The Darwin Mounds and the Dogger Bank

Case studies of the management of two potential Special Areas of Conservation in the offshore environment

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PART I: BACKGROUND

1 Report context

1.1 INTRODUCTION

Concern about human impacts on the natural environment has grown from a minority interest to an issue that governments and international organisations acknowledge needs to be addressed. As a result, marine conservation has become an accepted part of the environmental programmes of many coastal nations, and conservation measures have been developed and directed at the marine environment in general, as well as at specific locations, and for particular species. The resulting policies and programmes are wide ranging including Strategic Environmental Assessment, Codes of Practice, Biodiversity Action Plans and the establishment of Marine Protected Areas (MPAs).

Marine Protected Areas have been identified by IUCN, the World Conservation Union, as a key component in the integrated management of coastal and marine areas and part of their sustainable development. They are also recognised as a measure that can help achieve the three main objectives of living resource conservation as defined in the World Conservation Strategy (IUCN, 1980):

- to maintain essential ecological processes and life support systems;
- to preserve genetic diversity; and
- to ensure the sustainable utilisation of species and ecosystems.

There are many different types of MPA from Multiple-Use Management Areas such as the Great Barrier Reef Marine Park, to No-take Reserves such as the Saba Marine Park in the Netherlands Antilles. They also show considerable variety in their objectives, management measures and legal status. One thing most have in common, however, is a coastal location.

The conservation of wildlife and habitats beyond territorial waters has received limited attention, and the actions that have been taken in such waters have generally been focused on marine mammals or broader environmental assessment work. Very little has been done for the conservation of offshore benthic habitats or the less mobile wildlife of these environments, for example, and there are only a small number of offshore MPAs. But this situation has been changing as threats and pressures from human activity on the offshore environment become more apparent and more serious. This is particularly well illustrated by the scope, extent and associated impacts of fisheries which operate in all the world's oceans, from the continental shelf areas to the deep sea, and oil and gas production where technical advances have made it possible to exploit reserves from ice covered seas as well as from great depths.

An important contribution to the momentum for MPAs in offshore areas has come from international agreements and initiatives. The United Nations Convention on the Law of the Sea (UNCLOS) and the Convention on Biological Diversity (CBD) oblige countries to protect the marine environment. The Convention for the Protection of the North-east Atlantic (OSPAR), which applies to a geographic area that includes national offshore waters and the High Seas of a large part of the North Atlantic, is another example. Annex V of the Convention, which was adopted in 1998, supports the establishment of MPAs and work is

under way to develop criteria for the identification of potential sites. One of the major challenges is the delivery mechanism and this has led to consideration of essential related issues such as the legal regulations and legal instruments that could be used to establish offshore MPAs (e.g. Czybulka & Kersandt, 2000).

In Europe, the 1992 EU Directive on the Conservation of Natural Habitats and Wildlife Fauna and Flora (the Habitats Directive) requires the establishment of protected areas for habitats and species considered to be of European importance in the territories of member states. These sites will form the *Natura 2000* network, the requirements of which were transposed in UK law by the Conservation (Natural Habitats, &c) Regulations 1994. A High Court judgement in the UK (CO/1336/99) established that the Directive applies to both territorial waters and the UK Continental Shelf and superjacent waters. As a result, work is under way to select examples of habitats and species that occur in this offshore zone as possible UK Special Areas of Conservation (SACs) or Special Protection Areas (SPAs). The European Commission has made it clear in various documents that a similar situation is likely to be true for other member states (e.g. CEC, 1999; BfN 2001). A number of other member states are therefore also looking into potential offshore areas. In the case of Germany, for example, this includes an area known as the Weisse Bank and part of the eastern edge of the Dogger Bank.

1.2 WWF INTEREST IN OFFSHORE MARINE PROTECTED AREAS

WWF has had a long-standing interest in marine conservation in general and Marine Protected Areas in particular. This is clear from the first objective of WWF marine policy, which is "the establishment and implementation of a comprehensive, global network of ecologically representative, well managed marine protected areas (MPAs) designed to conserve areas of high biological importance and productivity".

Offshore MPAs are considered to be an essential part of such a global network of MPAs, which is why the importance of offshore areas, and opportunities for conservation of offshore habitats and species, have been highlighted in numerous reports and advocacy documents, particularly through the WWF North-east Atlantic Programme. Some of the early work on this subject was published in the late 1990s with a report on the potential for MPAs in UK offshore waters that included illustrations of the sorts of sites that should be considered for this type of protection (Gubbay, 1996). The practical implications and feasibility of managing offshore areas have also been discussed, using examples from Australia and the US where offshore MPAs have been in existence for many years (Gubbay, 1998). These ideas and others from the developing work on MPAs under the auspices of the OSPAR Commission have been used to develop WWF's view on an overall framework for MPAs in the North-east Atlantic (WWF, 2000).

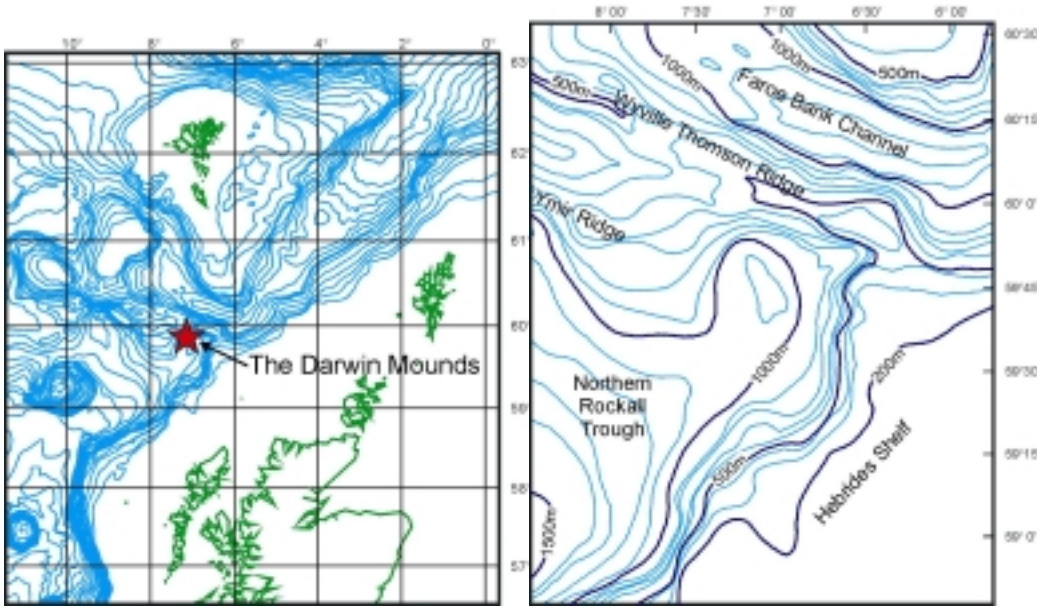
The opportunities presented by the offshore application of the EU Habitats Directive have also been targeted by WWF in its work on this issue. Comprehensive reviews of the information available on offshore reefs and submerged sandbanks, which are two of the habitat types identified for protection under the Habitats Directive, have provided an invaluable starting point for the identification of offshore SACs around these features (Rogers, 2000; Veligrakis *et al.*, 2000). These reviews have been used to prepare a report on the implementation of the Directive in offshore areas for these reefs and submerged sandbanks (WWF, 2001a & b). The scope for other habitats to be considered for offshore MPAs also exists, with an indication of habitats that might be considered in the WWF Offshore Directory (Gubbay, 1999).

2 The UK Continental Shelf and Slope

The UK Continental Shelf (UKCS) comprises those areas of the seabed and subsoil beyond the territorial sea over which the UK exercises sovereign rights of exploration and exploitation of natural resources. The continental slope is the range of seabed that slopes steeply down from the edge of the continental shelf (the shelf break), at ~200m depth and extends to the deep ocean floor at between 1,000m and 2,000m depth. The habitat comprises both the seabed and the overlying water. The characteristics of the continental shelf and slope are largely a function of prehistoric glacial action (the supply of considerable volumes of ice-rafted material to the region) and the influence of water dynamics. A brief description of the specific characteristics of the shelf and slope within the areas of interest for this report, around the Darwin Mounds and the Dogger Bank, are given here.

2.1 DARWIN MOUNDS REGION

FIGURE 1. Location of the Darwin Mounds and nearby topographic features



2.1.1 Bathymetry

In terms of offshore bathymetric features, the most prominent around the Darwin Mound region are the Faroe Shetland Channel, the Faroe Bank Channel, the Wyville Thomson Ridge and the Rockall Trough (Figure 1) These features have an important influence on the water circulation along the Atlantic Margin. In the Faroe Shetland Channel, waters are more than 1,000m deep. The Faroe Bank Channel lies perpendicular to the Faroe Shetland Channel at its southern limit. This channel has maximum water depths of 1,200m in the centre. The Wyville Thomson Ridge separates the Faroe Bank Channel from the Rockall Trough. It joins the Faroe Bank, at its westernmost extent, and the Scottish continental shelf in the east. The crest of the ridge lies 400m from the surface. The Rockall Trough is a huge feature extending from the Wyville Thomson Ridge in the north and is bordered to the east by the UK-Irish continental shelf, to the west by the Rockall Bank and extends south to the southern tip of Ireland. Its deepest point is 4,000m but it also contains far shallower (volcanic) features such

as the Rosemary Bank (300m deep at shallowest point) and the Anton Dohrn Seamount (550m deep at shallowest point) – each of these is higher than Ben Nevis!

2.1.2 Sedimentary environment

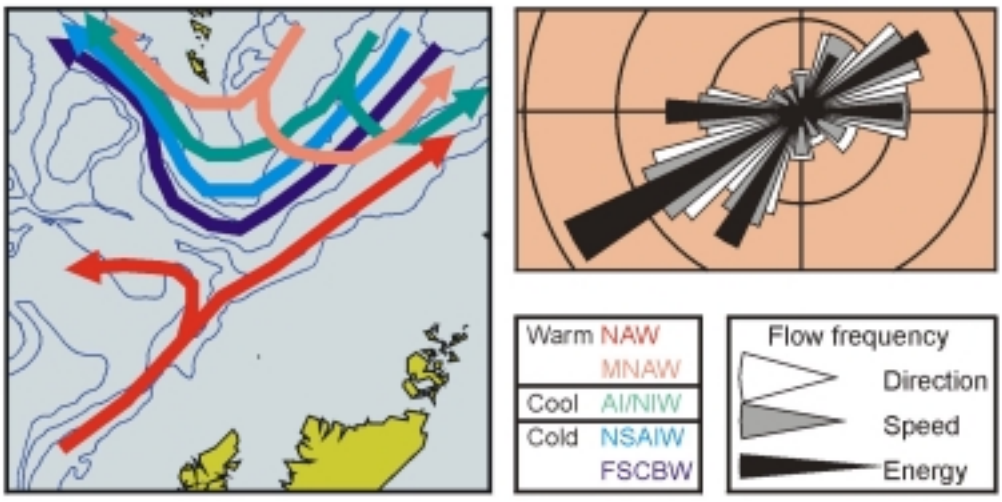
The seabed of the Atlantic Margin is composed of a range of sediments from fine mud to boulders and some areas of exposed bedrock. The continental shelf west of Shetland and the Western Isles is composed of a continuous stretch of mixed sand, gravel and hard substrates. Sandwave bedforms indicating current influence are often seen here. At the shelf-break sediment is predominantly sand but below depths of 1,000m, it becomes progressively muddier and richer in inorganic carbon. Deep-water muddy sands are found in basin areas either side of the Wyville Thomson Ridge. The Darwin Mounds are sand mound features that are located just to the south of the ridge. Pockmarks are also present in this region and run south into the northern part of the Rockall Trough. In the Faroe Shetland Channel, fine muddy sands are the dominant sediment type. Dense iceberg plough marks are common along the shelf edges here. The Rockall Trough basin area is characterised by fine muddy sediments and several large submarine slide and fan features formed by the movement of sediment down the continental slope. One example of this is found just to the south of the Wyville-Thomson Ridge – the Sula Sgeir Fan. This fan has a morainic ridge at its head and is covered with a series of channels and partially buried gullies. The eastern slope of the Rockall Trough also has iceberg plough marks to depths of 500m.

2.1.3 Hydrodynamics

Hydrographically the Darwin Mound region is dominated by the Continental Slope Current (CSC) and the North Atlantic Current in surface waters (Figure 2). The net flow of these two currents is to the north-east. The CSC flows polewards along the upper slope at speeds of ~ 1 knot, transporting warm North Atlantic Central Water (originating in the Bay of Biscay) over the Wyville-Thomson Ridge and through the Shetland sub-region into the Norwegian Sea. At a depth of 600 m in the Rockall sub-region, water temperatures are still quite high at around 7°C. In the Shetland sub-region, water temperatures drop rapidly to less than 0°C below about 550m, the sill depth of the Wyville-Thomson Ridge.

FIGURE 2. Currents in the Darwin Mounds area

Left panel indicates major currents, including assumed westward turning branch of warm North Atlantic Water (NAW) over the Darwin Mounds. Upper right panel indicates recent short-term, current meter observations from the Darwin Mounds (B. Bett, pers. obs.) showing the dominant south-westward flow and significant tidal reversal of that flow (B. Bett).



At depth, currents are influenced by colder, denser water masses of the Norwegian Sea Deep Water and Norwegian Sea Arctic Intermediate Water, entering the region from the north-east with a net flow to the south and west. The interactions between all the water masses in the area are highly variable both on short and long timescales and have a significant influence on current patterns in the area. In addition, the local bathymetry also has some influence on these patterns. For example, the Wyville Thomson Ridge limits deep-water outflow from the Faroe Shetland Channel. Overall, the currents in the region are highly complex and energetic, with large scale eddies present, especially along the shelf edge, south of the Faroe Shetland Channel. Severe waves and storms are also prevalent in the region.

2.1.4 Biology

Phytoplankton production in the region of the Darwin Mounds is highly seasonal and supports a diverse pelagic and benthic ecosystem. In terms of the benthos, several broad biogeographical provinces are found on the shelf and slope in this region. Three of these provinces are in shallow waters: Boreal Province, including the west of Shetland shelf and the Wyville Thomson Ridge; Lusitanian-Boreal province, comprising the west coast of Scotland; and South Iceland and Faroe Shelf. The two deep sea provinces are the Arctic Deep-Sea Province, centred on the Norwegian Sea but extending into the Faroe Shetland and Faroe Bank Channels, and the Atlantic Deep-Sea province, including most of the deep-water areas off north-west Europe. There are many factors that govern the distribution of the benthic communities seen in the area, including bathymetry, depth, current flow, past glaciations, temperature, salinity, and sediment deposition. The primary factor influencing community structure and species composition downslope in this region appears to be water depth.

Superimposed upon the broad biogeographical provinces are a number of unusual species assemblages with patchy distribution. For example, sponges comprising numerous species dominate some areas of seabed. In terms of biomass, species such as *Geodia barretti* and *Stryphnus ponderosus* predominate. Some of these animals are up to 80cm across. The Darwin Mounds themselves are colonised by the cold-water corals, *Lophelia pertusa* and *Madrepora oculata*, which provide the habitat for a variety of associated invertebrate fauna and fish. Also present around the mounds are large numbers of a giant protozoan, the xenophyophore, *Syringammina fragilissima.* Many of the benthic specimens sampled from the region are new to science.

Depth and hydrography govern the region's fish population distribution. Many examples of important commercial species are found both on the shelf (e.g. mackerel, herring, cod, hake) and in deeper waters (e.g. roundnose grenadier, Greenland halibut, orange roughy, blue ling). To date, the knowledge base for assessments of deep-water fish stocks and their life history is very limited. Two distinct fish assemblages have been noted in the region, either side of the Wyville Thomson Ridge. A far richer fish fauna comprising many commercially valuable species is found south of the ridge in the Rockall Trough as opposed to the fish stocks north of the ridge in the Faroe Shetland Channel, which are, in comparison, rather impoverished with a few exceptions.

Sixteen species of cetaceans have been recorded in the Atlantic Margin. Deep-water species of baleen whale (blue, fin and humpback) have been recorded from waters in excess of 1,000m. Some whales such as the Sei are also known to migrate through the region of the

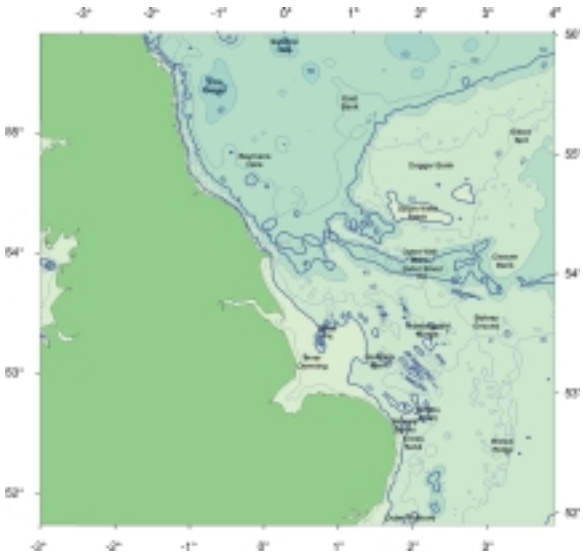
Atlantic Margin. Oceanic dolphin species such as the Atlantic white-sided dolphin and the common dolphin are abundant in the area.

2.2 DOGGER BANK REGION

2.2.1 Bathymetry

The central region of the North Sea surrounding the Dogger Bank is all continental shelf and no deeper than ~100m, the majority being <50m deep. Prominent topographical features around the central North Sea include the Oyster Ground depression and the Dogger Bank elevation, which marks a division between the southern and central North Sea. The South West Patch is one of the shallow parts of the Dogger Bank. The nearest adjacent coastline is Flamborough Head on the east coast of the UK mainland (Figure 3).

FIGURE 3. East coast of England and Dogger Bank region



2.2.2 Sedimentary environment

The North Sea shelf area is an ancient continental drift depression. Several kilometres of sediment, originating from the surrounding landmasses, overlie this depression. Some of these sediments contain substantial amounts of hydrocarbons. The glacial era also supplied sediment to the basin and helped to shape the bathymetry of the region. The sedimentary environment around the central North Sea is composed mainly of coarse sand, sand and gravel deposits, with finer grained muddy sediments in many of the depressions such as Oyster Ground and also those north west of the Dogger Bank (Figure 4).

FIGURE 4. North Sea sediments
(adapted from DTI SEA2)

2.2.3 Hydrodynamics

The Dogger Bank has a significant impact on the circulation in the southern North Sea. The general pattern of circulation in the North Sea is depicted in Figure 16 which shows the relative influences of water masses. These water masses have distinctive salinity and temperature characteristics. Both salinity and temperature may be highly variable on both annual and interannual time scales. The long-term variability, which exists in the North Sea in terms of sea surface temperature, has been closely correlated with the strength of the atmospheric circulation of the North Atlantic (North Atlantic Oscillation).

Stratification of the water column occurs over large areas of the North Sea during late spring and summer with the formation of a thermocline. Over the Dogger Bank region itself, the

water column remains relative well mixed, even during the summer months. Eddies are also a common feature throughout the North Sea. Re-suspension and dispersion of sediments from the seafloor is common throughout the majority of the North Sea as a function of wind-induced currents, tides and/or wave action. Tidal currents are the most energetic feature in the North Sea and stir the entire water column in most of the southern North Sea.

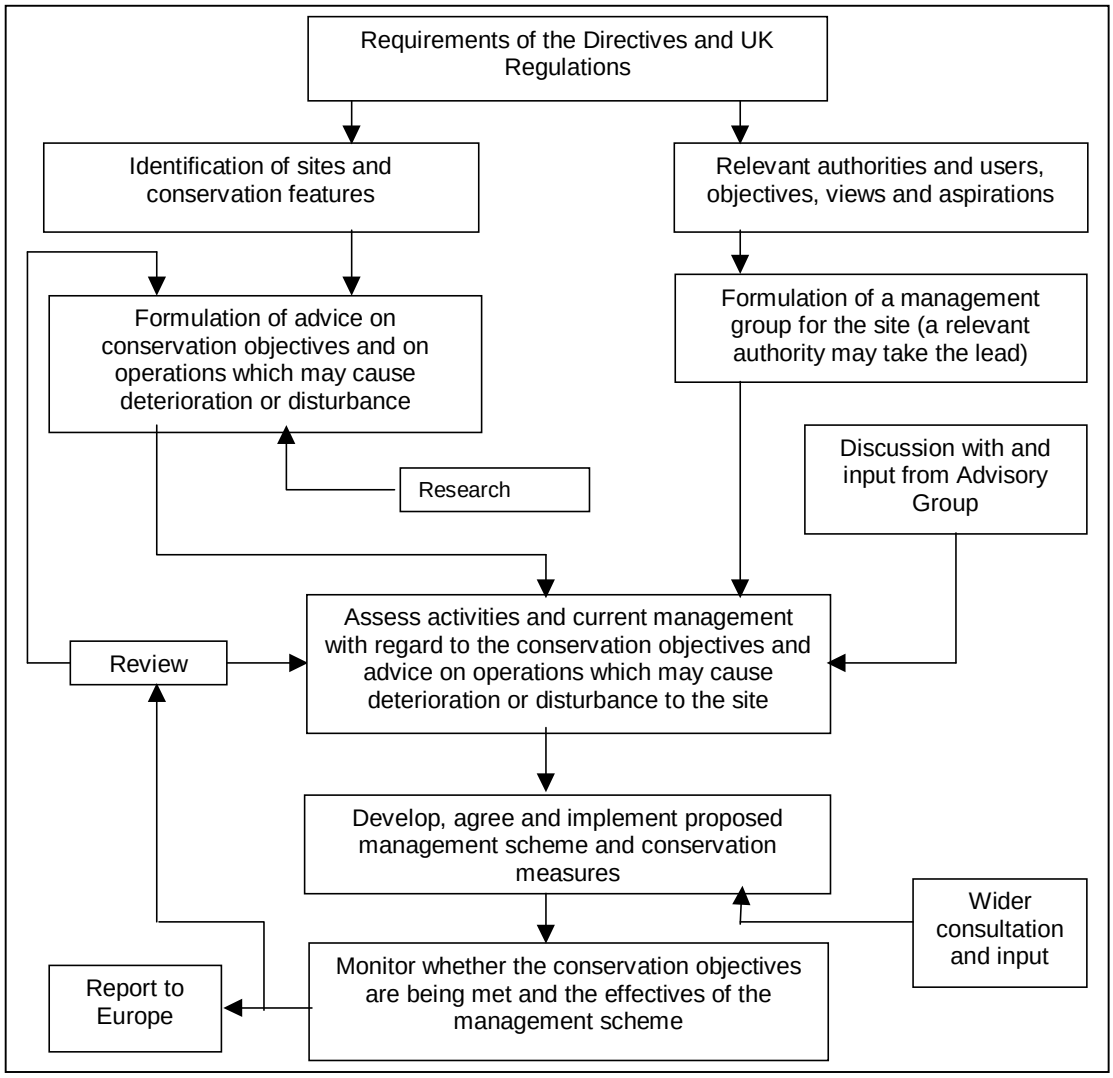
2.2.4 Biology

The North Sea is a productive and complex ecosystem that supports important populations of fish, cetaceans and seabirds. Phytoplankton in the North Sea is dominated by the dinoflagellate genera, *Ceratia*. Phytoplankton biomass has increased over the last 40 years over most of the North Sea and reflects climatic and hydrographic variability. In terms of zooplankton, the copepod genus *Calanus* has the highest abundance in the area. The North Sea benthos is regionally and locally heterogeneous and reflects the various habitat types. Marked changes in benthic communities have been reported for various areas of the North Sea and have been linked to climate factors, eutrophication and human impacts. Important commercial fisheries have existed in the North Sea for many years. Of the 230 known species of fish in the North Sea, 13 are main targets of commercial fisheries (cod, haddock, whiting, saithe, plaice, sole, mackerel, herring, Norway pout, sprat, sand eel, Norway lobster and deep-water prawn). Some areas of the North Sea are important for Minke whales, the harbour porpoise and white-beaked dolphins. The sea also supports half the north-east Atlantic populations of grey seals.

3 Special Areas of Conservation in offshore areas

In the UK, the marine elements of the *Natura 2000* programme have progressed through the identification of potential SACs, the introduction of legal provisions to facilitate their designation and management (the Habitats Regulations), and the provision of conservation advice from the conservation agencies. Management schemes are now being prepared for many of the sites. This is a task that is generally being undertaken by groups of relevant authorities, sometimes constituted into a management group, in consultation with a wider group of interested parties. The various stages are illustrated in Figure 5.

FIGURE 5. A model process for establishing a management scheme (SNH *et al.,* 1997)



There is no equivalent process for offshore SACs yet, but several strands of work are preparing the way for designation of offshore SACs on the UK Continental Shelf. The Joint Nature Conservation Committee, together with the country nature conservation agencies, the Department of Environment, Food and Rural Affairs (DEFRA), the Department of Trade and Industry (DTI) and other government departments are working on an "Offshore *Natura 2000* project", which aims to:

- identify and agree relevant habitats and species in the UK offshore area;
- consider habitat definitions for Annex I habitats found in the UK offshore area;
- consider site selection criteria for Annex I habitats and Annex II species under the Habitats Directive in relation to selection of sites in the offshore area;
- consider site selection for Birds Directive Annex 1 and migratory species in relation to selection of sites in the offshore area;
- collate existing data on relevant habitats and species of the offshore area;
- indicate at a generic level the type of conservation objectives that would apply to any Annex I or II features or relevant bird species.

The Offshore Petroleum Activities (Conservation of Habitats) Regulations, 2001 are one element of UK legislation that will be used to ensure that the requirements of the Birds and Habitats Directive are applied offshore. More general "offshore regulations" are also being drafted. Margaret Beckett, Secretary of State for the Environment, has stated that the Darwin Mounds is "a prime candidate for investigation for SAC status, and I expect (it) to be the first site to be confirmed once the regulations are in place" (23/10/01). This and other sites may also be suitable for protection under the developing OSPAR MPA programme – but as the OSPAR work is still at a developmental stage, the opportunities for using that mechanism are not considered further. Instead, the emphasis is on how offshore sites, and in particular the Darwin Mounds and the Dogger Bank, might be managed as SACs under the Habitats Directive.

3.1 MANAGEMENT SCHEMES FOR SACS

Because the offshore designation programme is at a very early stage in the UK, there are no examples of management schemes to draw on as potential models. There are, however, examples from other parts of the world, as well as a considerable body of knowledge on drawing up management schemes for marine protected areas within territorial waters. The UK marine SACs programme should be particularly helpful in this respect, as it is specifically geared to the requirements of the EC Habitats Directive, and complies with the current UK interpretation of what is required to implement the Directive.

The format used for seven UK marine SACs management schemes (Sound of Arisaig, Papa Stour and Loch nam Madadh in Scotland, and Plymouth Sound and Estuaries, Morecambe Bay, the Fal and Helford, and Flamborough Head in England) confirm that there is no standard approach, but that there are some common elements:

- conservation objectives – written in a style which reflects the requirements and uses the terminology of the Habitats Directive;
- site descriptions – concentrating on the features and species which are listed in various Annexes of the Habitats Directive;
- human activities – descriptions of the main activities carried out within and adjacent to the site;
- assessment of potential for damage and/or deterioration of the features and species;
- measures and targets to achieve/maintain favourable conservation status;
- action plans – proposals for actions, linked to named organisations and timetable; and
- monitoring and research – particularly requirements for condition and compliance monitoring.

These elements form the basis of the outline schemes of management presented in Part II of this report.

3.2 CONSERVATION OBJECTIVES FOR SACS

The Habitats Regulations include a duty for the nature conservation agencies to provide advice on suitable conservation objectives for any proposed SAC or SPA. A similar arrangement is likely to be appropriate for offshore sites and therefore the existing guidance on preparing such objectives (EN *et al.*,1998) have been used to develop the conservation objectives in this report. This guidance states that the conservation objectives for European marine sites should be: specific, measurable and reportable, realistic, consistent in approach and comprehensive. Further information is provided in a review of sites in a UK marine SACs project funded through the EU LIFE programme (EN *et al.*, 2001). This identifies two stages in developing conservation objectives: identifying the characteristics of the interest feature that define its conditions (e.g. quantity, quality and processes) and identifying the state of value of the attributes that equates to being favourable (i.e. targets). Both elements have been incorporated into the proposed objectives presented in Part II of this report.

3.3 MANAGEMENT ACTIONS FOR SACS

A common approach to developing management actions for inshore SACs has been to identify the activities that take place in and around the site, determine the sensitivity of such activities on the features of conservation interest and assess the vulnerability of each feature to the effects of each operation. Measures and targets are then linked to particular attributes of the site. A similar, but simplified, approach has been taken to develop proposals for the management schemes in Parts II & III of this report.

4 The Darwin Mounds and the Dogger Bank as case studies

There is a growing body of information on areas of nature conservation importance in the offshore environment (e.g. Baker *et al*, 2001), as well as various analyses of the legal regimes that apply to offshore areas (e.g. Czybulka & Kersandt, 2000). These provide an important foundation for establishment of offshore SACs but there are also other elements that need to be clarified such as the implications, opportunities, and difficulties of managing offshore protected areas. Much of the discussion about these latter issues is taking place at a general and theoretical level (e.g. Thiel & Koslow, 2001). The current report is intended to complement those discussions by looking at the implications of establishing offshore SACs at specific locations. The Darwin Mounds and the Dogger Bank have been chosen as suitable sites to examine in detail. They are considered to be good examples because:

- they include habitat types listed in the Habitats Directive and therefore potential locations for future SACs;
- they are subject to activities that result in some of the typical impacts on offshore habitats and wildlife;
- they lie outside territorial waters and therefore illustrate the sorts of international issues that will need to be tackled in the management of offshore SACs;
- they are remote from land and therefore subject to what are likely to be typical difficulties in the management of offshore sites (e.g. boundary definition, enforcement, knowledge base, promotion); and
- they illustrate the level of knowledge that might be available to managers seeking to establish offshore SACs

By proposing conservation objectives and preparing an outline management scheme for these two locations, the intention is to illustrate the range of issues that are likely to arise in the management of offshore SACs, as well as identifying gaps that need to be addressed if management of such areas is to be effective.

PART II: THE DARWIN MOUNDS

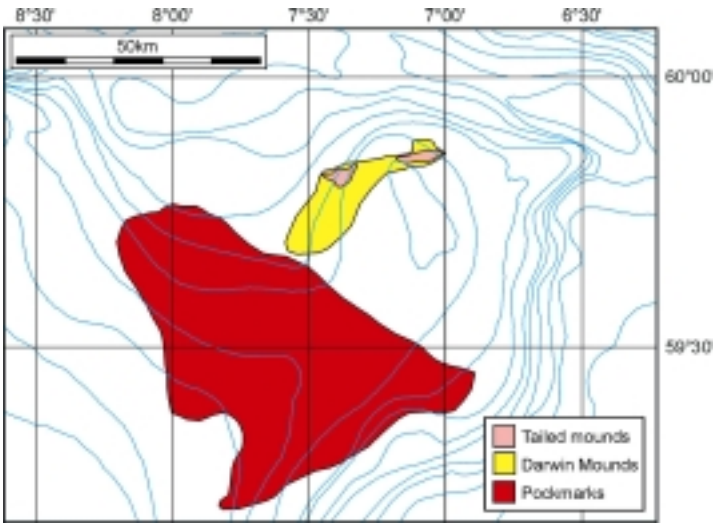
5 Description of the Darwin Mounds area

5.1 INTRODUCTION

The Darwin Mounds were discovered in 1998 by scientists from the Southampton Oceanography Centre during an environmental survey of the deep-sea bed to the north and west of Scotland. This survey was carried out on behalf of the Atlantic Frontier Environmental Network (AFEN), a consortium of oil companies with interests in these areas. The Darwin Mounds (named after the research vessel RRS *Charles Darwin*) were initially detected with SOC's deep-tow sidescan sonar system, Towed Ocean Bottom Instrument (TOBI). SOC scientists engaged in an environmental survey for the UK Department of Trade and Industry subsequently discovered a second group of mounds in 1999. These two main fields of mounds are referred to as Darwin Mounds East (c. 13 km x 4 km with about 75 mounds) and Darwin Mounds West (c. 13 km x 9 km with about 150 mounds). They are located in the north-east corner of the Rockall Trough, immediately south of the Wyville Thomson Ridge in a depth range of 900 to 1,060m.There are hundreds of mounds covering an approximate area of 100 km^2 (see Figure 6). Each of the mounds is c. 50-100m in diameter and up to 5m high. Note that no mounds of this type have been discovered in any other UK deep-water area surveyed to date.

A large area of seabed south of the Darwin Mounds is littered with pockmarks. These features, typically c. 50m in diameter with minimal negative relief, have been mapped in an area over 3,000 km^2. Although they are likely to have formed as a result of fluid escape from the seabed, to date there is no evidence of seepage from the region at present. These pockmarks appear to be closely related to the Darwin Mounds (see Masson *et al.*, submitted).

FIGURE 6. Seabed features in the vicinity of the Darwin Mounds



5.2 SEDIMENTS AND HYDRODYNAMICS

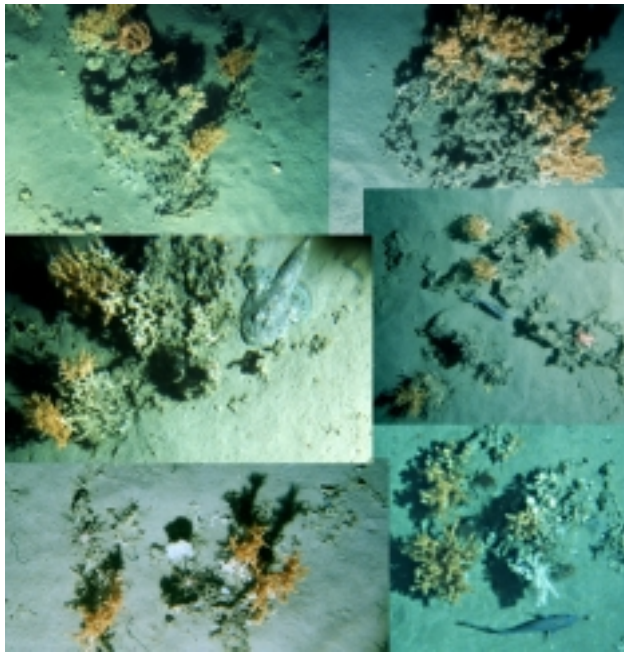
In contrast to the numerous biogenic (carbonate) mounds that occur in the north-east Atlantic, it is thought that the Darwin Mounds are sand volcanoes and resulted from fluidised sand "de-watering", possibly following sediment slumping on the south-west side of the Wyville Thomson Ridge. It has been suggested that they were created by pore water fluid escape (Masson *et al*., submitted). The mounds lie on the surface of a large sediment drift complex (Howe 1995, Stoker *et al.* 1998), which in the area of the mounds comprises a 15cm layer of rippled foraminiferous sand, indicating appreciable current activity in the area. The surface texture of the mounds is rubble-like, probably reflecting small accumulations of coral, coral debris and other organisms with positive relief. Some mounds are undisturbed and have well-developed coral patches, while others have become covered by sediment with no obvious coral. These may have been impacted by deep-water trawling activities.

The Darwin Mounds have teardrop-shaped "tails" hundreds of metres long that have been observed on TOBI sidescan sonar (30 kHz) as moderately high backscatter, but they have no topographic signature and are not visible at the seabed. They occur downstream of the mounds with a common north-east to south-west orientation, which suggests that deep-water flows, steered by topographic features, have a role in their formation. On a global scale, these are the first observations of such features. Background sediment around the mounds is relatively featureless, although some mounds occur in or at the edge of sediment wave fields. Sediments within the mounds have a greater thickness of sand than the outlying sediments. It is not entirely clear how the corals initially colonised this sand substratum (Masson *et al*, submitted), but coral growth in sand waves is known from other sites (e.g. Porcupine Seabight and Galicia Bank, pers. comm. ACES & Ecomound EU projects).

5.3 BIOLOGY

Having confirmed the location of the Darwin Mounds, further investigations were made by SOC using its WASP vehicle, an off-bottom towed video and still photography system and a variety of corers. The tops of the mounds were found to be home to live colonies of the deep-water coral species *Lophelia pertusa,* the less abundant *Madrepora oculata* and the biological community that they support (Figure 7). A single camera pass over one of the western mounds recorded 70 separate coral colonies giving an average density of 1 colony per $4m^2$ along the transect (Bett, 2001). It is therefore possible that one tailed mound may harbour many hundreds of colonies (Masson *et al.*, submitted).

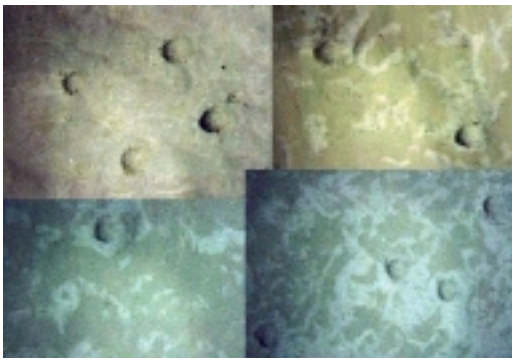
FIGURE 7. Coral communities of the Darwin Mounds showing *Lophelia pertusa* with associated invertebrates and fish (B.Bett, © SOC)



A detailed survey of the Darwin Mounds carried out during an SOC-funded cruise in 2000 included the use of high frequency sidescan (100 and 410 kHz, operated by Dr Andrew Wheeler, University College, Cork). With this system it appears to be possible almost to discriminate individual coral colonies. These are represented by spots of very high backscatter and tend to be slightly more abundant at the edges of the mounds. In some mound areas, 50 per cent of the seafloor was covered with these high backscatter patches. Analysis of sidescan sonar images suggests that the northernmost mounds, with higher elevation, have a denser coral cover than the lower mounds to the south. This could be a function of the preference of deep-water corals for more exposed conditions and more suitable attachment substrate and may also reflect a positive feedback mechanism between sediment trapping within established coral colonies, thereby increasing mound size (Masson *et al*., submitted). Numerous and diverse fauna are associated with the corals. Sponges, Brisingiid starfish and large echiuran worms are commonly seen associated with the corals. Echinothuriid sea urchins (*Calveriosoma hystrix* and *Sperosoma grimaldii*), pencil sea urchins (*Cidaris cidaris*), sea stars, gastropods and hermit crabs (*Parapagurus pilosimanus*) are also common. The most abundant species of fish found in the vicinity of the Darwin Mounds are cutthroat eels (*Synaphobranchus kaupi*) and the round-nosed grenadier *(Coryphaenoides rupestris*).

The mound tails described earlier are of particular interest as they appear to be characterised by particularly high-density populations of xenophyophores, giant protozoans unique to the deep-sea (Figure 8). The species present, *Syringammina fragilissima*, may grow up to 20cm in diameter.

FIGURE 8 Xenophyophores (*Syringammina fragilissima) Darwin* Mounds area



B.Bett, ©Atlantic Frontier Environmental Network)

Overall, the preliminary organic chemistry data from the Darwin Mounds area seem to support visual observations of locally enhanced biodiversity and biological activity in the vicinity of the mounds relative to the surrounding deep-ocean floor. Estimates of invertebrate density being two or three times higher on the mounds relative to the surrounding seabed have been made (Masson *et al.*, submitted). There is, however, no evidence to suggest that this enhanced biodiversity/activity is linked with hydrocarbon escape from the seabed (Masson *et al.*, submitted, or Kiriakoulakis www.pcweb.liv.ac.uk/ocean/org_geochem/kk_eug_abst.html) as has been suggested for some coral mound sites (Hovland & Thomsen, 1997).

The pockmark fauna is similar to that of background sediments from the Darwin Mound area. However, a higher density of large burrows in the pockmark area has been reported. Echinothurid urchins dominate megafauna in the region. Xenophyophores and cutthroat eels (*Synaphobranchus kaupi*) are also present. Some sponge growth was noted on hard substrata of cobbles and boulders situated within the pockmarks and one small *Lophelia* colony was also noted. No typical seep fauna (mussels and tubeworms) was noted.

Cetacean records from the waters to the north and west of Scotland reveal that fin whales, minke whales, sperm whales and pilot whales frequent the area, as well as the Atlantic white-sided dolphin (Weir *et al.*, 2001). Seabirds are also attracted to the general area of the Wyville Thomson Ridge, as it is a relatively shallow ridge providing richer feeding grounds than the surrounding deep-water areas. The northern fulmar is the most abundant species and is a year round resident (AFEN, 2001). Other species that have been recorded over the deep water are Leach's storm-petrels *Oceanodroma leucorhoa* and European storm petrels *Hydrobates pelagicus*. Gannets, kittiwake, puffin, common guillemot, great black-backed gull, herring gull and razorbill have also been present, some on a seasonal basis only, although all are more common over the shelf waters of north-west Scotland (Reid *et al.*, 2001).

6 Human activities and related issues of concern

6.1 FISHING

The major fisheries taking place in the area are deep-water demersal trawls that target blue ling and orange roughy, with by-catch of black scabbard fish, Portuguese dogfish and leafscale gulper shark, long-lining for hake and deepwater sharks, and semi-pelagic trawling for blue whiting and argentine. There is some difficulty in obtaining accurate fishing effort, catch and by-catch data from all countries that fish the area. Nevertheless, to give an example, the most abundant demersal fish species, landed by the UK fleet in 2000 in ICES block VIa (which includes the Darwin Mounds), are given in Table 1:

TABLE 1. Fish landings in ICES block VIa in the year 2000.

Demersal fish	Blue Whiting	Haddock	Sand Eels	Dogfish	Saithe	Ling	Whiting	Cod	Monk or Angler fish	Skates or Rays	Hake
Quantity (tonnes)	26458	6134	5771	3505	2614	2442	2362	2339	1541	1425	1033

French trawlers fishing for orange roughy and other deep-water commercial fisheries expend significant effort in the region of the Rockall Trough, with the greatest effort very close to the Darwin Mounds (Figure 9). This deep-water trawling has already had an impact on the *Lophelia* thickets on the eastern Darwin Mounds, as revealed by high frequency sidescan sonar (University College Cork) and photographic evidence (SOC) showing scours on the seabed left by trawlers and a scattering of dead coral debris left in their wake, as well as blackened sediments and disturbed surfaces (Figure 10). It is difficult to quantify the trawling impact due to the lack of complete photographic coverage from the region.

FIGURE 9. Hours fished by French trawlers landing in Scotland in 1998. (reproduced with the permission of the FRS Marine Laboratory, Aberdeen).

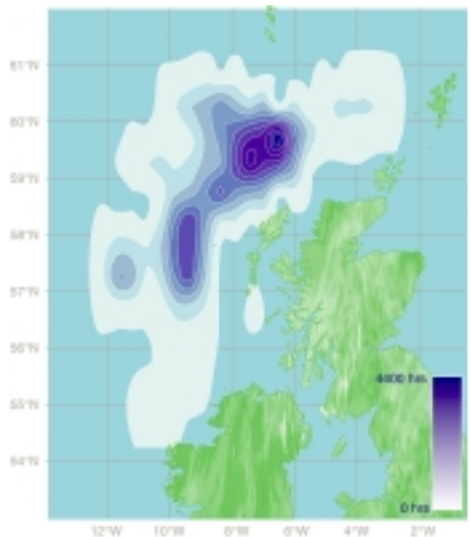


FIGURE 10. Box core sample from deep sea area subject to trawling impact. Note blackened sediment (left) resulting from decay of buried fauna and disturbed sediment surface (right).

(B.Bett, © Atlantic Frontier Environmental Network).

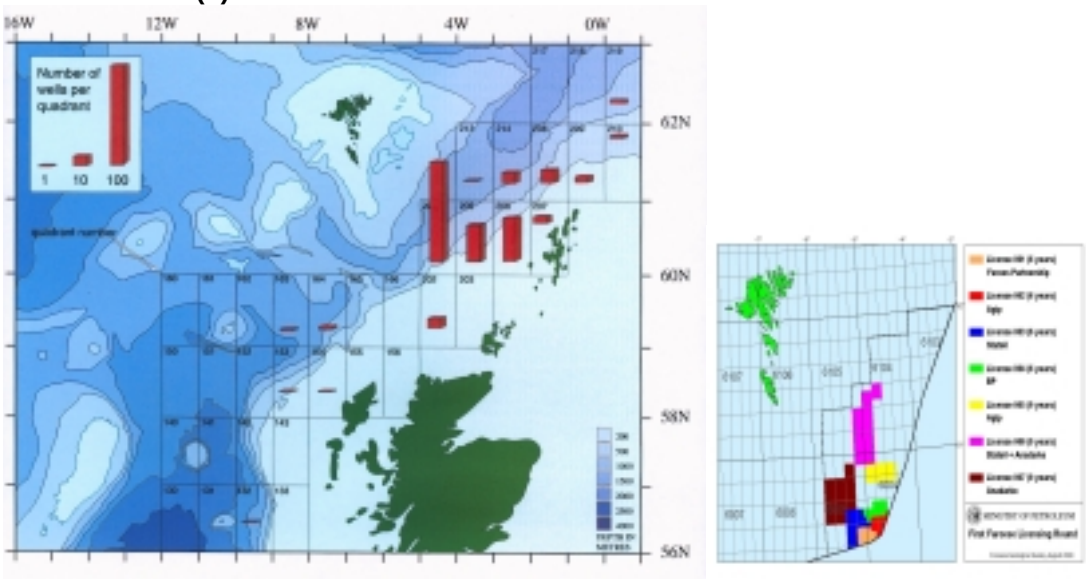
Other types of fishing in the area also raise conservation issues. Pelagic trawling brings with it the associated risks of by-catch as well as concerns about the status of the target species. The North Atlantic fishery of blue whiting, for example, which is an important catch from the region, is threatened with collapse if urgent action is not taken. Coastal states involved in the fishery have met six times but failed to agree on sharing the Total Allowable Catch for 2002.

The scale of the deep-water shark fishery is difficult to quantify. Given the considerable vulnerability of elasmobranchs to over-exploitation, this element of the long-line fishery may be an issue of concern – as could seabird by-catch during long-lining. The northern fulmar, which is abundant in the region, is known to be particularly vulnerable to being caught by this type of gear, but there is no information on whether this is a problem in the Darwin Mounds area.

6.2 OIL AND GAS EXPLORATION

The Darwin Mounds lie in an area opened for hydrocarbon exploration by the UK government in 2000 (Licence block numbers 164/9&10). The area has been the subject of oil industry geophysical surveys, but no drilling has taken place and no production licences have been issued at this time (Figure 11). The nearest UK fields in production are Foinaven and Schiehallion to the north-east. The region immediately to the north of the Darwin Mounds (the Wyville-Thomsin Ridge and part of the Faroe Bank Channel) is in an area of the UK Continental Shelf that might be considered for licensing in the future. An area in Faroese waters was also opened for licensing in 2000, following agreement over territorial rights between the UK and Denmark. Licences have been awarded to a number of companies in blocks 6004, 6005, 6105, 6104 for six and nine years. Seismic surveys have been carried out and exploration wells have been drilled in some of these blocks, but there have been no significant finds to date.

FIGURE 11. (a) Map of exploration and production drilling activity on the Atlantic Frontier (AFEN, 2000)
(b) Licensed blocks in Faroese waters



(a) **(b)**

Data from shallow water studies indicate that biological disturbance owing to drilling waste and cuttings discharge is detectable in benthic communities up to 5km from sites of drilling, although usually not further than 3km (Gray *et al.*, 1999). This disturbance may be either the physical smothering of organisms or chronic toxicological effects, resulting in a reduction in a number of sensitive species, increase in abundance of some opportunistic species, increased mortality, overall reduction in macrobenthos abundance and reduced macrobenthic diversity (OSPAR, 2000). The effects of production discharges are not yet well known, although there are several reports of accumulated hydrocarbons from produced water in marine organisms. A recent field experiment on the Norwegian shelf has shown significantly increased levels of PAHs in caged mussels and passive samplers up to 10km away from the nearest produced water discharge – up to 140 times the local background concentrations (Roee *et al.*, submitted, cited in OSPAR, 2000).

6.3 OTHER ACTIVITIES

To date, other than demersal fishing, scientific research is likely to have had the most direct impact on the Darwin Mounds. Ground-truthing, using core devices and small bottom trawls, will cause seabed disruption. However, the scale of this sampling is very limited.

There is little information available on the amount of shipping activity in the area around the Darwin Mounds Potential issues include spills and discharges of oil and other substances, rubbish disposal, acoustic disturbance and the introduction of non-indigenous species via ballast water discharge. Any impacts are principally in relation to species that frequent surface waters, such as cetaceans and seabirds, rather than the reef communities on the deep seafloor.

The nearest cable in the area is the Atlantic crossing cable and lies to the north of the Darwin Mound site at 59°54”N and traverses the 7-8°W latitude.

A relatively recent increase in bioprospecting of deep-sea organisms has been fuelled by the discovery of hyperthermophillic bacteria surrounding hydrothermal vents. Tools such as genomics and genetic engineering are used to search for bioactive molecules that have potential uses in medical and industrial fields. Sponges are thought to be ideal candidates for bioprospecting as each can live in symbiosis with dozens of different species of bacteria. A few different species of sponge have been observed on the Darwin Mounds. One of the major environmental problems associated with bioprospecting is the over-harvesting of resources and disturbance of the associated fauna.

The potential to use the deep ocean for waste disposal and dumping of unwanted material has been raised on a number of occasions. In the 1990s the two widely debated ideas of this type were the dumping of decommissioned offshore platforms in the deep sea, and whether the deep sea could be used for the safe long-term disposal of sewage sludge. Munitions have also been dumped in the ocean, but it is difficult to establish whether this has taken place in the vicinity of the Darwin Mounds. Precise effects of taking forward any of these ideas will depend on factors such as the type of material, the method of disposal, and location.

7 Management scheme area

7.1 POTENTIAL SITE BOUNDARIES

Deciding on the most suitable boundary for an MPA is always difficult, since the areas occupied by the habitats or species that are to benefit are rarely sharply defined or coincident. The usual approach is to include the most important zone for those species and habitats and some of the surrounding area to help take account of the gradation of habitats and communities, and to act as a buffer. Practical considerations are also important, since users and regulators need to identify the boundary on location. Three options are put forward in this report for a potential SAC around the Darwin Mounds (Figure 12). The primary consideration is to enclose the feature of conservation interest – the scientific basis – and the secondary consideration is a practical one.

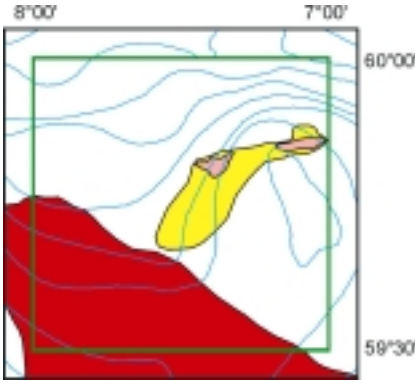
Option 1 – Encloses the main features of interest and uses an existing management boundary, which is concerned with the principal activity that will need to be managed in the area (i.e. fisheries). A straight-line boundary is drawn for ease of description and identification on the ground. (Co-ordinates 60°00'N 08°00'W, 60°00'N, 07°00'W, 59°30'N, 07°00'W, 59°30'N 08°00'W, approximate area 3,160km^2.)

Option 2 – Encloses the main features of interest in the area. A straight-line boundary is drawn for ease of description and identification on the ground, but it has no relationship to any existing management unit that is used in the area. (Co-ordinates 59°59'N 07°10'W, 59°51'N 06° 57'W, 59°23'N 07°59'W, 59°31'N 08° 12'W, approximate area 1,500 km^2.)

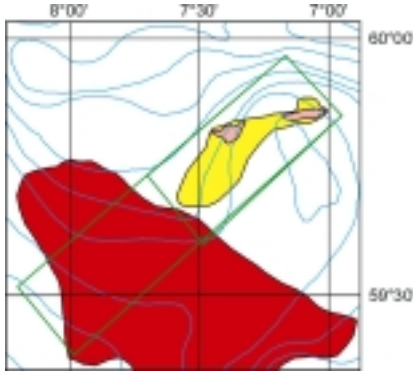
Option 3 – A more tightly drawn boundary around the main feature of interest specified in the Habitats Directive (i.e. reefs) but excludes features whose status in relation to the Habitats Directive has still to be determined. (i.e. pockmarks for which there is no evidence of leaking gas at present). A straight-line boundary is drawn for ease of description and identification on the ground. (Co-ordinates 59°59'N 07°10'W, 59°51'N 06°57'W, 59°36'N 07°29'W, 59°44'N 07°42'W, approximate area 780 km^2.)

The outline management scheme presented in Section 8 uses Option 1 as the overall site boundary and Option 3 as a "core zone" within the proposed protected area.

FIGURE 12. Possible boundaries for a Darwin Mounds SAC



OPTION 1
ICES Area VIa block 06



OPTIONS 2 & 3
Option 2 - mounds and an area of associated pockmarks
Option 3 – mounds

7.2 RELEVANT AND COMPETENT AUTHORITIES

Guidance prepared by the nature conservation agencies states that "management schemes should involve the views of all relevant authorities, and where appropriate, competent authorities as well as taking account of the concerns and aspirations of user groups and other interested parties" (SNH *et al.*, 1997). As management schemes have been developed for marine SACs within territorial waters, the various groups and parties who fulfil these roles have been identified. Table 2 is an initial list of bodies that may have similar roles in a potential Darwin Mounds SAC. Drawing up such a list suggests that there is no value in making a distinction between relevant and competent authorities for offshore areas, as it is principally government departments that will need to take action. A clearer approach will be to identify authorities and agencies, international bodies, other governments, user group associations (who will be a link to individual user groups), and other interested parities.

TABLE 2. Examples of organisations likely to have a role to play in a Darwin Mounds SAC

Organisation	**Acronym /initials**	**Organisation**	**Acronym/ initials**
UK authorities and agencies		**user group associations**	
Centre for Environment Fisheries and Aquacultural Science	CEFAS	Atlantic Frontier Environment Forum	AFEF
Crown Estate	CEC	Atlantic Frontier Environment Network	AFEN
Department of Environment, Food and Rural Affairs	DEFRA	EUROPECHE	
Department of Trade and Industry	DTI	International Association of Geophysical Contractors	IAGC
Department of Transport, Local Government and Regions	DTLR	International Association of Independent Tanker Operators	INTERTANKO
Fisheries Protection Service	FPS	International Cable Protection Committee	ICPC
Joint Nature Conservation Committee	JNCC	International Association of Oil and Gas Producers	OGP
Ministry of Defence	MoD	International Chamber of Shipping	ICS
Scottish Natural Heritage	SNH	National Federation of Fishermen's Organisations	NFFO
Scottish Executive		Scottish Fishermen's Federation	SFF
		UK Offshore Operators Association	UKOOA

Organisation	Acronym /initials	Organisation	Acronym/ initials
International bodies		Wildlife and Countryside Link	WCL
European Commission and its Directorates		Fish Producer organisations	
International Council for the Exploration of the Seas	ICES	Pelagic fishermen's associations	
International Maritime Organisation	IMO	other interested parties	
World Conservation Union	IUCN	British Geological Survey	BGS
NE Atlantic Fisheries Commission	NEAFC	Greenpeace	
Oslo and Paris Commission	OSPAR	Marine Biological Association of the UK	MBA
		Marine Conservation Society	MCS
		Royal Society for the Protection of Birds	RSPB
National governments		Sea Mammal Research Unit	SMRU
EU member states		Southampton Oceanography Centre	SOC
Norway		Scottish Association for Marine Science	SAMS
Iceland		The Wildlife Trusts	TWTS
		Whale and Dolphin Conservation Society	WDCS
		WWF	WWF

8 Management scheme framework

8.1 PURPOSE OF THE MANAGEMENT SCHEME

The purpose of management schemes for European marine sites is "to ensure that the necessary conservation measures are put in place to avoid deterioration of habitats or the habitats of species, or disturbance to species listed in the Habitats and Birds Directive" (EN *et al.*, 1998). The 1994 Habitats Regulations do not make the preparation of a management scheme compulsory, but state that if required, only one management scheme may be established for each site. Until the UK Offshore Regulations are agreed, it is unclear whether the same approach will be taken for offshore SACs.

In the case of the Darwin Mounds, we believe that a management scheme, founded in law, is essential to safeguard the nature conservation interests of area. The principal reasons are:

- significant damage has already occurred to features of nature conservation importance at the site (the coral reefs). A management scheme would provide a clear commitment to halt such damage, track any further changes, and set in place a long-term monitoring strategy. A management scheme would also put all of this into the public domain;
- the principal causes of damage to the Darwin Mound coral reefs have been known for some time, yet it is unclear what, if any, action is being taken to tackle the problem, who should be held accountable for progress, and any target timescales for resolving the problems. Issues such as these would have to be made clear and public in any management scheme document;
- there is uncertainty about the specific mechanisms that might be used to safeguard the Darwin Mounds and their legal status. Setting out such matters in a management scheme will make it easier for all affected and interested parties to play their part in the management of the site and identify any gaps that require new mechanisms to be introduced;
- a mix of international, regional and national bodies have an interest and various potential roles in the management of the site. Given the lack of experience of managing such sites in the EU, there is much scope for confusion over roles, including who should take the lead on certain issues. A management scheme would assist by including clear statements about requirements and respective roles;
- actions to safeguard the conservation interest of the Darwin Mounds will need to be communicated widely, clearly and consistently in the UK and abroad. The framework of a management scheme will be invaluable for this task;
- although the Darwin Mounds are far from land, there are many groups and individuals who have an interest in the area. A published management scheme will provide a clear focus for public discussion about what should happen to the site.

8.2 CONSERVATION OBJECTIVES

The conservation objectives for marine SACs are intended to "help set the standard against which the condition of the site's interest features can be compared to determine whether they are in favourable conditions and whether the management measures taken on the site have been successful" (EN *et al.*, 1998).

Those already in use for inshore SACs follow a consistent pattern, in that they focus on the features and sub-features of the site and introduce the concept of natural change. The features and sub-features of the Darwin Mounds have been described in Section 5 and are summarised in Table 3 using the same format as the management scheme for the Loch nam Madadh SAC on the Western Isles.

TABLE 3. Habitats Directive features and sub-features of the Darwin Mounds

Feature	Sub-feature	Physical components	Biological components
Reefs	Coral mounds	Sea bed mounds on foraminiferous sand ranging in size, up to around 100m in diameter and 5m in height above the seabed.	Colonies of deep-water coral species *Lophelia pertusa* and the (less abundant) *Madrepora oculata*. Numerous and diverse fauna associated with the coral.
	Mound tails	Mound "tails" are often teardrop-shaped features of sandy sediment distinguishable from the surrounding foraminiferous sand	Megafauna dominated by high densities of the xenophyophore *Syringammina fragilissima*
	Mound 'signatures'	Sandy sediments distinguished from surrounding sediments by sidescan sonar	Macrofauna and meiofauna have been sampled and are being analysed at the present time.

NB. Most of the coral mounds have associated "mound tails", but this is not the case for all the mapped coral mounds. They have therefore been identified as separate sub-features.

Current evidence suggests that the pockmarks in the area are likely to have formed as a result of fluid escape from the seabed. There is no evidence of active seepage from the region at present, but pockmarks may need to be added to this table and to other documentation if they are considered to be covered by the Habitats Directive as "submarine structures formed by leaking gas".

Using the existing guidelines and conservation objectives as examples, the following conservation objectives are proposed for the Darwin Mounds:

Subject to natural change, maintain the Darwin Mounds marine site in a favourable condition. In particular (but not exclusively) ensure that:

- the environmental and natural processes of the reefs and the sub-features (coral mounds, mound tails and mound signatures) are maintained; and
- the extent, diversity, species richness and distribution of the reefs and the sub-features (coral mounds, mound tails and mound signatures) are maintained

The phrase "in particular (but not exclusively)" is used so that the site is considered in its entirety and managed for the full range of habitats and species found in the area, rather than being limited to management of the Habitats Directive features. This is considered the most sustainable, logical and practical approach.

9 Management scheme proposals

9.1 ASSESSMENT OF THE POTENTIAL FOR DETERIORATION OR DISTURBANCE

Before deciding on appropriate measures for the management of an SAC, it is necessary to assess whether existing and proposed activities might have a detrimental effect on the features of conservation interest. For inshore SACs, this has been termed the "operations advice".

Table 4 summarises the sensitivity and vulnerability of the Darwin Mounds reefs to deterioration or disturbance. The table also illustrates the level of detail that can be provided on offshore deep sea habitats and species that have not been studied as intensively as those inshore, and where it is harder to get accurate information on use of the area.

TABLE 4. Assessment of potential for deterioration or disturbance of Darwin Mounds

Operation	Sensitivity and vulnerability to deterioration or disturbance	Comment
	REEF	
Physical Loss		There has been some removal/sampling of the reef communities and associated habitat for **scientific study**. The biological communities are also sensitive and vulnerable to smothering by suspended sediments from **deep-water trawling** in the general locality. If **oil and gas** extraction went ahead, localised smothering linked to disposal of drilling muds or any trenching activity associated with pipelines, may be an issue.
Removal	🕹	
Smothering	🕹	
Physical Damage		**Deep-water trawling** is the principal activity likely to cause physical damage (through siltation, abrasion and selective extraction) and is already known to have had some impact on coral thickets in parts of the Darwin Mounds. **Oil and gas** exploration is being considered in the area and, if approved, has the potential to cause siltation and abrasion effects in the immediate vicinity of any seabed activities.
Siltation	🕹	
Abrasion	🕹	
Selective extraction	🕹	
Non-physical disturbance		Noise and visual presence are unlikely to have any effect on the deep-water features of the Darwin Mounds but they are a potential source of disturbance to cetaceans that frequent the area. Those studying hydrothermal vent communities have raised concerns about potential effects of the strong illumination from Remotely Operated Vehicles used to investigate deep sea fauna. This is not a subject that has been investigated in relation to deepwater reefs.
Noise	?	
Visual presence	?	
Toxic contamination		**Oil and gas** development is being considered for the area and has the potential to introduce chemicals and contaminants, including dissolved and dispersed oil, that could have lethal and sub-lethal effects on the corals and, potentially, on the benthos. Risk of contamination from the adjacent licensed areas in the Faroes EEZ is unclear. Current
Introduction of synthetic compounds	**(🕹)**	
Introduction of non-synthetic compounds	**(🕹)**	

Operation	Sensitivity and vulnerability to deterioration or disturbance	Comment
Introduction of radionuclides	(⚓)	understanding of circulation patterns in the area and the physical barrier of the Wyville-Thomson Ridge suggests this is less likely than from areas that may be licensed south of the Ridge. **Shipping** activity is limited in the area but there is a potential for impacts on seabirds and cetaceans if there were any oil or chemical spills from vessels transiting the area. The deep-water features are unlikely to be affected.
Non-toxic contamination Nutrient enrichment Organic enrichment Changes in thermal regime Changes in turbidity Changes in salinity	 ? ? ? ? ?	The sensitivity of the reef communities to non-toxic contamination has not been determined but may be relevant if there are similar responses to those found in shallow water corals from this type of contamination. The offshore location of the site makes non-toxic contamination unlikely and therefore vulnerability would be low. This may change, however, if ideas for deep-sea **disposal of wastes** become a serious option. Any localised effects on seabed communities from fisheries discards and by-catch are also unknown
Biological disturbance Introduction of microbial pathogens Introduction of non-native species/translocation Selective extraction of species	 ? ? ⚓	The sensitivity of reef communities to microbial pathogens and non-native species is unknown at present. Vulnerability is likely to be low. In contrast, reef communities are both sensitive and vulnerable to selective extraction of species. **Deep-water trawling** has already had an impact on coral thickets in some parts of the Darwin Mounds.

? Lack of information on sensitivity at the present time

(⚓) Habitat is sensitive to the listed activity but not immediately vulnerable

⚓ Habitat is sensitive to the listed activity and currently vulnerable

The outline assessment presented in Table 4 suggests that the immediate priorities for management action should be:

- deep-water fisheries – because this is current activity and is known to have had a considerable impact on some areas of the Darwin Mounds;
- scientific research – because it is a current activity and is known to have some localised impact; and
- oil and gas exploration and production – because it is being considered for the area and has the potential to have an impact.

The assessment also points to shipping and waste disposal as potential activities of concern and therefore activities for which it will be desirable to propose management actions.

9.2 MEASURES AND TARGETS TO ACHIEVE FAVOURABLE CONSERVATION STATUS

A report on indications of good practice for establishing management schemes (EN *et al*, 2001) makes the point that "in order to provide a standard that can be monitored, the attributes that define condition must each have a target value representing favourable condition". The need to take account of natural processes and human impacts is also

recognised, and it is accepted that current understanding may make it impossible to set numerical targets and ranges. An example of how this has been applied can be found in the Sound of Arisaig management scheme. Using the same format, Table 5 shows the sorts of measures and targets that could be used to achieve favourable conservation status of the Darwin Mounds. Non-destructive methods have been proposed wherever possible.

TABLE 5. Measures and targets to achieve Favourable Conservation Status

Feature	Sub-feature	Attribute	Measure	Targets (subject to natural change)	Methodology	Information status
REEFS	Coral mounds	Extent and distribution	Area and relative distribution of mounds	Maintain overall extent of coral mounds	Sidescan sonar	Available
		Physical structural integrity	Percentage cover by coral, proportion of live/dead coral	No reduction in relative proportion of live coral cover	Video and stills imaging	Analysis under way
		Quality of coral colonies	Species (fish and invertebrates) richness within coral colonies	No change in overall species diversity	Video and stills imaging	Analysis under way
		Benthic community structure	Macrofauna and meiofauna abundance and diversity	No change in abundance and diversity	Box cores and megacores, microscopic identification	Analysis under way
	Mound tails	Extent and distribution of mound tails	Area and relative distribution of mound tails	Maintain overall extent of mound tails	Sidescan sonar	Available
		Benthic community structure	Macrofauna and meiofauna abundance and diversity	No change in abundance and diversity	Box cores and megacores, microscopic identification	Analysis under way
		Community structure	Abundance and density of megafauna - Xenophyophores & Spatangoids	No change in distribution and abundance	Video and stills imaging	Analysis under way
	Mound signa-tures	Extent and distribution of mound signatures	Area and relative distribution of mound signatures	Maintain overall extent of mound tails	Sidescan sonar	Available
		Benthic community structure	Macrofauna and meiofauna abundance and diversity	No change in abundance and diversity	Box cores and megacores, microscopic identification	No current programme of work
		Community structure	Abundance and density of megafauna	No change in distribution and abundance	Video and stills imaging	Analysis under way

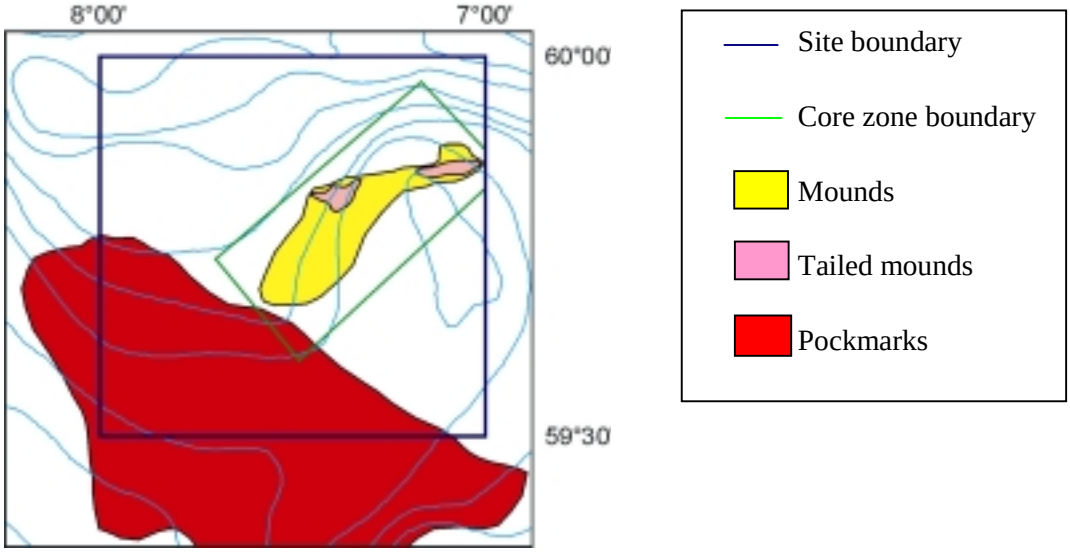
9.3 MANAGEMENT PROPOSALS

Table 6 provides a summary of management proposals for a Darwin Mounds SAC, an indication of the bodies that are likely to be responsible for taking the required action, and the mechanisms that could provide the legal basis. Figure 13 shows the proposed boundary and a "core zone".

TABLE 6. Management proposals for a Darwin Mounds SAC

Activity	Proposed Management Action	Relevant Bodies	Existing mechanisms available for use
Fisheries	• Prohibition of bottom trawling in the SAC	EC/UK	Regulation through CFP
	• Long-lining and semi-pelagic trawling prohibited in core zone until further information available on conservation implications	EC/UK	Regulation through CFP
	• All fishing vessels operating or transiting the SAC to have mandatory operational transponders	EC	Regulation through CFP
	• Observer scheme on all fishing vessels operating in the SAC and ICES rectangle IVa/06	EC/DEFRA/ SERAD/	Regulation through CFP
	• Routine patrol vessel allocated to area for enforcement purposes.	DEFRA/ SERAD/RN	Policy decision on deployment priorities
	• Collation of data on effort and landings specifically within the SAC & ICES IVa/06	ICES	SERAD/CEFAS
Oil and gas	• Strategic Environmental Assessment for exploration and production in the region	DTI	SEA Directive
	• Closed areas oil and gas exploration and production in blocks 164/9 and 164/10	DTI	Offshore regulations
	• Contingency warning system from adjacent production sites	DTI/ Operators	Continental Shelf Act Licence condition
	• Guidelines for seismic operations	Operators	Existing guidelines
Shipping	• Prohibition on the dumping of wastes	IMO	MARPOL
	• Presumption against ballast water exchange	DTLR	Merchant Shipping Regulations
Waste disposal	• A presumption against use of site for waste disposal	IMO, LDC, OSPARCOM	UNCLOS, MARPOL, OSPAR
Renewable energy	• A presumption against use of the site for renewable energy generation	DTI	Continental Shelf Act
Tele-communications	• A presumption against laying cables within the core zone and subject to EIA if elsewhere in the SAC	Coastal state, ICPC, UKCPC	UNCLOS
Scientific research	• Code of practice for operation in the area. Presumption against destructive sampling techniques	Research institutes	Voluntary
	• Research coordination network and common data pool.		

FIGURE 13. Proposed boundary and core zone for a Darwin Mounds SAC



9.3.1 Fisheries

The recommendations for fisheries management summarised in Table 6 are fundamental to the protection of the Darwin Mounds and need to be taken forward as a matter of urgency. There are no legal impediments to taking such action and existing mechanisms can be used. The difficulties are more likely to be in the implementation. These can, however, be overcome if concerted effort is put into the dissemination of information, to enforcement of the regulations, and to monitoring outcomes and activities in the area.

Prohibition on fishing

The main fisheries recommendations are to limit and prohibit various deep-water fisheries in the Darwin Mounds area. The powers of the European Community and member states to introduce such measures have been the subject of a specific legal interpretation by request of member states following discussion of the issue at the Habitats Committee in June 2000. This states that the Community is authorised to take protective measures with regard to protecting deep-water reefs, as this can be linked to the protection of "live aquatic resources" which is required within the CFP. At the same time it is clear from the residual authority left to member states that measures can only be applied to the fishermen of the member state concerned. Joint action is therefore essential, with member states needing to ask the Commission to take the regulatory measures necessary. It should also be noted that if the Community has not taken the necessary measures, member states are not exempt from the responsibility to protect the relevant habitats. The legal basis for this action is found in Regulation (EEC) No.3760/92 – a framework regulation of the Common Fisheries Policy – and Council Regulation (EC) No 850/98.

The measures taken to facilitate the recovery of cod and hake stocks by the European Commission are a practical example of what can be done. In this case, closed or controlled areas were introduced along with increased selectivity of fishing gears by using emergency powers available to the Commission. In the case of the proposed Darwin Mounds SAC, a similar approach could be used, introducing an emergency regulation as soon as possible and converting this into a permanent regulation once a management scheme for the site has been agreed.

To proceed, the UK government needs to identify the management action required for the Darwin Mounds, and to make a proposal to the European Commission Directorate General for Fisheries (DG Fish). The Commission should then draft a regulation under the Common Fisheries Policy's technical conservation measures. The regulation will need approval and adoption by the European Council.

Observer schemes

Observer schemes are already in operation and although some measures are voluntary, others are mandatory. The emergency cod and hake recovery measures illustrate one way to do this. UK vessels are not allowed to operate in specified areas unless they have a "Notice of Variation" on their operations. This includes a requirement for 48 hours notice of a trip to the area so that fisheries departments can arrange to have an observer on board.

The scale of any seabird by-catch associated with long-line fishing in the area is unknown – but evaluations of various gear modifications, such as underwater setting tubes, streamer lines and line weighting, suggest that they can substantially reduce such by-catch where it occurs (Lokkeborg, 1999; Dunn & Steel, 2001). In the short term it is recommended that an observer scheme be introduced to determine the likely scale of this issue in the proposed SAC. In the longer term, an appropriate set of technical measures to reduce seabird by-catch should be a requirement on all long-liners, regardless of whether they are operating inside or outside a Marine Protected Area.

Monitoring

Given the controls on fishing that are envisaged, there will be a need to monitor fishing activity in the area. Since January 2000 there has been a requirement for all EU vessels more than 24m long to fit and use satellite-monitoring equipment wherever they fish. The situation also applies to third parties fishing in EU waters. Deep-sea vessels of the type that operate in the area of the Darwin Mounds fall into this category and should therefore already be fitted with the necessary equipment. Because of concerns about the misuse of transponders, the Commission is considering introducing a requirement for manual input of data to show the location (at some specified intervals of time) if the system is not operating automatically. The proposal for mandatory operation of transponders within the proposed SAC is therefore consistent with existing and proposed regulations and does not present a legal problem.

Enforcement

Enforcement of fishing regulations in the area of the UK Continental Shelf – and therefore around the Darwin Mounds – is currently undertaken by aerial surveillance and Royal Navy vessels. There are no legal limitations to providing more focused effort in the vicinity. The difficulties are more likely to be logistical, with the need to organise an increased presence in the area. To show a clear and strong commitment to protecting the area, this must be taken forward as a matter of urgency.

Data collection

The conditions and type of fishing taking place in the area of the Darwin Mounds mean that large offshore vessels are used. These are already required to complete logbook records on landings and location, so the proposal for data collection should not require any new actions on the part of skippers. The main difference is likely to be more easily available access to the information for the ICES block, in routine reports on the management of the SAC.

Mineral extraction

There are no legal or practical impediments to introducing the measures recommended in Table 6 in relation to oil and gas exploration.

The area around the Darwin Mounds was opened for oil and gas exploration in 2000 in the 19th Licensing Round. A Strategic Environmental Assessment (UK area 4) of the wider area is currently in progress, to include additional field surveys in summer 2002. The DTI can prohibit further oil and gas activity in the area by ensuring that no licences are issued for the relevant blocks. Such a position is also clearly an option under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001, which are specifically concerned with ensuring that the Habitats Directive is applied in offshore areas in relation to oil and gas exploration and production. The Directive authorises the Secretary of State to decide whether any plan, project or aspect of this is likely to have a significant effect on a potential SAC, on its own or in combination with other plans or projects in the area. A licence or consent will only be granted if it is clear that the plan or project would not have an adverse effect, although in exceptional cases this may be allowed if there is overriding public interest.

In terms of a possible industry response to prohibiting oil and gas activity in the area, the recently published UK Offshore Oil and Gas Industry Strategy (UKOOA, 2001) states that "oil and gas reserves are sometimes found in areas of particular environmental sensitivity and it may be concluded that some discoveries cannot be developed". No reserves have been found in the Darwin Mounds area so far, but as the environmental sensitivity of the site is well known, the recommendation from this report is that the option of no exploration or development of oil and gas in blocks 164/9 & 164/10 should be formalised.

Exploratory drilling is taking place to the north of the Darwin Mounds in Faroese waters. On the UK Continental Shelf the nearest operational fields are Schiehallion and Foinaven. These fields have oil spill contingency plans, as well as oceanographic and meteorological data on the local prevailing conditions. The recommendation for an additional alert mechanism for any spills that have a likelihood of reaching the area of the Darwin Mounds in three or fewer days would be straightforward to incorporate. This action would clearly be most relevant to seabirds and cetaceans that frequent the area and is designed to ensure that proper consideration and necessary action is taken to minimise risk to the wildlife. Similar measures have been introduced as an early warning system in other parts of the world where MPAs are near oil and gas fields.

The Strategic Environmental Assessment for this area notes that "in view of the sensitivities … specific controls of seismic survey and production noise, and activities in the vicinity of the Darwin Mounds, are recommended under existing mechanisms". Guidelines to reduce disturbance to cetaceans are being followed for SEA4, which is work in progress. Given the recommendation in Table 6 that there should be no exploration and production in the Darwin Mounds SAC, it is consistent to introduce a parallel ban on seismic exploration in the same licence blocks once this survey work is complete. This has been done elsewhere for specific locations such as The Gully in Nova Scotia, Canada, and for large regions, as recommended by the scientific committee of the International Whaling Commission to protect grey whales in the Russian Arctic.

Shipping

The MARPOL Convention, administered by the International Maritime Organisation, deals with the prevention of pollution from ships. In the UK the various requirements are made legally binding through the Merchant Shipping Regulations. These regulations include specifying items that may or may not be dumped overboard in four zones, defined by their distance from the coast. In the case of the Darwin Mounds, the relevant zone is that which lies more than 25 nautical miles from any coastline. The regulations prohibit the disposal of plastics and oily wastes. And although there are no restrictions on the disposal of food wastes in these areas, it is considered that the disposal of any wastes would be inconsistent with high standards that should operate in an MPA.

The IMO is developing a new convention on the transfer of non-indigenous organisms via ballast water with voluntary guidelines recommended in the interim. Some countries already have national regulations concerning ballast water exchange. In Canada and the US, for example, this includes a requirement for ballast water exchange at sea in waters more than 2,000m deep. Taking a similar approach for the Darwin Mounds, which lie in water depths of 900-1,100m, it is recommended that ballast water exchange should not take place in the area.

Waste disposal

There are no proposals to use the surface waters, the water column, or the deep sea around the Darwin Mounds for waste disposal. The most relevant regulations to be considered if these were to become an option are UNCLOS, MARPOL, LDC & OSPAR with their supporting regulations in UK law. Waste disposal is considered to be inconsistent with high standards that should operate in a marine protected area and therefore the recommendation is for such activity to prohibited within the SAC.

Renewab/e energy

At present, there are no specific proposals for renewable energy generation on the UK Continental Shelf but outside territorial waters. Such activity would presumably have to be licensed in a similar way to oil and gas operations. As it is not possible to predict the precise technology that may be used if such operations become viable, a presumption against such activity in the Darwin Mounds area has been recommended. As with oil and gas, decisions to use offshore areas in this way will need to be viewed in the context of a Strategic Environmental Assessment and consideration of the specific potential effects of the proposal. There are no legal or practical limitations to applying such a recommendation.

Telecommunications

Laying cables is part of the freedom of the seas. Coastal states can introduce a procedure to approve the route on the Continental Shelf and EEZ, but they cannot impede the laying or maintenance of cables and pipelines. The principal controls are at the landfalls, where consents will be required. The International Cable Protection Committee promotes the safeguarding of submarine telecommunications against man-made and natural hazards. It also serves as a forum for the exchange of information on cable protection methods and programmes, and should therefore be informed of any proposals for offshore SACs.

The ideal arrangement would be to prohibit cable-laying in the Darwin Mounds area. However, given its status as an internationally recognised “freedom of the seas”, this is not possible at present. The recommendation is therefore to require an EIA for any proposals that include routes entering the SAC and a presumption against any cable laying in the core zone.

Scientific research

There is no official code of practice for scientific research in the area, although a research coordination network and common data pool exists within AFEN, ACES and Ecomound. Where possible, non-destruction sampling methods have been proposed to monitor the site (Table 5). It is recommended that this approach, together with a requirement to carry out investigations of proposed sampling sites (e.g. using ROVs or video surveys), should be undertaken to ensure that all sampling is targeted and avoids the most sensitive areas.

TABLE 7.Activities guide/zoning scheme for a Darwin Mounds SAC

ACTIVITY	UKCS	Proposed SAC	Core zone
Navigation			
SHIPPING	Yes	Yes	Yes
RECREATION			
Boating	Yes	Yes	Yes
PLACEMENT OF STRUCTURES			
Cables	Yes	Subject to EIA	Presumption against
Pipelines	Authorise	Authorise	No
FISHERIES			
Semi-pelagic trawling	Yes	Observer scheme	No
Long-lining	Yes	Observer scheme	No
Deepwater trawling	Yes	No	No
RESEARCH			
Study	Yes	Code	Code
Collection/bioprospecting	Yes	No	No
Seismic survey	Guideline	No	No
WASTE DISPOSAL			
Garbage	Yes	Presumption against	Presumption against
Ballast water	Yes	Presumption against	Presumption against
Sewage sludge/other	Yes	No	No
Munitions	Yes	No	No
Offshore installations	Licence	No	No
Plastics	No	No	No
Oily wastes	No	No	No
MINERAL EXTRACTION			
Aggregate	Licence	No	No
Oil and gas	Licence	No	No

The term “presumption against” is used in situations where international law, and custom and practice, does not allow for a prohibition at the present time. The table is therefore consistent with what is currently possible.

10 Research and monitoring

The Darwin Mounds are currently a prime study site of the EU-funded ACES and ECOMOUND programmes. These, together with other national initiatives (e.g. SOC research cruise in 2000), will yield a good general understanding of the Darwin Mounds environment. This research addresses both the general ecology of deep-water coral ecosystems and specifics of coral biology. An obvious outstanding issue is the impact of deep-water trawling on coral ecosystems and the wider deep-sea environment. The seabed impact of trawling is evident throughout the deep-sea area surrounding the UK, yet worldwide there is very little or no research to provide an objective assessment of the environmental effects of deep-water trawling. A recent attempt to obtain research funding (the TRIDENT project, led by University Gent) from the EU failed, despite general sympathy towards the project from within the Commission. Given the potentially competing goals of the Common Fisheries Policy and the Habitats Directive, there is a clear need for study of deep-water trawling impacts at the European level.

10.1 MONITORING THE DARWIN MOUNDS

A clear priority for any monitoring of the Darwin Mounds site is that it does not destroy, or at the very least causes minimal damage to, the fauna and seabed features (e.g. xenophyophores and coral). This should immediately rule out the use of any bottom-towed samplers or instruments, and would be a natural extension of the prohibition of commercial demersal trawling. Remote observation techniques (sidescan sonar and seabed photography and/or video) should be sufficient to establish the general health of the Darwin Mounds area.

Assessing the status of macro- and meio-benthos populations would, however, require direct sampling of the seabed environment. In developing a management strategy for the Darwin Mounds, it will be necessary to decide how “significant” these populations of the smaller benthos are, and what frequency and intensity of direct seabed sampling would be appropriate. Potential components of a more routine remote monitoring survey could include:

- medium frequency (e.g. 30kHz) broad area sidescan sonar survey to monitor general disposition of mounds, tails and pockmarks;
- high frequency (e.g. 100 / 400 kHz) localised sidescan sonar surveys to assess coral distribution on mounds and whether there is any evidence of seabed disturbance (e.g. trawling); and
- off-bottom towed camera surveys to census the health of megabenthos populations (e.g. corals and associated fauna on mounds, xenophyophores on tails, and the background sediment fauna generally).

The technology for these forms of survey is readily available, and may shortly be possible using autonomous underwater vehicles (e.g. UK AUTOSUB, Norwegian HUGIN, Icelandic GAVIA). At present these vehicles are operated from a support ship, but it is likely that in the not too distant future, AUV surveys could be mounted from shore stations or the AUV left “garaged” on-site between surveys.

PART III: THE DOGGER BANK

11 Description of the Dogger Bank area

11.1 INTRODUCTION

The Dogger Bank is a large and isolated positive topographic feature located in the central North Sea, ~100km off England's north-east coast (54-56^{o}N; 1-5^{o}E) and marks a division between the southern and central North Sea (Figure 14). This elongate sandbank (aligned ENE to WSW) is a moraine which extends 324km, has a maximum width of 120km (Pantin *et al*., 1991) and covers an area of 17,610 sq km. At its shallowest point in the south-west, it is less than 20m deep, standing >18m higher than the surrounding seabed (Stride, 1959).

FIGURE 14. Location map indicating area of subsequent Dogger Bank charts (B. Bett).

11.2 SEDIMENTS

Sand is the predominant sediment type in the central North Sea region. On the Dogger Bank itself, extensive areas of gravely sand and small patches of sandy gravel and gravel are present. During a DTI Strategic Environmental Assessment in 2001, samples were taken from the Dogger Bank. They consisted of mixed sediments, pebbles and shell fragments with sparse encrusting epifauna – typical of much of the Dogger Bank. (Figure 15). From some sites, a medium sand substratum prevailed. (BGS, 2001).

FIGURE 15. Seabed photograph from Dogger Bank area

(DTI, 2001)

These coarse sediments are probably the result of intensified wave action in the shallower waters. The Dogger Bank is largely composed of a core of glacial and glaciomarine sediments built up during the Devensian, and possibly deposited along the eastern edge of an ice sheet located in the western North Sea (Stride, 1959; Pantin 1991). The core of the bank is mantled by a layer of Holocene sand, ranging from ~ 1m thickness near the summit of the bank to 10m or more around the flanks (Pantin *et al*. 1991). As the sea level rose, the Dogger Bank became an island and was probably not completely covered by water until ~7,500 years ago. The presence of freshwater and salt marsh peat beds and clays containing intertidal molluscs are evidence of former coastal environments around the margins of the bank at this time (BGS, 2001).

11.3 HYDRODYNAMICS

The hydrographic regime over the Dogger Bank is complex. This is a function of Atlantic water from the north meeting the residual currents from the Straits of Dover to the south (Bohnecke, 1922) (Figure 16). Tidal current velocities over the bank are reduced, owing to the partial reflection of the tidal wave and frictional dissipation (Pantin *et al*., 1991). Eddies are likely to be formed, adding to the reduction of current velocity and increasing sedimentation over the bank (Kroncke & Knust 1995). Most of the water column remains mixed all year round.

FIGURE 16. North Sea currents (adapted from DTI, SEA2)

11.4 BIOLOGY

The benthic fauna (including macrobenthic infauna and epifauna and meiofauna) of the North Sea have been studied in some detail (e.g. Dyer *et al*., 1983; Frauenheim *et al.*, 1989; Huys *et al*., 1990; Kunitser *et al.*, 1992). Broad-scale species distribution patterns are evident from these studies and reflect general environmental differences within the North Sea in terms of temperature, water masses, depth, sediment and food supply. The Dogger Bank is a prominent transition point in terms of organism distribution, with considerable differences between species and community structures north and south of the bank (Kunitzer *et al.*, 1992).

The ecology of the Dogger Bank itself has been extensively investigated during the 20th century, and Kroncke & Knust (1995) concluded that this area is a unique ecological region, unlike any other in the North Sea. It is unusual in that high levels of phytoplankton production occur all year round (Brockmann & Wegner, 1985; Richardson & Olsen, 1987; Brockmann *et al.*, 1990) as a function of water column mixing. This seems to have a direct effect on the benthos (macrofauna), as they display little seasonality. The stomach contents and condition of dab also exhibit a correlation with the phytoplankton abundance (Kroncke & Knust, 1995).

Samples taken from the Dogger Bank in 2001 indicate a richer (more and larger animals of a range of species) fauna on the bank than that found on more southerly sandbanks (DTI, 2001).

Among those organisms retained on a 5mm sieve mesh, there were no major differences observed between the various stations sampled across the Dogger Bank. The dominant megafauna were the heart urchin, *Echinocardium cordatum*, the bivalve *Fabulina fabula* (Figure 17) and a range of larger polychaete worms including the "sand masons", *Lanice conchilega* and *Owenia fusiformis*. Bivalves species which dominated samples taken in the 1980s and included *Donax vittatus* and *Nucula tenuis* in the shallow parts and *N.tenuis*, *N.nitida* and *Thyasira flexuosa* in deeper areas

FIGURE 17. a) Fabulina fabula; b) Echinocardium cordatum

a)

(b)

photos from Azores University)

These results closely resemble previous studies of the area. Nevertheless, changes in the macrobenthos were noted on the Dogger Bank between the early 1950s and late 1980s. Species number was shown to have increased along with an increasing dominance of short-lived opportunistic species such as polychaete worms. In contrast, a decrease was found in the abundance of long-lived bivalves such as *Ensis ensis* and *Spisula subtruncata*. The total biomass of the fauna in the 1980s was up to eight times higher than that recorded in the 1950s (Kroencke, 1992). These changes in macrofauna composition likely reflect an increased anthropogenic input of organic material to the region (Kroncke & Knust, 1995). Looking further back, an analysis of long-term data set of changes between the early 1920s and late 1980s suggests no differences in community composition on the Dogger Bank (Frid *et al.*, 2000). Given the high level of fishing activity in the area, it has been suggested that impacts had already occurred.

In terms of water quality compared with the central North sea region, elevated levels of particle-associated heavy metals have been reported in the vicinity of the Dogger Bank (Delbeke & Joiris, 1987; Schmidt & Dicke, 1988). There has been much debate as to the source of these metals. A recent mesocosm study suggests that sediments from the Dogger Bank are a source of bioavailable metals and provide a partial geochemical explanation of these observations (Langston *et al*., 1999). In contrast to these studies, Chapman (1992) reported that Dogger Bank sediments were not polluted. Major reductions in the mean concentrations of dissolved cadmium and lead were observed in waters over the Dogger Bank between 1982 and 1990 (Scholten *et al*., 1998). Elevated dissolved and suspended particulate Pb concentrations in the Dogger Bank region are tentatively attributed to atmospheric inputs, and reduced removal by the lower concentrations of suspended particulate matter at these stations (Laslett, 1995).

Some commercially important species of demersal and pelagic fish have spawning grounds around the Dogger Banks. These include mackerel, herring, cod, whiting, plaice, sole, sand eels and sprat. Fisheries statistics of UK landings show a decline in the relative importance of skates and rays since the 1970s. This is consistent with the trend for catches of these species throughout the North Sea (Purdom & Garrod, 1970).

A ship-based survey in the North Sea in May 1994 showed that mass feedings of gannets, white-beaked dolphins *Lagenorhynchus albirostris* and white-sided dolphins *L. acutus* occurred at the Dogger Bank (Camphuysen *et al*., 1995). During the course of a more recent investigation of seabird and marine mammal feeding behaviour, large numbers of the northern fulmar, *Fulmarus glacialis* were observed over the Dogger Bank, as were black-legged kittiwake, *Risa tridactyla*, northern gannet, *Morus bassanus*, white-beaked dolphin *Lagenorhynchus albirostris* and harbour porpoise *Phocoena phocoena* (Camphuysen, 2001).

12 Human activities and related issues of concern

12.1 FISHING

The North Sea is one of the world's most important fishing grounds and the Dogger Bank was one of the great fishing grounds in the 19th and early 20th centuries. An assessment of the fishery on the Dogger Bank since 1950 reported that the relative importance of this area within the North Sea as a whole has increased for the English North Sea fishery for cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and plaice (*Pleuronectes platessa*), and for total demersal species. There is little trend for sole (*Solea solea*), and for skates and rays the importance of the Dogger Bank has declined (Purdom & Garrod, 1990). These trends are commented upon in the context of the impact of possible contamination of sediments in the vicinity of the Dogger Bank. A number of workers have found poor conditions of dab (*Limanda limanda*) in the vicinity of the Dogger Bank (Dethlefsen *et al*., 1987; Claussen, 1988; Büther, 1988; Dethlefsen, 1989; Knust, 1987; 1990a;b).

Information regarding the state of fisheries on the Dogger Bank itself is limited. However, within the central North Sea region as classified by DEFRA (which includes the Dogger Bank Region)[1], landings by the UK fleet in 2000 for the most abundant fish were:

Demersal	Quantity (tonnes)
Plaice	18,358
Haddock	6,628
Cod	6,613
Sand eels	5,978
Whiting	3,184
Lemon sole	2,124
Dab	1,482
Pelagic	
Herring	1,660

[1]www.defra.gov.uk/fish/fishstat/uksfs00.pdf

The main North Sea roundfish stocks are those for cod, haddock and whiting. Total landings of all these species have declined since a high point of the 1970s and 1980s when stocks were boosted by good year classes. Since then, the spawning stock biomass (SSB) has been declining. The cod stocks in the North Sea reached a historic low in 2000, with a high risk of stock collapse. Plaice landings have also declined steeply since 1990 as a function of an increased fishing rate and a long-term decline in the Spawning Stock Biomass[1]. At present, the highest fishing effort in the Dogger Bank region is that of the International effort from North Sea beam trawlers (www.oilandgas.org.uk/issues/fisheries/index.htm). Studies suggest that beam trawls are among the most damaging gears to benthic communities with fragile, long-lived, slow moving and/or sedentary species most vulnerable. The sediment structure may also change from coarse to fine-grained (Lindeboom & de Groot, 1988, Kaiser & Spencer,

1996, Fonteyne, 2000). The severity of the effects will be greatest in less dynamic areas where there is least natural disturbance (e.g. Elliot *et al.* 1998)

12.2 OIL AND GAS EXPLORATION

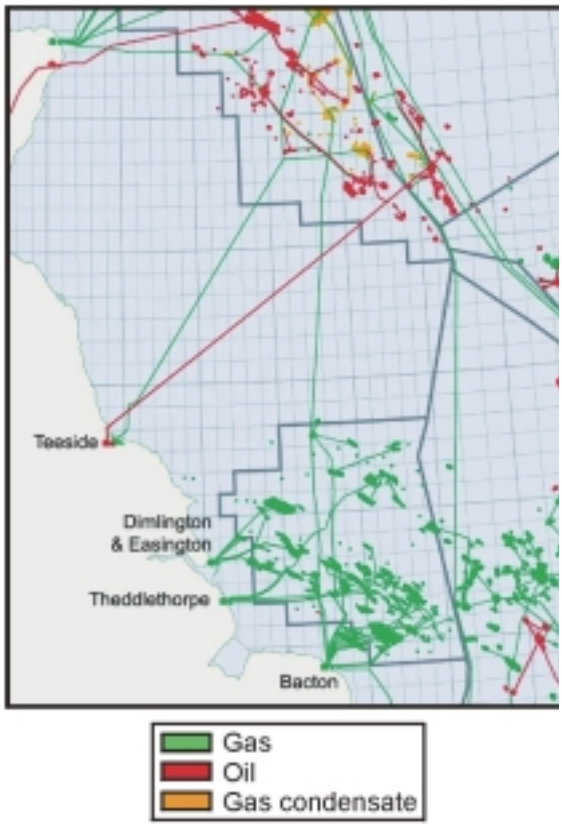
Oil and gas fields have been discovered on both the northern and southern extremities of the Dogger Bank, and oil and gas pipelines extend across central and northern regions. More gas pipelines are either planned or under construction (OSPAR, 2000). Biological impacts from drilling waste and cuttings discharge have been shown to influence benthic communities up to 5km from drilling sites. Some further development of the central North Sea area is anticipated through the 20th Round licensing process. The current DTI Strategic Environmental Assessment of this area (SEA2) estimates the discovery of two new fields that are likely to be developed by linkage to existing fields and/or infrastructure (DTI, 2001).

12.3 OTHER ACTIVITIES

In marked contrast to the Darwin Mounds area, the Dogger Bank and central North Sea more generally are subject to very considerable human impact. To a greater or lesser degree, it is likely that there has been human impact in the area for hundreds, if not thousands, of years. Given this history of exploitation, it is probably fair to say that at present, the central North Sea is not in a "natural state".

The North Sea has some of the busiest shipping lanes in the world. Although not as busy as the southern North Sea, routes through the central region may have a traffic of up to 10 commercial vessels a day, in addition to fishing fleet operations (DTI, 2001). Existing legislation not withstanding, issues of potential concern include spills and discharges of oil and other substances, rubbish disposal, acoustic disturbance and the introduction of non-indigenous species via ballast water discharge. Given that this area is characterised by shallow, well-mixed waters, these concerns relate to sea surface, water column and seabed environments.

FIGURE 18. Oil and gas fields and pipelines in the central North Sea (adapted from DTI, 2001).



In addition to oil and gas pipelines and associated seabed installations (Figure 18), two subsea communications cables cross the Dogger Bank area (Kingfisher Chart, 2001). Although their presence may be generally innocuous, their initial installation and any subsequent maintenance may cause significant local physical disturbance to the seabed and influence sedimentation patterns over a wider area. The continuing growth in international telecommunications suggests the possibility of future demands for additional cable laying across the central North Sea.

There is growing interest in the development of renewable energy sources, including offshore wind farms and other concepts. At present none of the proposed schemes appears to encroach on the Dogger Bank area (DTI, 2001). Such structures, whether seabed installed or anchored, are likely to have a significant physical impact on the local seabed environment and produce long-term modifications to the hydrodynamic regime and sedimentation patterns of the wider environment.

In addition to actual and potential impacts in the Dogger Bank area itself, a number of far field impacts may also give cause for concern. There are a number of licensed waste disposal sites (dredge spoil, industrial waste and previously sewage sludge) in the North Sea. These sites are in coastal waters, but their use may nevertheless influence the distribution of contaminants and the transport of sediments to more distant sea areas. Similarly, licensed marine aggregate extraction in coastal areas may also impact on the natural supply of sediments to more distant waters. In addition to these direct marine impacts, airborne, riverine and other terrestrial run-off sources of potential pollutants are thought to be of significant concern (e.g. OSPAR, 2000). This concern is for both toxic materials (e.g. metals and organic compounds) and for those organic substances (e.g. nutrients) that may result in excess eutrophication of the marine system.

13 Management scheme area

13.1 POTENTIAL SITE BOUNDARIES

Deciding on the most suitable boundary for an MPA is always difficult, since areas occupied by the habitats or species that are to benefit are rarely sharply defined or coincident. The normal approach is to include the most important zone for those species and habitats, and some of the surrounding area, to help take account of the gradation of habitats and communities and to act as a buffer. Practical considerations are also important, since users and regulators need to identify the boundary on location.

A further complication, in the case of a potential Dogger Bank SAC, revolves around the definition of a sublittoral sandbank under the Habitats Directive. The *Interpretation Manual of European Union Habitats* (EC, 1995) defines sandbanks as permanently submerged features, vegetated or non-vegetated, that occur where the water depth is seldom more than 20m below Chart Datum. The UK interpretation, at present being re-examined with a view to checking its applicability to offshore areas, gives further information on the substratum, topography and size of potential sandbank SACs (Table 8). In practice, the 30m, 35m and 40m depth contours have all been used in the literature to delineate the extent of the Dogger Bank (e.g. BGS, 2001; Eisma, 1990: Kronke, 1992).

The EU definition and UK interpretation raise two main issues – depth and sediment type – to be addressed when deciding on whether some or all of the Dogger Bank would qualify as a sandbank SAC. A related issue, which affects decisions about the boundary of any SAC on the Bank, is the geographic area that would need to be within any SAC to ensure that "the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future" (i.e. part of the definition of favourable conservation status which is sought for *Natura 2000* sites as given in Article 1 of the Directive).

TABLE 8. Working interpretation of sandbanks used by the UK (JNCC, 2001)

Habitat type (97/62/EC)	**Sandbanks which are slightly covered by sea water all the time**
EC interpretation (EC 1999)	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*. Plants: *Zostera marina*, free-living species of the *Corallinaceae* family. In the Baltic Sea also *Potamogeton pectinatus*, *Ruppia cirrhosa* and *Tolypella nidifica*. Around Tenerife, *Halophila decipiens* communities. Animals: Important wintering habitat for many bird species, in particular *Melanitta nigra* but also *Gavia stellata* and *Gavia arctica*. Resting places for seals. Invertebrate communities of sandy sublittoral (e.g. polychaetes).

Habitat type (97/62/EC)	**Sandbanks which are slightly covered by sea water all the time**
UK interpretation	
Substratum	This habitat comprises a range of sandy sediments (i.e. predominantly in the size range 0.0625-2mm). In terms of Folk's classification, sandbanks will generally be categorised as sands, muddy sands or gravely sands; they also include some forms of sandy gravels. Free-living *Corallinaceae* (i.e. maerl) are explicitly included in the EC definition. Eelgrass *Zostera marina* beds are also referable to this habitat type.
Height boundary	Chart Datum (Lowest Astronomical Tide may technically be more correct, but is in practice less easy to define on a map).
Depth	Predominantly <20 m in depth (but may include channels or other areas >20 m).
Topography	Topography is variable but includes distinct banks (i.e. elongated, rounded or irregular 'mound' shapes) that may arise from horizontal or sloping plains of sandy sediment. Where the areas of horizontal or sloping sandy habitat are intimately associated with the banks, they are included within the Annex I type.
Size	No lower limit, subject to sandbank being large enough to maintain its structure and function.

The working definition of sublittoral sandbanks being used by the UK suggests that at least part of the Dogger Bank would qualify as a sandbank SAC, given that there are areas shallower than 20m (parts of the "Dogger North Shoal", "South West Patch" and "Easternmost Shoal") and that sediments include muddy sands, sands and gravely sands (ICONA, 1992; Kroncke, 1992; BGS, 2001; Eisma, 1992).

Interpretations of sublittoral sandbanks by the Netherlands and Germany must also be taken into account, especially when considering the structural and functional integrity of any proposed SAC, as the Bank extends into the EEZ of these two countries. The tail of the Dogger Bank lies in the German EEZ 30-40m below Chart Datum. There is no firm view as yet on whether this area is a potential SAC but a report of work carried out for the German Federal Agency for Nature Conservation (BfN, 2001) suggests that the area would qualify as scientific investigations have revealed that it is still within the photic zone. The Netherlands has still to look at the issue of the definition of offshore sandbanks and whether its sector of the Dogger Bank is a potential SAC.

Given these uncertainties, three possible options are proposed for a potential Dogger Bank SAC (Figure 19).

Option 1 – Encloses the main feature of interest and uses an existing management boundary, which is concerned with the principal activity that will need to be managed in the area (i.e. fisheries). This includes the entire area of the Dogger Bank and sea areas under the jurisdiction of the UK, the Netherlands, Germany and Denmark. A straight-line boundary is drawn for ease of description and identification on the ground. (Coordinates 54°30'N 01° 00'E, 54°30'N 01°00'E, 55°30'N 01°00'E, 55°30'N 05°00'E, approximate area 25,190km^2.)

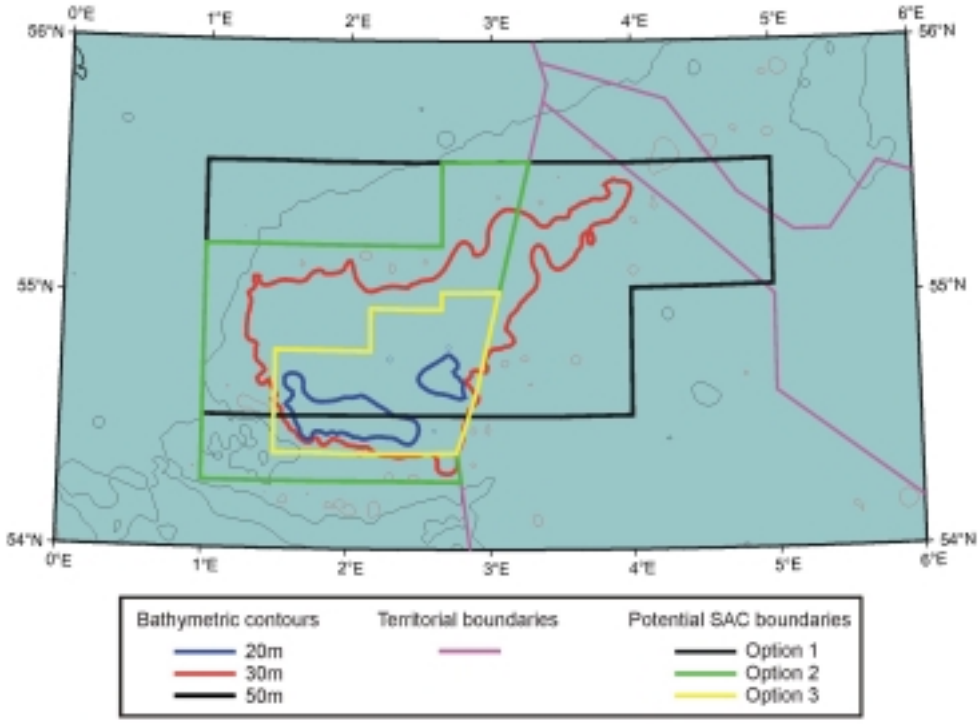
Option 2 – Encloses the main feature of interest, following the 30m depth contour, but limited to the UK Continental Shelf area of the North Sea. A straight-line boundary is drawn for ease of description and identification on the ground, but it has no relationship to any existing management unit that is used in the area. (Coordinates 54°15'N, 2°47' E [on UK median

line], 54°15’N, 1°00’E, 55°10’N, 1°00’E, 55°10’N, 2°40’E, 55°30’N, 2°40’E, 55°30’N, 3°17’E [on UK median line].)

Option 3 – A more tightly drawn boundary around the main feature of interest specified in the Habitats Directive (i.e. sandbank) that is limited to the 20m depth contour. A straight-line boundary is drawn for ease of description and identification on the ground. (Coordinates 54°23’N, 2°46’E [on UK median line], 54°23’N, 1°30’E, 54°45’N, 1°30’E, 54°45’N, 2°10’E, 54°55’N, 2°10’E, 54°55’N, 2°40’E, 54°58’N, 2°40’E, 54°58’N, 3°04’E [on UK median line].)

The outline management scheme presented in Section 15 uses Option 2 as the overall site boundary and Option 3 as a “core zone” within the proposed protected area. Ultimately this will need to be developed into a strategic approach for the Dogger Bank as a whole and therefore include parts that lie outside UK waters.

FIGURE 19. Dogger Bank chart area showing potential SAC boundaries



OPTION 1 - ICES Area IVb blocks 52-55 & 63-65
OPTION 2 – Straight line boundaries enclosing areas less than 30m in UK waters
OPTION 3 – Straight line boundaries enclosing areas less than 20m in UK waters
NB. The bathymetric contours shown may vary from other charts dependant on underlying dataset and the contouring process

13.2 RELEVANT AND COMPETENT AUTHORITIES

Guidance prepared by the nature conservation agencies states that “management schemes should involve the views of all relevant authorities, and where appropriate, competent authorities as well as taking account of the concerns and aspirations of user groups and other interested parties” (SNH *et al.*, 1997). As management schemes have been developed for marine SACs within territorial waters, the various groups and parties fulfilling these roles

have been identified. Table 9 is an initial list of bodies that may have similar roles in a potential Dogger Bank SAC. Drawing up such a list suggests that there is no value in making a distinction between relevant and competent authorities for offshore areas, as it is principally government departments that will need to take action. A clearer approach will be to identify authorities and agencies, international bodies, other governments, user group associations (who will be a link to individual user groups), and other interested parities.

TABLE 9. Examples of organisations likely to play a role in a Dogger Bank SAC

Organisation	Acronym/ initials	Organisation	Acronym/ initials
UK authorities and agencies		**User group associations**	
Centre for Environment Fisheries and Aquacultural Science	CEFAS	British Marine Aggregate Producers Association	BMPA
Crown Estate	CEC	European Community Sea Ports Organisation	ESPO
Department of Environment, Food and Rural Affairs	DEFRA	EUROPECHE	
Department of Trade and Industry	DTI	European Wind Energy Association	EWEA
Department of Transport and Local Regions	DTLR	International Association of Geophysical Contractors	IAGC
English Nature	EN	International Association of Independent Tanker Operators	INTERTANKO
Fisheries Protection Service	FPS	International Cable Protection Committee	ICPC
Joint Nature Conservation Committee	JNCC	International Association of Oil and Gas Producers	OGP
Ministry of Defence	MoD	International Chamber of Shipping	ICS
Scottish Executive?		Local Authorities International Environmental Organisation	KIMO
		National Federation of Fishermen's Organisations	NFFO
International bodies		Scottish Fishermen's Federation	SFF
ASCOBANS Secretariat		UK Offshore Operators Association	UKOOA
Common Wadden Sea Secretariat	CWSS	Wildlife and Countryside Link	WCL
European Commission and its Directorates			
European Environment Agency			
International Council for the Exploration of the Seas	ICES	**Other interested parties**	
International Maritime Organisation	IMO	British Geological Survey	BGS
International Union for the Conservation of Nature	IUCN	Marine Biological Association of the UK	MBA
Oslo and Paris Commission	OSPAR	Sea Mammal Research Unit	SMRU
		Southampton Oceanography Centre	SOC
		Scottish Association for Marine Science	SAMS
National Governments			
EU member states			
Norway			

14 Management scheme framework

14.1 PURPOSE OF THE MANGEMENT SCHEME

The purpose of management schemes for European marine sites is "to ensure that the necessary conservation measures are put in place to avoid deterioration of habitats or the habitats of species, or disturbance to species listed in the Habitats and Birds Directive" (EN *et al.*, 1998). The 1994 Habitats Regulations do not make the preparation of a management scheme compulsory, but state that if required, only one management scheme may be established for each site. Until the UK Offshore Regulations are agreed, it is unclear whether the same approach will be taken for offshore SACs.

In the case of the Dogger Bank we believe that a management scheme, founded in law, is essential to safeguard the nature conservation interests of area. The principal reasons are:

- the marine communities on the Dogger Bank are known to have changed significantly in the last century and at least some of these changes have been linked to human activity. A management scheme would provide a clear, documented commitment to track any further changes, give details of a long-term monitoring strategy and be a public statement of the actions aimed at bringing the site into favourable conservation status;
- the Dogger Bank lies in the waters of the UK, the Netherlands and Germany, and could be designated for protection by some or all of these countries. A management scheme for the area in UK waters would provide a documented starting point for discussion with other countries on how best to manage the entire area as a coherent feature;
- there is uncertainty about the specific mechanisms, and their legal status, that might be used to safeguard the Dogger Bank. Setting out such matters in a management scheme will make it easier for all affected and interested parties to play their part in the management of the site and identify any gaps that require new mechanisms to be introduced;
- a mix of international, regional and national bodies have an interest and various potential roles in the management of the Dogger Bank. Given the lack of experience of managing such sites in the EU, there is much scope for confusion over roles, including who should take the lead on certain issues. A management scheme would assist by including clear statements about requirements and respective roles;
- the actions required to safeguard the conservation interest of the Dogger Bank will need to be communicated widely, clearly and consistently in the UK and abroad. The framework of a management scheme will be invaluable for this task; and
- although the Dogger Bank is not adjacent to any coastline, there are many groups and individuals who have an interest in the area. A published management scheme will provide a clear focus for public discussion about what should happen to the site.

14.2 CONSERVATION OBJECTIVES

The conservation objectives for marine SACs are intended to "help set the standard against which the condition of the site's interest features can be compared to determine whether they are in favourable conditions and whether the management measures taken on the site have been successful" (EN *et al.*, 1998).

Those already in use for inshore SACs follow a consistent pattern in that they focus on the features and sub-features of the site (Table 10), maintain favourable conservation status, and introduce the concept of natural change. While the same approach could be taken for the Dogger Bank, this will not be sufficient for a number of reasons:

(a) The Dogger Bank is not an isolated feature. The majority of the actions required to achieve and maintain conservation status will be broadly based rather than specific to the area within the SAC. Many of the required actions may also need to influence activities taking place within the land borders of countries surrounding the North Sea

(b) It is debatable whether the current conservation status of the Dogger Bank is favourable and therefore an element of "restoration" may be desirable.

(c) The Dogger Bank is a relict feature. Dramatic natural changes have taken place since its formation by inundation following the last ice age. There is no clear and commonly accepted point in recent time to use as a baseline from which future natural change could be measured.

TABLE 10. Habitats Directive features and sub-features of the Dogger Bank

FEATURE	SUB-FEATURE	PHYSICAL COMPONENTS	BIOLOGICAL COMPONENTS
Sandbank	Sand and gravel communities	Sandy moraine comprised of gravely sand, sandy gravel and gravel with shell debris	Dominant megafauna are the heart urchin *Echioncardium cordatum*, the bivalve *Fabulina fabula* and a range of large polychaete worms including the sand mason *Lanice conchilega* and *Owenia fusiformis*
	Fine sand communities	Fine sand with some shell debris	Dominated by opportunistic, short-lived polychaetes (e.g. *Magelona spp., Scolelepis ciliata* and *Chaetozone setosa)*, bivalves and the ophiuroid *Amphiura filiformis*.
	Muddy sand communities	Muddy fine sand	Macrofauna dominated by *Amphiura filiformis*. Other species include *Nucula nitida, N.tenuis, Montacuta bidentata* and *Pholoe minuta*.

Given these issues, the suggested approach is to have conservation objectives to ensure that the Dogger Bank continues to exist as a sandbank feature, to see a positive trend in the condition of the associated sub-features, and to use it as a partial indicator of the health and functioning of the central/southern North Sea.

Subject to natural change, ensure that:

- the environmental and natural processes of the Dogger Bank are maintained; and
- there is an improving trend in the extent, diversity, species richness and distribution of its long-lived species and biological communities

The harbour porpoise (*Phocoena phocena*), which is listed on Annex II of the Habitats Directive, has been observed in the waters around the Dogger Bank. (SMRU, 2001). This needs to be taken into account in any management scheme for the area, even though the presence of this species would not be the principal reason for designating a Dogger Bank SAC.

Issues to be considered when proposing conservation objectives for the sandbank feature are similar to those that arise when deciding on conservation objectives for the harbour porpoise, because it is clear that favourable conservation status of this species cannot be achieved by actions taken within a Dogger Bank SAC alone, or even by site-based measures alone. General issues such as by-catch, water quality, prey availability and natural variability in the environmental conditions of the North Sea all play a part in affecting the status of this wide-ranging species. The UK Biodiversity Action Plan objectives and targets for the harbour porpoise have therefore been used to derive an objective for this species at the Dogger Bank. This will contribute towards achieving favourable conservation status for this species throughout its range in the North Sea.

"Ensure that measures taken at the Dogger Bank make a positive contribution to maintaining the current range and abundance of the harbour porpoise, with a longer term aim of ensuring that no anthropogenic factors inhibit a return to waters that previously held the harbour porpoise and achieving the favourable conservation status of this species".

(text in italics is from the UK Harbour Porpoise BAP, (Anon, 1999)).

15 Management scheme proposals

15.1 ASSESSMENT OF THE POTENTIAL FOR DETERIORATION OR DISTURBANCE

Before deciding on appropriate measures for the management of an SAC, it is necessary to assess whether existing and proposed activities might have a detrimental effect on the features of conservation interest. For inshore SACs this has been termed the "operations advice". Table 11 summarises the sensitivity and vulnerability of the Dogger Bank sandbank and harbour porpoise to deterioration or disturbance.

TABLE 11. Assessment of potential for deterioration or disturbance at the Dogger Bank

OPERATION	Sensitivity and vulnerability to deterioration or disturbance		COMMENT
	SB	HP	
Physical loss Removal Smothering	 **(🕹)** **(🕹)**	 - -	The sandbank is sensitive but not vulnerable to physical loss at the present time. This would change if the area were used for activities such as **aggregate extraction, dredge spoil disposal** or **offshore wind farms** which could result in localised removal and smothering.
Physical damage Siltation Abrasion Selective extraction	 🕹 🕹 🕹	 - - -	The habitat and its associated biological communities are sensitive and vulnerable to siltation, abrasion and selective extraction by **beam and otter trawling** in the area. There is also a potential vulnerability as a result of **construction activity** on the sandbank (e.g. cables, pipelines, oil/gas platforms, offshore windfarms) and **aggregate extraction**, although there are no specific proposals for such activities at the present time.
Non-physical disturbance Noise Visual presence	 - -	 🕹 🕹	There is a considerable amount of **shipping**, and hence noise and visual presence by vessel traffic, in the southern North Sea. While this does not have any implications for the physical habitat of the Dogger Bank (with the exception of the risk of grounding on the shallower parts of the Bank), cetaceans that frequent the area are sensitive and vulnerable to this activity.
Toxic contamination Introduction of synthetic compounds Introduction of non-synthetic compounds Introduction of radionuclides	 🕹 🕹 🕹	 🕹 🕹 🕹	Benthic communities on the Dogger Bank and harbour porpoise that frequent the area are sensitive and vulnerable to toxic contamination. Elevated concentrations of heavy metals (e.g. Zn & Pb) have been reportedly associated with particulate matter at the Dogger Bank in the past, and concentrations of several organocholorine pesticides and PAHs in the sediments are comparable with those of coastal areas. Elevated concentrations of heavy metals (e.g. Pb, Cu & Fe) have also been measured in fish taken in the vicinity of the Dogger Bank, compared with the northern North Sea. Potential sources are **oil and gas production** in the central and southern North Sea, **atmospheric inputs** and the offshore movement of **coastal contaminants**. Concentrations of artificial radionuclides (^{137}Cs) originating mainly from **nuclear reprocessing plants** at Sellafield, Dounreay and Cap de la Hague showed a peak in the central North Sea in the late 1970s.

OPERATION	Sensitivity and vulnerability to deterioration or disturbance		COMMENT
	SB	HP	
Non-toxic contamination			Comparison of macrofaunal communities on the Dogger Bank between the mid- and late 1900s showed higher species numbers, declines in diversity, increase in opportunistic short-lived species, decrease of long-lived bivalves, and increases in biomass. It has been suggested that anthropogenic factors, and in particular eutrophication, may have contributed to these changes. Likely sources of elevated nitrogen and phosphorus are **coastal and riverine discharges, atmospheric inputs** and **oil and gas products** that are known to affect benthos around rigs through nutrient enrichment.
Nutrient enrichment	⚓	?	
Organic enrichment	⚓	?	
Changes in thermal regime	?	?	
Changes in turbidity	⚓	?	
Changes in salinity	?	?	
Biological disturbance			With extensive **shipping** there is a high risk of non-native species being introduced to the southern North Sea.
Introduction of microbial pathogens	?	?	**Fishing** has been an important activity in and around the Dogger Bank for many years and has led to the selective extraction of species. Harbour porpoises are also affected as they are sensitive and vulnerable to being taken as bycatch.
Introduction of non-native species and translocation	⚓	⚓	
Selective extraction of species			

? Lack of information on sensitivity at present
(⚓) Habitat/species is sensitive to the listed activity but not immediately vulnerable
⚓ Habitat/species is sensitive to the listed activity and currently vulnerable
SB Sandbank
HP Harbour porpoise

The outline assessment presented in Table 11 suggests that management action should concentrate on:

- fisheries – an ongoing activity known to have an impact on benthic communities as well as harbour porpoises which can be a by-catch of some fisheries;
- pollution control – because of the known sensitivity and vulnerability of biological communities to toxic and non-toxic contamination;
- oil and gas extraction – an ongoing activity that is known to have at least some localised impact; and
- shipping – because of the considerable amount of vessel traffic in the area, the associated risk of alien species introductions and the sensitivity and vulnerability of cetaceans to noise and visual presence from this activity.

The assessment also points to construction and aggregate extraction as potential activities of concern and therefore those for which it would be desirable to propose management actions at the outset.

15.2 MEASURES AND TARGETS TO ACHIEVE FAVOURABLE CONSERVATION STATUS

A report on indications of good practice for establishing management schemes (EN *et al*, 2001) makes the point that "in order to provide a standard that can be monitored, the attributes that define condition must each have a target value representing favourable condition". There is also a recognition of the need to take account of natural processes as well as human impacts, and to accept that current understanding may make it impossible to set numerical targets and ranges. In the case of the Dogger Bank (and probably other offshore areas where the same situation arises), the points made earlier about seeking a positive direction in terms of status rather than a specific end-point, at least to start with, and the potential to use the habitat as part of a programme of monitoring broader issues concerned with the health of the central and southern North Sea, mean that a more general approach might be more appropriate.

The suggested measures and targets in Table 12 are predominantly influenced by actions taking place on the Dogger Bank itself. Others such as water quality, sediment quality, fish health and the extent and abundance of harbour porpoise (Table 13) will be influenced by factors that operate more widely in the North Sea as a whole and beyond. Such measures should be considered if the opportunity is taken to use SACs, such as the Dogger Bank, for wider benefits.

TABLE 12. Measures and targets for a Dogger Bank SAC

Feature	Attribute	Measure	Targets (subject to natural change)	Information status
SANDBANK	Extent	Area of sandbank	Maintain overall extent	Available
	Topography	Depth distribution of the sandbank	No significant deviation from baseline? (linked to extent and definition)	Available
	Sediment character	Sediment particle size distribution	Statistical parameters (e.g. mean, median, sorting coefficient etc) should not deviate substantially from established baseline	Available
	Sand and gravel, fine sand, and muddy sand biotopes	Distribution, extent and species composition of characteristic range of biotopes	An increase in extent and abundance of long-lived species and overall community diversity might be expected (this is an area of potential uncertainty)	Species lists available. Link to biotope classification required

TABLE 13. Potential measures and targets using the Dogger Bank SAC as part of a wider programme of monitoring ecosystem health in the central and southern North Sea

Feature	*Attribute*	*Measure*	*Targets (subject to natural change)*
Sandbank	Sediment quality	Concentrations of zinc and lead in sediment cores	Continued decreasing trend?
	Water quality	Concentrations of dissolved cadmium and lead	Continued decreasing trend?
	Phytoplankton production	Chlorophyll-a in surface waters (annual pattern and concentration?)	No significant deviation from established baseline?
	Fish health	Externally visible diseases and liver abnormalities in dab (*Limanda limanda*)	Decreasing trend?
	Ecosystem function	Sand eel/seabird breeding success	Breeding success of seabirds at Flamborough Head?
Harbour porpoise	Extent and abundance	Sightings (and associated modelling of density distribution)	No reduction in range and abundance (over x year periods)?

15.3 MANAGEMENT PROPOSALS

Tables 14 & 15 summarise illustrative management proposals for a Dogger Bank SAC that are focused on the area of the Dogger Bank itself. A comprehensive management scheme will also need to include measures, such as those concerned with pollution control, that must be applied more widely. Figure 20 shows the proposed boundary and a "core zone".

FIGURE 20: Proposed boundary and core zone for a Dogger Bank SAC

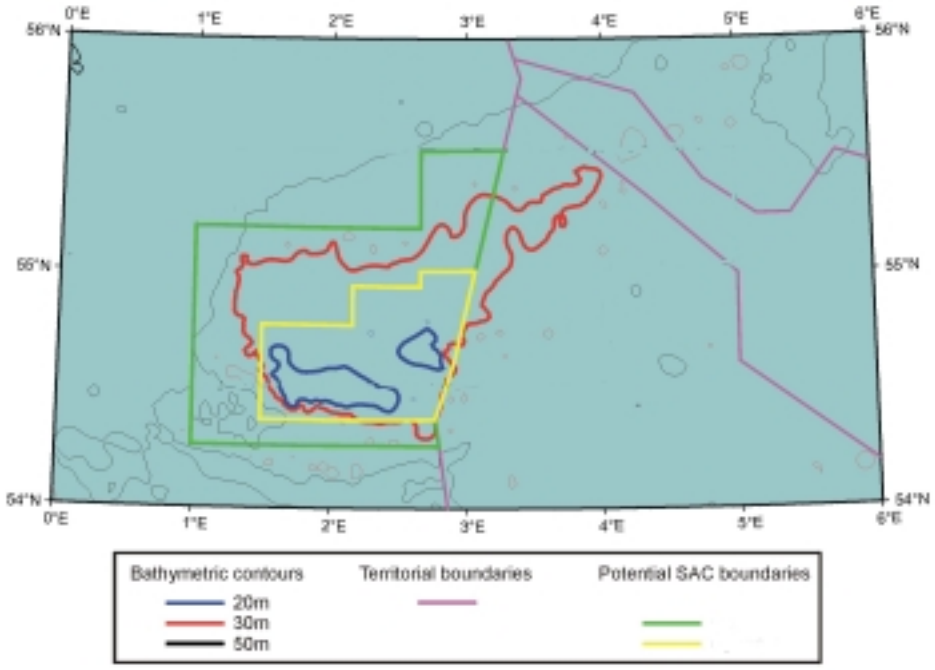


TABLE 14. Illustrative management proposals for a Dogger Bank SAC

Activity	Proposed Management Action	Relevant bodies	Existing mechanisms available for use
Fisheries	• Limits on beam trawling and otter trawling in a trial area identified as being subject to least fishing effort at the present time • Routine patrol vessel allocated to area for enforcement purposes • Collation of data on effort and landings specifically for the SAC	EC/UK DEFRA/ SERAD/RN ICES/CEFAS	Regulation through CFP Policy decision on deployment priorities Standard practice
Oil and gas	• Strategic Environmental Assessment for exploration and production in the region • No oil and gas exploration and production structures in the core zone • Guidelines for seismic operations	DTI DTI DTI/Operators	SEA Directive Licence condition Existing guidelines
Shipping	• Prohibition on the dumping of wastes • Presumption against ballast water exchange	IMO DTLR?	MARPOL Merchant Shipping Regulations
Waste disposal	• A presumption against use of site for waste disposal	IMO, LDC, OSPARCOM	UNCLOS, MARPOL, OSPAR
Renewable energy	• A presumption against use of the site for renewable energy generation structures	DTI?	Continental Shelf Act?
Tele-communications	• A presumption against laying of cables within the core zone and subject to EIA if elsewhere in the SAC	Coastal State, ICPC, UKCPC	UNCLOS
Scientific research	• Research coordination network and common data pool.	Research institutes	Voluntary

TABLE 15. Illustrative activities guide/zoning scheme for activities taking place within a Dogger Bank SAC

ACTIVITY	UKCS (N. Sea)	Proposed SAC	Core zone
Navigation			
SHIPPING	Yes	Yes	Yes
RECREATION			
Boating	Yes	Yes	Yes
PLACEMENT OF STRUCTURES			
Cables	Yes	Yes	Presumption against
Windfarms	Licence/SEA	Licence/SEA	No
Pipelines	Authorise	Authorise	No
FISHERIES			
Gill nets	EC Regs	Observer scheme	Observer scheme
Otter trawl	EC Regs	EC Regs	No in trial area
Seines	EC Regs	EC Regs	No in trial area
Beam trawl	EC Regs	EC Regs	No in trial area
RESEARCH			
Survey	Yes	Code	Code
WASTE DISPOSAL			
Ballast water exchange	Yes	Presumption against	Presumption against
Munitions	Yes	No	No
Dredge spoil	Yes	No	No
Sewage sludge	No	No	No
Plastics	No	No	No
Rubbish	No	No	No
Oily wastes	No	No	No
MINERAL EXTRACTION			
Oil and gas structures	Licence/SEA	Licence/SEA	No
Aggregate	Licence	No	No

The term “presumption against” is used in situations where international law, custom and practice does not allow for a prohibition at present. The table is therefore consistent with what is currently possible.

15.3.1 Fisheries

The recommendations for fisheries management are intended to facilitate recovery of benthic communities and establish undisturbed areas in at least part of the Dogger Bank by using some of the SAC as an experimental restoration site. This is consistent with the Habitat Directive, which has the restoration of the natural habitats and populations of species listed on the various Annexes as one of its purposes (Article 1). An experimental restoration site could be kept as small as practically possible (but large enough to monitor), so there is minimal disruption to fisheries or potential knock-on effects of increased fishing effort in the

surrounding area. One approach would be to choose from areas with the lowest fishing effort at present, preferably in shallower parts of the Dogger Bank. For example, surveillance data from the late 1990s indicated that fishing effort by beam trawls and otter trawls was probably least intensive in Dogger Bank areas such as the South West patch and Easternmost Shoal (Jennings *et al*., 2000). These areas also correspond to the shallower parts of the Dogger Bank and therefore waters less than 20m. After checking with more up to date surveillance and returns data, and consulting with relevant fishermen's organisations, it should be possible to identify and propose such an area.

There have been long-running discussions about the possibility of establishing experimental closed areas in the North Sea. The North Sea Ministerial Conferences have supported the idea and ICES have looked at possible suitable locations. The reasons for establishing such areas include making a contribution to the management of commercial fisheries (although clearly not the only mechanism, nor one that is necessarily appropriate for all species), marine wildlife conservation – particularly for less mobile species – habitat conservation, and as a tool to improve understanding of the functioning of marine systems. Studies on the effects of beam trawling in shallow, dynamic areas, such as the shallower parts of the Dogger Bank, suggest that the recovery of trawled areas will usually occur in less than a year. However, this presupposes that the resulting communities are typical of undisturbed shallow sandbanks in the North Sea, even though there have been no long-term studies to determine whether longer-lived and/or more vulnerable species will re-colonise these areas if they are left undisturbed for 10, 20 or even 50 years. Given the view that the impact on the Dogger Bank benthic communities may have occurred before the 1920s, present short-term studies are unlikely to give a complete picture of the potential for restoration of these areas.

A related issue concerns the establishment of undisturbed areas in the marine environment to act as reference areas/control sites against which to determine natural variation and trends, effects of human activities, support research, and secure the conservation of biodiversity. Such areas will need to encompass the full spectrum of habitat types in the North Sea, from shallow, highly dynamic areas to deep, sheltered habitats. The proposed experimental restoration area in the shallow part of the North Sea should be seen as a long-term measure that will contribute to all these aims. The proposals to select detailed site boundaries working with fishermen's organisations, and in areas where there is already minimal trawling activity, will be critical to their success.

There is no legal impediment to establishing an experimental restoration site as long as it is non-discriminatory and has the support of EU member states. The difficulties are more likely to be in the implementation. This can be overcome if concerted effort is put into explaining the reasons for such an initiative, working with fishermen's organisations to select a suitable area, and seeking to minimise disruption to fishing patterns. Good dissemination of information, enforcement of any regulations that are agreed, monitoring outcomes and activities in the area and feedback to interested parties will also be essential.

The scale of any harbour porpoise by-catch associated with gill netting in the area is unknown. In the short term it is recommended that an observer scheme be introduced to determine the likely scale of this issue in the proposed SAC. In the longer term, an appropriate set of technical measures to eliminate cetacean by-catch should be a requirement on all gill netting, regardless of whether they are operating inside or outside the marine protected area.

Issues concerning observer schemes, enforcement, monitoring, and data collection in relation to fisheries have already been discussed in Section 9.3.1. with reference to the Darwin Mounds.

15.3.2 Mineral extraction

There are no legal or practical impediments to introducing the measures recommended in Table 15 in relation to oil and gas exploration.

Gas production takes place on the southern margin of the Dogger Bank and a number of associated pipelines cross the central and southern parts of the Bank. A 20th Round of offshore licensing may include mature basins in the North Sea, including part of the southern margins of the Dogger Bank: a Strategic Environmental Assessment has been published for the area. The proposal to prohibit the placing of structures on the Dogger Bank is entirely within the power of the DTI and does not preclude extraction from any reserves that may be found in the area, given existing technologies that allow drilling and extraction some distance from reservoirs.

The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 are specifically concerned with ensuring that the Habitats Directive is applied in offshore areas in relation to oil and gas exploration and production. They state that the Secretary of State will decide on whether any plan or project is likely to have a significant effect on a potential SAC, on its own or in combination with other plans or projects in the area. A licence or consent will only be granted if it is clear that the plan or project would not have an adverse effect on the integrity of the site, although in exceptional cases this may be allowed if overriding public interest is involved.

15.3.3 Shipping

The MARPOL Convention, administered by the International Maritime Organisation, deals with the prevention of pollution from ships. In the UK the various requirements are made legally binding through the Merchant Shipping Regulations. The North Sea has been defined as a “Special Area” which prohibits the dumping and disposal of any wastes overboard within 12 miles of the coast, and no wastes except food wastes beyond 12 miles. Even though there are no restrictions on the disposal of food wastes in these areas, any such disposal would be inconsistent with the high standards that should operate in an MPA.

The IMO is developing a new convention on the transfer of non-indigenous organisms via ballast water, with voluntary guidelines recommended in the interim. Some countries already have national regulations concerning ballast water exchange, and introductions of non-indigenous species (e.g. the North American razor clam, *Ensis directus*) have been attributed to ships’ ballast water in the North Sea. At this stage, one of the ideas being considered is for coastal states, either singly or collectively, to specify ballast water treatment requirements within designated ballast water management areas. Given the intensity of shipping in the North Sea, it may be appropriate for this to become one such area and WWF is calling on ministers attending the Fifth North Sea Conference to take national and regional actions to reduce the risk of species introductions as soon as possible.

15.3.4 Waste disposal

The legal position regarding waste disposal at sea is covered by UNCLOS, MARPOL, LDC and OSPAR, with their supporting regulations in UK law. There are no proposals to use the sea or seabed of the Dogger Bank for waste disposal. The dumping of sewage sludge has been banned since 1999 while the dumping of dredge spoil (some of which may be contaminated and which requires a licence under the Food and Environment Protection Act), takes place closer inshore. Waste disposal is considered to be inconsistent with the high standards that should operate in a marine protected area and therefore the recommendation is for such activity to be prohibited within the SAC.

15.3.5 Renewable energy

There are no specific proposals for renewable energy generation on the Dogger Bank at present. Such activity would presumably have to be licensed in a similar way to oil and gas operations. As with oil and gas, decisions to use offshore areas in this way will need to be viewed in the context of a Strategic Environmental Assessment and consideration of the specific potential effects of the proposal. Given the localised effects of placing physical structures on the sandbank, it is recommended that the core zone of the proposed SAC is kept free of such structures. There are no legal or practical limitations to applying such a recommendation.

15.3.6 Telecommunications

Cable-laying is part of the freedom of the seas. Coastal states can introduce a procedure to approve the route on the Continental Shelf and EEZ, but they cannot impede the laying or maintenance of cables and pipelines. The principal controls are at the landfalls, where consents will be required. The International Cable Protection Committee promotes the safeguarding of submarine telecommunications against man-made and natural hazards. It also serves as a forum for the exchange of information on cable protection methods and programmes, and should therefore be informed of any proposals for offshore SACs.

The ideal arrangement would be to prohibit the laying of any additional cables across the Dogger Bank – but because such activity is an internationally recognised freedom of the seas, this is not possible at present. The proposal is therefore to require an EIA for any proposals that include routes entering the SAC, and a presumption against any cable laying in the core zone.

16 Research and monitoring

The North Sea, including its flora and fauna, is probably one of the most thoroughly researched coastal sea areas in the world. A multinational research effort has been directed towards North Sea studies for over a century and has provided very extensive coverage of the area as a whole. With this knowledge, it might be argued that the need for further fundamental study is not pressing. However, the extensive fisheries that have always paralleled this research effort confound any assessment of the "natural state" of the North Sea – so it is impossible to establish what the baseline condition should be. An effective conservation effort in the North Sea is therefore likely to produce a change in the current state of the environment. Conservation measures, at least initially, are likely to "restore" rather than "preserve" the features of interest. It is this restoration phase that will pose a significant challenge in respect of monitoring whether management measures are working. The planning and conduct of an effective monitoring programme is likely to require additional research effort and will have to consider an area of the North Sea substantially larger than any prospective SAC.

Any monitoring programme must take some account of how the environment may change in response to natural variations; taken alone, this may be a significant exercise. However, when taken in concert with the likelihood of a "restoration effect", the problem may be considerably more complex. The experimental fisheries exclusion area proposed above provides a practical example. The effect of fisheries exclusion can only be gauged against an appropriate control area. This must be fished, but must otherwise be identical in environmental character to the fisheries exclusion area. This level of control is always difficult to achieve in the natural environment and demands a significant commitment to the monitoring of a broad range of environmental factors. The latter is necessary to establish that an appropriate level of "control" has been achieved and, therefore, that the fished to non-fished comparison is valid. This is only the first of numerous difficulties that will have to be overcome if an effective monitoring scheme is to be designed: how large should exclusion and control areas be? How should they be co-located? What outcome parameters (e.g. biological) should be monitored, and how?

Monitoring geological conservation targets (extent, topography and sediment characteristics) can be carried out largely with non-destructive acoustic remote sensing techniques (e.g. swath bathymetry, sidescan sonar etc). As noted in the Darwin Mounds section above, such systems are readily available and easily deployed from a range of survey vessels – for example, the SOC AUTOSUB vehicle recently carried out a detailed topographic survey of a North Sea sandbank. Similarly, the larger members of the benthos (megabenthos) and demersal fish can be monitored in a non-destructive fashion using existing photographic or other optical techniques. The smaller members of the benthos (macrobenthos) that have provided the backbone for the vast majority of North Sea benthic research and monitoring initiatives to date are, however, rather more problematic. This group can only be monitored effectively by direct sampling of the seabed. Consequently, any intensive and/or long-term monitoring of the macrobenthos might risk introducing an additional impact on the environment through the volume of sampling undertaken. This might be avoided by using only the megabenthos (and demersal fish) as the biological monitoring target. Alternatively, macrobenthos sampling might be replaced by the use of a still smaller (physically) group of the benthos (meiobenthos), thereby reducing the degree of physical impact on the seabed resulting from

any sampling programme. Meiobenthos research studies in the North Sea date from at least the 1960s, in more recent decades have frequently been proposed as useful monitoring tools, and indeed have been taken up as such by some UK authorities (e.g. CEFAS).

Monitoring is an essential component of any environmental management plan. A Dogger Bank SAC monitoring programme will require very careful design and planning, probably involving new research, might consider some new approaches (e.g. meiobenthos) and must undoubtedly involve international collaboration.

PART FOUR: ISSUES CONCERNING THE MANAGEMENT OF OFFSHORE AREAS

17 Main issues raised by the case studies

The case studies used in this report to explore options and possibilities for the management of offshore areas as SACs have been valuable in highlighting issues that need to be addressed. The key points to emerge are discussed below.

17.1 THE KNOWLEDGE BASE

There is already a body of information about the biological, physical and chemical environment of the UK Continental Shelf, and the activities taking place offshore. This is the starting point for identifying potential SACs and considering appropriate management measures. However, two aspects of our knowledge base are particularly problematic – the dispersed nature of the information available, and the depth of knowledge.

Useful information about the offshore environment can be found in universities, research institutes, commercial organisations, and those responsible for the management of particular activities. Data are generally collected with a specific project or management action in mind rather than to build a broader picture of the offshore environment. This is likely to change with the instigation of the Strategic Environmental Assessment process, as demonstrated by the work of the Atlantic Frontier Environment Network, which included the area of the Darwin Mounds, and the SEA for North Sea oil and gas (SEA2), which included part of the Dogger Bank. This needs to be encouraged. Specific projects to collate this information with offshore SACs in mind, such as that being undertaken by JNCC, will reveal the scale of the task and will start to build this broader picture. This should also be encouraged as an ongoing process, rather than a one-off exercise, and a repository for the information identified to facilitate and support the offshore SAC programme.

The second issue concerns the depth of our knowledge and understanding of the offshore environment. While much descriptive information is available, it is not comprehensive and is unlikely to be as detailed as that available for inshore areas. It is also the case that less is known about the processes that drive these systems, what constitutes “natural change” or “favourable conservation status”, and the actions that will achieve desired management outcomes. It will be the norm, therefore, rather than the exception, to work with uncertainty when selecting sites, and considering management options. This needs to be acknowledged as an acceptable way forward.

17.2 DRAWING BOUNDARIES

The difficulties of drawing of boundaries around offshore SACs are the same as those for inshore areas, although obviously with the additional fact that there will be no possibility of using coastal landmarks as part of the process. The approach taken for the Darwin Mounds and the Dogger Bank has been to start with the obvious management boundaries used in those areas (i.e. those concerned with fisheries), and consider how well they fit with the extent of

the feature of interest. Given the greater uncertainties of dealing with offshore areas, it was considered inappropriate to propose site boundaries that are a precise fit with our current knowledge of the extent of these features. In the case of the Darwin Mounds, for example, this would require boundaries around each of the many mounds. In the case of the Dogger Bank, it would not allow for the fact that sandbanks rarely have sharply defined boundaries and may change, quite naturally, with prevailing conditions. The idea of a "core zone" is proposed in both these cases to ensure that management actions are well focused without losing the flexibility of incorporating the whole system within the protected areas and working with some uncertainty.

The definition of offshore habitats is also relevant when deciding on suitable boundaries for potential SACs, yet it is clear that the current definitions have been drawn up with inshore habitats in mind. The Dogger Bank case study illustrates this well. The definition of sandbanks suggests that only shallower parts of the feature might qualify, yet the management actions must ensure that that the specific structure and functions which are necessary for its long-term maintenance exist. It is clear that further detail is required on the habitats, listed in the Directive, that occur in offshore areas. This work could be done through the Habitats Committee of the Environment Directorate of the European Commission and incorporated into an updated EU Interpretation Manual.

Although the Habitats Directive is to be implemented out to the "200nm limit" or full extent of the EEZ, deep-water habitats (only *Lophelia* reefs) are minimally or perhaps only accidentally represented. Recent years have seen a rapid expansion of the fishing, oil and gas industries in Europe's deep-water territory and elsewhere, bringing with it a demonstrable threat to species and habitats not listed in the Directive. It may therefore be prudent to consider a broader set of deep-water habitats from the outset, on the assumption that the Habitats Directive (or other measures, e.g. OSPAR) will be expanded in future. Other deep-water habitats, present in UK or wider European waters, that might be considered include hydrothermal vents, seamounts, cold seeps and pockmarks, gas hydrates and submarine canyons (see Baker *et al.*, 2001).

17.3 RELEVANT AND COMPETENT AUTHORITIES

The case studies show that the emphasis being placed on identifying competent authorities for management purposes, as is done for inshore SACs, is inappropriate for offshore sites. Beyond territorial waters the only competent authorities that can take decisions and implement management actions are government departments. At the same time there is the essential need to liaise with other governments and international organisations. Government departments are the most appropriate bodies to carry out this task, although there is also a role for the European Commission in acting as a link or facilitator to ensure a good consultation and information exchange when drawing up management schemes for offshore SACs. There is likely to be a need for fisheries controls in any offshore SAC. This could usefully be acknowledged in any future revisions to the EU Habitats Directive and Common Fisheries Policy.

17.4 MANAGEMENT SCHEMES

The remoteness of potential offshore SACs from land does not rule out the need for them to be covered by management schemes. If anything, such schemes are even more necessary because of the uncertainties about how to manage these sites, about who should do what, and the fact that it will be essential to communicate widely about proposed management measures. The two case studies also show that there is no shortage of activities that need to be considered when trying to achieve conservation objectives for the sites. This is in fact more likely to be the case than situations where pristine sites, with no threats from human activities, can be left alone on the assumption that they will remain in favourable condition.

The framing of conservation objectives will involve the same process as that for inshore areas. But it is worth pointing out that even in offshore areas, it cannot be assumed that sites have favourable conservation status at the outset. This is particularly well illustrated in the case of the Dogger Bank.

Both case studies make management recommendations that will help achieve the conservation objectives and status for the potential SACs. The three areas that get most attention are fisheries, mineral extraction and waste disposal, although recommendations are also made in relation to other aspects such as shipping, and the placement of structures. With the exception of controls on cable-laying and certain categories of waste disposal, there appears to be a sufficient legal framework and existing mechanisms to support their introduction. What is less clear is whether the practical arrangements to make them effective can be introduced. This is particularly relevant when it comes to issues of enforcement, as there may be no legal impediment to the introduction of a particular measure, but great difficulty with putting it into practice.

The subject of enforcement of regulations and management proposals in offshore areas is probably the issue discussed most frequently, but until measures that require action to be taken are introduced, it will be difficult to judge what extra might be needed. There is certainly scope for extending current measures (e.g. national fisheries protection functions could be expanded to fisheries and habitats), and for further development or introduction of new technologies (e.g. satellite tracking of fishing vessels and the use of satellite telemetered data from autonomous *in situ* sensors).

17.5 RESEARCH AND MONITORING

Although there is certainly sufficient knowledge of the Darwin Mounds and the Dogger Bank to identify them as potential SACs and to start drawing up management plans, this is not true for the UKCS (full EEZ) as a whole. As noted above, the offshore survey and research promoted by the Atlantic Frontier Environmental Network and the DTI has rapidly addressed this lack of knowledge. Work to date has focused strongly on areas of immediate interest to oil and gas concerns; however, there are already plans to extend this activity to other areas, via the DTI's Strategic Environmental Assessment process. Consequently, the UK will be well placed to consider the development of offshore SACs in an integrated and comprehensive fashion. This approach should be encouraged and promoted among other European countries.

Recent research has shown that even very remote deep-sea locations can be subject to major large-scale changes as a result of natural variations (e.g. Billett *et al.,* 2001). Knowledge of

such natural variations is essential to any monitoring activity associated with an offshore SAC. Long-term environmental monitoring programmes are generally very rare in offshore/deep-sea locations and are costly and logistically complex undertakings. Therefore, it may be excessively prohibitive to expect or demand long-term monitoring of natural change at all potential offshore SACs. Even so, it may be reasonable to suggest that such long-term commitments be undertaken at a limited number of locations that span the major marine provinces of interest. For example, existing programmes address the hydrography of the Rockall Trough (joint venture of the Scottish Association for Marine Science and the Southampton Oceanography Centre) and Faroe-Shetland Channel (Fisheries Research Service, Aberdeen), the two main deep-water provinces of the UK's Atlantic Margin. Such programmes could be expanded to include biological and seabed monitoring. An "infant" seabed monitoring programme exists on the West Shetland Slope (the West of Shetland Transect), developed from the AFEN and DTI studies and recently offered additional support by the Natural Environment Research Council. Because of the need for long-term commitment, these activities are difficult to fund from conventional research sources, so they should be encouraged and supported where possible.

18 Conclusions

The Habitats Directive and the Birds Directive have opened up the possibility of giving legal protection to offshore areas of nature conservation importance. However, all aspects, from the identification of possible sites to making suggestions for management action, are at a very early stage. One way to ensure that the process moves forward, and that the end results are meaningful and effective, is to look at the specifics of what might be required at particular locations. The case studies used in this report have therefore been valuable in identifying the requirements and likely difficulties of establishing SACs at the Darwin Mounds and the Dogger Bank.

The first issue concerns our knowledge base when working in the offshore environment. Large tracts of the UK's deep-water EEZ remain largely unknown at present, although they are likely to be addressed by the continuing SEA process. It is also the case that less is known about the processes that drive these systems, what constitutes "natural change" or "favourable conservation status", and the actions that will achieve desired management outcomes. It will be the norm, therefore, rather than the exception, to work with uncertainty when selecting sites and considering management options. This needs to be acknowledged as an acceptable way forward.

A related issue is that offshore study and monitoring is costly and logistically complex. Integration with existing activities (fisheries protection, research studies, and even oil production vessels) would mitigate some of the cost, while use of novel technologies (satellite telemetered *in situ* sensor data, the use of autonomous vehicles etc) would assist with current logistic problems. This points to the need for a more strategic approach to studying and monitoring in the offshore environment that would not only make best use of what is done, but also ensure that the UK fulfils its obligations under national, European and international law.

A further issue concerns shortcomings in the Directive, particularly in relation to the habitats and species identified as the focus for conservation action. The inadequacy of the relevant Annexes for offshore areas has been recognised, although the European Commission has indicated that there are unlikely to be revisions until at least the first tranche of SACs has been given protection. However, this does not preclude preparatory work on the issue. The EUNIS classification (under development for the European Environment Agency) has started to address deep-sea habitats, and the EU Interpretation Manual could be extended to deal with such issues.

The outline management schemes for the Darwin Mounds and the Dogger Bank suggest that there are no legal constraints to introducing most measures that might be desirable for offshore SACs (although cables and some aspects of waste disposal are two exceptions). They also confirm that they are widely scattered among many provisions, both national and international. It is therefore essential that the proposed UK Offshore Regulations bring together the requirements for all sectors working offshore (including oil and gas, which currently has separate regulations regarding the implementation of the Habitats Directive offshore) to provide a coherent overall framework for action on *Natura 2000* sites in UK waters.

The practical arrangements to ensure that offshore SACs are effective are likely to be the most difficult problem to address. Much of this may be down to it being a relatively new requirement, but lessons should be learnt from the enforcement of fisheries regulations in particular. Enforcement in the offshore environment should not be seen as the task of one sector working on its own to a very narrow remit. It is essential to clarify where responsibility lies for enforcement of the measures that may be introduced for offshore SACs – but, at the same time, there is every reason to take advantage of the variety of enforcement systems used by many sectors working offshore.

Finally, one of the most significant factors in the success of offshore SACs is likely to be international cooperation and coordination. This will not only be necessary at governmental level but also between the different sectors working offshore. The European Commission has a central role to play in this, not only in overseeing implementation of the Directive but also by facilitating joint working of the numerous national and international bodies that need to be involved. This is essential as we move from nature conservation programmes that operate in areas where national provisions dominate, to those where national and international regimes coincide to a much greater extent.

There can be little doubt that the designation of SACs in offshore areas will be challenging. The UN Law of the Sea Convention already makes it clear that nations have responsibilities outside their territorial waters, and that these include nature conservation. The specific requirements introduced in the Habitats Directive and the Birds Directive are examples of measures that will help take this forward in the EEZs of EU member states. The designation of SACs has therefore become an international and a national responsibility, as well as being a progressive step for nature conservation in the offshore environment.

The outline management schemes for the Darwin Mounds and the Dogger Bank presented in this report show what can be done. They also reveal that time is not on our side. Remote places, wildlife in the deep sea, and highly dynamic features have already been impacted by human activity. Offshore SACs should be part of a serious and urgent attempt to reverse this trend that starts today.

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