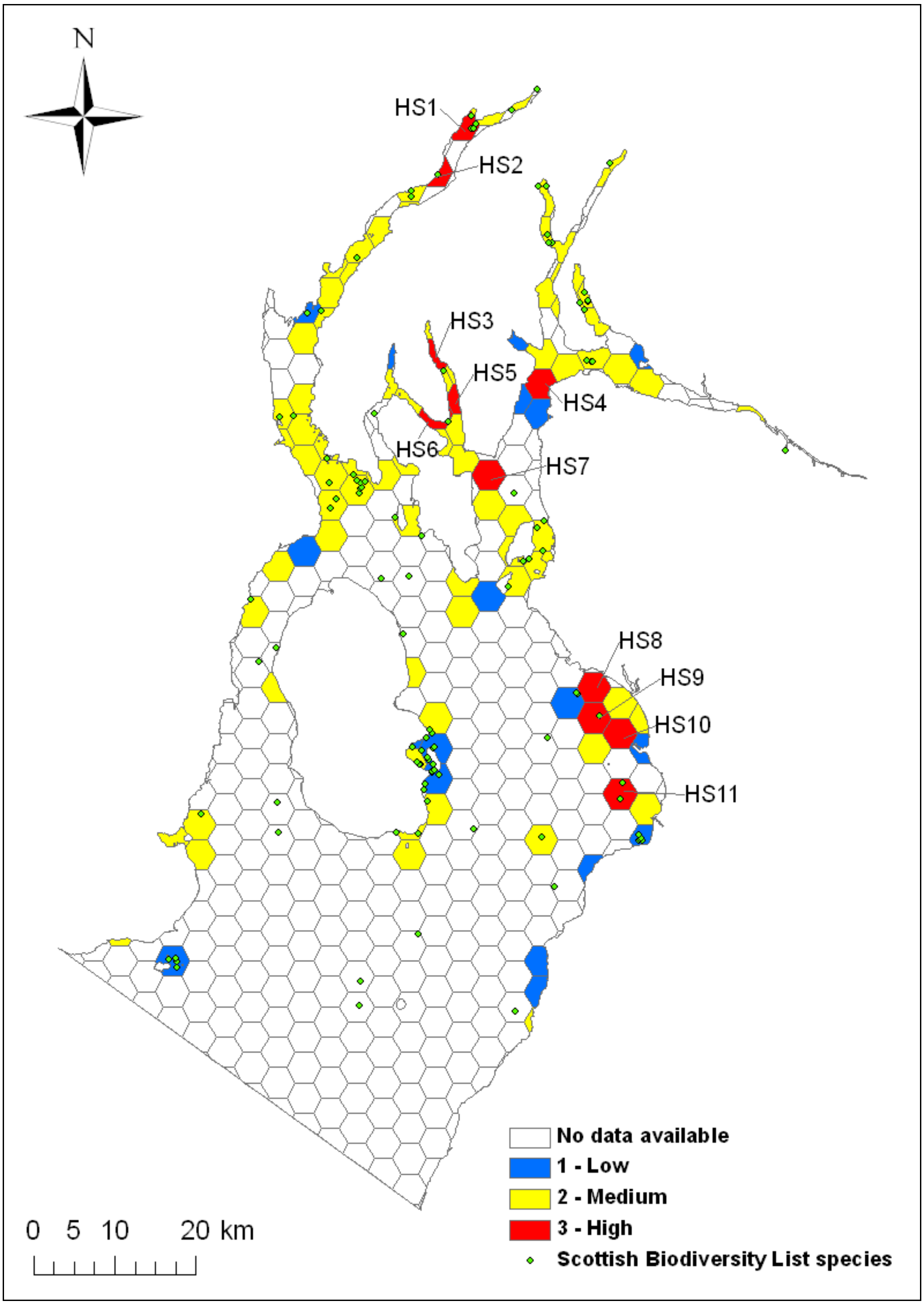


Figure 60. Species hotspots plotted against records of Scottish Biodiversity list species.

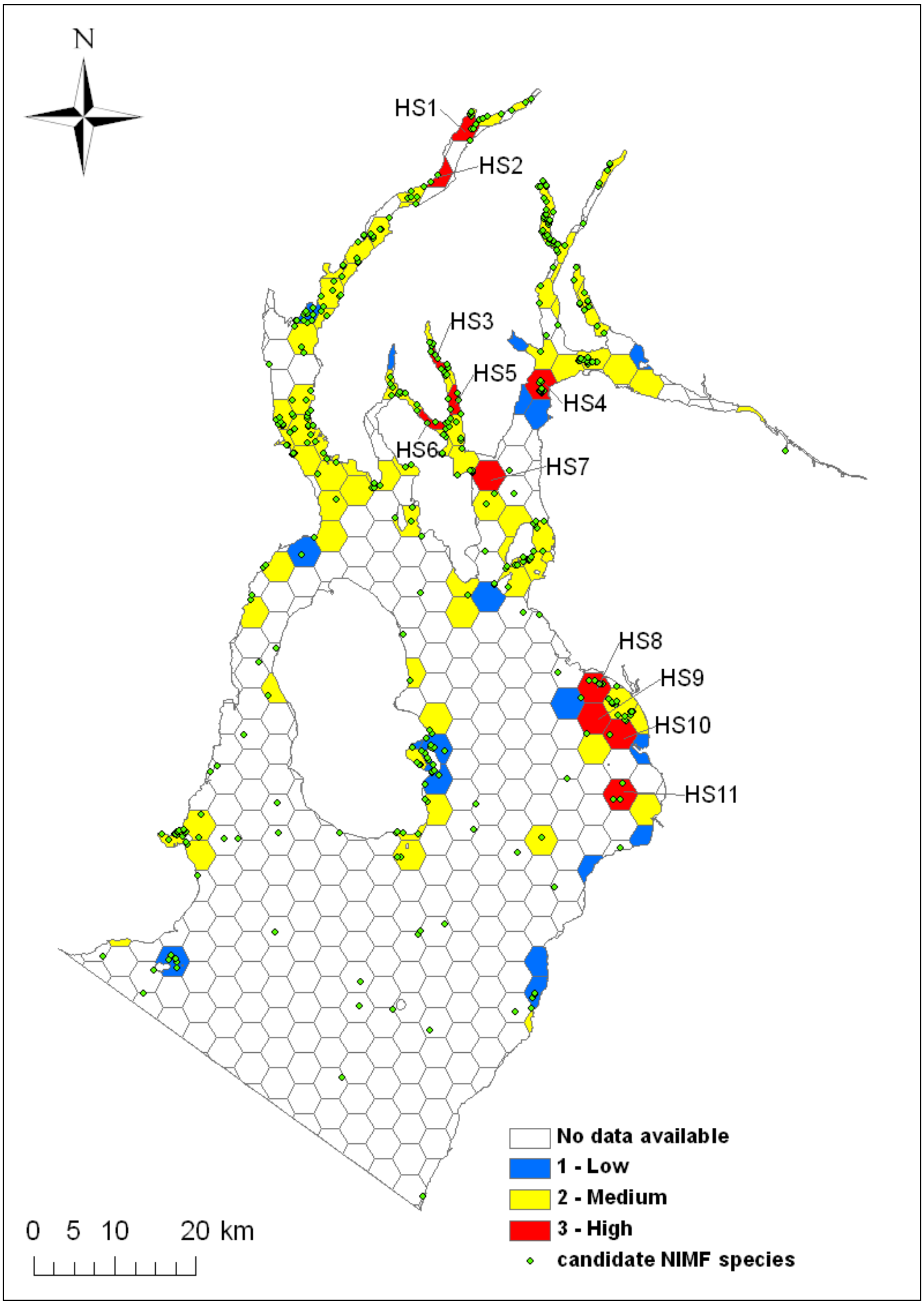


Figure 61. Species hotspots plotted against NIMF species records.

4.7 Predictive seabed habitat type diversity

The highest number of predictive seabed types occurs in the upper reaches of the Firth, especially in the lochs and the coastal margins (Figure 62). The highest diversity of predicted seabed habitat types occurred across the entrances to the sealochs (Loch Fyne and to the western and eastern sides of the Isle of Bute) but not actually within the lochs (with the exception of Gare Loch, Figure 63). There are also hotspots for predicted seabed habitat diversity in the outer Firth, around the Isle of Cumbrae and in the Kilbrannan Sound and the north of the Isle of Arran.

For areas where biotope richness is available, there seems to be little agreement between the hotspots for biotope richness and predictive seabed type diversity hotspots (see section 4.8). Of the 13 biotope richness hotspots just two were seabed habitat type diversity hotspots, with a further five having expected levels of seabed habitat type diversity and six having below expected levels of seabed habitat type diversity "cold spots". This indicates that predictive seabed habitat type diversity is not a good surrogate for biotope richness and cannot be used as such in the absence of biotope survey data for identifying hotspots.

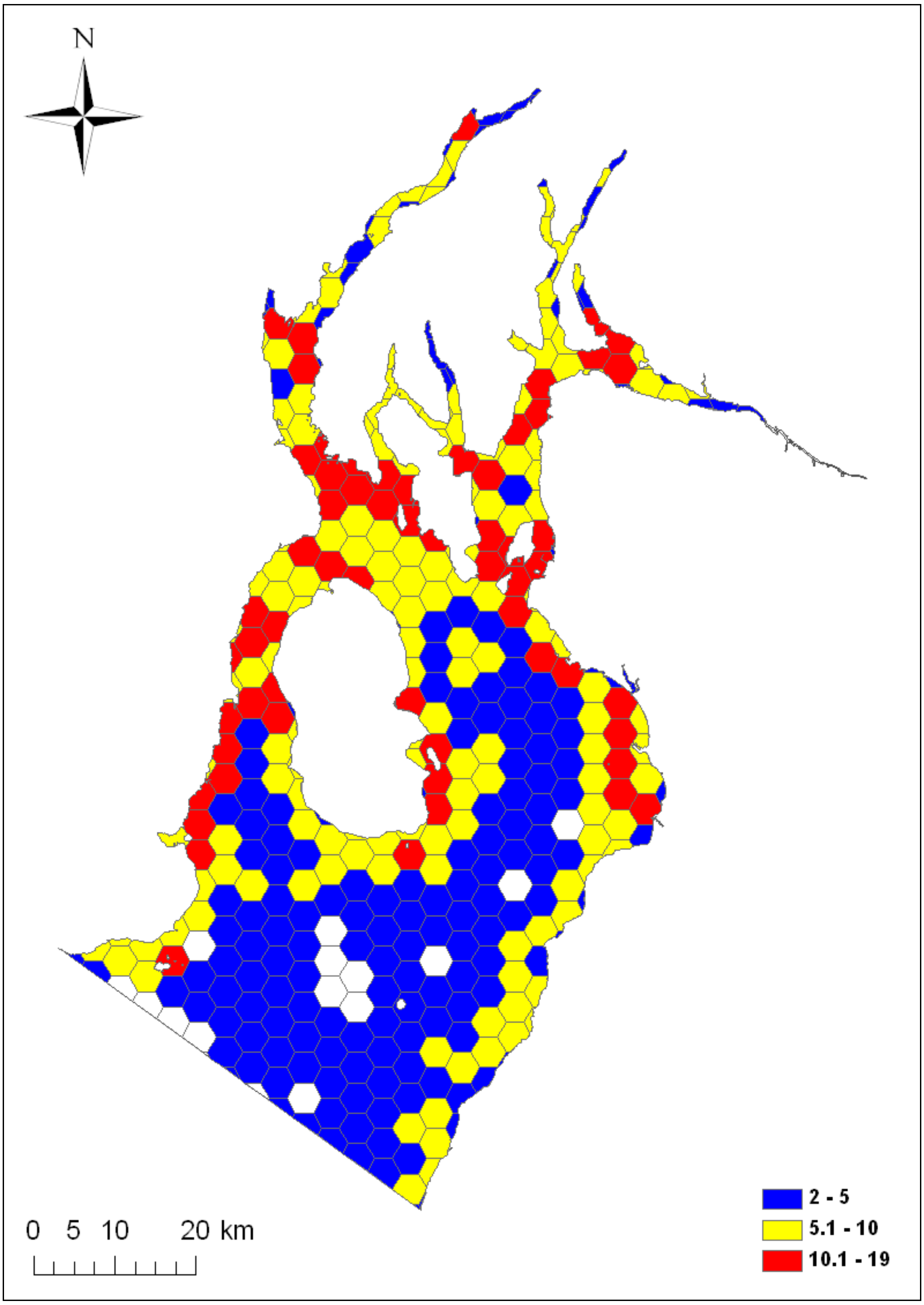


Figure 62. Number of predictive seabed habitat types in each 5 km diameter hexagon for the Firth of Clyde.

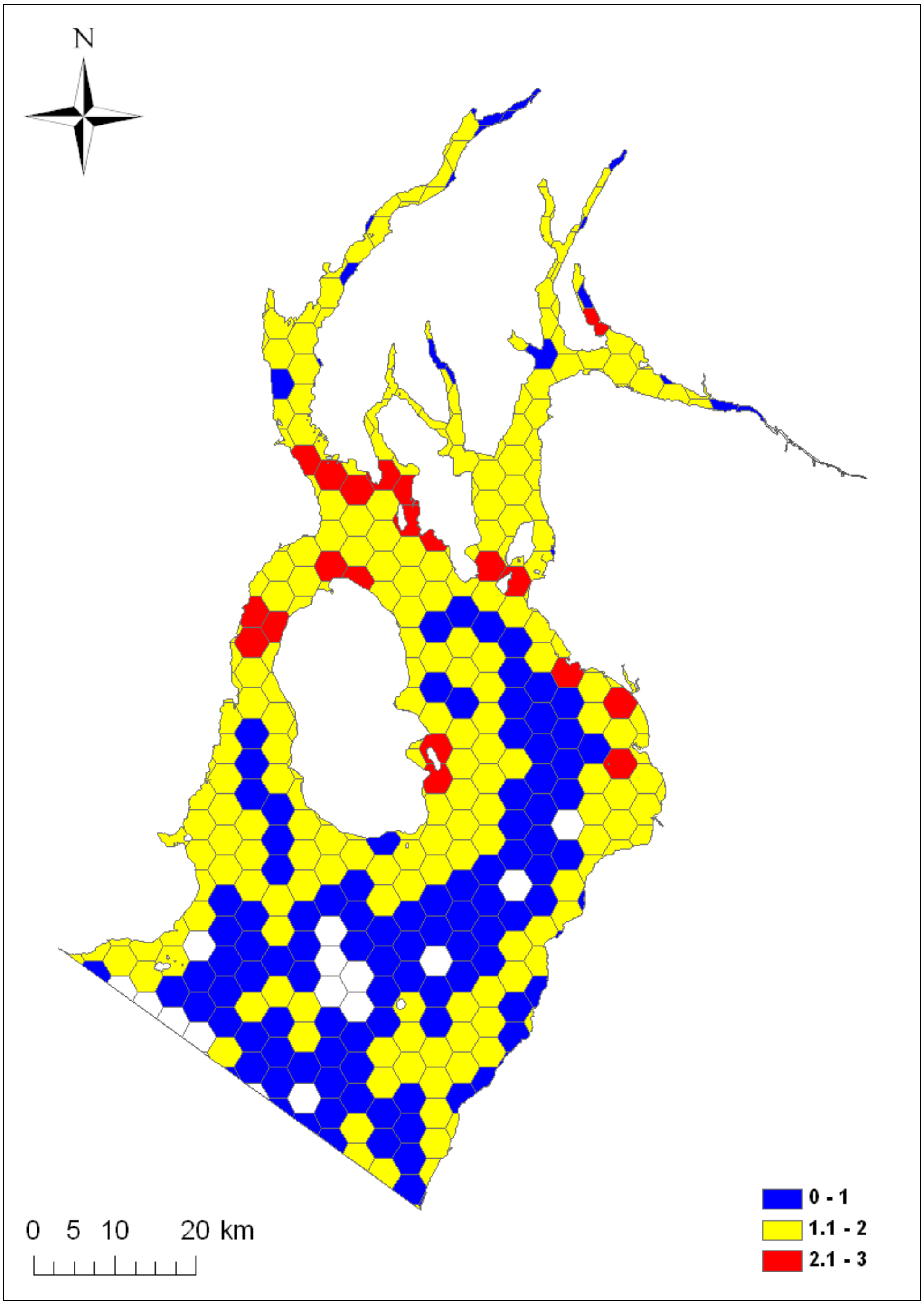


Figure 63. Diversity (H' – see section 3.6.9) of predictive seabed habitat types in each 5 km diameter hexagon for the Firth of Clyde.

4.8 Concordance among measures

In section 3.5.7 we described alternative approaches to identifying areas of important marine biodiversity for use in marine spatial planning (MSP). The individual layers created within the worked example presented in this report constitute of one of these approaches (a hotspot approach) and can be used separately or in combination with other approaches for MSP.

The hotspots themselves highlight specific areas where protection would give the most "value for money", that is they would protect high numbers of species and habitats (including priority features). Hotspots could also be used within decision support software such as Marxan to weight particular areas for inclusion within a network design for protected areas. Each of the layers could be used within a MSP GIS to highlight areas that require safeguarding for different reasons depending on the specific objectives of the plan. It is therefore useful to know the independence of each measure and how the combined scores represent the individual parts.

Table 8 shows the agreement between the different scores (for example whether for one hexagon species richness and biotope distinctness both scored highly). As individual measures, most of the scores are independent of each other. Importantly, the combined scores (i.e. species and biotope hotspot scores and species and biotope combined scores) show fair to very good agreement with their constituent parts, indicating that the combined scores provide a fairly comprehensive picture of the data. For example, species hotspot scores show good agreement with species richness and priority species scores and biotope hotspot captures both richness and priority biotopes well.

Few of the scores showed agreement with the number or diversity of physiographic types from the predictive seabed habitats. The predictive seabed habitat layers could be used separately, for example to produce landscape sensitivity maps for MSP, rather than as a proxy to identify important biodiversity. Interestingly mean species richness showed fair to moderate agreement with priority biotopes and biotope distinctness respectively.

It is clear from this analysis that no one measure captures all aspects of marine biodiversity and that, in the context of Marine Spatial Planning, multiple measures should be used.

The measures used in this study are not exclusive and other measures to support specific planning requirements could be added to the overall analysis to perhaps weight the hotspot calculation to reflect conservation priorities. For example, the priority species measure could be given higher priority for identifying areas for placing high levels of protection, or species/biotope richness could be given a greater weighting to identify those areas where large numbers of species/biotopes were represented.

4.9 Gaps analysis

Despite the wealth of information available for identifying important marine biodiversity within the Firth of Clyde, there are some significant gaps both spatially and in terms of the type of information available (for example for certain groups of species and seabed habitats).

Figure 4 and Figure 5 illustrate the availability of all data (with an indication of quality) for the identification of important biodiversity areas within the current study. For the worked example of the hotspot approach in this report only the hexagons shown in Figure 8 with more than 2 samples had enough information for determining the specific measures of diversity used and the resulting hotspot scores.

Table 8. Agreement between the different measures used in the hotspot analysis and hotspot scores.

	Mean species richness score	Priority species score	Mean Species TD	Biotope richness score	Biotope distinctness score	Score - priority biotopes	Number of Physiotypes	Physiographic type diversity	Species Hotspot score	Median biotope hotspot score	Combined Hotspot score
Mean species richness score	1										
Priority species score	0.04	1									
Mean Species TD	0.07	-0.03	1								
Biotope richness score	0.20	0.03	0.03	1							
Biotope distinctness score	0.33	0.09	0.37	0.12	1						
Score - priority biotopes	0.17	0.23	-0.10	0.51	0.19	1					
Number of Physiotypes	0.08	0.00	0.00	-0.09	-0.16	-0.04	1				
Physiographic type diversity	0.08	-0.03	-0.09	-0.03	-0.06	-0.03	0.59	1			
Species Hotspot score	0.57	0.37	0.42	0.12	0.02	0.09	0.05	0.01	1		
Median biotope hotspot score	0.25	0.06	-0.07	0.72	0.32	0.76	-0.10	-0.13	0.13	1	
Combined Hotspot score	0.24	0.29	0.12	0.40	0.25	0.52	-0.08	-0.24	0.12	0.63	1

Key
- Poor agreement = Less than 0.10
- Fair agreement = 0.10 to 0.30
- Moderate agreement = 0.30 to 0.50
- Good agreement = 0.50 to 0.70
- Very good agreement = 0.70 to 1.00

4.9.1 *Spatial distribution of data*

Spatially, data quality and quantity show a bias towards the coastal areas and sea lochs. There are a number of reasons for such disparities. Firstly collecting data (particularly benthic data) for the deeper areas further from the shore is more difficult and costly (relying primarily on remote methods of sampling). Deeper areas of seabed are often more homogenous and therefore sampling intensity does not necessarily need to be as high as in more heterogeneous seabeds which may be found closer to the coast. However, it is important that the species and habitats of these areas are represented as they contribute to the overall biodiversity of the region.

In order to assess potential gaps in representation we examined the number of hexagons containing each of the predicted seabed habitat type within the Firth of Clyde and identified how many contained collected samples. Two seabed types were not represented in the analysis at all due to a lack of associated samples (deep mixed sediments and infralittoral muddy sand) and three habitat types were under-represented[9] (circalittoral fine sand, circalittoral muddy sand and deep circalittoral coarse sediment). Figure 64 illustrates the distributions of these habitat types.

a) b)

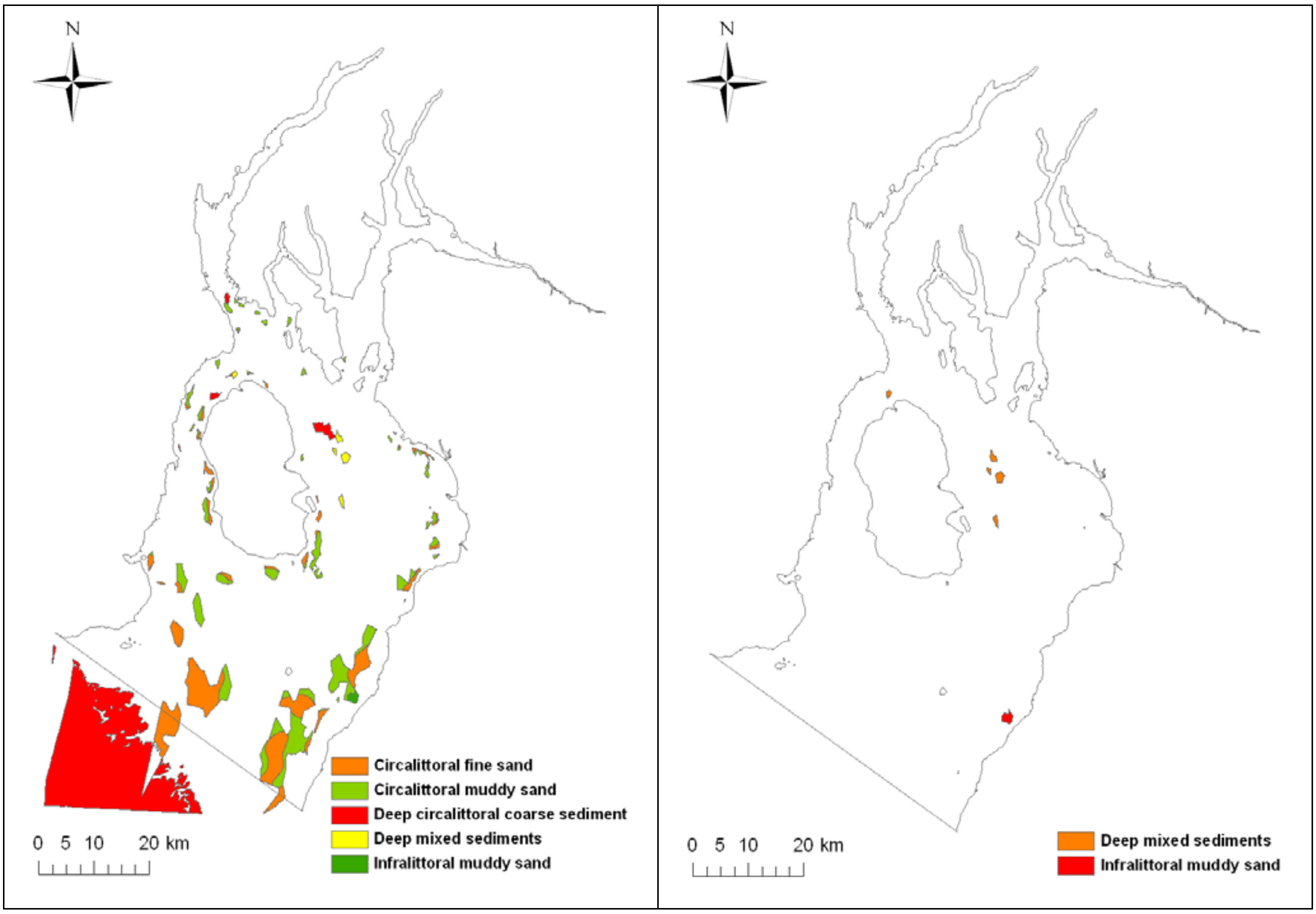


Figure 64. Distribution of a) under represented (less than 20% of hexagons containing seabed type have associated samples) and b) unrepresented seabed habitat types (no samples for those seabed types in any of the hexagonal units).

4.9.2 *Species and habitat data*

In areas where data do exist in substantial quantities, there are gaps in terms of the groups of species and habitats for which data are available and the quality level (see section 3.1) of different datasets at a taxonomic and taxonomic group level.

Firstly there are gaps in representation, which are an artefact of the priority species and habitat lists. In section 3.5 we reviewed the criteria for identifying important species and habitats with regards to different national and international agreements. The criteria for identifying Nationally Important Marine Areas included 'Area important for a priority marine feature'. Those 'priority marine features' would be identified as 'Nationally Important Marine Features' (NIMF) for which criteria are established in Connor *et al.* (2002). NIMF include species and habitats. Candidate NIMF were identified in the exercise undertaken by Hiscock *et al.* (2006). The presence of NIMF in an area enhances its value as a representative location for biodiversity conservation and should be taken into account in the current exercise.

[9] Less than 20% of the hexagons containing that seabed type had associated samples which could be used to identify species and habitats.

However, it should be noted that the list of NIMF species and habitats is currently a candidate list only.

The criteria for identifying candidate NIMF species and habitats do not require the same quantitative rigour that proved so difficult to apply in identifying marine BAP species and habitats. The cNIMF list is therefore a much better representation of marine species and habitats that are rare, in decline or threatened with decline. However, all of the BAP species and habitats are also NIMF and so the candidate NIMF list provides the most suitable measure to address the criterion 'Area important for a priority marine feature'.

Nevertheless, the list of NIMF species is not very 'even' in coverage across the major taxonomic groups. Some of the specialists approached to review groups indicated that they did not believe in the relevant concepts and, for instance, 'to a man' for the polychaetes declined to put any species forward. For other groups, relevant specialists were too busy and, although some obvious candidates could be included, a proper analysis was not undertaken: for instance, sponges. Although the candidate list, along with the other priority lists, nevertheless provides the best current indication of species to be protected, they do not represent the entire suite of marine biodiversity.

Secondly, identifying important areas of marine biodiversity in terms of total diversity is very sensitive to data availability, collection methods and survey effort. In this study we used only benthic species and habitats data (and for species taxonomic diversity we limited the analysis to six taxonomic groups) because this section of data are the most comprehensive (ease of sampling and static nature of many species). That is not to say that the analysis method presented here could not, and should not, be carried out on other taxonomic groups and species from the pelagic realm but the data gaps (in terms of quality and quantity) must first be filled. Currently pelagic species information does exist but the spatial resolution of the information is poor (see cetacean data from Appendix 7). Also because these species are highly mobile, identifying important areas requires greater temporal analysis and is currently confounded by the method of sampling (for example cetacean sightings are limited to where these species spend significant time at the sea surface).

4.9.3 *Variation in data quality*

With the current acceptance of the need to record information in a way that is not only fit for purpose but extends the use of the data beyond purpose[10], the problems encountered with trying to use some of the past data should be avoided in the future. Also despite the short comings of some of the data, there are possible ways of retaining lower quality data (while this is outside of the scope of this work, recommendations will be made). The two main quality issues that prevented data retention in analyses were inaccurate or estimated spatial positioning and taxonomic or habitat classification ambiguities (e.g. species only identified to genus or family). Estimated or low resolution position data could be included by repeating the analysis for each of the possible areas (hexagonal units) that the feature could exist in (where it had not been identified from other areas). An examination of these reiterations would allow an assessment of where the hotspots might change with the inclusion of this data and therefore identify potential areas where further research is needed to confirm the location of these features.

[10] Guidelines are currently being produced under the MEDIN framework (see section 3.2) to standardise biological data recording to extend the use of data beyond purpose.

Species records that were only identified to genus or family could be included if these were unique genera or families within the seabed type within a hexagonal unit (i.e. there are no other species of that family or genus). We examined five randomly selected hexagons to identify the number of additional genera that would be included in the analysis using this approach (see Appendix 9). In some cases over 10 additional genera could have been included. Whilst individual species richness and taxonomic distinctness measures may be influenced by these additions, it is less likely that the relative scores would change significantly. Such data were also associated with low quality datasets and therefore should be used with caution.

In the worked approach used in this study 59% of biotope records (mainly SeaSearch data) were excluded from analyses due to problems with translation of the biotopes to the EUNIS classification that could not be overcome. These data could be included as a separate entity within the overall analysis, by recalculating the biotope measures using these data separately to create new GIS layers. Scores for the overall assessment of important areas could be calculated by incorporating these additional measures. However, without knowing the relationship with the other classifications used it would be unclear where information had been duplicated. Instead, we recommend that separate layers of biotope richness and distinctness be produced using the biotope data in the alternative classification to examine whether different or additional areas are highlighted as important in terms of biotope diversity.

5. Conclusions and recommendations

The dataset compiled during this project and its subsequent analysis revealed patterns in the relative importance of biodiversity in different areas of the Firth of Clyde, based on the available information.

The approach employed here to identify important areas of marine biodiversity was in effect a systematic review[11] and followed the set steps involved in such a review, as outlined in the *Cochrane Handbook*.

1. Formulating a problem (approaches to identifying areas of important biodiversity)
2. Locating and selecting studies
3. Critical appraisal of studies
4. Collecting data
5. Analyzing and presenting results
6. Interpreting results
7. Improving and updating reviews

Such a method has the advantage that it is repeatable (for example it can be updated easily when new data becomes available), precise and unbiased.

5.1 The occurrence, distribution and extent of intertidal and subtidal species and habitats

This study constitutes the most comprehensive analysis of biodiversity for this region to date, despite gaps in the available data (see section 4.9 and below). A total of ca 133,000 data records were collated. The analysis of patterns of biodiversity encompassed an examination of the distribution patterns of species and habitats of conservation concern, together with detailed biodiversity hotspot analyses.

Estimates of areas of important biodiversity are extremely dependent on the state of current knowledge, and hence data coverage. Equally important is the fact that estimates of current distribution of species and biotopes are dependent on sampling or survey effort, and on the age of the dataset concerned. The analysis method worked through in this report to identify biodiversity 'hot spots' and 'cold spots' compensates for sample intensity, and gives an estimate of relative biodiversity, but only in very limited areas where the data meets set criteria in terms of quality and quantity for the analysis. Setting criteria for the inclusion and omission of datasets is therefore crucial for carrying out the sort of objective, defendable assessment upon which evidence based decisions are made.

The disadvantage with taking a systematic review approach is that large amounts of data are omitted due to quality issues, and the analysis does not incorporate subjective qualitative information. Although the more qualitative information (for

[11] A summary of research that uses explicit methods to perform a thorough literature and data search and critical appraisal of individual studies to identify the valid and applicable evidence to address a specific question. University of York (March 2001), Undertaking systematic reviews of research on effectiveness: CRD's guidance for those carrying out or commissioning reviews. CRD Report 4 (2nd edition). Cited 2007-06-27

example consultations with stakeholders), lower quality data, coarser or modelled data (for example the predictive seabed habitat map) are omitted from the analyses, they can still be, and were, collected and presented separately in the review and used to help with formulating a MSP in the absence of more detailed quantitative information.

5.1.1 *Limitations*

The main limitations on this study, and ultimately to the inclusion of biodiversity data in a Marine Spatial Plan in the Firth of Clyde area, are related to 1) data accessibility and 2) data coverage.

1. Fundamental accessibility of data within the project timeframe.

- Data collection was a time and resource intensive activity. Future studies must have clearly defined time-frames for data collection activities. During this project, the lengthy mobilization time for certain data prevented their use in the study (e.g. seal haul out data (SMRU), harbour porpoise and basking shark data (University of Plymouth), basking shark data (MCS)). Other data were discarded due to their coarse resolution, such as the JNCC cetacean data. Mobilization of data requires a targeted approach, and data holder engagement through site visits and, hence, the allocation of staff time.
- More complete and widely available metadata from the data providers would have significantly improved the effectiveness and the timescale of the data collation exercise.
- The data were provided in varied formats (e.g. some datasets had replicates aggregated while others had replicates recorded separately, an important issue for analyses that are dependent on sampling effort). This meant additional time had to be spent reformatting and restructuring datasets and this delayed the analysis phase of the project.

2. Data coverage.

- The spatial coverage of species and biotope survey data in the Firth of Clyde necessitated the use of large spatial units for mapping. Smaller spatial units could potentially be used in other areas where there is better coverage but there will inevitably be a trade-off between having sufficient samples in each spatial unit to make any comparisons meaningful and losing resolution in the spread of data by aggregating across too large an area. This highlights the need for new surveys to be undertaken across the study area, particularly in the outer Firth, where records are especially poor.
- The biotope analyses were concentrated in areas of the sea lochs, again due to the spatial coverage of data. Furthermore, species hotspot analyses indicate the extremely uneven data coverage and highlight large areas for which little is known. This emphasises the limitations that data availability place on large-scale analyses such as the present one.

5.1.2 *Recommendations for future data collation and collection for MSP*

Data availability and accessibility are paramount in MSP, as in coastal management planning and 'State of the Seas' reporting. The difficulties inherent in marine data acquisition in the UK were major obstacles to the Irish Sea Regional Seas Planning Pilot (JNCC, 2004) and Charting Progress (Defra, 2005), and this study was no exception.

For future collations of data we make the following recommendations.

- The time taken to acquire data from disparate organizations should not be underestimated.
- Visiting data holders was an extremely productive way of mobilizing their data, as it gave the authors the opportunity to explain the importance of the study and its data needs. It also allowed data to be collected *in situ*.
- Data acquisition was promoted by the project's connection with a defined project, the SSMEI and the Firth of Clyde pilot. Data providers 'bought in' to the projects aims and could see clear advantages in being associated with a Scottish project.
- Data providers should be made aware of the project's time frame and clear deadlines set for data acquisition.
- Data standardization (from multiple formats) and quality control are a major time constraint that should not be underestimated.

Past large scale data collation projects have found data acquisition difficult (see (Cowling, 2005)). This is why the UK Government set up the Marine Data Information Partnership, now the Marine Environmental Data Information Network (MEDIN). The growing network of marine Data Archive Centres and requirement for UK wide metadata and data standardization should enable projects such as this to collate data in less time in the not too distant future. The project team's association with the Data Archive for Seabed Species and Habitats was of considerable benefit to the project data acquisition and analysis.

- Data collation should be undertaken in liaison with the relevant national marine Data Archive Centres.

The gaps in data coverage are best filled by up to date surveys of the relevant areas. A sample bias is apparent in the distribution maps for priority species and habitats and inherent in the data, and may result from surveys focusing on areas of known occurrences of specific features. This bias highlights that future surveys should take a more objective approach to surveying areas and report on nil results, in order that a true representation of distributions is available.

Nevertheless, legacy data also has a role to play, and should be examined prior to re-survey. Legacy data also has the advantage of providing a 'before' and 'after' snapshot, which could be used to identify changes in the biodiversity of the Firth of Clyde over time.

For future data recording we recommend setting up protocols that promote high data quality (in line with the work being carried out by MEDIN) primarily in order to extend the use of the data beyond its initial purpose.

We recommend using a standard habitat classification (EUNIS) for the simple reason that it allows a comparison between like and like and avoids double badging (an important consideration when assessing relative biotope richness). This again will mean that large amounts of data cannot be used in the analysis of hotspots but could be used separately and with caution for MSP or focusing future survey work.

Further to this we recommend that more work be carried out to examine whether it is possible for the SeaSearch biotope classification to be translated to EUNIS without significant resurveying, and that the way Seasearch data are recorded in the future be revised so that the information is translatable.

5.2 Application of existing criteria for the identification of important marine biodiversity within MSP

The aim of the current study was to examine the available data and suggest ways in which areas of important biodiversity could be identified for the Firth of Clyde for the purposes of MSP.

The first decision made prior to identifying areas was the scale of planning unit. One option for utilising the information within a MSP would be to use a two-tiered scale of resolution, a finer scale or unit for the coastal areas and sea lochs and a coarser scale for the open Firth. In addition, the size and shape of planning units could be adapted depending on data availability, management issues and specific spatial issues relevant to marine spatial planning. For the purposes of the worked example of a hotspot approach presented here we chose 5 km diameter hexagons as a standard unit (see section 3.4 for the reasoning behind this).

- Using a standard scale of unit across the study area removes any spatial bias and allows a comparison of the relative importance of different areas in terms of biodiversity.

Another decision that must be taken early on in such a study is what approach to use to identify important areas for marine biodiversity. If the decision is to identify concentrations of priority species and habitats then a decision on which criteria are the most important is required. It is clear that the different lists available (BAP, NIMF, nationally rare and scarce, OSPAR, Scottish Biodiversity List and LBAP) are all created at different scales from local to international and the criteria span from extremely quantitative to rather more forgiving.

The key consideration is, however, which criteria can be applied at a local level. Only the LBAP criteria are designed to be applied at such small spatial scales and most of the other criteria simply cannot be adequately translated (for example nationally rare and scarce and NIMF criteria look at rarity at a UK-wide scale, while OSPAR criteria it is at a NE Atlantic regional sea scale). However, because LBAP criteria are based on BAP criteria and have specific data requirements for demonstrating decline, NIMF criteria are possibly better suited to application for MSP at local scales.

There is no easy solution to this issue and undoubtedly this complex problem will recur in the future until, for example, LIMF criteria (Locally Important Marine Features) are developed specifically to address this problem.

We could not apply these criteria at a local level during this study due to insufficient data to determine levels of, for example, decline. The recent review of BAPs and identification of candidate NIMFs ((Hiscock *et al.*, 2006)) drew heavily on a large number of national experts on particular species groups or habitats. Such a review was outside the remit of this study.

5.3 Identification of areas of biodiversity interest within the Firth of Clyde

The approach used in this report, identified a number of locations that are biodiversity hotpots for species or biotopes or both.

One site, at the mouth of Loch Shira, was categorised as a combined hotspot for both species and biotopes. A further nine locations scored highly for the final combined biodiversity hotspot score (see Appendix 8).

Overall, the following areas included combined biodiversity hotspots in the Firth of Clyde.

- Mouth of Loch Shira
- Loch Goil;
- the mouth of Holy Loch;
- the north of Loch Striven;
- Kyles of Bute;
- Ardlamont Point; and
- Loch Fyne, near Tarbert.

In addition, the following locations included biodiversity hotspots for species or biotopes alone.

- Northern Loch Fyne;
- Loch Striven;
- East of Dunoon in the upper Firth;
- East of Rothesay;
- Irvine Bay;
- Loch Long;
- Gare Loch and Loch Long;
- Loch Fyne around Barmore Island;
- Ardlamont Point, and
- Kames Bay.

The analysis also revealed several areas of particular species richness. These were:

- Glenan Bay;
- East of Loch Tarbert;
- West of Skipness;
- Kilchousland Bay; and
- North of Brodick Bay, Arran

All of the above areas may be considered to be of importance for marine biodiversity in the Firth of Clyde. But all the analysis is based on the current data, which is in itself patchy and dependant on sampling bias.

5.4 Recommendations for using the results of the current study in MSP

It is clear that no one measure provides a complete representation of biodiversity, and that a range of measures needs to be used (see Table 8). The biodiversity 'hotspot' approach has the advantage of combining different measures representative of priority features and diversity of features into one measure (where data allow) presenting the information as one relative rank of biodiversity importance for marine spatial planners to view. The concordance analysis demonstrated that the biodiversity hotspot scores represented the relative levels of species or biotope richness, number of priority species or biotopes, and taxonomic and biotope distinctness.

The individual biodiversity measures (e.g. species richness, biotope distinctness, seabed type diversity etc) and the distribution of priority species in respect to the various criteria could be used separately or in combination as part of the MSP. However, it should be noted that all of these measures, and species richness in particular, are highly dependent upon sampling intensity. For example, species richness could only be included in our analysis once it had been 'normalised' for sampling effort and locations of more than expected levels of species richness, relative to sampling effort, identified.

Other methods to identifying important areas for biodiversity are reviewed in section 3.5.7, and the GIS layers (including a layer showing areas identified by experts to be locally important) allowing these alternative approaches to be employed for MSP are available with this report and project GIS.

A hotspot approach aims to prioritise areas for protection based on cost effectiveness, in essence protecting the highest number of important species and habitats for the least cost. Whilst such a method (in particular where it combines different measures) can synthesise lots of information into a more simplified form for management and planning, there is a concern that this may obscure some of the finer detail that could also be important.

Taking an Ecosystem Approach to representing marine biodiversity requires all species and habitats to be represented within protected areas and in sufficient amounts (area and population size) to allow the ecosystem to function "normally". Despite gaps in data coverage, it may be possible to use the available data to identify areas (using predefined units such as the 5 km diameter hexagons) that allow a certain proportion of each of the habitats and species to be included in protected areas within the Marine Spatial Plan (MSP). Decision support software such as Marxan (Ball & Possingham, 2000) can be used to identify a number of possible areas.

- We recommend that a combination of approaches (biodiversity measures, biodiversity hotspots, representativeness of all features and sensitivity assessments) be used in the MSP.

The predictive seabed habitat type was explored as a potential surrogate for biotope survey data. But comparisons of seabed habitat type diversity with biotope richness indicate that this is not a viable option for the Firth of Clyde study area. However, the predictive seabed map may be used for examining coarse level representativeness, in protected areas, of all the habitats found in the Firth of Clyde within protected areas.

- An examination of the relationships between recorded habitats and predicted habitats would allow the confidence in using the predictive seabed maps as a surrogate to be assessed but was beyond the scope of the current study.

All maps generated in the course of this study must be considered within the context of expert knowledge of this study area. The maps are based on the data available but these reflect data availability and may miss important sites that have not been formally surveyed. As such, they may not be a definitive representation of regional patterns of biodiversity. The next stage of this project, stakeholder review (which our initial consultation with local experts can contribute to), is vital to allow refinement of the maps and improve on data gaps either through data archaeology or further survey work.

Additional future work may also include the assessment of sensitivity of the identified hotspots or key species or habitats to anthropogenic or environmental factors. Such assessments could provide additional layers and contextual information for the development of a marine spatial plan for the SSMEI Clyde Pilot study area.

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Appendix 1. Data provider contacts, their affiliation and outcomes of requests for data.

Contact	Organization	Outcomes
David Green	Aberdeen Institute for Coastal Science and Management	No data available but provided list of relevant contacts and contacted colleagues
Jim McKie and Fiona Thompson	FRS	Agreed to provide metadata and data and liaised with colleagues. Metadata received but data not available in time for analysis.
Callum Duncan	MCS	Provided lists of MCS surveys. Currently biotope matches for surveys are not available and 2007 surveys were not available for analysis as had not yet been inputted into marine recorder. MCS Basking Shark database received (past deadline to be included in analysis), agreed to contact local experts. No response received from contacts.
Mike Burrows	SAMS	Supplied additional related survey data and contacted SAMS colleagues. Received a number of datasets from SAMS staff (one Garroch Head dataset past deadline to be included in analysis). Identified Kilbrannon Sound as being an important hotspot for Northern Krill.
Myles O'Reilly	SEPA	Provided datasets and relevant metadata from SEPA.
Richard Sutcliffe	Glasgow LRC/Museum of Glasgow	Provided search of Recorder database (most data not relevant as birds, butterflies etc) and provided a number of historic Seasearch surveys not currently publicly available and offered to search for species within the museum's records for a small fee. Species lists not finalised in time to enable species and habitat specific searches.
Jim Atkinson, Fiona Hannah and Peter Barnett	Millport Marine Field Station	Provided access to staff, library resources and PhD theses. Peter Barnett has data available for Kames Bay and Hunstanton but currently unpublished therefore, not available for purposes of studies. Identified the following areas as being important; Ballantrae banks, South Arran ledges and Skelmorlie (herring spawning grounds), Minard island (*Limaria hians* present in deepest area but has been degraded by heavy trawling), head of the sealochs (Sea pens – *Funiculina quadrangularis*), North end of Cumbrae (Modiolus beds), Coulport, Loch Long and parts of Loch Fyne closed to the military (unfished for many years), Loch Ranza (*Ascophyllum nodosum* ecad *mackii*) and Burnt Island and the Kyles of Bute (seals).
Callan Duck	SMRU	Agreed to provide seal haul-out data but not received in time for analyses.
Jason Hall-Spencer	Ex-Millport now University of Plymouth	Provided five papers relating to maerl. Identified Otter Spit in Loch Fyne as being important as it is tide-swept and not subject to fishing activity. He noted it was highly diverse with maerl, sea pens and flame shells present.
Roger Coggan	CEFAS	No relevant data.
Ian Dixon	ERT (Scotland) Ltd (independent marine environmental monitoring and environmental consultancy)	No relevant data other than that already identified.
Christine Howson	Local expert	No data not already in public domain.

Contact	Organization	Outcomes
Dylan Todd	SNH	Provided MESH layers. Predominantly based on survey data available from JNCC Marine Recorder Snapshot.
Paul Robinson	JNCC	Provided public access to JNCC database, including MNCR surveys.
Colin Speedie	Basking shark expert	Provided effort based basking shark survey data associated mammal sightings. Data not available in time for analysis. He noted that the drop-off in the outer Firth of Clyde represents an important feeding area for basking sharks.
Lissa Goodwin	University of Plymouth	Agreed to provide effort based Harbour porpoise survey. Data not available in time for analysis.
Steven Mason	NTS Scotland (Arran)	Agreed to undertake search of species list undertaken – Species list not in time for analysis.
Tom Pearson	Millport (now retired)	No response.
Tim Dunn	JNCC Aberdeen	Provided link to Cetacean Atlas Data
Douglas Hoad	Clydeport	No response.
Howard Wood	COAST	Sent list of COAST surveys. Much of COAST data in from of SEASEARCH surveys which are included in JNCC snapshot and received from MCS. He also identified a number of areas including the Otter Ferry area in Loch Fyne important for flame shells and maerl, Pladda, especially reef 300m south of Island) as important for it's biodiversity it has tide-swept reefs with little fishing impact from dredging. He also identified only occurrence of *Corynactis viridis* he knows of in the Clyde and many hydroids and anemones present. Sanda Island as being important due to the tide-swept reefs featuring a huge variety of anemones hydroids, sponges and fish such as wrasse. Lamlash Bay was highlighted as being important for species and communities having large areas of maerl to the north of the bay and a seagrass bed. Other areas of seagrass, maerl and rocky reef around Arran were identified (See Figure 15/16 for full list). Bennan head was also noted as an important fish spawning ground.
Peter Hayward	University of Swansea	No response after initial email and telephone conversations. Has some student field course data from Cumbrae area.
Tony Wass	ASW Fishing Charters	Identified the area from Cumbrae to Loch Long and Ballantrae Banks as being an important area for juvenile fish and for spawning however he noted that many spawning areas disturbed by fishing. Indicated that the first mile from shore around the whole Clyde is particularly important for juvenile fish. The following areas were also considered to be important areas for recreational angling; Banks of Largs and Fairlie , Entrance to Loch Ryan, Ballantrae beach, Greenock Esplanade, Holy Isle, Pladda, Sanda, the wrecks of Longwy and Ailsa Craig.
John Liddiard	Freelance Underwater Photographer and Diving Journalist	Identified the wrecks of the Akka, Wallachia and Europa and also Ailsa Craig as important recreational dive sites.
Owen Paisley	Seasearch Coordinator	Upper Loch Fyne important for *Pachycerianthus*. Inchmarnock (West of Bute) important for Maerl and Flame shell beds. Otter spit important for Maerl beds.
Various	Recreational dive operators	Identified the following areas as being important for recreational diving; Gantock Rocks, Little Cumbrae, Wemyss Bay, Loch Goil and the head of Loch Long, in addition to the wrecks of the Akka, Greenock, Wallachia, Beale, Kintyre, Europa, Champion, Iona, Curassier and Lady Isabella.

Appendix 2. Metadata schema for project

Element	Description
MetadataID	Unique reference code Mandatory
Title	UK Gemini 2.1 mandatory
Alternative Title	UK Gemini 2.1 optional
Dataset Language	UK Gemini 2.1 mandatory
Abstract	UK Gemini 2.1 mandatory
Topic Catagory	UK Gemini 2.1 mandatory
Lineage	UK Gemini 2.1 optional
Start Date	UK Gemini 2.1 mandatory
End Date	UK Gemini 2.1 mandatory
Reference Date	UK Gemini 2.1 mandatory
Originator	UK Gemini 2.1 optional (Mandatory for this project)
Contributor(s)	UK Gemini 2.1 optional
West Bounding Longitude	UK Gemini 2.1 mandatory
East Bounding Longitude	UK Gemini 2.1 mandatory
North Bounding Latitude	UK Gemini 2.1 mandatory
South Bounding Latitude	UK Gemini 2.1 mandatory
Spatial Reference System	UK Gemini 2.1 mandatory
Spatial Resolution	UK Gemini 2.1 optional
Data Format	UK Gemini 2.1 mandatory
Distributor	UK Gemini 2.1 mandatory
Frequency of Update	UK Gemini 2.1 mandatory
Access constraint	UK Gemini 2.1 optional
Use Constraints	UK Gemini 2.1 optional
Dataset Character Set	UK Gemini 2.1 optional
Metadata Standard Used	UK Gemini 2.1 optional (Mandatory for this project)
Completeness	UK Gemini 2.1 mandatory
Spatial Accuracy	ISO19115 optional (Mandatory for this project)
Temporal Accuracy	ISO19115 optional (Mandatory for this project)
Taxonomic Consistency	ISO19115 optional (Mandatory for this project)
DataType	ISO19115 optional (Mandatory for this project)
Method	ISO19115 optional (Mandatory for this project)
Reference	UK Gemini 2.1 optional
Subject	UK Gemini 2.1 mandatory
Purpose	ISO19115 optional (Mandatory for this project)
Scope	ISO19115 optional (Mandatory for this project)
Overall Quality	ISO19115 optional (Mandatory for this project)
Metadata Point of Contact	UK Gemini 2.1 mandatory
Metadata Date of Update	UK Gemini 2.1 mandatory

Appendix 3 Permission document

SSMEI Firth of Clyde Pilot – Data permission form

For [name/organization]
....
....

a) Analysis

1. Use and analysis of data to create a report for the Review of Biodiversity for Marine Spatial Planning within the Firth of Clyde.
2. Use of data to produce GIS layers to assist with Marine Spatial Planning objectives.

b) Dissemination

In addition to use on the above project DASSH aims to make marine survey data available over the World Wide Web, in order to contribute to the national resource of marine environmental data. DASSH will:

1. Provide searchable access to and download facilities for datasets via an on-line catalogue of both metadata and data via the DASSH (www.dassh.ac.uk) and *MarLIN* (www.marlin.ac.uk) websites;
2. Progress metadata to the Marine Date Information Partnership (MDIP) Metadata Discovery Portal, and
3. Progress metadata and data in standard format to the National Biodiversity Network (NBN) Gateway (www.searchnbn.net).

DASSH may also progress metadata and/or data to international biological data portals, for example the Ocean Biogeographic Information System (OBIS) and the Global Biodiversity Information Facility (GBIF). Use of data available via the DASSH website is subject to the DASSH Terms and Conditions.

c) Storage / Archiving of datasets

Data/images submitted to DASSH will be archived in the form provided by the data provider. Intellectual Property Rights (IPR) associated with the data, images or videos remains with the current IPR owner. Nothing in this agreement constitutes a transfer of Intellectual Property Rights.

DASSH holds and processes data/images for the following purposes:

1. To provide a digital archive for marine benthic survey data of both species and habitats.
2. To provide a digital repository for marine benthic images, video and ROV image data.
3. To transfer benthic survey data into a standard format, and progress the data to the archive.

d) Data Protection

The collection and storage of personal data, as defined in the Data Protection Act (1998) and any subsequent amendments, needs explicit written consent from the subject of that data. This information will be held and processed by DASSH only for the following purposes:

1. To maintain the contact details of data providers, owners of intellectual property rights and original recorders of records & where appropriate display their name(s) on the DASSH, *MarLIN*, MDIP and NBN websites for copyright purposes.
2. To comply with international metadata standards for the collection of data.

Agreement

a) I confirm that I consent (on behalf of myself / my organization) to the use of data in the Review of Biodiversity for Marine Spatial Planning within the Firth of Clyde.

b) I confirm that I consent (on behalf of myself / my organization) to the storage and display of the data specified in the Appendix (overleaf) for the purposes set out in the statements above.

Please check applicable statement

- ☐ Metadata only archived
- ☐ Metadata and data archived in DASSH
- ☐ Metadata and data archived by DASSH and disseminated on the DASSH website
- ☐ Metadata and data archived by DASSH, disseminated on the DASSH website and sent to the National Biodiversity Network

c) I agree to DASSH recording and processing the information about myself / my organization.

I understand that this information will be used only for the purposes set out in the statement above and my consent is conditional upon the DASSH complying with its duties and obligations under the Data Protection Act.

Name [please print]…………………………………………………………… …….

Signature……………………………………………….Date…………………………

Appendix 4. Priority species and habitat lists for the Firth of Clyde.

Table A4.1. Important species recorded in the Firth of Clyde by designation. Shading refers to species that occur solely on the Scottish Biodiversity List.

NBN Species code	Phylum / Division	Species	Common name	Nationally rare or scarce	BAP	LBAP	c NIMF	Scottish Biodiversity List	OSPAR
NBNSYS0000155961	Porifera	*Phakellia ventilabrum*	Chalice sponge	yes			yes		
NBNSYS0000156196		*Eurypon clavatum*					yes	yes	
NBNSYS0000156916	Cnidaria	*Funiculina quadrangularis*	Tall sea pen		yes	yes	yes		
NBNSYS0000156935		*Pachycerianthus multiplicatus*	Fireworks anemone	yes	yes		yes		
NBNSYS0000156967		*Gonactinia prolifera*		yes					
NBNSYS0000156984		*Bolocera tuediae*		yes					
NBNSYS0000157040		*Paraphellia expansa*					yes	yes	
NBNSYS0000157278	Nemertea	*Cerebratulus fuscus*						yes	
NBNSYS0000157370		*Tetrastemma robertianae*						yes	
NBNSYS0000158595	Annelida	*Amalosoma eddystonense*		yes					
NBNSYS0000159512		*Baldia johnstoni*		yes			yes		
NBNSYS0000159727		*Sabellaria spinulosa*	Ross worm				yes		
NBNSYS0000163236	Crustacea	*Monoculodes gibbosus*		yes			yes		
NBNSYS0000163290		*Leucothoe spinicarpa*					yes		
NBNSYS0000163379		*Parametaphoxus fultoni*					yes		
NBNSYS0000163533		*Guernea coalita*					yes		
NBNSYS0000163625		*Eriopisa elongata*		yes			yes		
NBNSYS0000163633		*Maera loveni*					yes		
NBNSYS0000163665		*Microprotopus longimanus*					yes		
NBNSYS0000163724		*Corophium affine*					yes		
NBNSYS0000163735		*Siphonoecetes striatus*					yes		

NBN Species code	Phylum / Division	Species	Common name	Nationally rare or scarce	BAP	LBAP	c NIMF	Scottish Biodiversity List	OSPAR
NBNSYS0000163769		*Parvipalpus capillaceus*					yes		
NBNSYS0000164551		*Palinurus elephas*	Crayfish, Crawfish or Spiny lobster		yes		yes		
NBNSYS0000165627	Mollusca	*Liostomia clavula*					yes		
NBNSYS0000166224		*Modiolus modiolus*	Horse mussel				yes		
NBNSYS0000166254		*Atrina fragilis*	Fan Mussel	yes	yes	yes	yes	yes	
NBNSYS0000166396		*Devonia perrieri*						yes	
NBNSYS0000166568		*Arctica islandica*	Icelandic cyprine				yes		yes
NBNSYS0000166895	Brachiopoda	*Terebratulina retusa*		yes					
NBNSYS0000167009	Bryozoa	*Arachnidium fibrosum*						yes	
NBNSYS0000167480	Echinodermata	*Antedon petasus*					yes		
NBNSYS0000167664		*Echinus esculentus*	Edible sea urchin				yes		
NBNSYS0000167717		*Psolus phantapus*					yes		
NBNSYS0000167733		*Cucumaria frondosa*		yes			yes		
NBNSYS0000167741		*Ocnus planci*					yes		
NBNSYS0000167872	Chordata	*Diazona violacea*	Football sea squirt				yes		
NBNSYS0000167904		*Styela gelatinosa*	Loch Goil sea squirt	yes	yes	yes	yes		
NBNSYS0000167937		*Pyura microcosmus*					yes		
NBNSYS0000168023		*Lampetra fluviatilis*	River lamprey				yes		
NBNSYS0000168045		*Cetorhinus maximus*	Basking shark		yes			yes	yes
NBNSYS0000168111		*Raja batis*	Common skate					yes	
NBNSYS0000168150		*Anguilla anguilla*	Common eel				yes	yes	
NBNSYS0000168173		*Clupea harengus*	Herring		yes		yes	yes	
NBNSYS0000168189		*Salmo salar*	Atlantic salmon				yes		yes
NBNSYS0000168193		*Osmerus eperlanus*					yes		

NBN Species code	Phylum / Division	Species	Common name	Nationally rare or scarce	BAP	LBAP	c NIMF	Scottish Biodiversity List	OSPAR
NBNSYS0000168223		*Apletodon dentatus*	Small-headed clingfish				yes		
NBNSYS0000168233		*Lophius piscatorius*	Sea monkfish		yes		yes		
NBNSYS0000168255		*Gadus morhua*	Cod		yes		yes	yes	yes
NBNSYS0000168262		*Merlangius merlangus*	Whiting		yes		yes	yes	
NBNSYS0000168268		*Molva molva*	Ling		yes		yes	yes	
NBNSYS0000168275		*Pollachius virens*	Saithe				yes	yes	
NBNSYS0000168281		*Trisopterus esmarkii*	Norway pout					yes	
NBNSYS0000168582		*Ammodytes marinus*	Lesser sand-eel		yes		yes	yes	
NBNSYS0000168583		*Ammodytes tobianus*	Lesser sand-eel					yes	
NBNSYS0000168618		*Pomatoschistus minutus*	Sand goby				yes		
NBNSYS0000168650		*Scomber scombrus*	Mackerel		yes				
NBNSYS0000168717		*Pleuronectes platessa*	Plaice		yes		yes	yes	
NBNSYS0000169138		*Halichoerus grypus*	Grey seal				yes		
NBNSYS0000169166		*Phocoena phocoena*	Common porpoise		yes		yes	yes	yes
NBNSYS0000188641		*Caretta caretta*	Loggerhead turtle		yes	yes	yes	yes	yes
NBNSYS0000188646		*Dermochelys coriacea*	Leathery turtle		yes	yes	yes	yes	yes
NBNSYS0000169428	Rhodophyta	*Lithothamnion corallioides*	Coral maerl	yes	yes		yes		
NBNSYS0000169445		*Phymatolithon calcareum*	Common maerl		yes				
NBNSYS0000169549		*Callophyllis cristata*		yes					

Table A4.2. Important species not recorded in the Firth of Clyde dataset compiled during the current project but considered of importance.

NBN Species code	Phylum / Division	Species	Common Name	Nationally rare or scarce	BAP	LBAP	c NIMF	Scottish Biodiversity List	OSPAR
NBNSYS0000163237	Crustacea	*Monoculodes packardi*		yes			yes		
NBNSYS0000163466		*Austrosyrrhoe fimbriatus*		yes			yes		
NBNSYS0000166277	Mollusca	*Ostrea edulis*	Native oyster		yes	yes	yes	yes	yes
NBNSYS0000166354		*Thyasira gouldi*	Northern hatchet shell	yes		yes	yes	yes	
NBNSYS0000167861	Chordata	*Leptoclinides faeroensis*		yes			yes		
NBNSYS0000168170		*Alosa alosa*	Allis shad			yes	yes		yes
NBNSYS0000168171		*Alosa fallax*	Twaite shad			yes	yes		
NBNSYS0000169127		*Lutra lutra*	Otter			yes			
NBNSYS0000169149		*Delphinus delphis*	Common dolphin		yes	yes	yes	yes	
NBNSYS0000169358	Rhodophyta	*Gelidiella calcicola*		yes			yes		
NBNSYS0000169481		*Schmitzia hiscockiana*		yes			yes		
NBNSYS0000170030	Phaeophyta	*Asperococcus scaber*		yes			yes		
JNCCMNCR00000839		*Ascophyllum nodosum mackaii*			yes	yes	yes	yes	

Table A4.3. Important biotopes recorded in the Firth of Clyde by designation. EUNIS level 1-3 habitats have been excluded from the list.

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A1.1 High Energy Littoral Rock	LR.HLR						
A1.11	LR.HLR.MusB	Reefs			Mussel and/or barnacle communities		
A1.12		Reefs					
A1.2 Moderate Energy Littoral Rock	LR.MLR						
A1.21		Reefs	Intertidal boulder communities		*Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders AND Underboulder communities		
A1.22	LR.MLR.MusF.MytFR	Reefs					
A1.3 Low Energy Littoral Rock	LR.LLR						
A1.31	LR.LLR.F	Large shallow inlets and bays AND Reefs	Estuarine rocky habitats		*Ascophyllum nodosum* on very sheltered mid eulittoral rock AND *Fucus vesiculosus* on variable salinity mid eulittoral boulders & stable mixed substrata AND *Ascophyllum nodosum* & *Fucus vesiculosus* on variable salinity mid eulittoral rock AND *Fucus ceranoides* on reduced salinity eulittoral rock		
A1.4 Communities of littoral rockpools	LR.FLR						

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A1.41	LR.FLR.Rkp	Reefs			Coralline crust-dominated shallow eulittoral rockpools AND Fucoids and kelp in deep eulittoral rockpools AND Seaweeds in sediment-floored eulittoral rockpools		
A1.42	LR.FLR.Rkp	Reefs					
A2.2 Littoral sand and muddy sand	LS.LSa						
A2.21		Mudflats and sandflats not covered by seawater at low tide				*Mytilus edulis* and *Fabricia sabella* in littoral mixed sediment	
A2.22	LS.LSa.MoSa.BarSa	Mudflats and sandflats not covered by seawater at low tide					
A2.23	LS.LSa.FiSa.Po	Mudflats and sandflats not covered by seawater at low tide					
A2.24	LS.LSa.MuSa	Large shallow inlets and bays AND Mudflats and sandflats not covered by seawater at low tide	Intertidal mudflats			Polychaete / bivalve dominated muddy sand shores	
A2.3 Littoral mud	LS.LMu						

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A2.31	LS.LMu.MEst.NhomMacStr	Mudflats and sandflats not covered by seawater at low tide	Intertidal mudflats				Intertidal mudflats
A2.32	LS.LMu.UEst.Hed.Cvol	Mudflats and sandflats not covered by seawater at low tide	Intertidal mudflats				Intertidal mudflats
A2.4 Littoral mixed sediments	LS.LMx	Mudflats and sandflats not covered by seawater at low tide			Littoral mixed sediments		
A2.41	LS.LMx.GvMu.HedMx		Sheltered muddy gravels	Sheltered muddy gravels	Littoral mixed sediments		
A2.43	LR.FLR.Eph.BLitX				Littoral mixed sediments		
A2.6 Littoral sediments dominated by aquatic angiosperms	LS.LMp						
A2.61	LS.LMp.LSgr.Znol	Mudflats and sandflats not covered by seawater at low tide	Seagrass (*Zostera*) beds	Seagrass (*Zostera*) beds		*Zostera noltii* beds in littoral muddy sand	Seagrass (*Zostera*) beds
A2.7 Littoral biogenic reefs	LS.LBR						

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A2.72	LS.LBR.LMus.Myt	Reefs	Blue mussel beds				Intertidal *Mytilus edulis* beds on mixed and sandy sediments
A3.1 Atlantic and Mediterranean high energy infralittoral rock	IR.HIR						
A3.11	IR.HIR.KFaR	Reefs			*Alaria esculenta* on exposed sublittoral fringe bedrock		
A3.2 Atlantic and Mediterranean moderate energy infralittoral rock	IR.MIR						
A3.21	IR.MIR.KR	Reefs	Tide-swept channels		*Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders AND Underboulder communities		
A3.22	IR.MIR.KT.XKT	Large shallow inlets and bays AND Reefs	Tide-swept channels				
A3.3 Atlantic and Mediterranean low energy infralittoral rock	IR.LIR	Reefs					
A3.31	IR.LIR.K.Lsac.Ldig	Large shallow inlets and bays AND Reefs					
A3.32	IR.LIR.KVS.LsacPsaVS	Large shallow inlets and bays AND Reefs					

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A3.34	IR.LIR.Lag.FcerEnt	Coastal lagoons AND Reefs	Saline lagoons	Saline lagoons			
A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	CR.MCR						
A4.21	CR.MCR.EcCr	Reefs					
A4.3 Atlantic and Mediterranean low energy circalittoral rock	CR.LCR						
A4.31	CR.LCR.BrAs	Reefs				*Neocrania anomala* and *Protanthea simplex* on very wave-sheltered circalittoral rock AND *Neocrania anomala*, *Dendrodoa grossularia* and *Sarcodictyon roseum* on variable salinity circalittoral rock	
A4.7 Features of circalittoral rock	CR.FCR						
A4.71	CR.FCR.Cv	Reefs					
A5.1 Sublittoral coarse sediment	SS.SCS						
A5.12	SS.SCS.ICS	Sandbanks which are slightly covered by sea water all the time	Subtidal sands and gravels				

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A5.13	SS.SCS.CCS		Subtidal sands and gravels		*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand		
A5.2 Sublittoral sand	SS.Ssa						
A5.23	SS.SSa.IFiSa	Sandbanks which are slightly covered by sea water all the time	Subtidal sands and gravels				
A5.24	SS.SSa.IMuSa.EcorEns		Subtidal sands and gravels				
A5.25	SS.SSa.CFiSa		Subtidal sands and gravels				
A5.3 Sublittoral mud	SS.Smu						
A5.31	SS.SMu.SMuLS	Coastal lagoons	Subtidal sands and gravels	Saline lagoons		Sublittoral mud in low or reduced salinity (lagoons)	
A5.34	SS.SMu.IFiMu.Are	Large shallow inlets and bays			*Philine aperta* and *Virgularia mirabilis* in soft stable infralittoral mud		
A5.36	SS.SMu.CFiMu.SpnMeg		Mud habitats in deep water	Mud habitats in deep water	Seapens and burrowing megafauna in circalittoral fine mud AND Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud AND *Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud		Sea-pen and burrowing megafauna communities
A5.37	SS.SMu.OMu.StyPse		Mud habitats in deep water	Mud habitats in deep water			
A5.4 Sublittoral mixed sediments	SS.SMx						

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A5.43	SS.SMx.IMx		Sheltered muddy gravels AND File shell beds		*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	Infralittoral mixed sediment AND *Sabella pavonina* with sponges and anemones on infralittoral mixed sediment AND *Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	
A5.44	SS.SMx.CMx				Circalittoral mixed sediment AND *Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment AND Circalittoral mixed sediment AND Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment AND Circalittoral mixed sediment	*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment AND Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment AND *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	
A5.5 Sublittoral macrophyte-dominated sediment	SS.SMp						
A5.51	SS.SMp.Mrl.Lgla		Maerl beds	Maerl beds		*Lithothamnion glaciale* maerl beds in tide-swept variable salinity infralittoral gravel	Maerl beds

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A5.52	SS.SMp.KSwSS	Large shallow inlets and bays				Kelp and seaweed communities on sublittoral sediment	
A5.53	SS.SMp.SSgr.Zmar	Mudflats and sandflats not covered by seawater at low tide AND Large shallow inlets and bays AND Coastal lagoons	Seagrass (*Zostera*) beds	Seagrass (*Zostera*) beds	*Ruppia maritima* in reduced salinity infralittoral muddy sand	*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand AND R*uppia maritima* in reduced salinity infralittoral muddy sand	Seagrass (*Zostera*) beds
A5.6 Sublittoral biogenic reefs	SS.SBR						
A5.62	SS.SBR.SMus.ModT	Large shallow inlets and bays AND Reefs	Horse mussel (*Modiolus modiolus*) beds	Horse mussel (*Modiolus modiolus*) beds		*Modiolus modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata AND *Modiolus modiolus* beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata AND *Modiolus modiolus* beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata	Horse mussel (*Modiolus modiolus*) beds
A5.7 Features of sublittoral sediments	SS.Smu						

EUNIS Code	Biotope Code	Annex I	BAP	LBAP	candidate NIMF	Scottish Biodiversity List	OSPAR
A5.72	SS.SMu.IFiMu.Beg		Mud habitats in deep water	Mud habitats in deep water		*Beggiatoa* spp. on anoxic sublittoral mud	
B3.1 Supralittoral rock (lichen or splash zone)	LR.FLR						
B3.11	LR.FLR.Lic	Reefs					

Appendix 5. Source priority species and habitats lists.
Table A5.1. UK Biodiversity Action Plan List of Priority Species (JNCC, 2007b).

NBN scientific name	NBN authority	Common name	Group	Status on original UK BAP list
Ammodytes marinus	Raitt, 1934	Lesser Sandeel	bony fish	
Amphianthus dohrnii	von Koch, 1878	Sea-fan Anemone	cnidarian	Species Action Plan
Anotrichium barbatum	C. Agardh Nägeli	Bearded Red Seaweed	alga	Species Action Plan
Aphanopus carbo	Lowe, 1839	Black Scabbardfish	bony fish	Grouped plan species
Arachnanthus sarsi	Carlgren, 1912	Scarce Tube-Dwelling Anemone	cnidarian	
Arrhis phyllonyx	M Sars, 1858	A deep-sea shrimp	crustacean	
Ascophyllum nodosum ecad mackii		Wig Wrack or Sea-loch Egg Wrack	alga	Species Action Plan
Atrina fragilis	Pennant, 1777	Fan Mussel	mollusc	Species Action Plan
Balaenoptera acutorostrata	Lacépède, 1804	Minke Whale	sea mammal	Grouped plan species
Balaenoptera borealis	Lesson, 1828	Sei Whale	sea mammal	Grouped plan species
Balaenoptera musculus	Linnaeus, 1758	Blue Whale	sea mammal	Grouped plan species
Balaenoptera physalus	Linnaeus, 1758	Fin Whale	sea mammal	Grouped plan species
Caretta caretta	Linnaeus, 1758	Loggerhead Turtle	turtle	Grouped plan species
Centrophorus granulosus	Schneider, 1801	Gulper shark	shark/skate/ray	
Centrophorus squamosus	Bonnaterre, 1788	Leafscraper shark	shark/skate/ray	
Centroscymnus coelolepsis	Barbosa du Bocage & Brito Capello, 1864	Portuguese dogfish	shark/skate/ray	
Cetorhinus maximus	Gunnerus, 1765	Basking Shark	shark/skate/ray	Species Action Plan
Clavopsella navis	Millard, 1959	Brackish hydroid	cnidarian	Statement
Clupea harengus	Linnaeus, 1758	Herring	bony fish	Grouped plan species
Coregonus lavaretus	Linnaeus, 1758	Whitefish (Powan, Gwyniad or Schelly)	bony fish	
Coryphaenoides rupestris	Gunnerus, 1765	Roundnose grenadier	bony fish	Grouped plan species
Cruoria cruoriaeformis	P.L. Crouan & H.M. Crouan Denizot	A red seaweed	alga	
Dalatias licha	Bonnaterre, 1788	Kitefin shark	shark/skate/ray	
Delphinus delphis	Linnaeus, 1758	Common Dolphin	sea mammal	Grouped plan species
Dermochelys coriacea	Vandelli, 1761	Leatherback Turtle	turtle	Grouped plan species
Dermocorynus montagnei	P.L. Crouan & H.M. Crouan	A red seaweed	alga	
Dipturus batis	Linnaeus, 1758	Common skate	shark/skate/ray	
Edwardsia timida	de Quatrefages, 1842	Timid Burrowing Anemone	cnidarian	
Eubalaena glacialis	Müller, 1776	Northern right whale	sea mammal	Grouped plan species
Eunicella verrucosa	Pallas, 1766	Pink Sea-fan	cnidarian	Species Action Plan
Fucus distichus	Linnaeus	Brown Algae	alga	

NBN scientific name	NBN authority	Common name	Group	Status on original UK BAP list
Funiculina quadrangularis	Pallas, 1766	Tall sea pen	cnidarian	Statement
Gadus morhua	Linnaeus, 1758	Cod	bony fish	Grouped plan species
Galeorhinus galeus	Linnaeus, 1758	Tope shark	shark/skate/ray	
Gitanopsis bispinosa	Boeck, 1871	an Amphipod Shrimp	crustacean	
Globicephala melas	Traill, 1809	Long-finned pilot whale	sea mammal	Grouped plan species
Grampus griseus	G. Cuvier, 1812	Risso`s dolphin	sea mammal	Grouped plan species
Haliclystus auricula	Rathke, 1806	a stalked jellyfish	cnidarian	
Hippocampus guttulatus	Cuvier, 1829	Long snouted seahorse	bony fish	
Hippocampus hippocampus	Linnaeus, 1758	Short snouted seahorse	bony fish	
Hippoglossus hippoglossus	Linnaeus, 1758	Atlantic halibut	bony fish	
Hoplostethus atlanticus	Collett, 1889	Orange roughy	bony fish	Grouped plan species
Hyperoodon ampullatus	Forster, 1770	Northern bottlenose whale	sea mammal	Grouped plan species
Isurus oxyrinchus	Rafinesque, 1810	Shortfin mako	shark/skate/ray	
Lagenorhynchus acutus	Gray, 1828	Atlantic white-sided dolphin	sea mammal	Grouped plan species
Lagenorhynchus albirostris	Gray, 1846	White-Beaked Dolphin	sea mammal	Grouped plan species
Lamna nasus	Bonnaterre, 1788	Porbeagle shark	shark/skate/ray	
Leptopsammia pruvoti	Lacaze-Duthiers, 1897	Sunset Cup Coral	cnidarian	Species Action Plan
Leucoraja circularis	Couch, 1838	Sandy ray	shark/skate/ray	
Lithothamnion corallioides	P.L. Crouan & H.M. Crouan P.L. Crouan & H.M. Crouan	Coral Maërl	alga	
Lophius piscatorius	Linnaeus, 1758	Sea monkfish	bony fish	Grouped plan species
Lucernariopsis campanulata	Lamouroux, 1815	A stalked jellyfish	cnidarian	
Lucernariopsis cruxmelitensis	Corbin, 1978	A stalked jellyfish	cnidarian	
Megaptera novaeangliae	Borowski, 1781	Humpback Whale	sea mammal	Grouped plan species
Merlangius merlangus	Linnaeus, 1758	Whiting	bony fish	Grouped plan species
Merluccius merluccius	Linnaeus, 1758	European hake	bony fish	Grouped plan species
Mesoplodon bidens	Sowerby, 1804	Sowerby`s beaked whale	sea mammal	Grouped plan species
Mesoplodon mirus	True, 1913	True`s Beaked Whale	sea mammal	Grouped plan species
Micromesistius poutassou	Risso, 1826	Blue whiting	bony fish	
Mitella pollicipes	Gmelin, 1789	Gooseneck Barnacle	crustacean	
Molva dypterygia	Pennant, 1784	Blue Ling	bony fish	Grouped plan species

NBN scientific name	NBN authority	Common name	Group	Status on original UK BAP list
Molva molva	Linnaeus, 1758	Ling	bony fish	Grouped plan species
Orcinus orca	Linnaeus, 1758	Killer Whale	sea mammal	Grouped plan species
Ostrea edulis	Linnaeus, 1758	Native Oyster	mollusc	Species Action Plan
Pachycerianthus multiplicatus	Carlgren, 1912	Fireworks anemone	cnidarian	
Padina pavonica	Linnaeus Thivy	Peacock's tail	alga	
Palinurus elephas	Fabricius, 1787	Crayfish, Crawfish or Spiny Lobster	crustacean	
Phoca vitulina	Linnaeus, 1758	Eastern Atlantic harbour seal/common seal	sea mammal	
Phocoena phocoena	Linnaeus, 1758	Harbour Porpoise	sea mammal	Species Action Plan
Phymatolithon calcareum	Pallas Adey & D.L. McKibbin	Common Maërl	alga	
Physeter macrocephalus	Linnaeus, 1758	Sperm Whale	sea mammal	Grouped plan species
Pleuronectes platessa	Linnaeus, 1758	Plaice	bony fish	Grouped plan species
Prionace glauca	Linnaeus, 1758	Blue shark	shark/skate/ray	
Raja undulata	Lacepede, 1802	Undulate ray	shark/skate/ray	
Reinhardtius hippoglossoides	Walbaum, 1792	Greenland halibut	bony fish	Grouped plan species
Rostroraja alba	Lacepède, 1803	White or Bottlenosed skate	shark/skate/ray	
Scomber scombrus	Linnaeus, 1758	Mackerel	bony fish	Grouped plan species
Solea vulgaris	Quensel, 1806	Sole	bony fish	Grouped plan species
Squalus acanthias	Linnaeus, 1758	Spiny dogfish	shark/skate/ray	
Squatina squatina	Linnaeus, 1758	Angel shark	shark/skate/ray	
Stenella coeruleoalba	Meyen, 1833	Striped dolphin	sea mammal	Grouped plan species
Styela gelatinosa	Traustedt, 1886	Loch Goil Sea Squirt	tunicate	Statement
Swiftia pallida	Madsen, 1970	Northern Sea Fan	cnidarian	
Tenellia adspersa	Nordmann, 1844	Lagoon sea slug	mollusc	Statement
Thunnus thynnus	Linnaeus, 1758	Blue-fin tuna	bony fish	
Trachurus trachurus	Linnaeus, 1758	Horse Mackerel	bony fish	Grouped plan species
Tursiops truncatus	Montagu, 1821	Bottlenosed dolphin	sea mammal	Grouped plan species
Ziphius cavirostris	G. Cuvier, 1823	Cuvier`s beaked whale	sea mammal	Grouped plan species

Table A5.2. UK Biodiversity Action Plan List of Priority habitats (JNCC, 2007b)

BAP broad habitat	UK BAP habitat	Changes since original UK BAP list of habitats
Littoral rock	Intertidal chalk	Revised name; (currently within Littoral and sub littoral chalk HAP)
Littoral rock	Intertidal boulder communities	New habitat
Littoral rock	*Sabellaria alveolata* reefs	No change
Littoral sediment	Coastal saltmarsh	No change
Littoral sediment	Intertidal mudflats	Revised name; (currently Mudflats)
Littoral sediment	Seagrass beds	No change (includes both intertidal and subtidal beds)
Littoral sediment	Sheltered muddy gravels	No change
Littoral sediment	Peat and clay exposures	New habitat
Sublittoral rock	Subtidal chalk	Revised name; (currently within Littoral and sublittoral chalk HAP)
Sublittoral rock	Tide-swept channels	Name change and habitat expansion
Sublittoral rock	Fragile sponge & anthozoan communities on subtidal rocky habitats	New habitat
Sublittoral rock	Estuarine rocky habitats	New habitat
Sublittoral rock	Seamount communities	New habitat
Sublittoral rock	Carbonate mounds	New habitat
Sublittoral rock	Cold-water coral reefs	Revised name; (currently Lophelia pertusa reefs)
Sublittoral rock	Deep-sea sponge communities	New habitat
Sublittoral rock	*Sabellaria spinulosa* reefs	No change
Sublittoral sediment	Subtidal sands and gravels	No change
Sublittoral sediment	Horse mussel beds	Revised name; (currently Modiolus modiolus beds)
Sublittoral sediment	Mud habitats in deep water	No change
Sublittoral sediment	File shell beds	New habitat
Sublittoral sediment	Maerl beds	No change
Sublittoral sediment	Serpulid reefs	No change
Sublittoral sediment	Blue mussel beds	New habitat
Sublittoral sediment	Saline lagoons	No change

Table A5.3. Local Biodiversity Action Plan for Argyll and Bute (JNCC, 2007a). Species for which action plans have been prepared

Group	Species
Fish	Allis shad (*Alosa alosa*)
Fish	Twaite shad (*Alosa fallax*)
Fish	Basking shark (*Cetorhinus maximus*)
Local species	*Ascophyllum nodosum mackii* beds
Local species	Atlantic salmon
Local species	Turtles
Mammals	Common dolphin (*Delphinus delphis*)
Mammals	Grouped plan for baleen whales
Mammals	Grouped plan for toothed whales
Mammals	Harbour porpoise (*Phocoena phocoena*)
Molluscs	Fan mussel (*Atrina fragilis*)
Molluscs	Native oyster (*Ostrea edulis*)
Molluscs	Northern hatchett shell (*Thyasira gouldi*)
Sea anemones	Tall sea pen (*Funiculina quadrangularis*)
Sea squirts	Sea squirt (*Styela gelatinosa*)

Table A5.4. Local Biodiversity Action Plan for Argyll and Bute (Source:(JNCC, 2007a)). Habitats for which action plans have been prepared

Group	Habitat
Priority Habitats	Coastal saltmarsh
Priority Habitats	Maerl beds
Priority Habitats	*Modiolus modiolus* beds
Priority Habitats	Mud habitats in deep water
Priority Habitats	Mudflats
Priority Habitats	Saline lagoons
Priority Habitats	Seagrass beds
Priority Habitats	Serpulid reefs
Priority Habitats	Sheltered muddy gravels

Table A5.5. OSPAR Species (OSPAR, 2004).

Scientific Name	Common Name	OSPAR Regions where the species occur	OSPAR Regions where the species is under threat and/or in decline
Invertebrates			
Arctica islandica (Linnaeus, 1767)	Ocean quahog	I, II, III, IV	II
Megabalanus azorics (Pilsbry, 1916)	Azorean barnacle	V	All where it occurs
Nucella lapillus (Linnaeus, 1758)	Dog whelk	All	II, III, IV
Ostrea edulis (Linnaeus, 1758)	Flat oyster	I, II, III, IV	II
Patella ulyssiponensis aspera (Roding, 1798)	Azorean limpet	V	All where it occurs
Fish			
Acipenser sturio (Linnaeus, 1758)	Atlantic sturgeon	II, IV	All where it occurs
Alosa alosa (Linnaeus, 1758)	Allis shad	II, III, IV	All where it occurs
Cetorhinus maximus (Gunnerus, 1763)	Basking shark	All	All where it occurs
Coregonus lavaretus oxyrinchus (Linnaeus, 1758)	Houting	II	All where it occurs
Dipturus batis (Linnaeus, 1758) (synonym: *Raja batis*)	Common skate	All	All where it occurs
Raja montagui (Fowler, 1910) (synonym: *Dipturus montagui*)	Spotted ray	II, III, IV, V	All where it occurs
Gadus morhua (Linnaeus, 1758) – populations in the OSPAR regions II and III	Cod	All	II, III
Hoplostethus atlanticus (Collect, 1889)	Orange roughey	I, V	All where it occurs
Petromyzoan marinus (Linnaeus, 1758)	Sea lamprey	I, II, III, IV	All where it occurs
Salmo salar (Linnaeus, 1758)	Salmon	I, II, III, IV	All where it occurs
Thunnus thynnus (Linnaeus, 1758)	Bluefin tuna	V	All where it occurs
Caretta caretta (Linnaeus, 1758)	Loggerhead turtle	IV, V	All where it occurs
Dermochelys coriacea (Vandelli, 1761)	Leatherback turtle	All	All where it occurs
Mammals			
Balaena mysticens (Linnaeus, 1758)	Bowhead whale	I	All where it occurs
Balaenoptera musculus (Linnaeus, 1758)	Blue whale	All	All where it occurs
Eubalaena glacialis (Muller, 1776)	Northern right whale	All	All where it occurs
Phocoena phocoena	Harbour porpoise	All	II, III

Table A5.6. OSPAR Habitats List (OSPAR, 2004).

Description	OSPAR Regions where the habitat occur	OSPAR Regions where te habitat is under threat and/or in decline
Carbonate mounds	I,V	V
Deep-sea sponge aggregations	I, III, IV, V	V
Oceanic ridges with hydrothermal vents/fields	I, V	V
Intertidal mudflats	I, II, III, IV	All where they occur
Littoral chalk communities	II	All where they occur
Lophelia pertusa reefd	All	All where they occur
Ostrea edulis beds	II, III, IV	All where they occur
Seamounts	I, IV, V	All where they occur
Sea-pen and burrowing megafauna communities	I, II, III, IV	II, III
Zostera beds	I, II, III, IV	All where they occur

Table A5.7. Nationally Rare and Scarce Species (Sanderson, 1996). UR= Under recorder; R = rare; S= Scarce; NN = non-native; UC = Uncommon; #= designated undder Wildlife & Countryside Act.

Species	Type of organism/ common name	Diagnosis	Rare	Scarce
Porifera (sponges)				
Stelletta grubii	Sponge	UR		*
Stryphnus ponderosus	Sponge	UR	*	
Thymosia guernei	Sponge	UR		*
Suberites massa	Sponge	R/(NN?)	*	
Adreus fascicularis	Sponge	R	*	
Axinella damicornis	Sponge			*
Phakellia ventilabrum	Sponge			*
Mycale lingua	Sponge			*
Desmacidon fruticosum	Sponge		*	
Stylostichon dives	Sponge	UR		
Clathria barleei	Sponge			*
Plocamilla coriacea	Sponge			*
Tethyspira spinosa	Sponge			*
Dysidea pallescens	Sponge		*	
Hydroids (sea firs)				
Diphasia alata	Hydroid			*
Tamarisca tamarisca	Hydroid			*
Aglaophenia kirchenpaueri	Hydroid			*
Lytocarpia myriophyllum	Hydroid			*
Hartlaubella gelatinosa	Hydroid			*
Laomedea angulata	Hydroid			*
Obelia bidentata	Hydroid		*	
Soft and horny corals				
Parerythropodium coralloides	Sofe coral			*
Eunicella verrucosa#	Pink sea fan	UC		
Sea anemones & corals				
Pachycerianthus multiplicatus	Fireworks anemone			*
Arachnanthus sarsi	Sea anemone		*	
Parazoanthus anguicomus	Sea anemone	UR		*
Parazoanthus axinellae	Sea anemone			*
Anthopleura thallia	Red spotted sea anemone			*
Aiptasia mutabilis	Trumpet anemone			*
Cataphellia brodricii	Latticed corkley sea anemone			*
Amphianthus dohrnii	Sea fan anemone		*	
Halcampoides elongatus	Sea anemone		*	
Anemonactis mazeli	Sea anemone			*
Mesacmaea mitchellii	Sea anemone			*
Nematostella vectensis#	Starlet anemone			*

Species	Type of organism/ common name	Diagnosis	Rare	Scarce
Edwardsia ivelli#	Ivell's sea anemone		*	
Edwardsia timida	Sea anemone			*
Scolanthus callimorphus	Sea anemone		*	
Caryophyllia inornata	Cup coral		*	
Hoplangia durotrix	Weymouth carpet coral		*	
Balanophyllia regia	Scarlet and goldstar coral			*
Leptopsammia pruvoti	Sunset cup coral		*	
Echiura				
Amalosoma eddystonense	Echiuran worm	UR		*
Annelida (polychaete worms)				
Sternaspis scutata	Polychaete worm		*	
Baldia johnstoni	Polychaete worm			*
Ophelia bicornis	Polychaete worm		*	
Armandia cirrhosa#	Lagoon sand worm		*	
Alkmaria romijni#	Tentacled lagoon worm			*
Crustacea (barnacles, shrimps, crabs and lobsters)				
Mitella pollicipes	Goose barnacle		*	
Rissoides desmaresti	Mantis shrimp			*
Apherusa clevei	Amphipod		*	
Apherusa ovalipes	Amphipod			*
Monoculodes gibbosus	Amphipod		*	
Monoculodes packardi	Amphipod		*	
Metopa robusta	Amphipod		*	
Harpinia laevis	Amphipod			*
Menigrates obtusifrons	Amphipod		*	
Nannonyx spinimanus	Amphipod		*	
Sophrosyne robertsoni	Amphipod		*	
Austrosyrrhoe fimbriatus	Amphipod		*	
Acanthonotozoma serratum	Amphipod		*	
Pereionotus testudo	Amphipod		*	
Gammarus chevreuxi	Amphipod			*
Gammarus insensibilis	Lagoon sand shrimp			*
Pectenogammarus planicrurus	Amphipod			*
Eriopisa elongata	Amphipod			*
Microdeutopus stationis	Amphipod		*	
Corophium lacustre	Amphipod			*
Paradulichia typica	Amphipod		*	
Synisoma lancifer	Isopod (a sea slater)			*
Typton spongicola	Sponge shrimp		*	
Clibanarius erythropus	Hermit crab		*	
Cestopagurus timidus	Hermit crab		*	

Species	Type of organism/ common name	Diagnosis	Rare	Scarce
Dromia personata	Sponge crab			*
Ebalia granulosa	Crab			*
Achaeus cranchii	Crab			*
Xaiva biguttata	Crab			*
Mollusca				
Leptochiton scabridus	Chiton			*
Jujubinus striatus	Gastropod		*	
Bittium lacteum simplex	Gastropod		*	
Alvania cancellata	Gastropod			*
Hydrobia neglecta	Gastropod	UR		*
Truncatella subcylindrica	Looping snail		*	
Paludinella littorina#	Gastropod		*	
Caecum armoricum#	De Folin's lagoon snail		*	
Circulus striatus	Gastropod		*	
Ocinebrina aciculata	Gastropod		*	
Jordaniella truncatula	Gastropod		*	
Stiliger bellulus	Sea slug		*	
Tritonia manicata	Sea slug		*	
Tritonia nilsodhneri	Sea slug			*
Okenia elegans	Sea slug	UR		*
Okenia leachii	Sea slug		*	
Trapania maculata	Sea slug		*	
Trapania pallida	Sea slug			*
Greilada elegans	Sea slug		*	
Thecacera pennigera	Sea slug			*
Doris sticta	Sea slug			*
Atagema gibba	Sea slug		*	
Proctonotus mucroniferus	Sea slug		*	
Hero formosa	Sea slug	UR		*
Tenellia adspersa#	Lagoon sea slug		*	
Caloria elegans	Sea slug		*	
Aeolidiella alderi	Sea slug			*
Aeolidiella sanguinea	Sea slug		*	
Onchidella celtica	Sea slug			*
Pteria hirundo	Wing shell		*	
Atrina fragilis	Fan mussel	UR		*
Lucinella divaricata	Bivalve		*	
Thyasira gouldi#	Northern hatchet shell	?	*	
Galeomma turtoni	Weasel eye shell		*	
Acanthocardia aculeata	Spiny cockle		*	
Callista chione	Bivalve		*	
Pholadidea loscombiana	Bivalve	UR		*

Species	Type of organism/ common name	Diagnosis	Rare	Scarce
Sea mats (bryozoans)				
Victorella pavida#	Trembling seamat		*	
Amathia pruvoti	Bryozoan		*	
Hincksina flustroides	Bryozoan		*	
Bugula purpurotincta	Bryozoan	UR		*
Epistomia bursaria	Bryozoan		*	
Plesiothoa gigerium	Bryozoan		*	
Escharoides mamillata	Bryozoan		*	
Porella alba	Bryozoan		*	
Watersipora complanata	Bryozoan		*	
Schizobrachiella sanguinea	Bryozoan		*	
Cylindroporella tubulosa	Bryozoan		*	
Smittina affinis	Bryozoan	UR		*
Turbicellepora magnicostata	Orange peel bryozoan		*	
Hippoporidra lusitania	Bryozoan			*
Echinodermata (starfish, sea urchins, sea cucumbers)				
Asteronyx loveni	Brittlestar			*
Ophiopsila annulosa	Brittlestar	UR		*
Ophiopsila aranea	Brittlestar	UR	*	
Paracentrotus lividus	Purple rock urchin			*
Strongylocentrotus droebachiensis	Green sea urchin			*
Cucumaria frondosa	Sea cucumber			*
Sea squirts				
Synoicum incrustatum	Colonial ascidian		*	
Polysyncraton lacazei	Colonial ascidian		*	
Leptoclinides faeroensis	Colonial ascidian		*	
Phallusia mammillata	Ascidian			*
Styela gelatinosa	Ascidian		*	
Microcosmus claudicans	Ascidian		*	
Red seaweeds				
Gelidium sesquipedale	Red Seaweed		*	
Gelidiella calcicola	Red Seaweed			*
Lithothamnion corallioides	Maerl			*
Cryptonemia lomation	Red Seaweed		*	
Dermocorynus montagnei	Red Seaweed		*	
Schmitzia hiscockiana	Red Seaweed	UR/UC		*
Cruoria cruoriaeformis	Red Seaweed			*
Gigartina pistillata	Red Seaweed			*
Tsengia bairdii	Red Seaweed		*	
Gracilaria bursa-pastoris	Red Seaweed			*
Gracilaria multipartita	Red Seaweed			*

Species	Type of organism/ common name	Diagnosis	Rare	Scarce
Aglaothamnion diaphanum	Red Seaweed		*	
Aglaothamnion priceanum	Red Seaweed		*	
Anotrichium barbatum	Red Seaweed		*	
Bornetia secundiflora	Red Seaweed		*	
Dasya corymbifera	Red Seaweed		*	
Dasya punicea	Red Seaweed		*	
Chondria coerulescens	Red Seaweed		*	
Lophosiphonia reptabunda	Red Seaweed		*	
Pterosiphonia pennata	Red Seaweed			*
Brown seaweeds				
Halothrix lumbricalis	Brown seaweed			*
Pseudolithoderma roscoffense	Brown seaweed			*
Leblondiella densa	Brown seaweed		*	
Asperococcus scaber	Brown seaweed			*
Zanardinia prototypus	Penny weed			*
Choristocarpus tenellus	Brown seaweed			*
Sphacelaria mirabilis	Brown seaweed		*	
Padina pavonica	Turkey feather alga			*
Carpomitra costata	Tassle weed			*
Desmarestia dresnayi	Brown seaweed			*
Green algae/stoneworts				
Cladophora battersii	Green alga		*	
Tolypella nidifica	Bird's nest stonewort		*	
Lamprothamnium papulosum#	Foxtail stonewort			*

Table A5.8. Candidate NIMF Species List (Hiscock & Harris, 2007).

Record Number	Scientific name	Record Number	Scientific name
1	*Adreus fascicularis*	52	*Aspididelectra melolontha*
2	*Alkmaria romijni*	53	*Celleporina decipiens*
3	*Armandia cirrhosa*	54	*Celleporina tubulosa*
4	*Baldia johnstoni*	55	*Codonellina lacunata*
5	*Boccardia (sp. undetermined)*	56	*Epistomia bursaria*
6	*Sabella flabellata*	57	*Escharoides mamillata*
7	*Sabellaria alveolata*	58	*Haplopoma bimucronatum*
8	*Sabellaria spinulosa*	59	*Hippoporidra lusitania*
9	*Sternaspis scutata*	60	*Microporella appendiculata*
10	*Stygocapitella subterranea*	61	*Palmicallaria elegans*
11	*Ascophyllum nodosum mackaii*	62	*Schizobrachiella sanguinea*
12	*Asperococcus scaber*	63	*Schizomavella cristata*
13	*Choristocarpus tenellus*	64	*Schizomavella hondti*
14	*Desmarestia dresnayi*	65	*Schizomavella ochracea*
15	*Fucus distichus*	66	*Schizomavella teresae*
16	*Halothrix lumbricalis*	67	*Schizoporella cornualis*
17	*Leblondiella densa*	68	*Smittina affinis*
18	*Padina pavonica*	69	*Smittoidea amplissima*
19	*Pseudolithoderma roscoffense*	70	*Turbicellepora magnicostata*
20	*Sphacelaria mirabilis*	71	*Watersipora complanata*
21	*Zanardinia prototypus*	72	*Amathia pruvoti*
22	*Cladophora battersii*	73	*Farrella repens*
23	*Aglaothamnion diaphanum*	74	*Mimosella gracilis*
24	*Aglaothamnion feldmanniae*	75	*Mimosella verticillata*
25	*Aglaothamnion priceanum*	76	*Clibanarius erythropus*
26	*Anotrichium barbatum*	77	*Palinurus elephas*
27	*Apoglossocolax pusilla*	78	*Mitella (Pollicipes) pollicipes*
28	*Bornetia secundiflora*	79	*Allomelita pellucida*
29	*Chondria coerulescens*	80	*Amphitholina cuniculus*
30	*Cruoria cruoriaeformis*	81	*Arrhis phyllonyx*
31	*Cryptonemia lomation*	82	*Austrosyrrhoe fimbriatus*
32	*Cryptonemia seminervis*	83	*Byblis gaimardii*
33	*Dasya corymbifera*	84	*Cerapus crassicornis*
34	*Dasya punicea*	85	*Colomastix pusilla*
35	*Dermocorynus montagnei*	86	*Corophium affine*
36	*Gelidiella calcicola*	87	*Dulichia tuberculata*
37	*Gracilaria bursa-pastoris*	88	*Epimeria tuberculata*
38	*Laurencia pyramidalis*	89	*Eriopisa elongata*
39	*Lithothamnion corallioides*	90	*Euonyx chelatus*
40	*Lophosiphonia reptabunda*	91	*Gammarus chevreuxi*
41	*Polysiphonia foetidissima*	92	*Gammarus insensibilis*
42	*Pterosiphonia pennata*	93	*Gitanopsis bispinosa*
43	*Schmitzia hiscockiana*	94	*Guernea coalita*
44	*Tsengia bairdii*	95	*Haploops setosa*

Record Number	Scientific name	Record Number	Scientific name
45	*Anguilla anguilla*	96	*Harpinia laevis*
46	*Aphanopus carbo*	97	*Ingolfiella britannica*
47	*Apletodon dentatus*	98	*Laetmatophilus tuberculatus*
48	*Argentina silus*	99	*Leptocheirus hirsutimanus*
49	*Clavopsella navis*	100	*Leptocheirus pectinatus*
50	*Diphasia alata*	101	*Leucothoe procera*
51	*Diphasia nigra*	102	*Leucothoe spinicarpa*
103	*Liljeborgia kinahani*	158	*Balaenoptera borealis*
104	*Listriella picta*	159	*Balaenoptera musculus*
105	*Listriella mollis*	160	*Balaenoptera physalus*
106	*Maera loveni*	161	*Megaptera novaeangliae*
107	*Melphidippa goesi*	163	*Erignathus barbatus*
108	*Metopa solsbergi*	164	*Halichoerus grypus*
109	*Microprotopus longimanus*	165	*Phoca groenlandica (Pagophilus groenlandicus)*
110	*Monoculodes borealis*	166	*Phoca (Pusa) hispida*
111	*Monoculodes gibbosus*	167	*Phoca vitulina*
112	*Monoculodes packardi*	168	*Kogia (Physeter) breviceps*
113	*Monoculodes tuberculatus*	169	*Physeter macrocephalus (P.catodon)*
114	*Parametaphoxus fultoni*	170	*Nephasoma rimicola*
115	*Parvipalpus capillaceus*	171	*Acipenser sturio*
116	*Peltocoxa brevirostris*	172	*Alosa alosa*
118	*Plusymtes glaber*	173	*Alosa fallax*
119	*Pontocrates arcticus*	174	*Ammodytes marinus*
120	*Siphonoecetes striatus*	175	*Brosme brosme*
122	*Sophrosyne robertsoni*	176	*Clupea harengus*
123	*Tritaeta gibbosa*	177	*Coregonus lavaretus*
124	*Leptognathia paramaca*	178	*Coregonus oxyrhynchus*
125	*Antedon petasus*	179	*Coryphaenoides rupestris*
126	*Asterina phylactica*	180	*Gadus morhua*
127	*Asteronyx loveni*	181	*Gobius cobitis*
128	*Cucumaria frondosa*	182	*Gobius couchi*
129	*Echinus esculentus*	183	*Gobius gasteveni*
130	*Hippasteria phrygiana*	184	*Hippocampus guttulatus*
131	*Leptometra celtica*	185	*Hippocampus hippocampus*
132	*Ocnus planci*	186	*Hoplostethus atlanticus*
133	*Ophiopsila annulosa*	187	*Lampetra fluviatilis*
134	*Ophiopsila aranea*	188	*Lepadogaster candollei*
135	*Paracentrotus lividus*	189	*Lophius piscatorius*
136	*Parastichopus tremulus*	190	*Macrourus berglax*
137	*Psolus phantapus*	191	*Malacocephalus laevis*
138	*Strongylocentrotus droebachiensis*	192	*Merlangius merlangus*
139	*Thyone inermis*	193	*Merluccius merluccius*
140	*Eubalaena glacialis*	194	*Micromesistius poutassou*
141	*Delphinus delphis*	195	*Molva dypterygia*

Record Number	Scientific name	Record Number	Scientific name
142	*Globicephala melas (melaena)*	196	*Molva molva*
143	*Grampus griseus*	197	*Nemichthys scolopaceus*
144	*Lagenorhynchus acutus*	198	*Notacanthus bonapartei*
145	*Lagenorhynchus albirostris*	199	*Notacanthus chemnitzii*
146	*Orcinus orca*	200	*Osmerus eperlanus*
147	*Pseudorca crassidens*	201	*Petromyzon marinus*
148	*Stenella coeruleoalba*	202	*Pleuronectes platessa*
149	*Tursiops truncatus*	203	*Pollachius virens*
150	*Odobenus rosmarus*	204	*Pomatoschistus minutus*
151	*Phocoena phocoena*	205	*Reinhardtius hippoglossoides*
152	*Hyperoodon ampullatus*	206	*Salmo salar*
153	*Mesoplodon bidens*	207	*Scomber scrombrus*
154	*Mesoplodon europaeus*	208	*Sebastes marinus*
155	*Mesoplodon mirus*	209	*Solea vulgaris*
156	*Ziphius cavirostris*	210	*Thunnus thynnus*
157	*Balaenoptera acutorostrata*	211	*Trachurus trachurus*
212	*Diazona violacea*	264	*Endectyon delaubenfelsi*
213	*Leptoclinides faeroensis*	265	*Eurypon clavatum*
214	*Microcosmus claudicans*	266	*Haliclona angulata*
215	*Phallusia mammillata*	267	*Hexadella racovitzai*
216	*Polysyncraton lacazei*	268	*Leuconia gossei*
217	*Pyura microcosmus*	269	*Macandrewia azorica*
218	*Styela gelatinosa*	270	*Mycale cf. contarenii*
219	*Synoicum incrustatum*	271	*Mycale similaris*
220	*Caecum armoricum*	272	*Myxilla perspinosa*
221	*Truncatella subcylindrica*	273	*Phakellia ventilabrum*
222	*Laomedea angulata*	274	*Quasillina brevis*
223	*Siboglinum holmei*	275	*Raspaciona aculeata*
224	*Ostrea edulis*	276	*Spanioplon armaturum*
225	*Pseudamnicola confusa*	277	*Spinularia spinularia*
226	*Thyasira gouldi*	278	*Spongionella pulchella*
227	*Modiolus modiolus*	279	*Stylostichon dives*
228	*Tenellia adspersa*	280	*Suberites massa*
229	*Polyplumaria flabellata*	281	*Sycandra utriculus*
230	*Haliclystus auricula*	282	*Hanleya nagelfar*
231	*Lucernariopsis campanulata*	283	*Leptochiton scabridus*
232	*Lucernariopsis cruxmelitensis*	284	*Leptochiton arcticus*
233	*Actinauge richardi*	285	*Neomenia dalyelli*
234	*Aiptasia mutabilis* (formerly *Aiptasis couchii)*	286	*Leptochiton sarsi*
235	*Aiptasiogeton comatus*	287	*Lepeta caeca*
236	*Alcyonium glomeratum*	288	*Osteopelta ceticola*
237	*Amphianthus dohrnii*	289	*Micropilina minuta*
238	*Anemonactis mazeli*	290	*Pilus conicus*
239	*Glaucus pimplet*	291	*Aeolidiella sanguinea*

Record Number	Scientific name	Record Number	Scientific name
240	*Arachnanthus sarsi*	292	*Kaloplocamus ramosus*
241	*Caryophyllia inornata*	293	*Baeolidia cryoporos*
242	*Caryophyllia smithii*	294	*Tritonia episcopalis*
243	*Cataphellia brodricii*	295	*Doto cindyneutes*
244	*Cornularia cornucopiae*	296	*Nematomenia banulensis*
245	*Edwardsia timida*	297	*Onchidella celtica*
246	*Edwardsia ivelli*	298	*Arctica islandica*
247	*Eunicella verrucosa*	299	*Astarte acuticostata*
248	*Funiculina quadrangularis*	300	*Atrina fragilis*
249	*Halcampoides elongatus*	301	*Atrina pectinata*
250	*Leptopsammia pruvoti*	302	*Barnea candida*
251	*Nematostella vectensis*	303	*Cardiomya curta*
252	*Pachycerianthus multiplicatus*	304	*Chlamys alicei*
253	*Paraphellia expansa*	305	*Chlamys sulcata* (OF. Muller, 1776)
254	*Parazoanthus anguicomus*	306	*Diplodonta torelli*
255	*Parerythropodium hibernicum (coralloides)*	307	*Glossus humanus*
256	*Scolanthus callimorphus*	308	*Goethemia elegantula*
257	*Phellia gausapata*	309	*Lametila abyssorum*
258	*Swiftia pallida*	310	*Lepton lacerum*
259	*Axinella damicornis*	311	*Limatula jeffreysi*
260	*Chelonaplysilla noevus*	312	*Malletia abyssorum*
261	*Clathria barleei*	313	*Mancikellia pumila*
262	*Desmacidon fruticosum*	314	*Montacuta cylindracea*
263	*Dysidea pallescens*	315	*Myonera sulcifera*
316	*Mysella ovata*	369	*Metzgeria gagei*
317	*Neopycnodonte cochlear*	370	*Mitrella rosacea*
318	*Nucula tumidula*	371	*Moelleria costulata*
319	*Nuculana pernula*	372	*Mohnia mohni*
320	*Scacchia tenera*	373	*Odostomia angusta*
321	*Tropidomya abbreviata*	374	*Odostomia nitens*
322	*Xylophaga anselli*	375	*Odostomia umbilicaris*
323	*Xylophaga gagei*	376	*Oenopota dictyophora*
324	*Adeuomphalus ammoniformis*	377	*Oenopota scalaris*
325	*Admete viridula*	378	*Onoba islandica*
326	*Akritogyra helicella*	379	*Ophieulima minima*
327	*Alvania cancellata*	380	*Orbitestella sarsi*
328	*Alvania jeffreysi*	381	*Otina ovata*
329	*Alvania wyvillethomsoni*	382	*Papuliscala cerithielloides*
330	*Alvania zetlandica*	383	*Philine lima*
331	*Amauropsis islandica*	384	*Pseudosetia turgida*
332	*Bathybela nudator*	385	*Pseudotorellia fragilis*
333	*Bathycrinicola curta*	386	*Retusa operculata*
334	*Bathycrinicola macrapex*	387	*Rhinodiaphana ventricosa*
335	*Benthomangelia macra*	388	*Skenea ossiansarsi*

Record Number	Scientific name	Record Number	Scientific name
336	*Boreotrophon dabneyi*	389	*Skenea profunda*
337	*Brachystomia carrozzai; Odostomia carrozzai*	390	*Solariella amabilis*
338	*Brookesena turrita*	391	*Solariella cinta*
339	*Buccinum oblitum*	392	*Solaria obscura*
340	*Calliopaea oophaga, Stiliger oophaga*	393	*Solariella varicosa*
341	*Calliopaea bellula, Stiliger bellulus*	394	*Tjaernoeia exquisita*
342	*Cantrainea peloritana*	395	*Turrisipho lachesis*
343	*Cerithiopsis barleei*	396	*Xyloskenea naticiformis*
344	*Cerithiopsis jeffreysi*	397	*Caretta caretta*
345	*Cirsonella romettensis*	398	*Dermochelys coriacea*
346	*Claviscala richardi*	399	*Eretmochelys imbricata*
347	*Crinolamia angustispira*	400	*Chelonia mydas*
348	*Curveulima macrophthalmica*	401	*Lepidochelys kempi*
349	*Danilia tinei*	402	*Tanystylum conirostre*
350	*Dikoleps cutleriana*		
351	*Ektonos turbonilloides*		
352	*Elachisina globuloides*		
353	*Epitonium greenlandicum*		
354	*Eudaronia apera*		
355	*Fusceulima profectilabrum*		
356	*Ganesa nitidiscula*		
357	*Granigyra tenera*		
358	*Gymnobela aquilarum*		
359	*Gymnobela engonia*		
360	*Gymnobela pyrrhogramma*		
361	*Gymnobela watsoni*		
362	*Haloceras laxa*		
363	*Heliacus subvariegatus*		
364	*Laona flexuosa*		
365	*Liostomia clavula*		
366	*Lissotesta turrita*		
367	*Lusitanops sigmoidea*		
368	*Margarites groenlandicus, M. striates*		

Table A5.9. Candidate NIMF Habitat List (Hiscock & Harris, 2007).

Record number	Biotope name	Biotope Code
1	*Alaria esculenta* forest with dense anemones and crustose sponges on extremely exposed infralittoral bedrock	IR.HIR.KFaR.AlaAnCrSp
2	*Alaria esculenta* on exposed sublittoral fringe bedrock	IR.HIR.KFaR.Ala
3	*Laminaria saccharina* with *Phyllophora* spp. and filamentous green seaweeds on variable or reduced salinity infralittoral rock	IR.LIR.KVS.LsacPhyVS
5	Bryozoan turf and erect sponges on tide-swept circalittoral rock	CR.HCR.XFa.ByErSp
7	*Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders	IR.MIR.KR.Ldig.Bo
9	Deep sponge communities	CR.HCR.DpSp
10	*Eunicella verrucosa* and *Pentapora foliacea* on wave-exposed circalittoral bedrock	CR.HCR.XFa.ByErSp.Eun
11	Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock	CR.FCR.Cv.SpCup
12	Cirratulids and *Cerastoderma edule* in littoral mixed sediment	LS.LMx.Mx.CirCer
13	Littoral mixed sediments	LS.LMx
14	*Ascophyllum nodosum* & *Fucus vesiculosus* on variable salinity mid eulittoral rock	LR.LLR.FVS.AscVS
15	*Ceramium* sp. and piddocks on eulittoral fossilised peat	LR.HLR.FR.RPid
16	*Fucus ceranoides* on reduced salinity eulittoral rock	LR.LLR.FVS.FcerVS
18	*Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders	LR.MLR.BF.Fser.Bo
19	*Fucus serratus* with sponges, ascidians and red seaweeds on tideswept lower eulittoral mixed substrata	LR.HLR.FT.FserTX
21	*Fucus vesiculosus* on variable salinity mid eulittoral boulders & stable mixed substrata	LR.LLR.FVS.FvesVS
22	Littoral caves & overhangs	LR.FLR.CvOv
23	*Mytilus edulis* and piddocks in eulittoral firm clay	LR.MLR.MusF.MytPid
24	Underboulder communities	Fser.Bo & Ldig.Bo (c.f. Fser.Fser.Bo & Ldig.Ldig.Bo)
25	Faunal communities on variable or reduced salinity infralittoral rock	IR.LIR.IFaVS
26	Seaweeds in sediment-floored eulittoral rockpools	LR.FLR.Rkp.SwSed
27	Fucoids and kelp in deep eulittoral rockpools	LR.FLR.Rkp.FK
28	*Ascophyllum nodosum* on very sheltered mid eulittoral rock	LR.LLR.F.Asc
29	*Ascophyllum nodosum* ecad *mackaii* beds on extremely sheltered mid eulittoral mixed substrata	LR.LLR.FVS.Ascmac
30	Coralline crust-dominated shallow eulittoral rockpools	LR.FLR.Rkp.Cor
32	*Mytilus edulis* and *Fucus vesiculosus* on moderately exposed mid eulittoral rock	LR.MLR.MusF.MytFves
33	Mussel and/or barnacle communities	LR.HLR.MusB
39	*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment	SS.SMx.CMx.ClloMx
40	Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment	SS.SMx.CMx.ClloModHo
44	*Polydora ciliata* and *Corophium volutator* in variable salinity infralittoral firm mud or clay	SS.SMu.SMuVS.PolCvol
48	*Capitella capitata* and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment	SS.SMu.SMuVS.CapTubi

Record number	Biotope name	Biotope Code
49	Oligochaetes in variable or reduced salinity infralittoral muddy sediment	SS.SMu.SMuVS.OlVS
54	*Melinna palmata* with *Magelona* spp. and *Thyasira* spp. in infralittoral sandy mud	SS.SMu.ISaMu.MelMagThy
56	*Capitella capitata* in enriched sublittoral muddy sediments	SS.SMu.ISaMu.Cap
59	*Philine aperta* and *Virgularia mirabilis* in soft stable infralittoral mud	SS.SMu.IFiMu.PhiVir
65	Seapens and burrowing megafauna in circalittoral fine mud	SS.SMu.CFiMu.SpnMeg
66	Burrowing megafauna and *Maxmuelleria lankesteri* in circalittoral mud	SS.SMu.CFiMu.MegMax
67	*Brissopsis lyrifera* and *Amphiura chiajei* in circalittoral mud	SS.SMu.CFiMu.BlyrAchi
68	*Ampharete falcata* turf with *Parvicardium ovale* on cohesive muddy sediment near margins of deep stratified seas	SS.SMu.OMu.AfalPova
71	*Neomysis integer* and *Gammarus* spp. in variable salinity infralittoral mobile sand	SS.SSa.SSaVS.NintGam
79	*Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand	SS.SSa.IMuSa.SsubNhom
85	*Halcampa chrysanthellum* and *Edwardsia timida* on sublittoral clean stone gravel	SS.SCS.ICS.HchrEdw
86	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand	SS.SCS.ICS.MoeVen
91	*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel	SS.SCS.CCS.MedLumVen
93	*Neopentadactyla mixta* in circalittoral shell gravel or coarse sand	SS.SCS.CCS.Nmix
95	Methane-derived authigenic carbonate (MDAC) reef	EUNIS code: A5.1
96	Circalittoral mixed sediment	SS.SMx.CMx
97	*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	SS.SMx.IMx.Lim
98	*Lophelia* reefs	SS.SBR.Crl.Lop
99	*Ostrea edulis* beds on shallow sublittoral muddy mixed sediment	SS.SMx.IMx.Ost
100	*Ruppia maritima* in reduced salinity infralittoral muddy sand	SS.SMp.SSgr.Rup
101	*Serpula vermicularis* reefs on very sheltered circalittoral muddy sand	SS.SBR.PoR.Ser

Table A5.10. Scottish Biodiversity List Species and Habitats (Scottish Biodiversity Forum, 2005).

Marine group name	Item name	Common name
Mammal	*Balaenoptera acutorostrata*	Minke whale
Mammal	*Balaenoptera physalus*	Fin whale
Mammal	*Delphinus delphis*	Common dolphin
Mammal	*Eubalaena glacialis*	Northern right whale
Mammal	*Globicephala melas*	Long-finned pilot whale
Mammal	*Grampus griseus*	Risso's dolphin
Mammal	*Hyperoodon ampullatus*	Northern bottlenose Whale
Mammal	*Lagenorhynchus acutus*	Atlantic White-sided dolphin
Mammal	*Lagenorhynchus albirostris*	White-beaked dolphin
Mammal	*Megaptera novaeangliae*	Humpback whale
Mammal	*Mesoplodon bidens*	Sowerby's beaked whale
Mammal	*Mesoplodon mirus*	True's beaked whale
Mammal	*Orcinus orca*	Killer whale
Mammal	*Phocoena phocoena*	Common porpoise
Mammal	*Physeter catodon*	Sperm whale
Mammal	*Pseudorca crassidens*	False killer whale
Mammal	*Tursiops truncatus*	Bottle-nosed dolphin
Mammal	*Ziphius cavirostris*	Cuvier's beaked whale
Reptile	*Chelonia mydas*	Green turtle
Reptile	*Lepidochelys kempii*	Kemp's ridley turtle
Reptile	*Caretta caretta*	Loggerhead turtle
Reptile	*Dermochelys coriacea*	Leathery turtle
Cartilagenous fish (Chondrichthyes)	*Cetorhinus maximus*	Basking shark
Cartilagenous fish (Chondrichthyes)	*Raja batis*	Skate
Cartilagenous fish (Chondrichthyes)	*Raja clavata*	Roker
Bony fish (Actinopterygii)	*Ammodytes marinus*	Sand-eel
Bony fish (Actinopterygii)	*Ammodytes tobianus*	Sand-eel
Bony fish (Actinopterygii)	*Anguilla anguilla*	Eel
Bony fish (Actinopterygii)	*Bathysolea profundicola*	Deepwater sole
Bony fish (Actinopterygii)	*Brosme brosme*	Torsk
Bony fish (Actinopterygii)	*Clupea harengus*	Herring
Bony fish (Actinopterygii)	*Gadus morhua*	Cod
Bony fish (Actinopterygii)	*Merlangius merlangus*	Whiting

Marine group name	Item name	Common name
Bony fish (Actinopterygii)	*Merluccius merluccius*	Hake
Bony fish (Actinopterygii)	*Molva molva*	Ling
Bony fish (Actinopterygii)	*Pleuronectes platessa*	Plaice
Bony fish (Actinopterygii)	*Pollachius virens*	Saithe
Bony fish (Actinopterygii)	*Sebastes viviparus*	Norway haddock
Bony fish (Actinopterygii)	*Trisopterus esmarkii*	Norway pout
Echinoderm	*Ophiopsila annulosa*	Brittlestar
Mollusc	*Aeolidiella sanguinea*	Sea slug
Mollusc	*Aldisa zetlandica*	
Mollusc	*Amauropsis islandicus*	
Mollusc	*Atrina fragilis*	Fan Mussel
Mollusc	*Buccinum humphreysianum*	
Mollusc	*Ceratia proxima*	
Mollusc	*Devonia perrieri*	
Mollusc	*Eubranchus doriae*	
Mollusc	*Facelina annulicornis*	
Mollusc	*Hancockia uncinata*	
Mollusc	*Hydrobia neglecta*	
Mollusc	*Manzonia crassa*	
Mollusc	*Okenia leachii*	
Mollusc	*Ostrea edulis*	Flat oyster
Mollusc	*Otina ovata*	
Mollusc	*Simnia patula*	
Mollusc	*Thyasira gouldi*	Northern hatchet-shell
Mollusc	*Trapania pallida*	Sea slug
Ribbon worm (Nemertinea)	*Amphiporus hastatus*	
Ribbon worm (Nemertinea)	*Carinoma armandi*	
Ribbon worm (Nemertinea)	*Cerebratulus fuscus*	
Ribbon worm (Nemertinea)	*Emplectonema neesii*	
Ribbon worm (Nemertinea)	*Nemertopsis flavida*	
Ribbon worm (Nemertinea)	*Procephalothrix filiformis*	
Ribbon worm (Nemertinea)	*Psammamphiporus elongatus*	
Ribbon worm (Nemertinea)	*Ramphogordius sanguineus*	
Ribbon worm (Nemertinea)	*Tetrastemma robertianae*	

Marine group name	Item name	Common name
Ribbon worm (Nemertinea)	*Tetrastemma vermiculus*	
Ribbon worm (Nemertinea)	*Tubulanus linearis*	
Sponge (Porifera)	*Axinella damicornis*	Sponge
Sponge (Porifera)	*Eurypon clavatum*	
Sponge (Porifera)	*Macandrewia azorica*	
Sponge (Porifera)	*Myxilla perspinosa*	
Sponge (Porifera)	*Quasillina brevis*	
Sponge (Porifera)	*Spinularia spinularia*	
Sponge (Porifera)	*Spongionella pulchella*	
Sponge (Porifera)	*Stryphnus ponderosus*	
Bryozoan	*Ammatophora nodulosa*	
Bryozoan	*Arachnidium clavatum*	
Bryozoan	*Arachnidium fibrosum*	
Bryozoan	*Arachnidium hippothooides*	
Bryozoan	*Arachnidium simplex*	
Bryozoan	*Bowerbankia gracillima*	
Bryozoan	*Buskea quincuncialis*	
Bryozoan	*Coronopora truncata*	
Bryozoan	*Cylindroporella tubulosa*	Bryozoan
Bryozoan	*Gephyrotes nitidopunctata*	
Bryozoan	*Haplota clavata*	
Bryozoan	*Hypophorella expansa*	
Bryozoan	*Smittina crystallina*	
Coelenterate (=cnidarian)	*Actinauge richardi*	
Coelenterate (=cnidarian)	*Amphianthus dohrnii*	Sea-fan anemone
Coelenterate (=cnidarian)	*Anthopleura thallia*	Glaucus pimplet
Coelenterate (=cnidarian)	*Arachnanthus sarsi*	
Coelenterate (=cnidarian)	*Caryophyllia inornata*	Cup coral
Coelenterate (=cnidarian)	*Diphasia alata*	
Coelenterate (=cnidarian)	*Edwardsia timida*	
Coelenterate (=cnidarian)	*Halcampoides elongatus*	Burrowing anemone
Coelenterate (=cnidarian)	*Hartlaubella gelatinosa*	Hydroid
Coelenterate (=cnidarian)	*Octocorallia*	
Coelenterate (=cnidarian)	*Paraphellia expansa*	
Coelenterate (=cnidarian)	*Parazoanthus axinellae*	

Marine group name	Item name	Common name
Coelenterate (=cnidarian)	*Polyplumaria flabellata*	
Coelenterate (=cnidarian)	*Tamarisca tamarisca*	Hydroid
Coelenterate (=cnidarian)	*Ventromma halecioides*	
Alga	*Ascophyllum nodosum ecad mackaii*	
Alga	*Codium adhaerens*	
Alga	*Codium bursa*	
Alga	*Cruoria cruoriaeformis*	
Marine habitat	*Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed circalittoral rock	
Marine habitat	Anemones, including *Corynactis viridis*, crustose sponges and colonial ascidians on very exposed or wave surged vertical infralittoral rock	
Marine habitat	*Aphelochaeta* spp. and *Polydora* spp. in variable salinity infralittoral mixed sediment	
Marine habitat	*Audouinella purpurea* and *Cladophora rupestris* on upper to mid-shore cave walls	
Marine habitat	Barren and/or boulder-scoured littoral cave walls and floors	
Marine habitat	*Beggiatoa* spp. on anoxic sublittoral mud	
Marine habitat	Bryozoan turf and erect sponges on tide-swept circalittoral rock	
Marine habitat	*Caryophyllia smithii* and *Swiftia pallida* on circalittoral rock	
Marine habitat	*Caryophyllia smithii, Swiftia pallida* and large solitary ascidians on exposed or moderately exposed circalittoral rock	
Marine habitat	*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment	
Marine habitat	*Cerianthus lloydii* with *Nemertesia* spp. and other hydroids in circalittoral muddy mixed sediment	
Marine habitat	Circalittoral fine mud	
Marine habitat	Circalittoral sandy mud	
Marine habitat	Coral reefs	
Marine habitat	*Corynactis viridis* and a mixed turf of crisiids, *Bugula, Scrupocellaria*, and *Cellaria* on moderately tide-swept exposed circalittoral rock	
Marine habitat	Crustose sponges and colonial ascidians with *Dendrodoa grossularia* or barnacles on wave-surged infralittoral rock	
Marine habitat	Crustose sponges on extremely wave-surged infralittoral cave or gully walls	
Marine habitat	Cushion sponges and hydroids on turbid tide-swept sheltered circalittoral rock	

Marine group name	Item name	Common name
Marine habitat	Cushion sponges and hydroids on turbid tide-swept variable salinity sheltered circalittoral rock	
Marine habitat	Cushion sponges, hydroids and ascidians on turbid tide-swept sheltered circalittoral rock	
Marine habitat	*Dendrodoa grossularia* and *Clathrina coriacea* on wave-surged vertical infralittoral rock	
Marine habitat	Faunal crusts on wave-surged littoral cave walls	
Marine habitat	*Flustra foliacea* and colonial ascidians on tide-swept exposed circalittoral mixed substrata	
Marine habitat	*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	
Marine habitat	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	
Marine habitat	*Flustra foliacea,* small solitary and colonial ascidians on tide-swept circalittoral bedrock or boulders	
Marine habitat	Foliose seaweeds and coralline crusts in surge gully entrances	
Marine habitat	Fucoids in tide-swept conditions	
Marine habitat	Fucoids in variable salinity	
Marine habitat	Green algal films on upper and mid-shore cave walls and ceilings	
Marine habitat	*Halichondria bowerbanki*, *Eudendrium arbusculum* and *Eucratea loricata* on reduced salinity tide-swept circalittoral mixed substrata	
Marine habitat	*Halidrys siliquosa* and mixed kelps on tide-swept infralittoral rock with coarse sediment	
Marine habitat	Infralittoral mixed sediment	
Marine habitat	Kelp and seaweed communities in tide-swept sheltered conditions	
Marine habitat	Kelp and seaweed communities on sublittoral sediment	
Marine habitat	Kelp in variable or reduced salinity	
Marine habitat	*Laminaria hyperborea* forest with a faunal cushion (sponges and polyclinids) and foliose red seaweeds on very exposed upper infralittoral rock	
Marine habitat	*Laminaria hyperborea* on tide-swept, infralittoral mixed substrata.	
Marine habitat	*Laminaria hyperborea* on tide-swept, infralittoral rock	
Marine habitat	*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment	
Marine habitat	*Lithophyllum fasciculatum* maerl beds on infralittoral mud	

Marine group name	Item name	Common name
Marine habitat	*Lithothamnion glaciale* maerl beds in tide-swept variable salinity infralittoral gravel	
Marine habitat	Littoral mud	
Marine habitat	Maerl beds	
Marine habitat	Mixed turf of bryozoans and erect sponges with *Sagartia elegans* on tide-swept ciraclittoral rock	
Marine habitat	Mixed turf of hydroids and large ascidians with *Swiftia pallida* and *Caryophyllia smithii* on weakly tide-swept circalittoral rock	
Marine habitat	*Modiolus modiolus* beds on open coast circalittoral mixed sediment	
Marine habitat	*Modiolus modiolus* beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered circalittoral mixed substrata	
Marine habitat	*Modiolus modiolus* beds with fine hydroids and large solitary ascidians on very sheltered circalittoral mixed substrata	
Marine habitat	*Modiolus modiolus* beds with hydroids and red seaweeds on tide-swept circalittoral mixed substrata	
Marine habitat	*Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment	
Marine habitat	*Mytilus edulis* and *Fabricia sabella* in littoral mixed sediment	
Marine habitat	*Mytilus edulis* beds on littoral mud	
Marine habitat	*Mytilus edulis* beds on reduced salinity tide-swept infralittoral rock	
Marine habitat	*Mytilus edulis* beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock	
Marine habitat	*Neocrania anomala* and *Protanthea simplex* on very wave-sheltered circalittoral rock	
Marine habitat	*Neocrania anomala, Dendrodoa grossularia* and *Sarcodictyon roseum* on variable salinity circalittoral rock	
Marine habitat	Offshore circalittoral mixed sediment	
Marine habitat	Offshore circalittoral mud	
Marine habitat	*Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	
Marine habitat	*Ostrea edulis* beds on shallow sublittoral muddy mixed sediment	
Marine habitat	*Phakellia ventilabrum* and Axinellid sponges on deep, wave-exposed circalittoral rock	
Marine habitat	*Phymatolithon calcareum* maerl beds in infralittoral clean gravel or coarse sand	

Marine group name	Item name	Common name
Marine habitat	*Phymatolithon calcareum* maerl beds with *Neopentadactyla mixta* and other echinoderms in deeper infralittoral clean gravel or coarse sand	
Marine habitat	*Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand	
Marine habitat	Polychaete / bivalve dominated muddy sand shores	
Marine habitat	Polychaete-rich deep *Venus* community in offshore gravelly muddy sand	
Marine habitat	*Ruppia maritima* in reduced salinity infralittoral muddy sand	
Marine habitat	*Sabella pavonina* with sponges and anemones on infralittoral mixed sediment	
Marine habitat	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock	
Marine habitat	*Sabellaria spinulosa* with kelp and red seaweeds on sand-influenced infralittoral rock	
Marine habitat	*Serpula vermicularis* reefs on very sheltered circalittoral muddy sand	
Marine habitat	Sparse fauna (barnacles and spirorbids) on sand/pebble-scoured rock in littoral caves	
Marine habitat	Sparse *Modiolus modiolus*, dense *Cerianthus lloydii* and burrowing holothurians on sheltered circalittoral stones and mixed sediment	
Marine habitat	Sponges and shade-tolerant red seaweeds on overhanging lower eulittoral bedrock and in cave entrances	
Marine habitat	Sponges, bryozoans and ascidians on deeply overhanging lower shore bedrock or caves	
Marine habitat	Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock	
Marine habitat	Sponges, shade-tolerant red seaweeds and *Dendrodoa grossularia* on wave-surged overhanging lower eulittoral bedrock and caves	
Marine habitat	Sublittoral coarse sediment (unstable cobbles and pebbles, gravels and coarse sands)	
Marine habitat	Sublittoral mixed sediment in low or reduced salinity (lagoons)	
Marine habitat	Sublittoral mud in low or reduced salinity (lagoons)	
Marine habitat	Sublittoral sands and muddy sands	
Marine habitat	Submerged fucoids, green or red seaweeds (low salinity infralittoral rock)	
Marine habitat	*Venerupis senegalensis, Amphipholis squamata* and *Apseudes latreilli* in infralittoral mixed sediment	

Marine group name	Item name	Common name
Marine habitat	*Verrucaria mucosa* and/or *Hildenbrandia rubra* on upper to mid shore cave walls	
Marine habitat	Very tide-swept faunal communities	
Marine habitat	*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand	
Marine habitat	*Zostera noltii* beds in littoral muddy sand	

Appendix 6. Analyses for scoring diversity indices

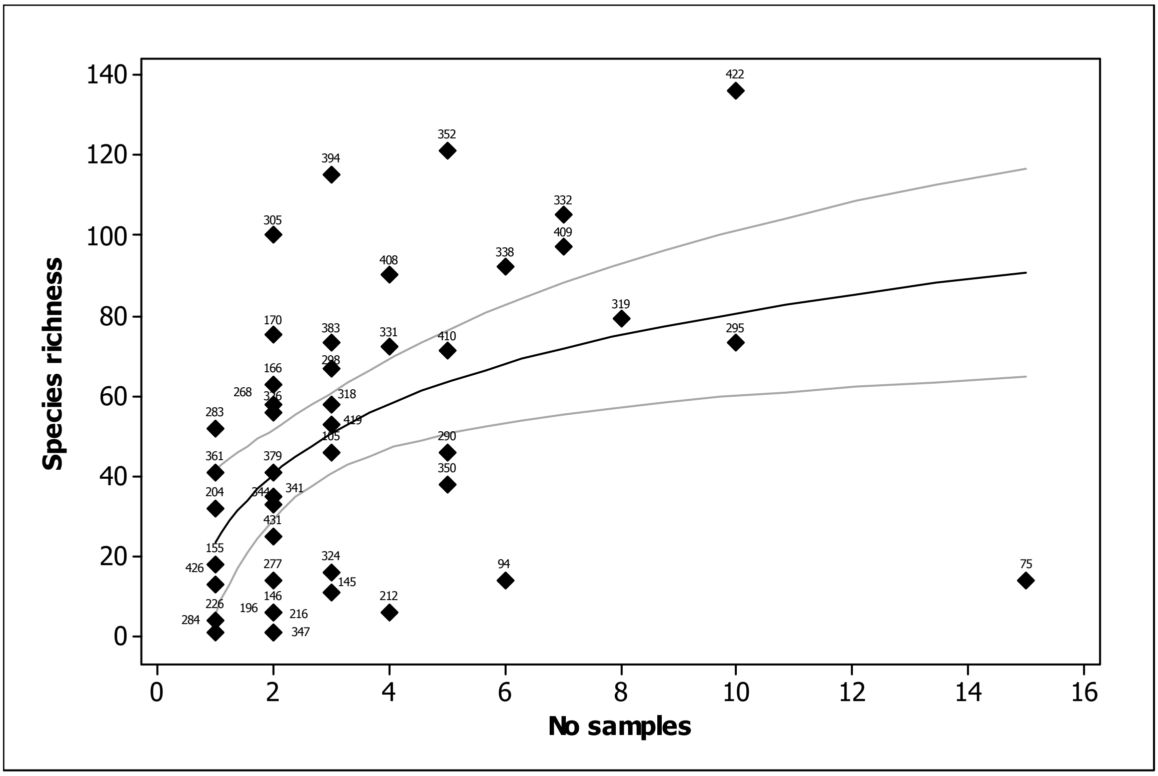


Figure A6.1. Species richness for predictive seabed habitat type A1 (littoral rock and other hard substrata). Data are plotted with log_{10} regression and 95% confidence intervals. Hexagons above the confidence intervals were scored 3 (above expected levels of species richness), hexagons within the confidence intervals were scored 2 (expected levels of species richness) and hexagons below the confidence intervals were scored 1 (below expected levels of species richness).

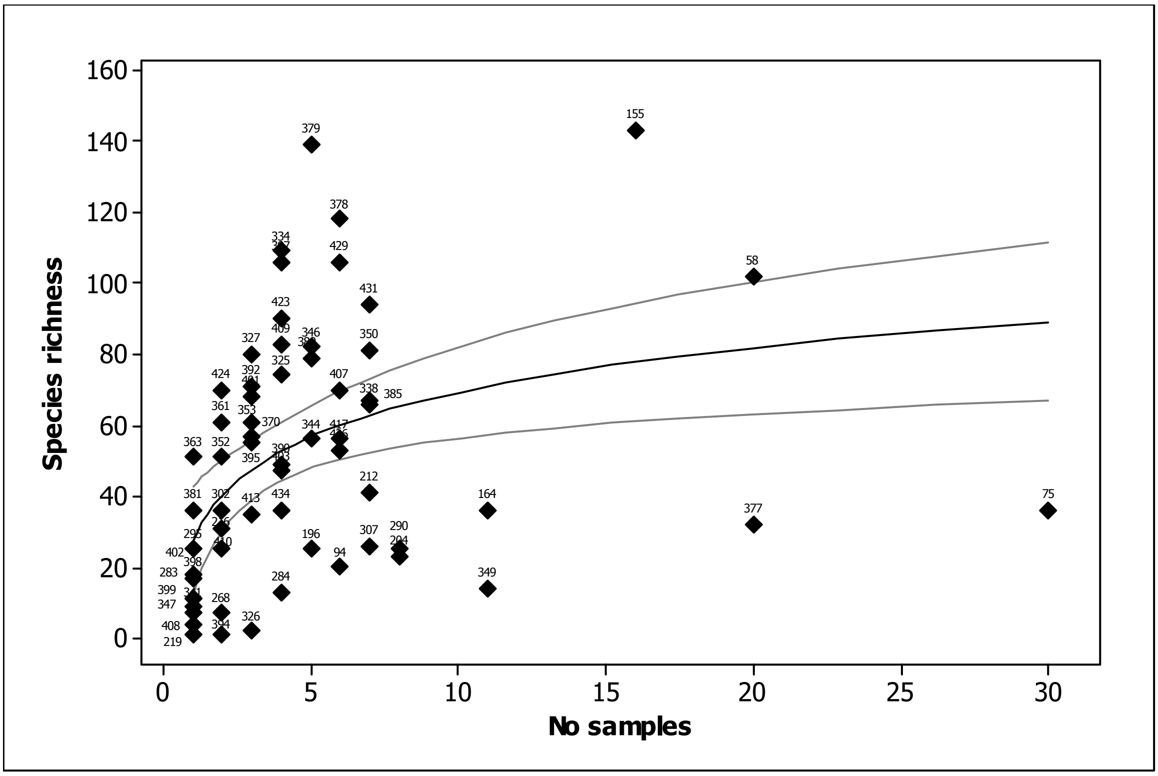


Figure A6.2. Species richness for predictive seabed habitat type A2 (littoral sediment). Data are plotted with log_{10} regression and 95% confidence intervals. Hexagons above the confidence intervals were scored 3 (above expected levels of species richness), hexagons within the confidence intervals were scored 2 (expected levels of species richness) and hexagons below the confidence intervals were scored 1 (below expected levels of species richness).

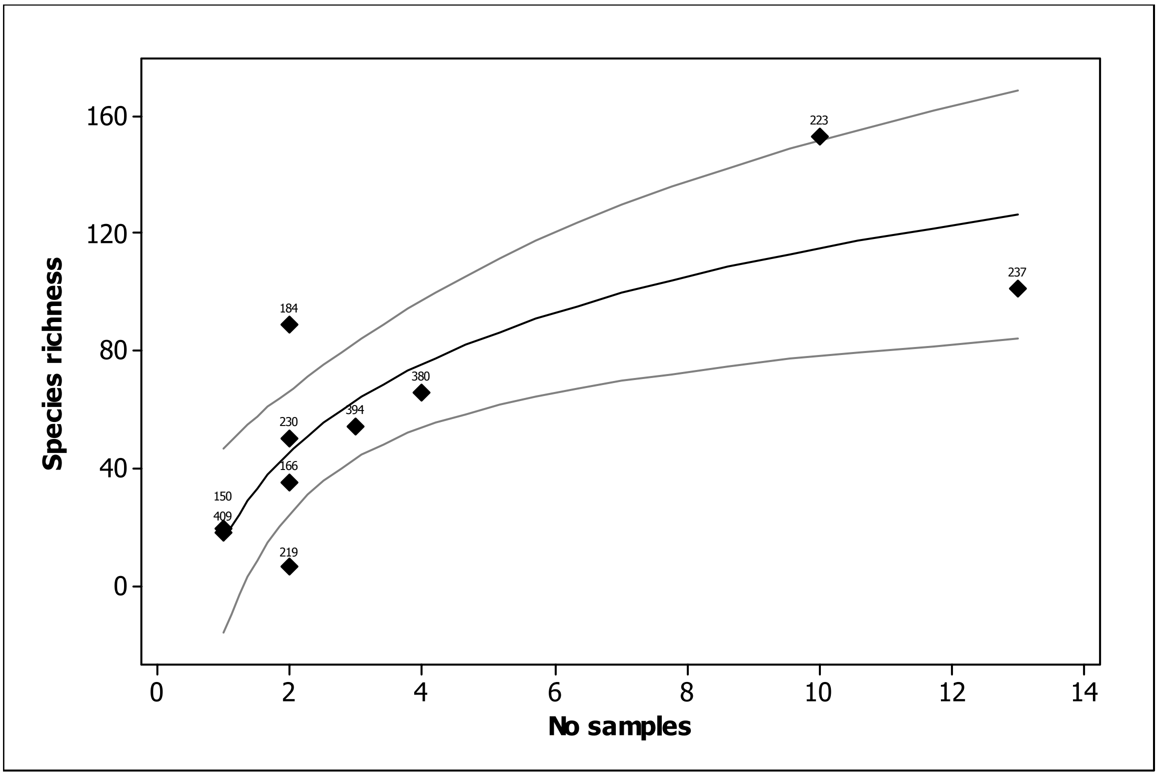


Figure A6.3. Species richness for predictive seabed habitat type A3 (infralittoral rock and other hard substrata). Data are plotted with log_{10} regression and 95% confidence intervals. Hexagons above the confidence intervals were scored 3 (above expected levels of species richness), hexagons within the confidence intervals were scored 2 (expected levels of species richness) and hexagons below the confidence intervals were scored 1 (below expected levels of species richness).

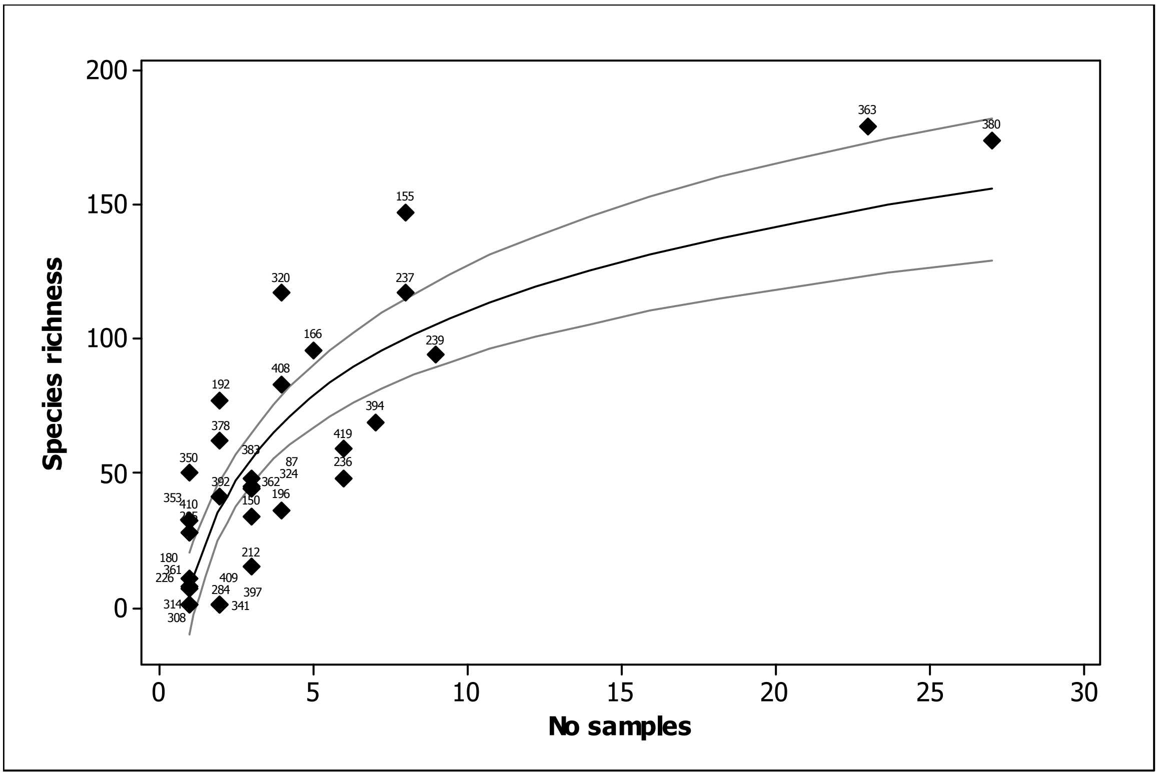


Figure A6.4. Species richness for predictive seabed habitat type A4 (circalittoral rock and other hard substrata). Data are plotted with log_{10} regression and 95% confidence intervals. Hexagons above the confidence intervals were scored 3 (above expected levels of species richness), hexagons within the confidence intervals were scored 2 (expected levels of species richness) and hexagons below the confidence intervals were scored 1 (below expected levels of species richness).

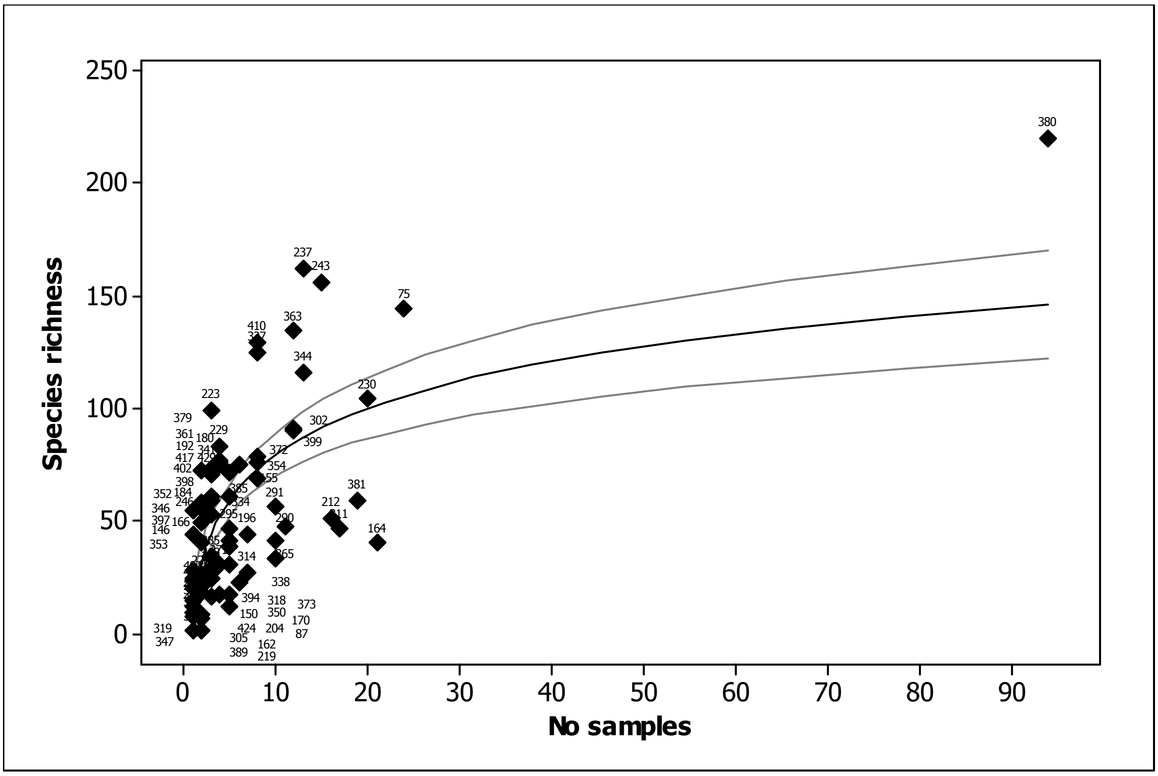


Figure A6.5. Species richness for predictive seabed habitat type A5 (sublittoral sediment). Data are plotted with log_{10} regression and 95% confidence intervals. Hexagons above the confidence intervals were scored 3 (above expected levels of species richness), hexagons within the confidence intervals were scored 2 (expected levels of species richness) and hexagons below the confidence intervals were scored 1 (below expected levels of species richness).

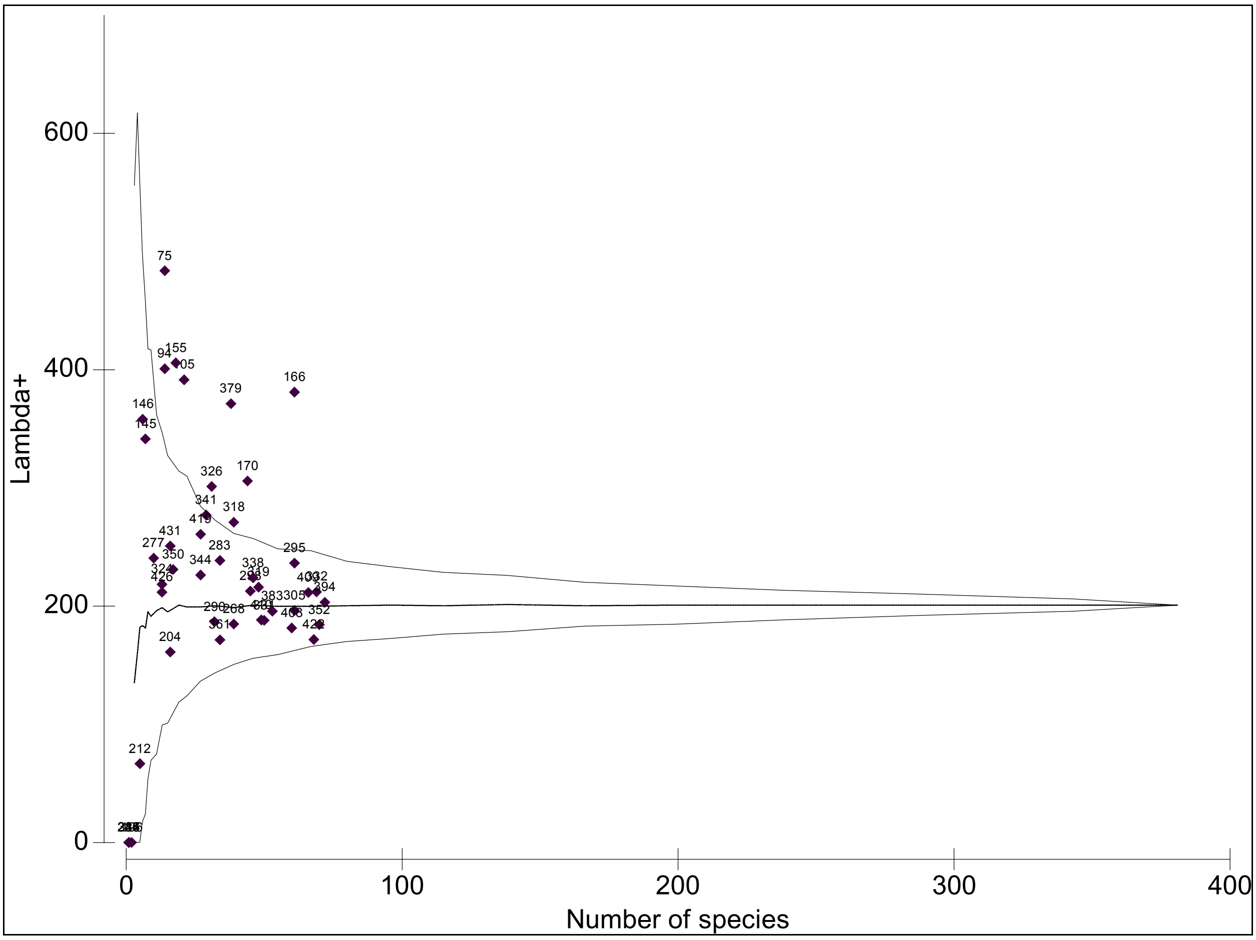


Figure A6.6. Average species distinctness (Δ+) funnel plot showing data points within predictive seabed habitat type A2 (littoral sediment) for each hexagon. The plotted funnel indicates the 95% confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of species from a predictive seabed habitat type A2 master list. Data points outside this area depart significantly from random expectation (Clarke & Warwick, 1998). Deviations below the funnel were assigned a score of 1, as these show below expected levels of taxonomic distinctness, while those above the funnel were scored 3, being higher than expected. The hexagons that fell within the area of the 95% confidence intervals (funnel area) were scored 2.

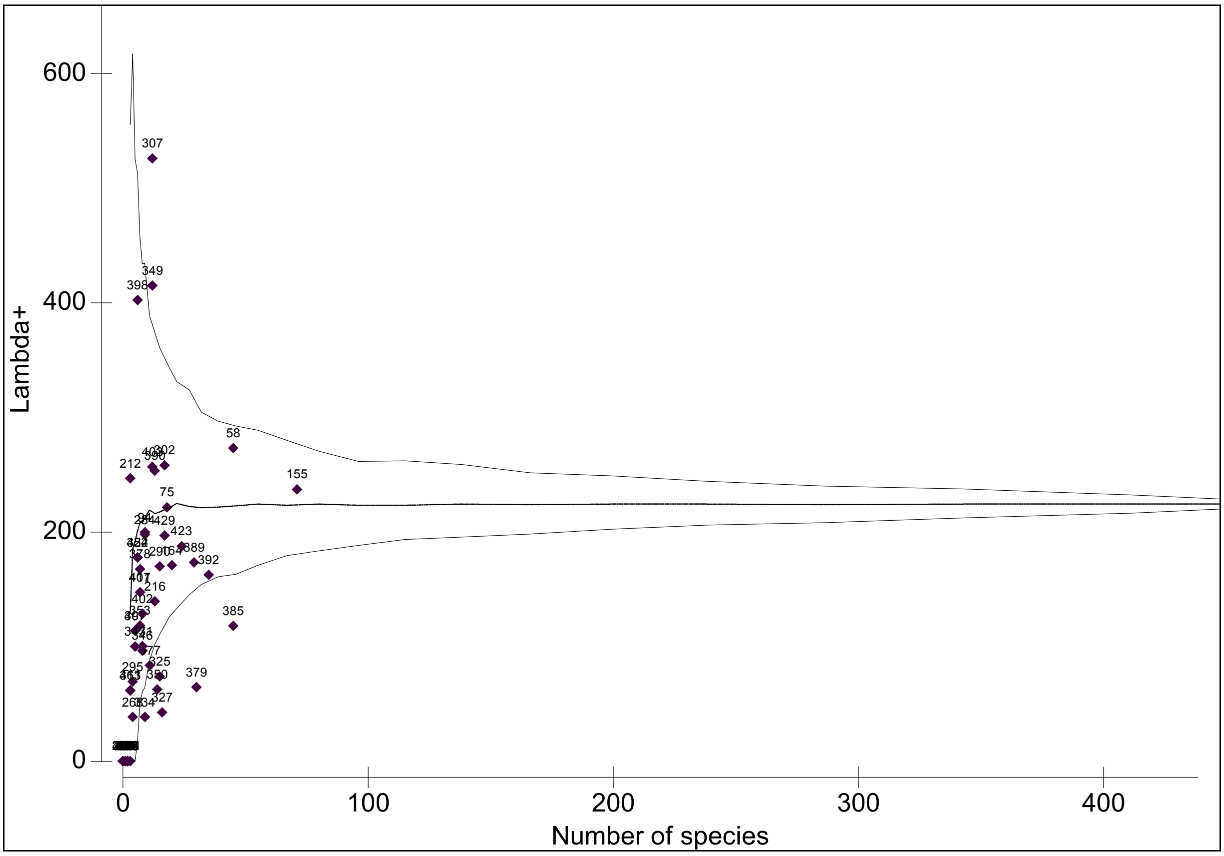


Figure A6.7. Average species distinctness (Δ+) funnel plot showing data points within predictive seabed habitat type A3 (infralittoral rock and other hard substrata) for each hexagon. The plotted funnel indicates the 95% confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of species from a predictive seabed habitat type A3 master list. Data points outside this area depart significantly from random expectation (Clarke & Warwick, 1998). Deviations below the funnel were assigned a score of 1, as these show below expected levels of taxonomic distinctness, while those above the funnel were scored 3, being higher than expected. The hexagons that fell within the area of the 95% confidence intervals (funnel area) were scored 2.

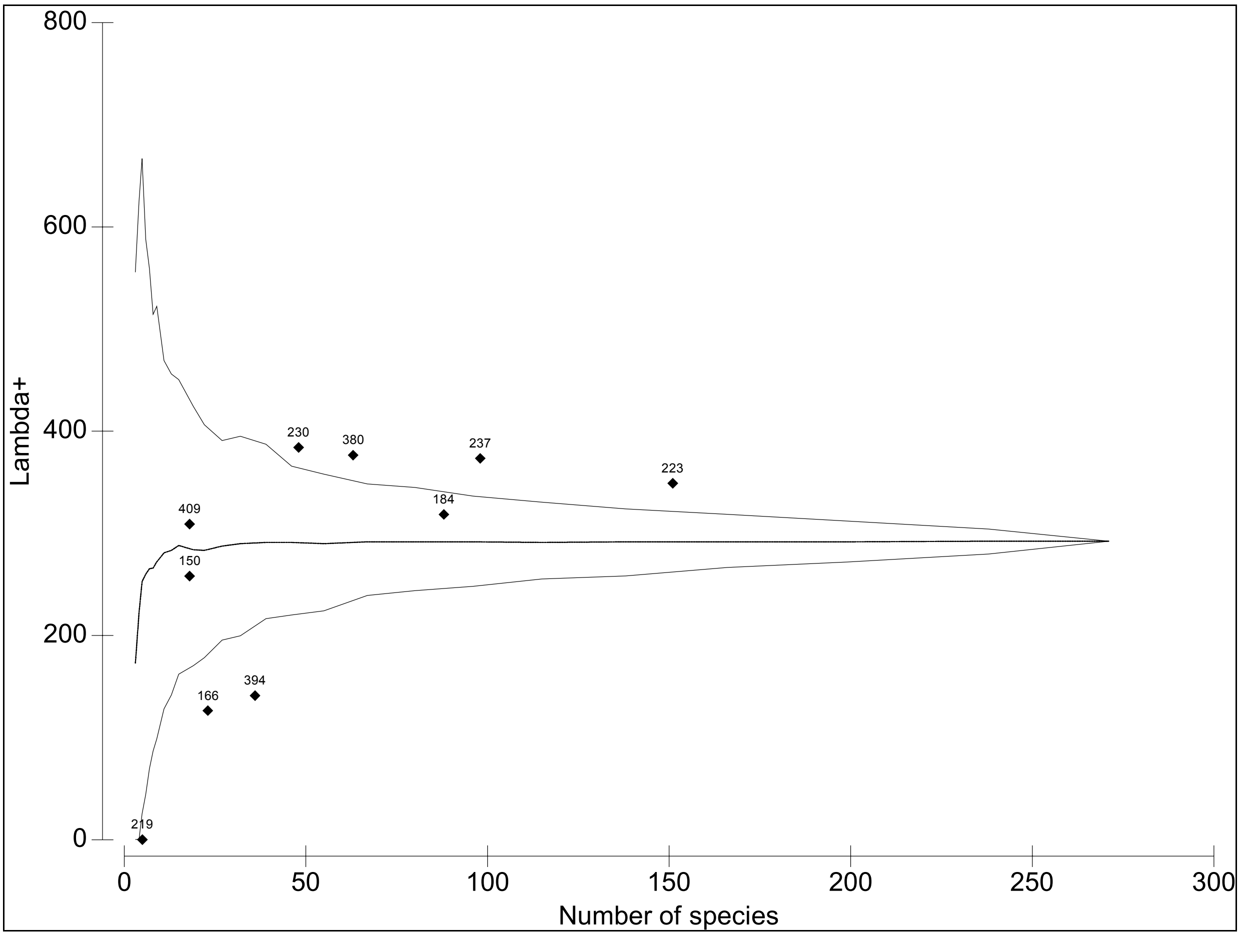


Figure A6.8. Average species distinctness (Δ+) funnel plot showing data points within predictive seabed habitat type A4 (circalittoral rock and other hard substrata) for each hexagon. The plotted funnel indicates the 95% confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of species from a predictive seabed habitat type A4 master list. Data points outside this area depart significantly from random expectation (Clarke & Warwick, 1998). Deviations below the funnel were assigned a score of 1, as these show below expected levels of taxonomic distinctness, while those above the funnel were scored 3, being higher than expected. The hexagons that fell within the area of the 95% confidence intervals (funnel area) were scored 2.

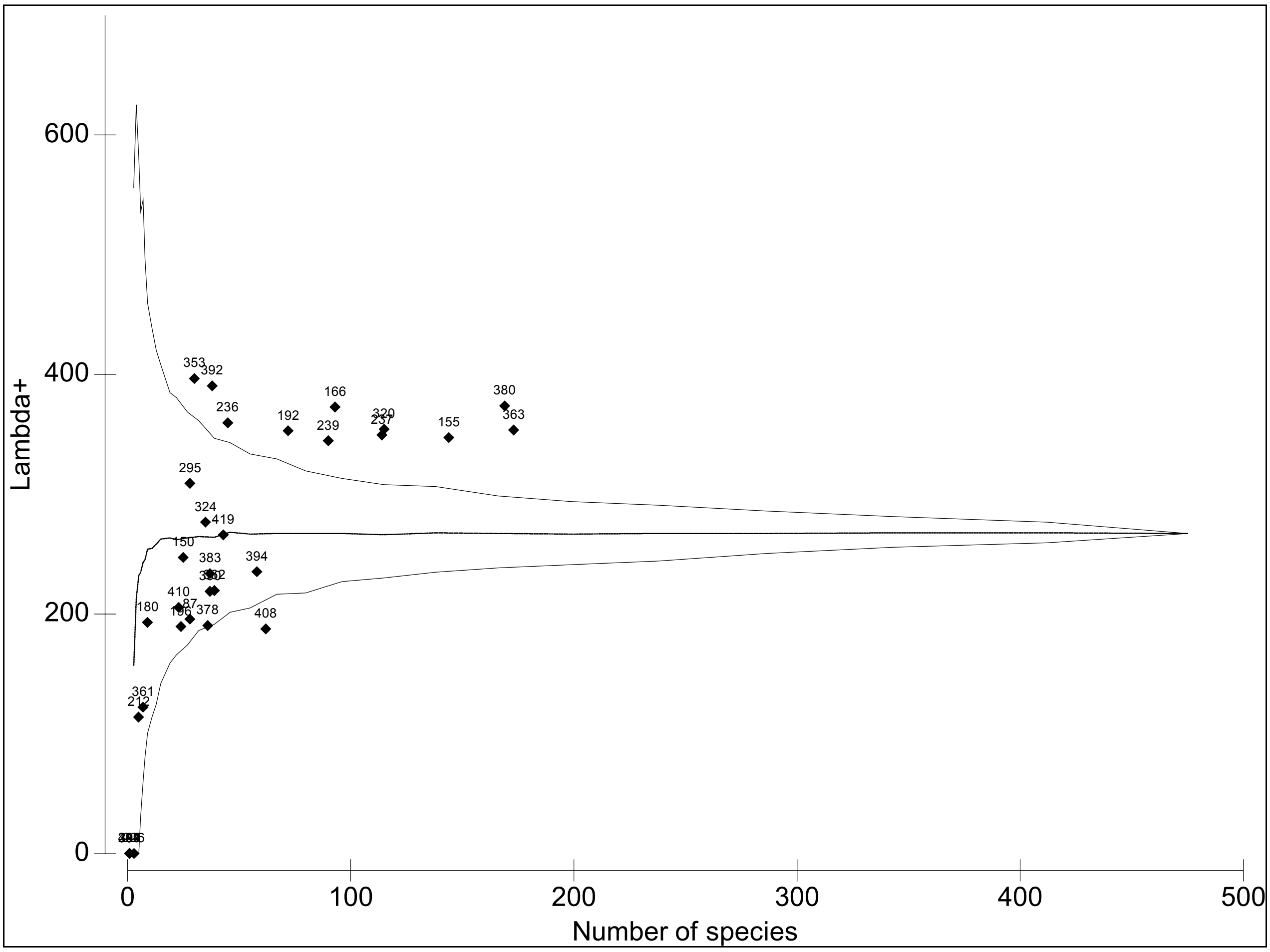


Figure A6.9. Average species distinctness (Δ+) funnel plot showing data points within predictive seabed habitat type A4 (circalittoral rock and other hard substrata) for each hexagon. The plotted funnel indicates the 95% confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of species from a predictive seabed habitat type A4 master list. Data points outside this area depart significantly from random expectation (Clarke & Warwick, 1998). Deviations below the funnel were assigned a score of 1, as these show below expected levels of taxonomic distinctness, while those above the funnel were scored 3, being higher than expected. The hexagons that fell within the area of the 95% confidence intervals (funnel area) were scored 2.

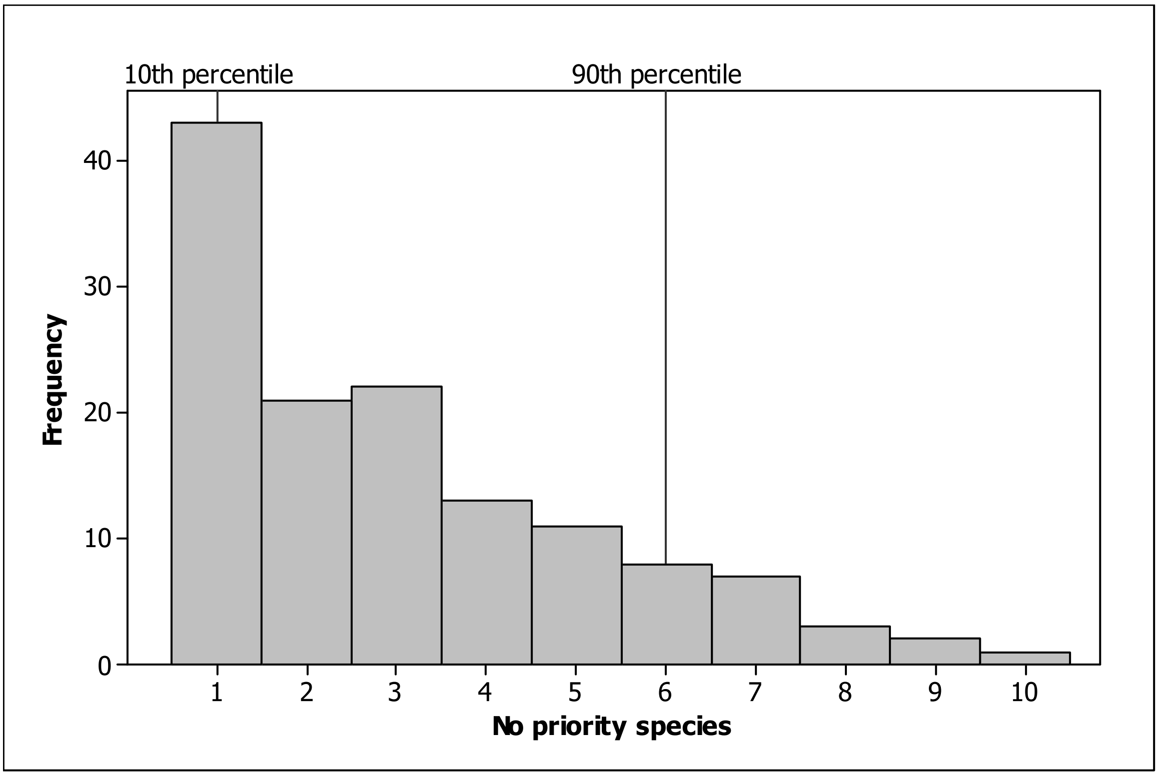


Figure A6.10. Frequency distribution of number of priority species by hexagon, with 10th and 90th percentiles indicated. Areas with low priority species scores fell below the 10th percentile and areas with high numbers of priority species fell above the 90th percentile, the remaining hexagons were scored 2.

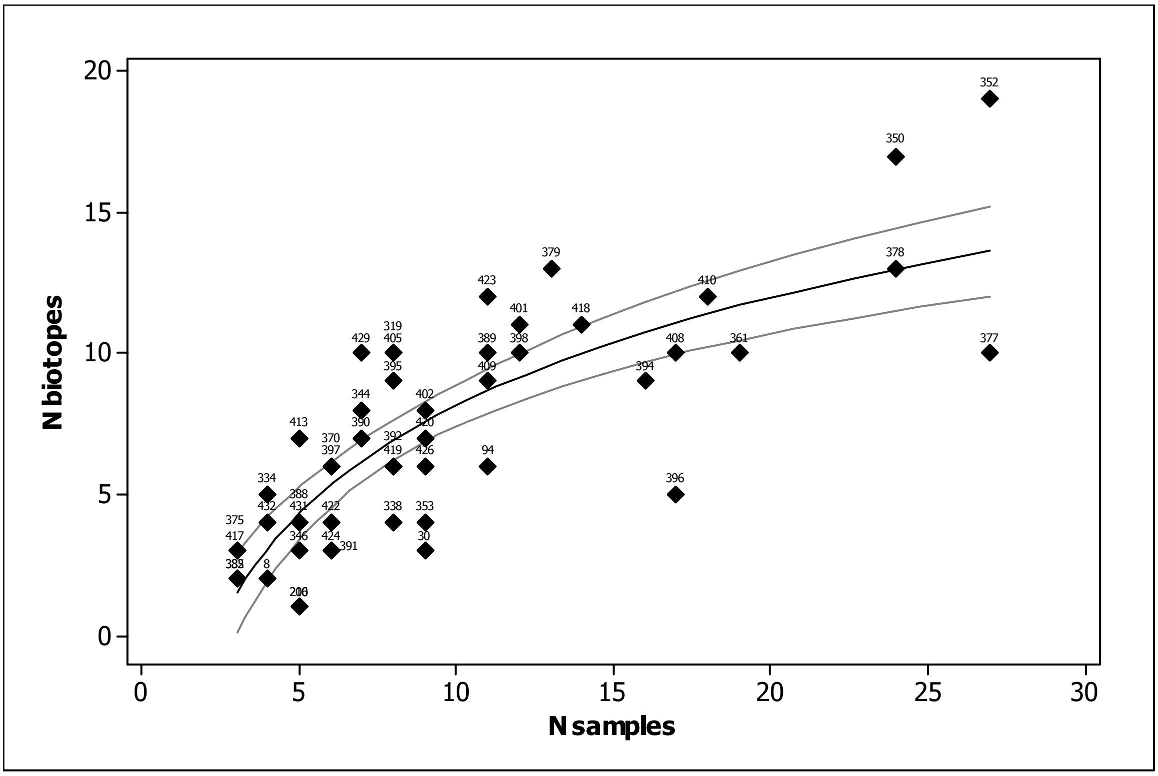


Figure A6.11. Relationship between biotope richness and sampling effort for the Firth of Clyde. The regression was conducted with $\log_{10}$ transformation of the x axis and 95% confidence intervals are shown (grey lines). Data points, representing hexagons, within the grey 95% confidence intervals represent the area in which 95% of the data would be predicted to fall if repeat measures were taken. Data points above this area have more biotopes per sample effort than would be predicted whilst data points below the lower confidence interval have less biotopes than would be predicted.

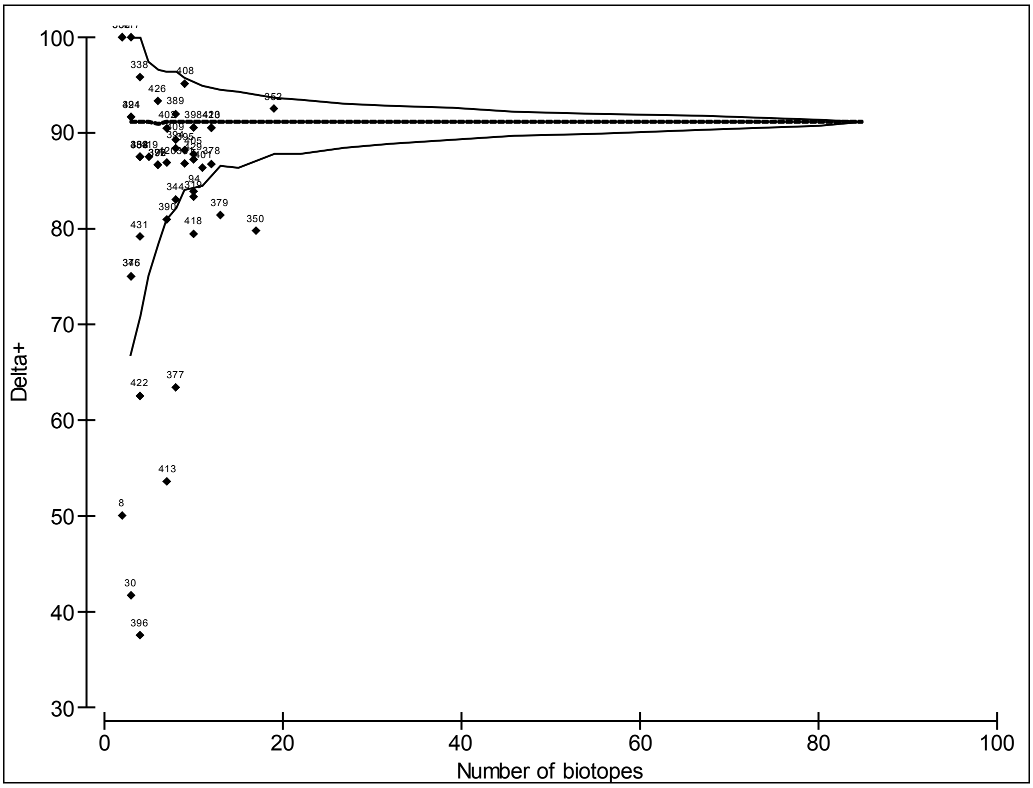


Figure A6.12. Average biotope distinctness (Δ+) funnel plot showing data points for all hexagons. The plotted funnel indicates the 95% confidence intervals for random 'expected' distinctness based on 1000 random permutations of the same number of biotopes from a regional biotopes master list. Data points outside this area depart significantly from random expectation (Clarke & Warwick, 1998).

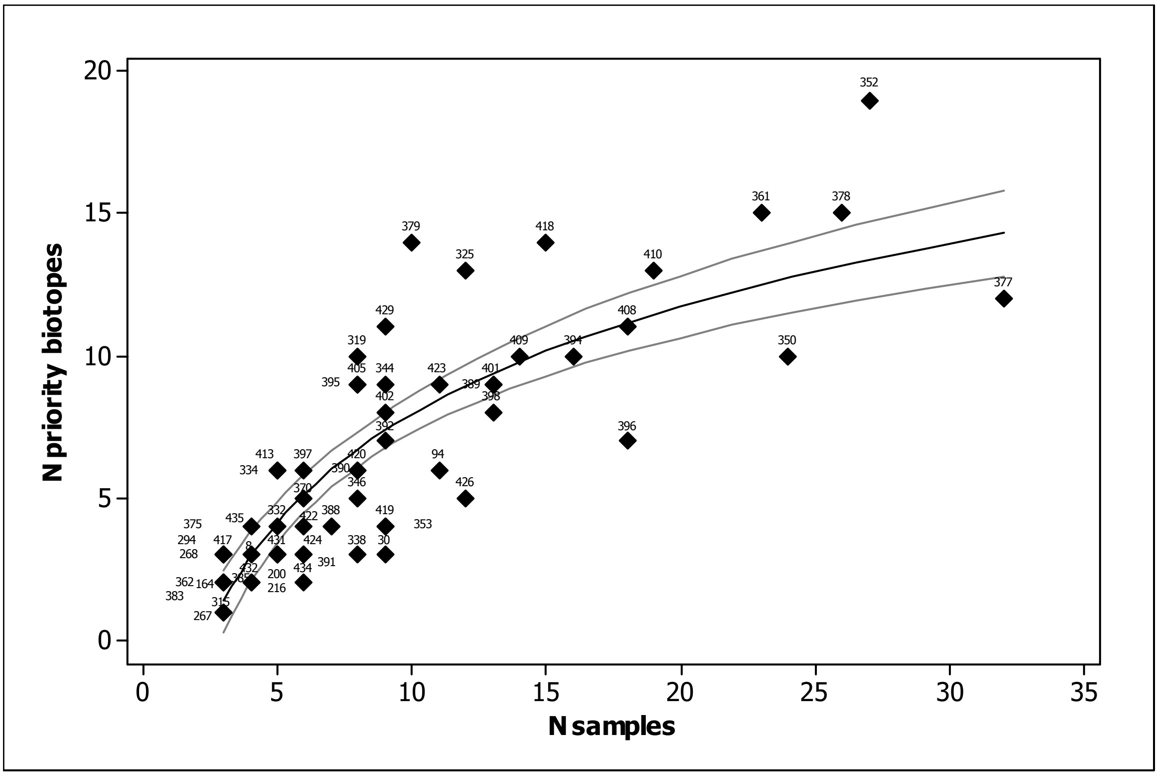
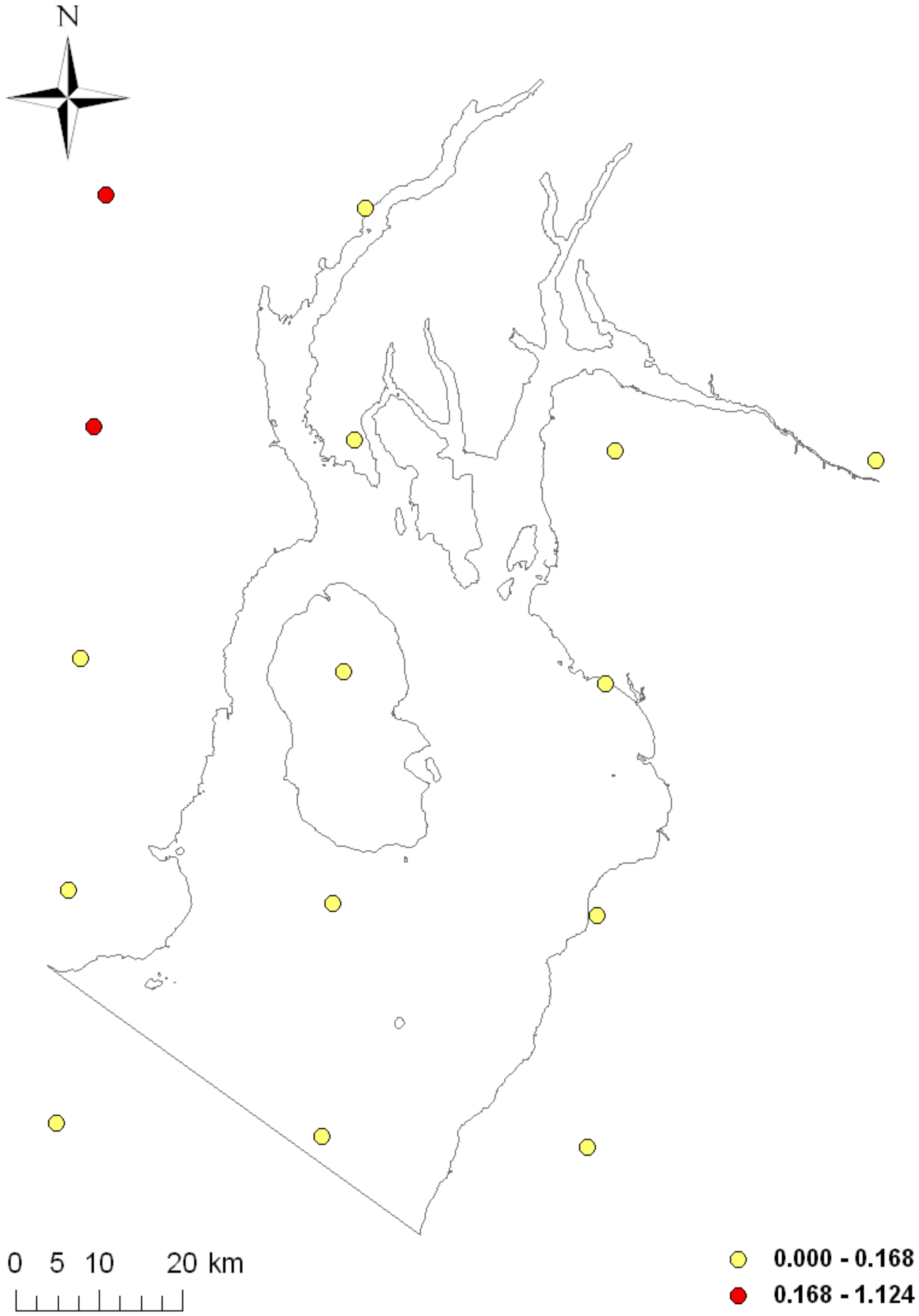


Figure A6.13. Relationship between the number of priority biotopes the Firth of Clyde and sampling effort. The regression was conducted with $\log_{10}$ transformation of the x axis and 95% confidence intervals are shown (grey lines). Data points, representing 5 km diameter hexagons, within the grey 95% confidence intervals represent the area in which 95% of the data would be predicted to fall if repeat measures were taken. Data points above this area have higher numbers of priority biotopes per sample effort than would be predicted whilst data points below the lower confidence interval have less priority biotopes than would be predicted.

Appendix 7. Harbour porpoise encounter rates per standard hour (JNCC cetacean data). The resolution of these data were too coarse to be included in analyses.



Appendix 8. Hotspot Annexes.

Species Hotspot Results	Hotspot 1	Hotspot 2	Hotspot 3	Hotspot 4	Hotspot 5	Hotspot 6	Hotspot 7	Hotspot 8	Hotspot 9	Hotspot 10	Hotspot 11
Hexagon id	429	422	378	363	353	346	320	243	229	223	192
Location name	Mouth of Loch Shira	Northern Loch Fyne	Loch Striven	East of Dunoon in the upper Firth of Clyde	Loch Striven	Kyles of Bute	East of Rothesay	Irvine Bay	Irvine Bay	Irvine Bay	Irvine Bay
Occurrence within MPA (including voluntary)	Upper Loch Fyne - SNH Marine Consultation Area										
Amount of coastline (km)	5.157537	4.536602	8.198506	5.247338	5.296627	8.389386	0.404858	0.579602	0.000000	0.000000	0.000000
Area of heagon (km^2)	7.013352	5.262960	3.100042	10.619183	4.264731	4.070534	12.150104	12.151708	12.178482	12.178482	12.178482
Number of Physiographic types	11	6	3	11	6	8	12	10	8	11	12
Physiographic Diversity	1.947294	1.534531	0.723723	1.899168	1.182951	1.749472	1.726022	2.248739	2.289345	1.705601	1.845180
Species Richness Mean	3	3	3	3	3	3	3	3	3	3	3
Taxonomic distinctiveness mean	3	3	3	3	3	3		2	1	2	2
Priority species score	2	2	2	2	2	2	3	3	3	3	3
Species Hotspot	3	3	3	3	3	3	3	3	3	3	3
Quality	High	Medium	High	High	High	High	High	High	High	High	High
Confidence	High	Medium	High	High	High	High	High	High	High	High	High

Habitat Hotspot Results	Hotspot 12	Hotspot 13	Hotspot 14	Hotspot 15	Hotspot 16	Hotspot 17	Hotspot 18	Hotspot 19	Hotspot 20	Hotspot 21
Hexagon id	429	417	413	405	395	379	344	352	319	334
Location name	mouth of Loch Shira	Northern Loch Goil	Northern Loch Fyne	Loch Long	Gare Loch and Loch Long	mouth of Holy Loch	Loch Fyne around Barmore Island	Kyles of Bute	Ardlamont Point	Kames Bay
Occurrence within MPA (including voluntary)	Upper Loch Fyne - SNH Marine Consultation Area							North end of Bute - SSSI		
Amount of coastline (km)	5.157537	7.386861	3.155676	2.807865	5.852883	6.029888	6.132772	8.794664	5.670716	5.754984
Area of heagon (km^2)	7.013352	3.793825	1.153957	1.134457	2.554438	8.866646	7.239995	3.127513	9.010858	2.847521
Number of Physiographic types	11	6	5	5	5	7	8	6	14	10
Physiographic Diversity	1.947294	1.410883	1.349494	1.493674	1.349147	0.949340	1.470609	1.498554	2.045030	1.774409
Biotope richness	3	2	3	3	3	3	3	3	3	3
Biotope Distinctiveness	2	3	1	2	2	1	2	2	1	2
Priority biotope score	3	3	3	3	3	3	3	3	3	3
Biotope Hotspot score	3	3	3	3	3	3	3	3	3	3
Quality	Medium	Medium	Medium	Medium	Medium	Medium	Medium	High	Medium	Medium
Confidence	High	High	High	High	High	High	High	High	High	High

Combined Hotspot results	Hotspot 22
Hexagon id	429
Location name	mouth of Loch Shira
Occurrence within MPA (including voluntary)	Upper Loch Fyne - SNH Marine Consultation Area
Amount of coastline (km)	5.157537
Area of heagon (km^2)	7.013352
Number of Physiographic types	11
Physiographic Diversity	2
Species Richness Mean	3
Taxonomic distinctiveness mean	2
Priority species score	3
Species Hotspot	3
Biotope richness	3
Biotope Distinctiveness	2
Priority biotope score	3
Biotope Hotspot score	3
Quality	High
Confidence	High

Appendix 9. Results for 5 hexagons for extra records including records to genus level in analysis.

Hex ID	58	162	230	327	385
Total extra genera represented	15	1	18	21	4