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and of Wild Fauna and Flora
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Second Report by the United Kingdom under Article 17

on the implementation of the Directive from January 2001 to December 2006

Conservation status assessment for :

H1180: Submarine structures made by leaking gases

Please note that this is a section of the report. For the complete report visit http://www.jncc.gov.uk/article17

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H1180 Submarine structures made by leaking gases

Audit trail compiled and edited by JNCC and the UK Inter-Agency Marine Monitoring Group

This paper and accompanying appendices contain background information and data used to complete the standard EC reporting form (Annex D), following the methodology outlined in the commission document "Assessment, monitoring and reporting under Article 17 of the Habitats Directive, Explanatory Notes and Guidelines, Final Draft 5; October 2006". The superscript numbers below cross-reference to the headings in the corresponding Annex D reporting form. This supporting information should be read in conjunction with the UK approach for habitats (see 'Assessing Conservation Status: UK Approach').

1. National-biogeographic Level Information

1.1 General description and correspondence with National Vegetation Classification (NVC) and other habitat types

Table 1.1.1 provides a summary description of H1180 and its relations with UK classifications.

Submarine structures consist of sandstone slabs, pavements, and pillars up to 4 m high, formed by aggregation of carbonate cement resulting from microbial oxidation of gas emissions, mainly methane. The formations are interspersed with gas vents that intermittently release gas. The methane most likely originates from the microbial decomposition of fossil plant materials (Jackson and McLeod 2000, 2002). The structures are created through a process of precipitation (attributed to the oxidation of methane) whereby the carbonate cements the normal seabed sediment, forming rock-like concretions of 'Methane-Derived Authigenic Carbonate (MDAC) (Judd 2001).

The first sub-type of submarine structures is known as a "bubbling reef". A variety of sublittoral topographic features are included in this habitat such as: overhangs, vertical pillars and stratified leaf-like structures with numerous caves. The second type is carbonate structures within "pockmarks". Pockmarks are depressions in soft sediment seabed areas, up to 45 m deep and a few hundred meters wide. Not all pockmarks are formed by the expulsion of shallow gas deposits and of those formed by leaking gases; many do not contain substantial carbonate structures and are therefore not included in this feature. The associated benthic communities consist of invertebrate specialists of hard marine substrata and are different from the surrounding (usually) muddy habitat. The diversity of the infauna community in the muddy slope surrounding the pockmark may also be high (European Commission 2006).

'Submarine structures made by leaking gases' have a restricted distribution in European waters due, in part, to their relationship to sources of shallow gas, which occur in the North Sea, a small portion of the Irish Sea and part of the Mediterranean Sea. Within UK waters, this habitat is mainly (but not exclusively) associated with large pockmarks commonly found in the Fladen and Witch Grounds in the northern North Sea as well as part of the Irish Sea (Jackson and McLeod 2000, 2002). Only a proportion of the pockmarks have been examined in detail for presence of the feature. Two of the three pockmarks closely investigated in a recent site survey contained excellent examples of this Annex I habitat (Judd 2001).

It is known that natural gas seeps are not confined to pockmarks, and occurrences of these carbonates in sediments not suitable for pockmark formation are known in the North Sea and elsewhere (Judd, 2005). Small, low-lying reefs of MDAC have been found in the shallow water (<10 m) of Cardigan Bay in North Wales and have been surveyed in detail by Countryside Council for Wales (CCW) (Irving *et al.* 2006).

Table 1.1.1 Summary description of habitat H1180 and its relations with UK vegetation/habitat classifications

Classification	Correspondence with Annex I type	Comments
EU Interpretation Manual	= H1180	The habitat description was updated from the original in the document 'DOC.HAB. 06-09/03'. Description of habitat above taken from this document.
NVC	Not applicable	
BAP priority habitat type	Not applicable	

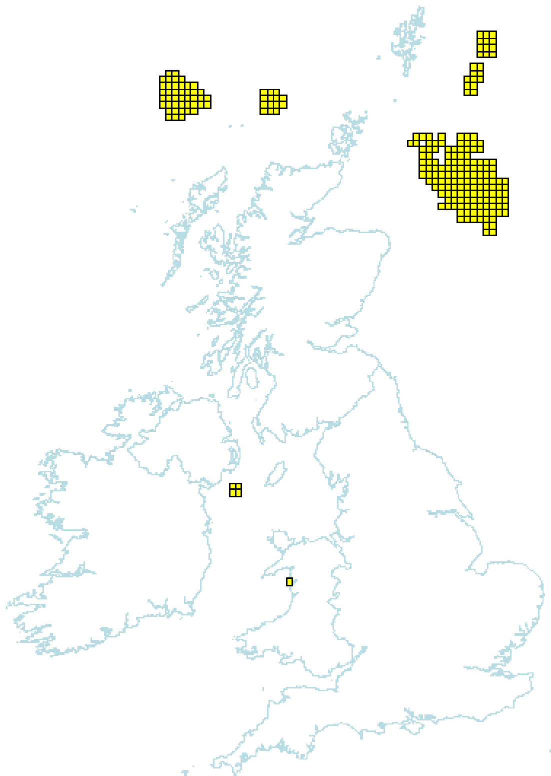
2. Range [2.3]

2.1 Current range

Range surface area[2.3.1]: **13,188 km^2**
Date calculated[2.3.2]: **May 2007**
Quality of data [2.3.3]: **Poor**

Range surface area was calculated within a Geographical Information System (GIS) environment by mapping known areas of Irish Sea MDAC (taken from CCW (R. Holt *pers comm*.), Strategic Environmental Assessment 6 Survey (Judd 2005)) and British Geological Survey maps of fluid seep areas (Graham *et al.* 2001); the above estimate was therefore "based on partial data with some extrapolation".

The resulting distribution is displayed in Map 2.1.1 on an adapted Ordnance Survey 10-km grid which had been expanded to the north and west, in order that the smallest occurrences can be seen. Due to the practical difficulties in detecting MDAC remotely, we do not know the true range of this feature (Judd 2001). Therefore Map 2.1.1 only represents areas that have the potential for the feature to occur.

Map 2.1.1 Habitat range map [1.1] for H1180	**Map 2.1.2** Habitat distribution map [1.2] for H1180
	As Map 2.1.1
This map is based on an extended OS 10-km square grid map. As the grid has been extended North and West it has been distorted due to the projection. The map should therefore be taken as indicative only.	

2.2 Trend in range since c.1994

Trend in range: **Unknown**
Trend magnitude: **Not applicable**
Trend period: **1994-2006**
Reasons for reported trend: **Unknown**
There are no trend data for this feature.

2.3 Favourable reference range

Favourable reference range[2.5.1]: **Unknown**
MDAC will only form where there is leakage of methane. Where the sediment is not suitable, there may be no morphological feature as evidence of fluid escape (Judd, 2001). Therefore 'submarine structures made by leaking gases' will only be found where both conditions are met and then only at some of those sites. Within UK waters, this habitat is mainly (but not exclusively) associated with large pockmarks formed through the expulsion of shallow gas. Pockmarks are widespread in the North Sea, but there is little evidence of MDAC.

Since the range of the feature is dependent on geological processes rather than ecological processes, and these are unlikely to be affected by anthropogenic activities (even if individual examples of the feature have been impacted), the actual range is likely to be equivialnt to the favourable reference range. However, in the absence of both a true range estimate (Map 1.2.1 represents potential range only) and trend data, it is not appropriate to report a favourable reference range estimate at this time.

2.4 Conclusions on range

Conclusion[2.6.i]: **Unknown**
There are insufficient data on the feature to judge this – the true range of the feature is unknown and there are no trend data from which to gauge any change in its distribution.

3. Area [2.4]

3.1 Current area

Total UK extent [2.4.1]: **Unknown**
Date of estimation [2.4.2]: **May 2007**
Method [2.4.3]: **Not applicable**
Quality of data [2.4.4]: **Poor**
As can be seen from Table 3.1.1, there are no area estimates for this feature at the country or UK level. Therefore, data quality can only be considered poor for the purpose of this assessment.

Table 3.1.1 Area of H1180 in the UK

	Area (ha)	Method [2.4.3]	Quality of data [2.4.4]
England	Unknown	Not applicable	Not applicable
Scotland	Unknown	Not applicable	Not applicable
Wales	Unknown	Not applicable	Not applicable
Northern Ireland	Unknown	Not applicable	Not applicable
Total UK extent [2.4.1]	Unknown	Not applicable	Poor

Method used to estimate the habitat surface area: 1 = only or mostly based on expert opinion; 2 = based on remote sensing data; 3 = ground based survey. Only the most relevant class is given if more than one applies.
Quality of habitat surface area data: 'Good' e.g. based on extensive surveys; 'Moderate' e.g. based on partial data with some extrapolation; 'Poor' e.g. based on very incomplete data or on expert judgement

Although a total area extent figure is unavailable for this feature, evidence from known occurrences shows that the extent of each is very small. Present information suggests that this habitat probably covers less than 1,000 ha. As such, this habitat may be considered rare (JNCC 2006a).

The feature is often a small part of a larger physiographic feature (i.e. pockmarks). While the area of pockmarks and leaking gases can be estimated there is no reliable estimate for the area of submarine structures themselves and each individual occurrence is smaller than the area covered by the pockmark. For example at the Braemar site, the pockmarks cover a range of sizes from those with diameters between 5 and 10 m and a maximum depth of 0.5 m; to larger (less prevalent) pockmarks with a diameter of between 50 and 130 m and a maximum depth of approximately 5 m. Only a proportion of the pockmarks have been examined in detail for presence of this feature and two of the three pockmarks closely investigated in a recent site survey contained examples of the feature (Hartley 2005 cited in JNCC 2006a and b).

Shallow MDAC structures in Wales at Holden's Reef have been estimated to cover between 0.3 ha (a combination of direct measurement underwater, multibeam and sidescan survey (Irving *et al.* 2006)) and 1 ha (Judd 2005), while other reefs in Cardigan Bay probably cover less than 10 ha (Irving *et al.* 2006).

Due to the significant logistical problems of surveying this feature it is likely to remain the case that we have no reliable figures for its true area.

3.2 Trend in area since c.1994

Trend in area: **Unknown**
Trend magnitude: **Not applicable**
Trend period: **1994-2006**
Reasons for reported trend: **Unknown**
There are no historical figures for the extent of the feature

3.3 Favourable reference area

Favourable reference area[2.5.2]: **Unknown**
In the absence of a current area estimate and trend data, it is not possible to determine the favourable reference area.

3.4 Conclusions on area covered by habitat [2.6.ii]

Conclusion[2.6.ii]: **Unknown**
There is insufficient information to make a judgement on area. Further, due to logistical problems and the nature of the feature, this situation is not expected to change in the foreseeable future.

4. Specific structures and functions (including typical species)

4.1 Main pressures [2.4.10]

210 Professional fishing
211 fixed location fishing
212 trawling
510 Energy transport
512 pipe lines
700 Pollution
851 modification of marine currents
860 Dumping, depositing of dredged deposits

- Fisheries and Industrial Pressures (210, 211, 212, 510, 512, 700, 851, 860) - See 5.1 below for full description.

4.2 Current condition

Unknown – no monitoring data exist to date for the feature.

4.3 Typical species

Typical species[2.5.3]: **None used**
Typical species assessment[2.5.4]: **Not applicable**

Little is known about the ecology of this feature and many of the species associated with the pockmark sub-type feature are more properly associated with the pockmarks themselves (JNCC 2006 a and b). The following information is provided for context only and has not been transferred to Annex D.

Pockmarks provide a potentially favourable habitat for a variety of deep-water fish species (cod, haddock, wolf-fish and conger eel) presumably through the provision of food and shelter. Pockmarks which have active gas seeps and associated structures may be of ecological significance because of the presence of chemosynthetic organisms (e.g. the pogonophoran worm *Siboglinum fiordicum*) which are a potential food-source for other organisms, in addition, MDAC provides a hard substrate suitable for colonisation by certain benthic organisms (Judd 2001). Benthic communities consist of invertebrate specialists of hard marine substrata and are different from the surrounding (usually) muddy habitat. The diversity of the infauna community in the muddy slope surrounding the pockmark may also be high (European Commission 2006). Sulphide seeping out of the sediment in active pockmarks can support mats of sulphur-oxidising bacteria. Such mats are a good visual guide to the presence of active seepage (Dando and Hovland 1992) and were observed in video data from the Scanner pockmark in the North Sea. Although such mats are normally described as *Beggiatoa* sp. (Hovland and Judd 1988), no positive identification has been made of the mats in North Sea pockmarks. Epifauna on the carbonate structures contrast with that of the surrounding muddy seabed and are characterised by high densities of anemones (*Urticina feline* and *Metridium senile*) (JNCC 2006 a and b). In character Braemar Pockmarks differ from the Scanner Pockmark in that they are smaller and characterised by different species of anemones as well as hydroids (JNCC 2006 a and b). Egg masses of Buccinid gastropods are a frequent occurrence on the carbonate-cemented rocks (JNCC 2006 a and b).

Bubbling reefs: These formations support a zonation of diverse benthic communities consisting of algae and/or invertebrate specialists of hard marine substrates different to that of the surrounding habitat. Animals seeking shelter in the complex structure of the reefs further enhance the biodiversity (European Commission 2006). The shallow water MDAC reefs in Cardigan Bay have a range of species that broadly reflect the range typical of other slightly sand-scoured rocky reefs in the area. They also include large numbers of cryptic species, especially crustaceans and territorial fish that make use of the open matrix of carbonate 'nodules'. The top of the reef supports dense stands of filamentous and foliose red and brown algae (Irving *et al.* 2006).

4.4 Conclusions on specific structures and functions (including typical species)

Conclusion[2.6.iii]: **Unknown**

Little is known about the ecology of the feature. Most of the above information relates to the surrounding pockmarks rather than the hard structures themselves. Therefore, it is not possible to comment on the current status of structures or functions.

In regard to typical species, there are no surveillance data relating to trends in any of the species listed above. It is therefore not possible to assess the status of 'Typical Species' for this feature.

5. Future prospects

5.1 Main factors affecting the habitat

5.1.1 Conservation measures

The features are all currently outside the Special Area of Conservation (SAC) suite and do not have conservation measures in place at present. Scanner and Braemar Pockmarks are Draft SACs (dSACs).

The prospects of this feature in terms of maintaining its condition in light of anthropogenic influences are mixed. Although regulations are in place to regulate oil and gas activity around SACs in the UK Continental Shelf Designated Area (JNCC 2006a and b) and a mechanism is available through the European Commission to modify fishing activity in the sensitive areas if this is deemed to be necessary, there is still a risk to non-identified sites, particularly shallow inshore sites.

5.1.2 Main future threats[2.4.11]

The most obvious major future threats to H1180 are listed below. These are also referred to in Section 4.1.

210 Professional fishing
211 fixed location fishing
212 trawling
510 Energy transport
512 pipe lines
700 Pollution
851 modification of marine currents
860 Dumping, depositing of dredged deposits
990 Other Natural Processes

- Fisheries and Industrial Pressures (210, 211, 212, 510, 512, 700, 851, 860)

Fishing activities are the most widespread source of anthropogenic physical disturbance of benthic communities of Northern Europe and represent the most significant human activity causing change in the UK's marine environment (de Groot and Lindeboom 1994; Lafolley and Tasker 2004). Of the six "Class A - Priority Human Pressures" identified by OSPAR, fisheries account for three (OSPAR 2000). The effects of fisheries include (Laffoley and Tasker 2004):

(i) Removal of target species (including genetic effects) – given the size of most fish stocks the fishing pressure exerted upon them is outside safe biological limits.
(ii) Mortality of non-target species.
(iii) Physical disturbance of the seabed.
(iv) Shifts in community structure.
(v) Indirect effects on the food web.

There is also evidence indicating that over-fishing is often a precondition for eutrophication, disease outbreaks, or species introductions (Jackson *et al*. 2001). The combined effect of all these impacts is to reduce the overall stability of marine ecosystems (Royal Commission on Environmental Pollution 2004). It is often difficult to establish direct relationships between specific fisheries activities and ecological effects as many ecosystem properties and components that are affected directly or indirectly by fishing also show substantial natural variability. In addition, there are many gaps in our knowledge of marine ecological processes and so it is not always possible to establish clear links between ecological change and environmental or anthropogenic factors.

The biological and physical structure of the habitat in the Braemar pockmarks are known to have been partially impacted by bottom trawling which has dispersed, fragmented and possibly buried some of the carbonate formations; trawling may also have modified the structure of the encircling pockmarks (Hartley *pers. comm.*). However, much of the interest feature is still intact (JNCC 2006a). The Braemar Pockmarks site is located in an area currently licensed for oil and gas exploration and is in close proximity to an existing oil field (JNCC 2006a). The area is also actively trawled for *Nephrops norvegicus* (which are known to burrow into sediments covering some of the carbonate structures) and whitefish (Fisheries Research Service (FRS) 2006 cited in JNCC 2006a). There is also evidence that fishing for pelagic species occurs in the vicinity of this site (FRS 2006 cited in JNCC 2006a). However, most fisheries information in offshore waters is reported at a coarse statistical rectangle level, and therefore can only indicate general activity within the area in question and this limits the certainty with which exposure to fishing activities at the Braemar Pockmarks site can be assessed (JNCC 2006a).

The carbonate structures which comprise this feature are vulnerable to mechanical disturbance from human activities that could result in the smothering or, in more open areas, the removal of the structures altogether (JNCC 2006a and b). Activities which may result directly or indirectly in the deterioration or disturbance of the feature include the following:

(i) Physical damage by abrasion (e.g. cable/pipeline laying); The Holden's reef example is subject to fishing with pots and possibly vulnerable to towed benthic gear. The nodular structure of the reef itself is fairly delicate and breaks if impacted. The CCW marine monitoring team have seen newly broken rock on the site, possibly from lobster pots being moved (Irving *et al*. 2006).
(ii) Pollution by introduction of synthetic and/or non-synthetic compounds (e.g. hydrocarbon extraction).
(iii) Non-toxic effects by changes in turbidity (e.g. plumes from cable/pipeline laying).

- Climate Change (990)

A paucity of oceanographic data prevents a precise estimate of the effects of climate change on the feature. According to the UK Climate Impacts Programme (UKCIP) projections (2002, cited in The Royal Society 2005), sea temperatures in this area may rise by between 0.5-1°C by the 2020s (under low and high emissions scenarios respectively). Increased summer thermal stratification may occur isolating the sea-bed from the full extent of the temperature rise expected at the sea surface. However, the feature may be affected by changes in ocean circulation patterns (JNCC 2006a). Significant changes in ocean acidity are also likely to be felt at this site by the end of this century (The Royal Society 2005).

The biological outcomes of climatic changes are difficult to forecast: specific ecosystem impacts of changes in temperature, salinity, nutrient levels remain unknown, but any change is expected to occur slowly, over a 100 years or so (JNCC 2006a). There is a low risk of rapid shifts in benthic communities because of the stabilising influence of the North Atlantic. Nevertheless, these carbonate structures may be particularly sensitive to ocean acidity change. To make calcareous structures, seawater has to be supersaturated with calcium and carbonate ions to ensure that once formed the calcium carbonate does not dissolve. Lower pH reduces the carbonate saturation of the seawater, making calcification harder and also weakening any structures that have been formed (Stephen Dye, cited in JNCC 2006a; The Royal Society 2005).

5.2 Future condition (as regards range, area covered and specific structures and functions)

5.2.1 Common Standards Monitoring (CSM) condition assessments

There are no CSM data for the feature as none have yet been designated.

5.3 Conclusions on future prospects (as regards range, area covered and specific structures and functions)

Conclusion[2.6.iv]: Unknown

It is unclear what the future prospects of the feature are. Many examples are found in the offshore area and are physically separated from most human pressures due to location (e.g. depth, distance from shore etc.). However, this also means that any possible impacts are difficult to detect. Therefore, although possible pressures can be identified, the impacts cannot be verified.

6. Overall conclusions and judgements on conservation status 2.6

Conclusion[2.6]: **Unknown**

All parameter assessments are Unknown.

Table 6.1 Summary of overall conclusions and judgements

Parameter	Judgement	Grounds for Judgement	Confidence in Judgement*
Range	Unknown	The data coverage is not sufficient to make a judgement at a national level. The true range of the feature is unknown and there are no trend data from which to gauge any change in its distribution.	3
Area covered by habitat type within range	Unknown	The data coverage is not sufficient to make a judgement at a national level. No trend data area is available for this feature and the favourable reference area is unknown.	3
Specific structures and functions (including typical species)	Unknown	The data coverage is not sufficient to make a judgement at a national level. Little is known about the ecology of the feature. Most of the above information relates to the surrounding pockmarks rather than the hard structures themselves. It is not possible to comment on the current status of structures or functions. In regard to typical species, there are no surveillance data relating to trends in any of the species listed above. It is therefore not possible to assess the status of 'Typical Species' for this feature.	3
Future prospects (as regards range, area covered and specific structures and functions)	Unknown	No or insufficient reliable information available. It is unclear what the future prospects of the feature are. Many examples are found in the offshore area and are physically separated from most human pressures due to location (depth, distance from shore etc.). However, this also means that any possible impacts are difficult to detect. Therefore, although possible pressures can be identified, the imipacts cannot be verified.	3
Overall assessment of conservation status	Unknown	All parameter conclusions are Unknown.	3

Key to confidence in judgement: 1 = High; 2 = Medium; 3 = Low

7. Annexed material (including information sources used 2.2)

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