Implementation of the EU Habitats Directive Offshore: Natura 2000 sites for reefs and submerged sandbanks

Volume I: Introduction and Rationale

A report by WWF

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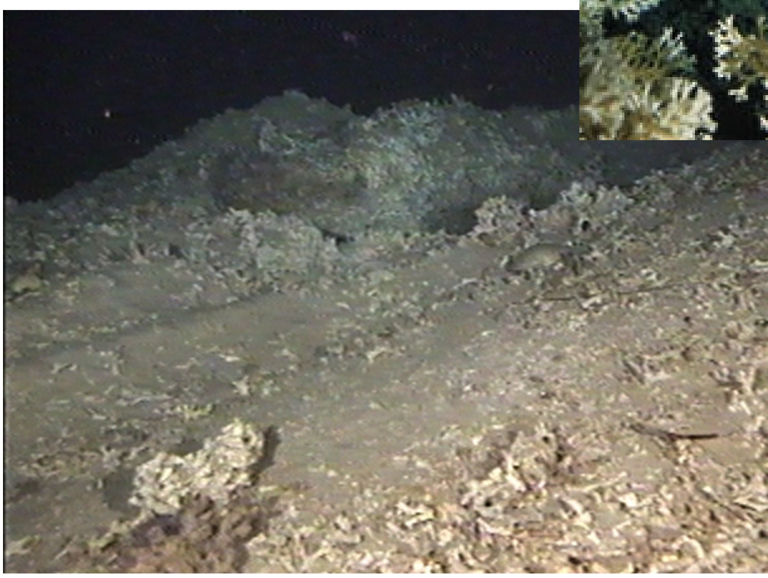

Implementation of the EU Habitats Directive Offshore:
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A report by WWF based on:

"Habitats Directive Implementation in Europe
Offshore SACs for reefs"
by A. D. Rogers
Southampton Oceanographic Centre, UK;

and

"Submerged Sandbanks in European Shelf Waters"
by Velegrakis, A., Collins, M.B., Owrid, G. and A. Houghton
Southampton Oceanographic Centre, UK;

commissioned by WWF

For information please contact:

Dr. Sarah Jones
WWF UK
Panda House
Weyside Park
Godalming
Surrey GU7 1XR
United Kingdom

Tel +441483 412522
Fax +441483 426409
Email: sjones@wwf.org.uk

Inner cover page photo: Trawling smashes cold water coral reefs
P.Buhl-Mortensen, University of Bergen, Norway

Prepared by Sabine Christiansen and Sarah Jones

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Alistair Davison: WWF Scotland
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LIST OF ACRONYMS

BGR	Biogeographic Region
cNGO	conservation non-governmental organisation
EEZ	Exclusive Economic Zone
EU	European Union
EU HD	European Union Habitats Directive (92/43/EEC)
ESSB	European Submerged Sandbanks Database
MPA	Marine Protected Area
NEA	North East Atlantic
NGO	non-governmental organisation
nm	nautical mile
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
SOC	Southampton Oceanographic Centre
SOES	School of Ocean and Earth Sciences, Southampton, UK
SAC	Special Area of Conservation
SCI	Site of Community Importance
SPA	Special Protection Area
UK	United Kingdom
UN	United Nations

1. INTRODUCTION

1.1 The Habitats and Birds Directives

The European Union's Habitats Directive[1], in conjunction with the Bird's Directive[2] is the main legal tool of the European Union for nature conservation. The Habitat Directive's fundamental purpose is to establish a network of protected sites through Community territory, the Natura 2000 network. The Habitats Directive also recognises that migratory species cannot be protected by the Natura 2000 network alone and may require non-site based, general management of human activities for their protection. The Natura 2000 network is designed to maintain or help maintain both the distribution and abundance of threatened or potentially threatened species and habitats, both terrestrial and marine.

The Natura 2000 site selection process is a shared responsibility between EU Member States and the European Commission. Member States propose sites to protect habitats and species listed in the Directive. The lists are subject to a process of assessment and negotiation between the Commission and the Member States through a series of Biogeographic Region (BGR) seminars, before a final list of Sites of Community Importance is adopted. However, the deadlines for proposing and adopting the list of SCIs (June 1998) have not been met.

1.2 WWF position on the Habitats and Birds Directives

WWF strongly supports the Habitats Directive and is working to ensure that the sites selected for Natura 2000 are adequate to achieve the aims of the Directive.

WWF believe it is the most important nature conservation legislation in Europe because:

- the Directive represents a real attempt to conserve Europe's biodiversity based on sound scientific evidence. The sites will not just be a collection of national or regional parks designated for a variety of reasons.

- the sites to be designated under the Directive are intended to protect a representative sample of Europe's threatened or potentially threatened habitats and species – as listed in the Annexes of the Directives.

[1] Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna.

[2] Council Directive 79/409/EEC on the conservation of wild birds.

- it does not seek to rule out economic activities in Natura 2000 areas but aims to promote sustainable activity in support of conservation objectives for these areas.

1.3 The marine environment offshore

There has been a lack of clarification for many years as to whether or not the Habitats Directive applies in the marine environment offshore (out to the 200nm Exclusive Economic Zone (EEZ) or other national fishing/continental shelf limit if the Member State has not declared an EEZ under The UN Law of the Sea). The geographical coverage of the Habitats Directive in European Union waters was referred to by the Commission in a document COM (1999) 363 final Communication from the Commission to the Council and the European Parliament "Fisheries Management and Nature Conservation in the Marine Environment" (p10) the following statement is made:

> "*The provisions of the "Habitats" Directive automatically apply to marine habitats and marine species located in territorial waters (maximum 12 miles). However, if a Member State exerts its sovereign rights in an exclusive economic zone of 200 nautical miles (for example, the granting of an operating license for a drilling platform), it thereby considers itself competent to enforce national laws in that area, and consequently the Commission considers in this case that the "Habitats" Directive also applies, in that Community legislation is an integral part of national legislation".*

There are at least two habitats listed in the Annex 1 of the Habitats Directive that occur beyond 12nm offshore. These habitats are "reefs" (Natura 2000 Code 1170) and "submerged sandbanks" (Natura 2000 Code 1110) as defined by the Interpretation Manual of European Union Habitats (EUR15/2). Another habitat listed on the Habitats Directive is "sub-marine structures made by leaking gases" (Natura 2000 Code 1180, refer to Annex V). Its definition could describe further offshore features. It is also of note that several offshore marine species, including the harbour porpoise, bottlenose dolphin and monk, common and grey seals are listed in the Habitats Directive for potential site selection. Bird species listed in the Birds Directive may also qualify.

At the first round of seminars in 1999, to review the sufficiency of site proposals from Member States on a national level, only Denmark proposed sites beyond 12nm offshore. On

5th November 1999, a UK High Court decision (following legal action by Greenpeace) ruled that the Habitats Directive "applies to the UK Continental Shelf and to the superjacent waters up to a limit of 200 nautical miles from the baseline from which the territorial sea is measured".

The legal situation for meeting the requirements of the Natura 2000 network is particularly complex and/or uncertain. While some activities such as oil and gas exploration are regulated nationally, fishing is under the competence of the Common Fisheries Policy at a European Union level and shipping at a global level by the International Maritime Organization. Several Member States have not legally declared a 200nm Exclusive Economic Zone under The United Nations Law of the Sea. National claims over the seabed of the continental shelf and fishing limits in superjacent waters vary considerably between Member States. There is currently only four EU Member States out of twenty-one countries bordering the Mediterranean Sea. Moreover, it is the 12nm offshore boundary rather than a 200nm offshore boundary that is significant in denoting the competence over human activities in the Mediterranean. Implementing EU legislation in Mediterranean waters that are heavily exploited by non-EU countries is often extremely difficult. The Baltic Sea is also bordered by non-EU countries.

1.4 WWF's position on implementing the Habitats and Birds Directives offshore.

- As the European Union and/or EU Member States have competence over human activities on the seabed and superjacent waters out to the limit of the European EEZ (or other national fishing limits/continental shelf limits), WWF supports the application of the Habitats Directive (and Birds Directive) out to the EEZ (or other national fishing limits/continental shelf limit).

- The Natura 2000 network offshore will have benefits for sustainable and integrated marine management.

- The marine habitats and species in the Habitats Directive do not appropriately represent the full range of habitats and species we believe should be listed to meet conservation objectives. The lists of habitats and species are based on a marine classification system

- For southern European habitats (CORINE system of classification): This classification system is particularly flawed for northern European habitats and offshore habitats.

- Despite the complex and/or uncertain legal situation offshore WWF considers that any study focusing on ecological requirements such as that of the Natura 2000 network should not be initially constrained by legal geographical and administrative boundaries. It is unclear how the requirements of the Habitats and Birds Directives in the marine environment will be met unless the Directives are integrated with other national, EU, regional and global legislation.

1.5 WWF European Shadow List and the marine environment offshore

In June 2000, WWF published the "Habitats Directive WWF European Shadow List". This was an evaluation by WWF and partner conservation non-governmental organisations (cNGOs) of a selection of example habitats and species. The Shadow List showed that Member States current proposals do not ensure the conservation of habitats and species selected. However, it was not timely for the WWF European Shadow List to focus on the offshore marine environment because:-

- There had been a lack of clarification for many years as to whether or not the Habitats Directive applies out to the EEZ (or other national fishing/continental shelf limits). Therefore, the timescales for Member States to identify offshore SACs in line with the timescales referred to in the Directive are unrealistic. WWF believes there should be adequate time and new timescales set for collection of existing data for offshore sites and consultation with scientific experts and user groups in order to identify and designate appropriate sites.

- WWF has concentrated its effort to help identify a comprehensive list of habitats and species that are appropriate for the offshore marine environment through work being undertaken to implement the Regional Seas Conventions (e.g. The Convention for the Protection of the Marine Environment of the NE Atlantic, OSPAR). Information is being compiled in a new WWF report "The Offshore Directory"[3].

[3] "The Offshore Directory" was initially compiled for WWF by Dr Susan Gubbay in 1999 and includes offshore features such as hydrothermal vents, xenophyophores, ocean fronts, pock marks and deep sea fish as well as seabirds, sea mounts, carbonate mounds and cold water corals. Further information is being added to The Directory including chapters on "sponge fields" and "muddy habitats" for publication in 2001.

1.6 The review of "reefs" and "submerged sandbanks"

As a contribution to the implementation of the Habitats Directive offshore WWF has commissioned scientific experts from Southampton Oceanographic Centre (UK) to:

(i) Give their opinion of the scientific definitions of "reefs" and "sandbanks" as defined by the Interpretation Manual of European Union Habitats.

(ii) From this opinion, (and within the constraints of time and data availability) identify sandbanks and reefs throughout European Union and adjacent waters (i.e. ignore legal boundaries) and gaps in information.

The work is represented in a series of volumes based on two pieces of work:

"Habitats Directive Implementation in Europe: Offshore SACs for reefs"
by A. D. Rogers
Southampton Oceanographic Centre, UK;

and

"Submerged Sandbanks in European Shelf Waters"
by Veligrakis, A., Collins, M.B., Owrid, G. and A. Houghton
Southampton Oceanographic Centre, UK

The informations given in the scientific reports was spit up geographically (Volume II: Northeast Atlantic and North Sea, Volume III: Mediterranean Sea). In these volumes, maps illustrate the location of the sites described in the databases and the most important facts of each of the sites are tabled country by country. The original databases are presented in separate volumes (Volume IV: Reefs, Volume V: Submerged Sandbanks) and should be quoted for the full information. In particular the descriptions of offshore reefs are supplemented with plenty of ecological informations and numerous maps.

2. RATIONALE

2.1 Habitat definitions

2.11 Reefs (A.D. Rogers, SOC)

The Interpretation Manual of European Union Habitats (EUR15/2) interprets “reefs” (Natura 2000 Code 1170) as:

> *"Submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the seafloor in the sublittoral zone but may extend into the littoral zone where there is an uninterrupted zonation of plant and animal communities. These reefs generally support a zonation of benthic communities of algae and animals species including concretions, encrustations and corallogenic concretions".*

Animals associated with such reefs are given as "mussel beds (on rocky substrates), invertebrate specialists of hard marine substrates (e.g. sponges, Bryozoa and cirripedian Crustacea)".

According to the Interpretation Manual of European Union Habitats, a reef can be a submarine, biogenic concretion which arises from the seafloor and which supports a community of animals. *Lophelia pertusa* reefs, thickets and even individual colonies fall into the definition of what physically makes a coral reef according to the European Habitats Directive. Interestingly, the Habitats Directive also specifies "rocky substrates ..... which arise from the seafloor ...". Therefore this definition not only includes biogenic reefs but also submarine rocky structures such as seamounts, rocky banks and pinnacles.

A large number of definitions of what represents a reef can be found in the biological literature. For example, **biogenic reefs** can be classed as reefs that are produced by a combination of biological and geological processes. A biogenic reef is a significant, rigid skeletal framework that influences deposition of sediments in its vicinity and that is topographically higher than the surrounding sediment (Hallock, 1996). A **coral reef** is a rigid skeletal structure in which stony corals are the major framework constituents. Another term used for a limestone structure or build-up produced by biological activity is "**bioherm**". Less rigid accumulations of biologically produced sediments are sometimes called **reef mounds** (James, 1983).

Most definitions of coral reefs used by governments, non-governmental organisations and scientists are very similar or contain components of those outlined above. For example from Holt *et al*. (1998):

Biogenic reefs have been defined for the purposes of this report as - solid, massive structures which are created by accumulations of organisms, usually rising from the seabed, or at least clearly forming a substantial, discrete community or habitat which is very different from the surrounding seabed. The structure of the reef may be composed almost entirely of the reef building organism and its tubes or shells, or it may to some degree be composed of sediments, stones and shells bound together by the organism.

2.12 Submerged sandbanks

(A. Velegrakis, M.B. Collins, G.Owrid and A.Houghton, SOC)

The Interpretation Manual of the European Union Habitats (EUR15/2) defines "sandbanks which are slightly covered by sea water all the time" (Natura 2000 Code 1110) as:

> *"Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20m below Chart Datum."*

However, as this interpretation may have been influenced by the assumption that the Habitats Directive would apply only within the limits of the Member State relatively shallow territorial seas, the scope of the study was extended to include all banks within the continental shelf waters, irrespective of water depth. Moreover, as a large number of banks consist of sedimentary material of mixed composition (i.e. of mixtures of siliciclastic and/or biogenic sands, muds and gravels), such banks were also included in the study.

Further bank characteristics and processes are described in detail in Appendix I of this report. Of particular relevance to the identification of a representative network of Natura 2000 sites for submerged sandbanks, is the broad description of sandbank characteristics related to topography and sedimentary processes rather than a depth of 20m (sentence inserted by WWF). Coastal and shelf seas in their entirety are associated mostly with linear banks (refer to Appendix III) consisting mainly of sand-sized sediments with grain sizes of between 0.06 and 2 mm, (see Folk (1980)). Even in the cases of the large 'diffuse' banks of the continental shelf which owe their morphology more to the topography of the underlying hard rock substrate than to the sedimentary processes of the continental shelf, the surficial sedimentary material consists mostly of sand-sized sediments. In comparison, banks found in the deeper areas of the continental margin (for a definition of this term, see Symonds *et al*., (2000)), such as the continental slope and rise and the proximal areas of the abyssal plains, are likely to consist of finer sedimentary material (i.e. of sediments with grain sizes of less than sand - 0.06 mm). Finally, the relatively few banks of extremely high relief (found mainly in the deeper areas of the continental margin) are, in most cases, only veneered by a thin sedimentary cover consisting mainly of hard rock substrate.

A recent study (Dyer and Huntley, 1999) has developed a descriptive classification scheme, in order to unify the approaches of marine geologists and physical oceanographers. According to this system, sandbanks can be divided into: (i) open shelf linear banks (Type 1), which can be up to 80 km long, ~10 km wide and tens of metres in height; (ii) linear banks formed in the mouths of wide estuaries (Type 2A); (iii) 'irregular' banks (flood and ebb deltas) formed in the mouths of narrow-mouthed estuaries and inlets (Type 2Bi); (v) 'shore-attached banks,' occurring at angles to retreating coastlines (Type 2Bii); and (vi) 'banner' (Type 3A) and 'en-enchelon' (Type 3B) banks associated with tidal eddies, generated close to stable and retreating headlands, respectively (refer to Appendix III).

2.2 Methodology

2.21 Reefs (A.D. Rogers, SOC)

This inventory was compiled from the scientific literature that could be located within a short period of time for offshore reef sites in European waters. The inventory is not exhaustive as much of the literature on seamounts is either held in unrefereed reports, often not in English, or in old expedition reports or in specialist systematic works. These could not all be located in the time for the inventory. Indeed, some of the sites described merit separate reports in their own right. It will become immediately obvious from the reefs inventory that there is almost no information for many of the offshore sites described. For sites that have been studied in the past information is clearly out of date, especially in view of the potential impacts of modern fishing methods on offshore reef and seamount sites. Further study of offshore reefs is a matter of urgency at a European and international level (see Rogers, 1994, 1999).

Sites are described in numerical order, approximately north to south. In some cases, where full co-ordinates for a site area are not given they maybe located in an Admiralty Chart. Most of this inventory has relied on very detailed bathymetric maps provided in scientific papers.

Some sites may fall outside of EU waters, further plotting of national limits is required to reveal where these cross European boundaries.

2.22 Submerged sandbanks

(A. Velegrakis, M.B. Collins, G.Owrid and A.Houghton, SOC)

The European Submerged Sandbank Database (ESSD) was designed specifically for this project. The criteria used in the selection of these banks (under limitations detailed in this section below) were: (i) the banks had to be submerged; (ii) the banks had to be greater than, or equal to, 5 metres in height, with respect to the surrounding seabed; and (iii) the banks had to be located within the European Shelf Waters.

The UK Admiralty Charts have been the primary source of information for compiling the European Submerged Sandbanks Database (ESSB). The charts were used to: (a) locate all the marked (and some unmarked, but identifiable) banks of the European Shelf; and (b) derive information on certain environmental parameters of the banks, such as their dimensions, water depth and sediment composition. The information was collated according to the format described in Appendix II. The delimitation of these regions is based (generally) on recognised geographical areas (such as the English Channel, Irish Sea, etc.) and *not* on the legal delimitations of the maritime boundaries (see Appendix IV).

The sediment (substrate) details presented in the ESSD are limited by the accuracy and resolution of the original information e.g. the UK Admiralty Charts. This source of information provides details on the seabed sediment distribution according to the UK Admiralty seabed classification regime; this is based mainly on the macroscopic examination of a small number of seabed samples and not on more accurate laboratory-based analyses. In addition, as the main purpose of the UK Admiralty Charts is the safe ship navigation and not the description of marine environment, the spatial resolution of the sedimentary information is reduced also.

Both the scarcity of sources and the limited resources of the present study have influenced the accuracy of the results. As the primary information sources have been the UK Admiralty Charts, the chart accuracy and resolution control the accuracy and detail of the results. Thus, banks with horizontal and vertical dimensions smaller than the horizontal and vertical resolution of the available charts have not been included, except in exceptional cases. It should be noted that the chart resolution always decreases with the distance from the coast (and with increasing water depth); thus, comparatively low banks of the outer shelf and continental slope and rise have not been included in the ESSD. For example, contourite drifts (Faugeres and Stow, 1993; Marani *et al.*, 1993; Stoker *et al*., 1998), the large sedimentary bodies found on the continental slope, continental rise and proximal areas of abyssal plain, are not included in the ESSD. Although these sedimentary accumulations can be very significant, in terms of horizontal dimensions (e.g. the Faro Drift at the southern Portuguese continental margin (Stow *et al*., 1986)), they are rarely noted in the low-resolution charts of the outer continental margin; this is due to their relatively low relief (height less than 100 m).

2.3 WWF Conclusions

The definition of "reefs" as stated in the Interpretation Manual of the European Union Habitats (EUR 15/2) is broad. It includes both geophysical and biological information and can be applied to a variety of reef structures. These include coral reefs, seamounts and raised rocky platforms. The methodology of the "reefs" inventory, Rogers (2000), includes the identification of seamounts and coral reefs. However, capacity limitation meant that the inventory did not extend to the comprehensive identification of all reefs such as raised rocky platforms and rocky ridges caused by iceberg plough marks. Further consideration is also required to determine what size limit of boulder or cobble constitutes a reef. It is likely that an extension of work on the "reefs" inventory detailed in this report will identify more sites that qualify for the Natura 2000 definition.

The work by Velegrakis *et. al,* (2001) leads WWF to conclude that the "seldom more than 20m" definition of submerged sandbanks detailed in the Interpretation Manual should not be strictly applied if the ecological requirements of the Natura 2000 network are to be met for sandbanks. For example, the submerged sandbanks classification (Dyer and Huntley, 1999), as used in the ESSB, classifies several different types of bank found on the continental shelf, none of which have a 20m depth limitation as part of their classification. A pragmatic approach would include all submerged sandbanks on the continental shelf and within EU waters if they are of the same classified type as banks that are found at 20m depth or under.

The sediment descriptions used in the ESSB are from the Admiralty Charts. However there are several respected and widely used sediment classification systems. It is important to note that Velegrakis *et al.*(2001) emphasise the morphology of submerged sandbanks rather than grain size profile in determining whether a submerged sandbank qualifies for the ESSB.

WWF is currently compiling “The Offshore Directory” that gives further information on offshore features. Some of the marine features detailed in The Directory are covered by habitats and species listed in the Habitats Directive and Birds Directive for site designation, many are not. It is quite clear that there needs to be a review of the lists of marine habitats and species if a representative network of Natura 2000 sites offshore is to be achieved.

3. REFERENCES

American Geological Institute, 1974. Dictionary of Geological Terms. National Academy of Sciences, Anchor Press/Doubleday, New York.

Berne, G., Auffret, J.P. and Walker, P., 1988. Internal structure of subtidal sandwaves revealed by high resolution seismic reflection. Sedimentology, 35, 5-20.

Berne, S. Trentesaux, A., Stolk, A., Missiaen, T. and DeBatsist, M., 1994. Architecture and long term evolution of a tidal sandbank: The Middelkerke Bank (southern North Sea): Marine Geology, 121, 52-72.

Brampton, A., Evans, C.D.R., and Velegrakis A.F., 1998. South Coast Mobility Study, CIRIA PR 65, London. 201 pp.

Caston, V.N.D, 1972. Linear sandbanks in the southern North Sea. Sedimentology, 18, 63-78.

Collins M.B., Shimwell, S., Gao, S., Powell, H., Hewitson, C., and Taylor, J.A., 1995. Water and sediment movement in the vicinity of linear sandbanks: The Norfolk Banks, Southern North Sea. Marine Geology, 123, 125-142.

European Commission, 1999. Communication from the Commission to the Council and the European Parliament. Fisheries Management and Nature Conservation in the Marine Environment. (COM) 1999-363.

European Commission, 1999. Natura 2000. Interpretation Manual of European Union Habitats (EUR 15/2). DG Environment, Nature protection, coastal zones and tourism.

DETR, 1999. Government View: New arrangements for the Licensing of Minerals Dredging (Interim Procedures). Mineral and Waste Planning Division, Department of Environment, Transport and the Regions. London. 15pp.

Duane, D.B., Field, M.E., Meisburger, E.P., Swift, D.J.P. and Williams, S.J., 1972. Linear shoals on the Atlantic inner continental shelf, Florida to Long Island. In D.J.P.Swift, D.B. Duane, O.H. Pilkey (editors), Shelf Sediment Transport: Process and Pattern, Doweden, Hutchinson and Ross, Stroudsbourg: 447-498.

Dyer, K. R. and Huntley, D. A., 1999. The origin, classification and modelling of sand banks and ridges. Continental Shelf Research, 19, 1285-1330.

Ebersole, B.A., Cialone, M.A. and Prater, M.D., 1986. RCPWAVE-A Linear Wave Propagation Model for Engineering Use. Regional Processes Numerical Modelling System, Report N° 1. Department of the US Army.

Faugeres, J-C. and Stow, D.A.V., 1993. Bottom-current-controlled sedimentation: a synthesis of the contourite problem. Sedimentary Geology, 82, 287-297.

FitzGerald, D.M., Penland, S. and Nummedal, D., 1984. Control of barrier island shape by inlet sediment bypassing: East Frisian Islands, West Germany. In B. Greenwood and R.A. Davis, Jr. (editors), Hydrodynamics and Sedimentation in Wave-Dominated Coastal Environments, Marine Geology, 60, 355-376.

Folk, R.L., 1980. Petrology of the Sedimentary Rocks. (2nd Edition). Hemphill Publishing Company, Austin, Texas, U.S.A.

Harris, P.T., 1988. Large scale bedforms as indicators of mutually evasive sand transport and the sequential infilling of wide mouth estuaries. Sedimentary Geology, 57, 272-298.

Hayes, M.O. and Kana, T.W., 1976. Terrigenous Clastic Depositional Environments. University of South Carolina (Columbia) Technical Report N° 11. 364pp.

Hallock, P., 1996. Reefs and reef limestones in earth history. In: Birkeland C (Ed.) Life and Death of Coral Reefs, Chapman & Hall, New York, pp.13-42.

Holt, T.J., Rees, E.I., Hawkins, S.J., Seed, R., 1998. Natura 2000, Volume IX: Biogenic Reefs. English Nature/Scottish Association for Marine Sciences, 170pp.

Houbolt, J. J. H. C., 1968. Recent sediments in the Southern Bight of the North Sea. Geologie en mijnbouw, 47, 245-273.

Huthnance, J.M., 1982a. One mechanism forming linear sandbanks. Estuarine, Coastal and Shelf Science, 14, 79-99.

Huthnance, J.M., 1982b. On the formation of sandbanks of finite extent. Estuarine, Coastal and Shelf Science, 15, 277-299.

James, N.P., 1983. Reefs in carbonate depositional environments. In: Scholle PA, Bebout DG, Moore CH (Eds.) AAPG Memoir 33. American Association of Petroleum Geologists, Tulsa, Oklahoma, pp. 345-462.

Kenyon, N.H., Belderson, R.H., Stride A.H. and Johnson, M.A., 1981. Offshore tidal sandbanks as indicators of net sand transport and as potential deposits. International Association Sedimentologists, Special Publication, 5, 257-268.

Marani, M., Roveri, A.A.M. and Trincardi, F., 1993. Sediment drifts and erosional Mediterranean: seismic evidence of bottom-current activity. Sedimentary Geology, 82, 207-220.

Pattiarachi, C.B. and Collins, M.B., 1987. Mechanisms for linear sandbanks formation and maintenance, in relation to dynamical oceanographic observations. Progress in Oceanography, 19, 117-166.

Pingree, R.D., 1978. The formation of Shamples and other banks by the tidal stirring of the seas. Journal of the Marine Biological Association of the UK, 58, 211-226.

Pingree, R.D., and Maddock, L., 1979. The tidal physics of headland flows and offshore tidal bank formation. Marine Geology, 32, 269-289.

Rogers, A.D., 1994. The biology of seamounts. Advances in Marine Biology, 30: 305-350.

Rogers, A.D., 1999. The biology of Lophelia pertusa (Linnaeus 1758) and other deep-water reef-forming corals and impacts from human activities. International Review of Hydrobiology, 84 (4): 315-410.

Rogers, A.D., 2000. Habitats Directive Implementation in Europe: Offshore SACs for reefs. Report to WWF (unpublished).

Royal Court of Justice (UK), 1999, Judgement as approved by the Court of Case No: CO/1336/1999. The Queen v The Secretary of States for Trade and Industry (respondant) ex parte Greenpeace Limited (applicant). Before the Hon Mr Justice Maurice Kay.

Smith, J.D., 1969. Geomorphology of a sand ridge. Journal of Geology, 17, 39-55.

Stoker, M.S., Akhurst M.C., Howe, J.A. and Stow, D.A.V., 1998. Sediment drifts and contourites on the continental margin off northwest Britain. Sedimentary Geology, 115, 33-51.

Stow, D.A.V., Faugeres, J.C., and Gonthier, E., 1986. Facies distribution and textural variation in Faro drift contourites: velocity fluctuation and drift growth. Marine Geology, 72, 71-100.

Suter, J.R., Mossa, J. and Penland, S., 1989. Preliminary assessment of the occurrence and effects of utilisation of sand and aggregate resources of the Luisiana inner shelf. Marine Geology, 90, 31-37.

Swift, D.J.P. and Field, M.E., 1981. Evolution of a classic sand ridge field: Maryland sector, North American inner shelf. Sedimentology, 28, 461-482.

Symonds, P.A., Eldholm, O., Mascle, J. and Moore, G.F., 2000. Characteristics of continental margins. In P.J. Cook and C.M. Carleton (editors), Continental Shelf Limits: the Scientific and Legal Interface, Oxford University Press: 25-63.

Velegrakis, A.F., Voulgaris G., and Collins M.B., 1994. The role of waves and currents in the maintenance of a nearshore gravel bank. Proceedings of the 2nd International Conference on the Geology of Siliciclastic Shelf Seas, Ghent, 1994, 124-126.

Veligrakis, A., Collins, M.B., Owrid, G. and Houghton, A., 2001. Submerged Sandbanks in European Shelf Waters. Report to WWF (unpublished).

WWF, 2000. Habitats Directive- WWF European Shadow List.

Appendix I: Bank characteristics and processes
(from "Submerged Sandbanks in European Shelf Waters"
by Velegrakis, A., Collins, M.B., Owrid, G. and A. Houghton,
Southampton Oceanographic Centre, UK).

Introduction

Marine banks are defined as elevations of the sea floor of relatively large area, surrounded by deeper water (American Geological Institute, 1974). This general definition implies that banks may consist of any type of material (i.e. hard rock and/or unconsolidated sedimentary meterial). However, the consesus between geologists and marine scientists is that the term refers mainly to sedimentary accumulations, formed and maintained by different types of marine flows (Pattiaratchi and Collins, 1987). Coastal and shelf seas, in particular, are associated mostly with linear banks consisting mainly of sand-sized sediments (i.e. of sedimentary material with grain sizes of between 0.06 and 2 mm, see Folk (1980)). Even in the cases of the large 'diffuse' banks of the continental shelf, which own their morphology more to the topography of the underlying hard rock substrate than to the sedimentary processes of the continental shelf, the surficial sedimentary material consists mostly of sand-sized sediments. In comparison, banks found in the deeper areas of the continental margin (for a definition of this term, see Symonds *et al*., (2000)), such as the continental slope and rise and the proximal areas of the abyssal plains, are likely to consist of finer sedimentary material (i.e. of sediments with grain sizes of less than 0.06 mm). Finally, the relatively few banks of extremely high relief (found mainly in the deeper areas of the continental margin) are, in most cases, only veneered by a thin sedimentary cover consisting mainly of hard rock substrate

Classification of sandbanks

A recent study (Dyer and Huntley, 1999) has developed a descriptive classification scheme, in order to unify the approaches of marine geologists and physical oceanographers. According to this system, sandbanks can be divided into: (i) open shelf linear banks (Type 1), which can be up to 80 km long, ~10 km wide and tens of metres in height; (ii) linear banks formed in the mouths of wide estuaries (Type 2A); (iii) 'irregular' banks (flood and ebb deltas) formed in the mouths of narrow-mouthed estuaries and inlets (Type 2Bi); (v) 'shore-attached banks,' occurring at angles to retreating coastlines (Type 2Bii); and (vi) 'banner' (Type 3A) and 'en-enchelon' (Type 3B) banks associated with tidal eddies, generated close to stable and retreating headlands, respectively.

Sea level rise and coastal retreat have a profound effect on continental shelf sandbanks. These sedimentary accumulations have formed under the influence of hydrodynamic regimes that have the fluid power to transport enough sediment to support their growth and maintenance (Kenyon *et al*., 1981). Thus, their generation requires plentiful sources of mobile sediments, supplied either from the local seabed or from coastal erosion. Most banks appear to have been created during the last post-glacial rise of the sea level i.e. the Flandrian Transgression (Dyer and Huntley, 1999). The banks can be differentiated into two main groups: relict and modern sedimentary bodies. Relict (or 'moribund') banks are those which have formed under different hydraulic conditions than those existing presently. Typical examples of this group are the relict sandbanks found at the outer shelf (100-140 m water depths) of the Celtic Sea (Kenyon *et al.,* 1981). Such banks are not involved actively in modern sedimentary processes, although movement of superficial material may take place under extreme conditions (i.e. extreme storm waves). In contrast, if there are dynamic interactions between the banks and the present hydrodynamic regime, then the sandbanks are classified as modern or 'active'.

Typical examples of this group are the relatively shallow banks of the Southern North Sea (Berne *et al*., 1994; Collins *et al*., 1995).

Bank formation and maintenance

The most important mechanisms proposed for the formation and maintenance of linear sandbanks on continental shelves are: (i) the 'spiral flow concept' (Houbolt, 1968); (ii) stability analysis (Smith, 1969; Huthnance, 1982a,b); (iii) lateral migration (Caston, 1972); (iv) detachment from the coast (Duane *et al*., 1972); and (v) tidal stirring (Pingree, 1978; Pingree and Maddock, 1979). These mechanisms are now presented, in more detail.

(i) The 'spiral flow concept' mechanism

Houbolt (1968) observed that the flow over the North Sea banks was weaker than that in the troughs (swales) between them. This investigation proposed that, in order to compensate for the velocity differences, the flow should form two counter-rotating spirals. This pattern results in upwelling and flow convergence on the bank crests. One problem associated with the Houbolt (1968) theory is that it cannot explain the formation of banks from an originally flat bed; thus, the model is able to describe only the maintenance of already formed sandbanks, rather than their actual formation from a plane bed.

(ii) The stability analysis mechanism

Smith (1969) suggested a simplified equation for the two-dimensional sand transport over sandbanks: $\partial h/\partial t = - k\ \partial \tau/\partial x$, where h is the local elevation of the bed, τ is the mean bed shear stress (which is responsible for the transport of sediments) and k is assumed to be constant at a mean bed level. This relationship shows that sediment deposition (i.e. an increase in bed elevation) occurs when the shear stress decreases in the x direction, whereas sediment erosion (i.e. a decrease in bed elevation) takes place when the shear stress (and sediment transport) increases in the same direction. Swift and Field (1981) found that the Smith (1969) model could explain sandbank formation in the Maryland sector of the North American inner continental shelf.

(iii) Lateral migration mechanism

Observations on the flow patterns and sedimentary morphology of the North Sea sandbanks showed that these banks are characterised by 'flood dominant flow on one side, and ebb dominant flow on the other side' (Caston 1972). This flow asymmetry can cause sediment recirculation around the banks and sand convergence on the bank crests. The sand convergence results in sand accumulation and, thus, growth of the bank both vertically and laterally. The growth was considered to be the result of two processes. The first process is associated with near-bed currents, which transport the sediment up the slope of the bank; the second process is controlled by the wave action, which intermittently disperses the sand away from the crest. Caston (1972) proposed also that these flow and sediment transport patterns might result in a multiplication of banks

(iv) 'Detachment from the coast' mechanism

Duane *et al.*, (1972) considered the development of sandbanks, which were originally attached to the coast. This mechanism is related to sea level rise; in this sense, these banks may be considered (at least partially) as relict features associated with the Flandrian Transgression. Such banks are detached from the shoreline, through erosion of the coastal (proximal) end of the bank. The resulting offshore sandbanks can then be maintained by helical flows, generated by storm-induced currents.

(v) Tidal stirring mechanism

Tidal flow interactions with headlands may result in the formation of residual eddies (Pingree, 1978; Pingree and Maddock, 1979; Pattiaratchi and Collins, 1987; Dyer and Huntley, 1999). In these cases, the balance of forces might cause a low-pressure region at the centre of the eddy, leading to divergence of the surface flow and a convergence of the near-bed flow; this pattern may result in sand accumulation and sandbank formation.

The mechanisms of formation and maintenance of banks related to the mouths of estuaries are also complex, controlled by the interaction of tidal and wave-induced currents with the estuarine and coastal sediments (Harris, 1988; Dyer and Huntley, 1999). The height to which the banks grow above the surrounding seabed is controlled by the local wave regime; extreme wave activity can result in major bank erosion (Berne *et al.*, 1988; Berne *et al.*, 1994). Generally, all sedimentary bank formation and maintenance is controlled by intricate patterns of sediment transport. These patterns are the result of the interaction of different types of marine flows (e.g. tidally-, wind- and wave-induced currents and their combinations) with the sedimentary material of the continental margin.

Environmental significance of banks

The environmental significance of banks is threefold. Firstly, they can form particular habitats on the seabed, characterised by different substrate (sediment type), hydrodynamics and ecology, compared with the surrounding seabed (see also Section 4). This difference might have a particular significance in the case of the relict or moribund banks, which may combine substantial substrate differences from the surrounding environments with minimal substrate agitation (Kenyon *et al.* 1981). Secondly, banks play a very important role in the direct protection of the coastal zone and its habitats (e.g. sea cliffs, beaches, estuaries and salt marshes), as they dissipate considerably the incoming wave energy. Within this context, relatively inshore sandbanks may be regarded as natural coastal defences against the wave activity.

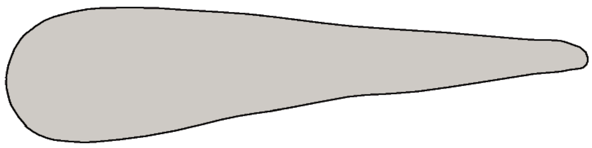
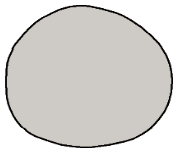
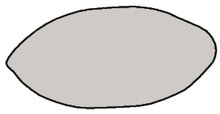
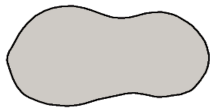
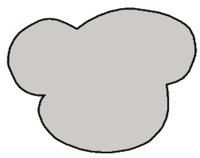
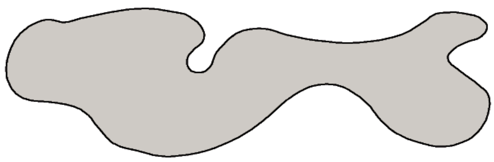
Finally, active continental shelf sandbanks interact with the surrounding sedimentary environments, such as other banks and/or the coastal environments. In the most energetic of the continental shelf environments, sandbanks routinely exchange sedimentary material with the surrounding areas (Hayes and Kana 1976; FitzGerald *et al.*, 1984; Velegrakis *et al.*, 1994; Collins *et al.*, 1995; Brampton *et al.*, 1998). Moreover, bank-induced wave refraction and diffraction alter the direction of wave energy propagation (Ebersole *et al.*, 1986) and may concentrate the wave energy on particular segments of the coastline. Consequently, the patterns of the regional coastal sediment drift may be also modified, indirectly, by the presence of banks. Therefore, any changes in the elevation and shape of the offshore sandbanks either natural or human-induced (from activities such as navigational and/or marine aggregate dredging) can result in significant modifications of the coastal transport cells and hence, of the adjacent coastline and its habitats (Suter *et al.*, 1989).

The significance of sandbanks as a natural coastal defence, a supplier or store of sediments and as a particular habitat has been already recognised in legal and marine policy frameworks. For example, certain human-induced activities which may affect the banks themselves and/or their role as natural coastal defences (e.g. marine aggregate and/or navigational dredging) are regulated and, in many cases, Environmental Impact Assessment (EIA) studies are required before any interference is licensed (DETR, 1999).

Appendix II: Description of the format of the fields used in the European Submerged Sandbanks Database

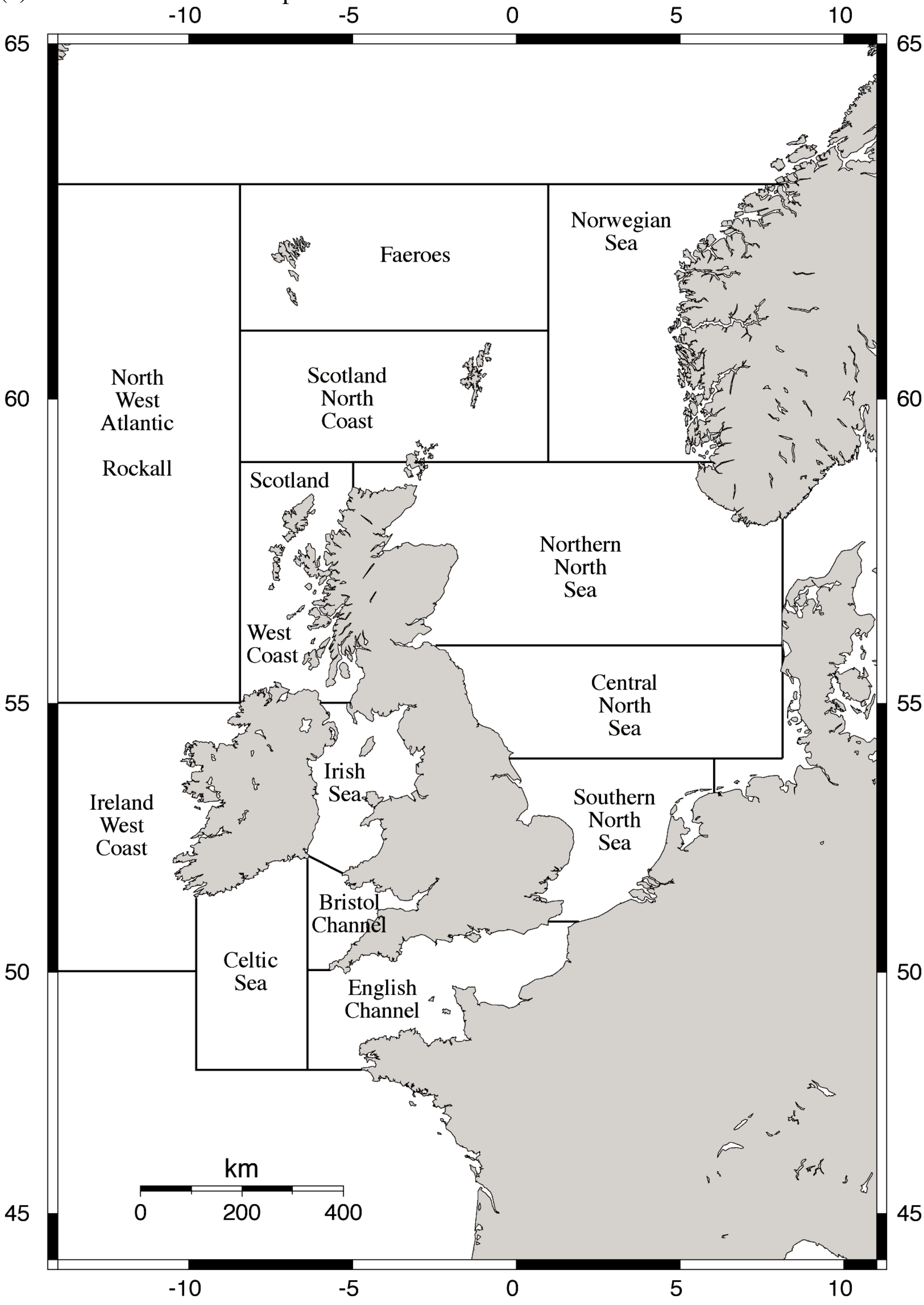
REMARK	EXPLANATION
ID NO.	Banks are individually numbered from 1 (Straits of Dover) to 457 (Aegean Sea).
SITE NAME	The name of the banks is taken from charts. This particular field is left blank when the bank is unnamed.
SITE CLASSIFICATION	The banks have been categorised as linear, asymmetric linear, radial, asymmetric radial, irregular, bank cluster and 'diffuse (these descriptions are sketched in Appendix III). The classification was based, in general terms, on the description of Dyer and Huntley (1999) and the plan shape of the bank.
GEOGRAPHICAL LOCATION	In order to make the location of each bank easier, the area was divided into 24 regions. The delimitation of these regions is based (generally) on established divisions (such as the English Channel or the Irish Sea) and not on legal maritime boundaries. These boundaries are delimited by latitude and longitude boxes (see Appendix IV).
POSITION	Referred to the mid-point of the bank and expressed as (decimal) Latitude and Longitude.
WATER DEPTH	The height of the water column (in metres) above the mid-point of the bank. All depths are reduced to Chart Datum, which, in most cases, is the water depth associated with the Lowest Astronomical Tide (LAT). This location is not necessarily the highest point on the bank.
SITE DIMENSIONS	The approximate area of the banks, estimated from the Admiralty Charts. The length and width of each bank was measured directly from the charts. These dimensions were used then to calculate the plan surface area of the bank.
BANK HEIGHT	The height is defined as the elevation of the bank at the mid-point, relative to the surrounding (level) seabed.
SITE ORIENTATION	The orientation is expressed as N-S or E-W.
SEDIMENT COMPOSITION	The information was obtained from the Admiralty Charts. In the case where the sediment type was not indicated on the bank itself, the composition was assumed to be similar to that of the surrounding seabed.
GENERAL DESCRIPTION	This provides a summary of the main features of each bank including: basic plan shape; surface topography; the gradient of the sides and any other interesting features. Additionally, the topography and sediment composition of the surrounding seabed is highlighted.
CHART DETAILS	Chart No, Title, Scale and Date of Chart.
STATE JURISDICTION	The State within whose waters a particular bank is located. For banks lying in international waters or disputed waters (e.g. in straits), the state jurisdiction simply refers to the legislative country.

Appendix III: Sketch showing the basic plan shapes used for morphological classification of the banks in the European Submerged Sandbanks Database.

LINEAR	
ASYMMETRIC LINEAR	
RADIAL	 OR 
ASYMMETRIC RADIAL	 OR 
IRREGULAR	
CLUSTERS OF BANKS	TWO OR MORE BANKS THAT ARE CLOSELY GROUPED. THE INDIVIDUAL BANKS MAY FALL INTO ANY OF THE ABOVE CATEGORIES.
DIFFUSE	ANY BANK THAT IS NAMED, ON A CHART BUT WHOSE BOUNDARIES ARE NOT DEFINED CLEARLY IN THE REPRESENTATION.

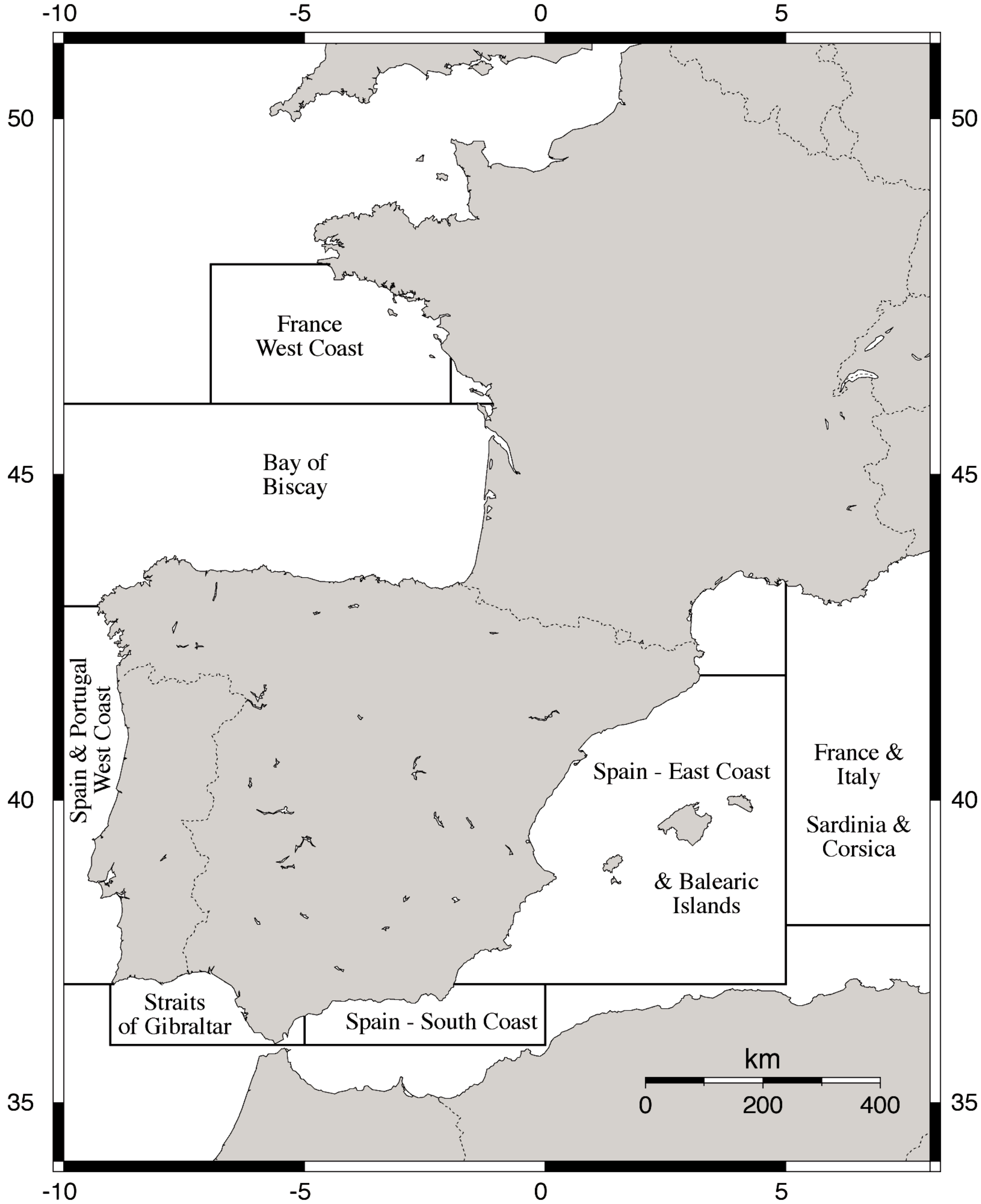
Appendix IVa: Geographical limits of the regions used in the European Submerged Sandbanks Database

(a) UK and Northern Europe



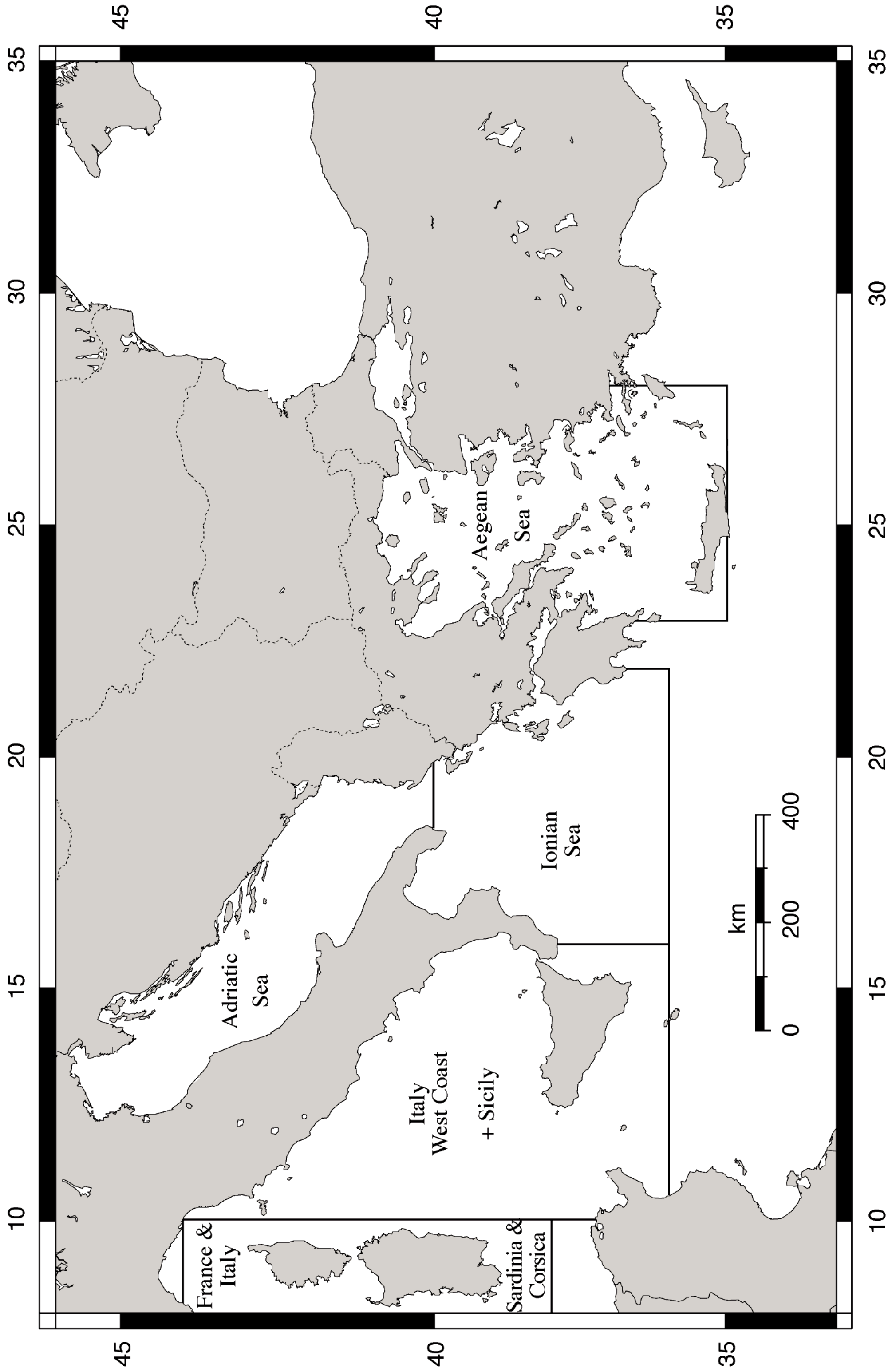
Appendix IVb: Geographical limits of the regions used in the European Submerged Sandbanks Database.

(b) Spain and France



Appendix IVc: Geographical limits of the regions used in the European Submerged Sandbanks Database.

(c) Eastern Mediterranean



Appendix V: "Definition- general description of the vegetation, syntaxa, abiotic features, origin" of sandbanks, reefs and sub-marine structures in the Interpretation Manual of European Union Habitats (EUR 15/2).

Natura 2000 Code 1110: Sandbanks which are slightly covered by seawater at all times

Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20m below Chart Datum. Non-vegetated sandbanks or sandbanks with vegetation belonging to the *Zosteretum marinae* and *Cymodoceion nodosae*.

Natura 2000 Code 1170: Reefs

Submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the seafloor in the sublittoral zone but may extend into the littoral zone where there is an uninterrupted zonation of plant and animal communities. These reefs generally support a zonation of benthic communities of algae and animals species including concretions, encrustations and corallogenic concretions.

Natura 2000 Code 1180: Sub-marine structures made by leaking gases

Spectacular sub-marine complex structures, consisting of rocks, pavements and pillars up to 4 metres high. These formations are due to the aggregation of sandstone by carbonate cement resulting from microbial oxidation of gas emissions, mainly methane. The methane most likely originated from microbial decomposition of fossil plant materials. The formations are interspersed with gas vents that intermittently release gas. These formations shelter a highly diverse ecosystem with brightly coloured species.