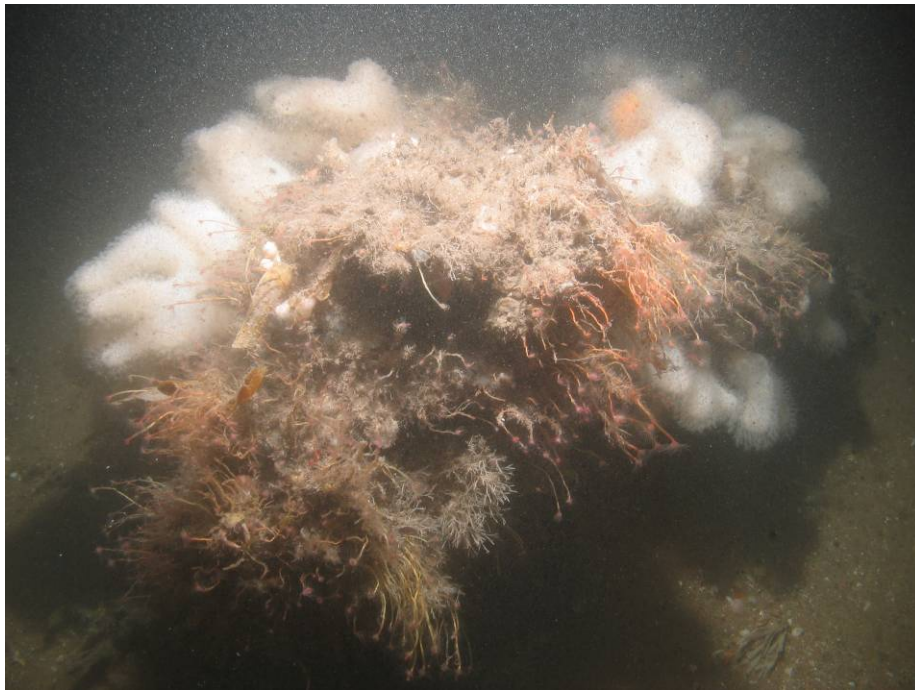




Offshore Special Area of Conservation: Croker Carbonate Slabs

SAC Selection Assessment Document



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Version 7.0 (July 2015)

¹ Cover photo illustrates soft corals (*Alcyonium digitatum*) and dense *Tubularia indivisa* hydroids on a methane derived authigenic carbonate structure in the Croker Carbonate Slabs site

Introduction

This document provides detailed information about the Croker Carbonate Slabs SAC/SCI and evaluates its interest features according to the Habitats Directive selection criteria and guiding principles. The site was submitted to the European Commission in 2012 and accepted as a Site of Community Importance in 2013. Further information became available in 2012 & 2013 to indicate the interest feature extended beyond the existing site boundary. The present document is a revised version of JNCC's Site Assessment Document that supported the original site nomination, taking into account the recently available information.

The advice contained within this document is produced to fulfil requirements of JNCC under Part 2 of the Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (as amended), relating to the conservation of natural habitat types and habitats of species through identification of Special Areas of Conservation (SACs) in UK offshore waters. Under these Regulations, JNCC has an obligation to provide certain advice to Defra to enable the Secretary of State to fulfil her obligations under the Regulations, and to Competent Authorities to enable them to fulfil their obligations under the Regulations.

This document includes information required under Regulation 7 of the Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (as amended), to enable the Secretary of State to transmit to the European Commission the list of sites eligible for designation as Special Areas of Conservation (SACs). JNCC have been asked by Defra to provide this information to Government.

Sites eligible for designation as offshore marine SACs are selected on the basis of the criteria set out in Annex III (Stage 1) to the Habitats Directive and relevant scientific information. Sites are considered only if they host a Habitats Directive Annex I habitat or Annex II species. Moreover, sites for Annex II species must contain a clearly identifiable area representing physical and biological factors essential to these species' life and reproduction to be eligible. Socio-economic factors are not taken into account in the identification of sites to be proposed to the European Commission².

In addition to information on the Annex I habitats and/or Annex II species hosted within the site, this document contains i) a chart of the site, ii) its name, location and extent, and iii) the data resulting from application of the criteria specified in Annex III (Stage 1) to the Habitats Directive. This is in line with legal requirements outlined under Regulation 7. JNCC has adhered to the format established by the Commission for providing site information. This format is set out in the 'Natura 2000 Standard data form' (CEC, 1995) (prepared by the European Topic Centre for Biodiversity and Nature Conservation on behalf of the European Commission to collect standardised information on SACs throughout Europe).

NOTE: No recent evidence has been made available to infer any changes to the non-qualifying features listed in the original Site Assessment Document. The present document only updates our formal advice for the designated feature 1180 Submarine structures made by leaking gases

² Following European Court of Justice 'First Corporate Shipping' judgement [C-371/98](#) (7 November 2000)

Document Version Control

Version and issue date	Amendments made	Issued to and date
SAC SAD version 7.0	Comments incorporated from the MPA Technical Group and JNCC MPA Sub-Group.	Defra (July 2015)
SAC SAD version 6.0	Document updated to reflect new data and proposed site boundary change to incorporate revised extent of MDAC feature.	JNCC MPA Sub-Group 11/06/15 MPA Technical Group 18/05/15
SAC SAD version 5.0 05/09/12	Version updated, pSAC to cSAC throughout, detailed site descriptions of Braemar and Scanner sites of MDAC.	Public (5 th September 2012)
SAC SAD version 4.0 08/05/12	Final site recommendation to Government	Defra, Devolved Administrations (8 th May 2012)
SAC SAD version 3.1 19/12/11	Consultation comments incorporated, Light touch review comment concerning Section 7 addressed. Site map coordinate grid added.	Defra, MPA Sub-Group, UKMBPSG (30 th January, 2012)
SAC SAD version 3.0 01/06/11	Site changed to possible SAC throughout the document	Public consultation (June 2011)
SAC SAD version 2.0 18.03.11	Formal recommendation to Government	Defra, Devolved Administrations, and other Govt. departments 18.03.11
SAC SAD version 1.0 07.12.10	Site boundary defined; site, habitat and data maps created; report edited	John Goold, 07.12.10

Further information

This document is available as a pdf file on JNCC's website for download (jncc.defra.gov.uk).

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Croker Carbonate Slabs SAC: Selection Assessment Document

1. Site name Croker Carbonate Slabs	2. Site centre location 53°46'96" N, 5°22'75" W (Datum: WGS 1984)
3. Site surface area 10,768 ha / 108 km ² (Datum: WGS 1984 UTM Zone 30 North, calculated in ArcGIS 9.2)	4. Biogeographic region Atlantic

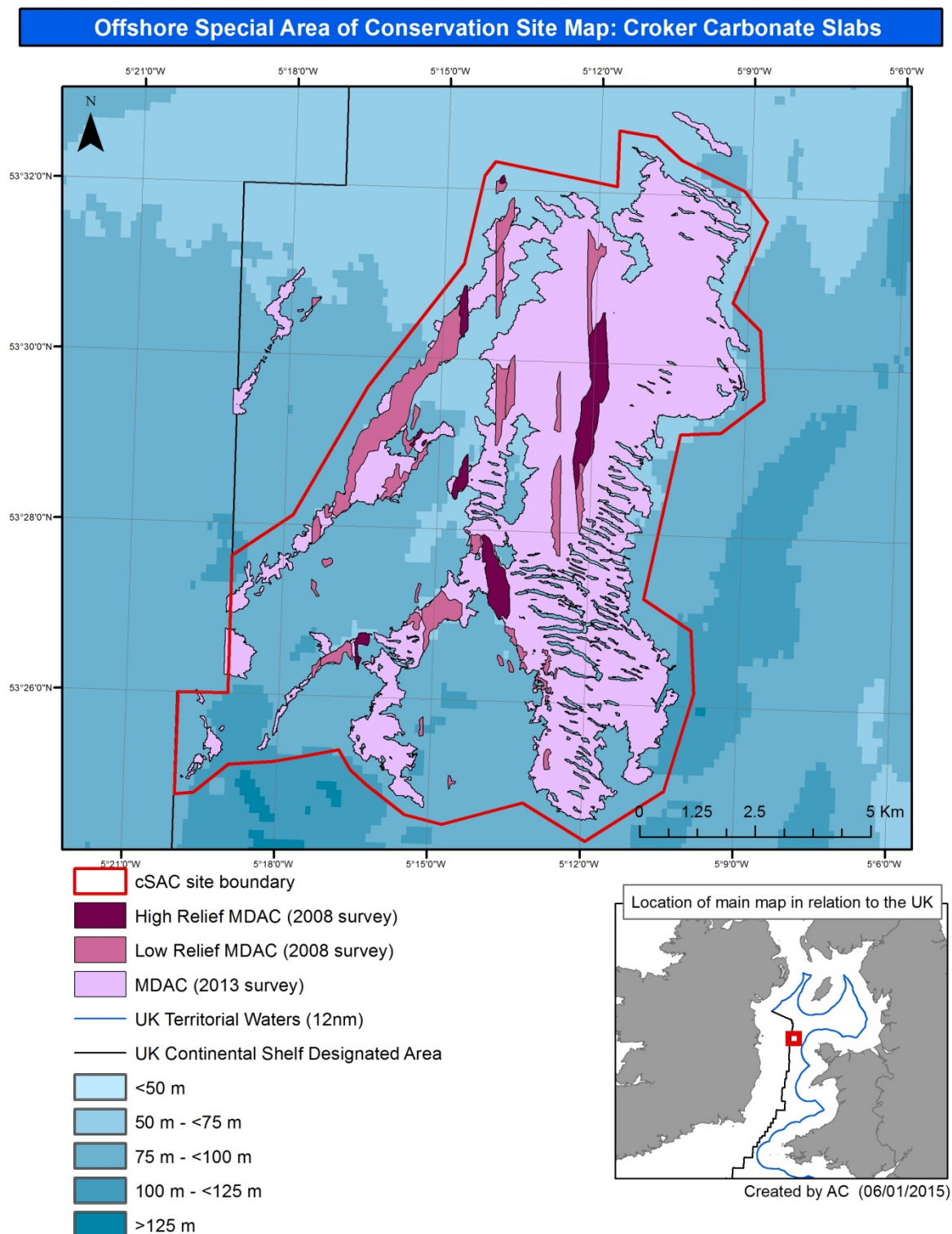
5. Interest features under the EU Habitats Directive

1180 Submarine structures made by leaking gases

1351 Harbour porpoise (*Phocoena phocoena*) (non-qualifying)

1364 Grey seal (*Halichoerus grypus*) (non-qualifying)

6. Map of site



Site map projected in UTM (Zone 30N, WGS84 datum). This product has been derived in part from material obtained from the UK Hydrographic Office with the permission of the Controller of Her Majesty's Stationery Office and UK Hydrographic Office (www.ukho.gov.uk). NOT TO BE USED FOR NAVIGATION. The exact limits of the UK Continental Shelf are set out in orders made under section 1(7) of the Continental Shelf Act 1964 (© Crown Copyright). World Vector Shoreline © US Defense Mapping Agency. Map copyright JNCC 2015.

7. Site summary

The Croker Carbonate Slabs is an area in the mid-Irish Sea, approximately 30km west of Anglesey, where an area of over 5,500 ha (55km²) of the Annex I feature “submarine structures made by leaking gases” has been identified. The site lies in 70m water depth in the north descending down to approximately 120m at the south west corner. The seabed surface is composed of extensive areas of exposed methane-derived authigenic³ carbonate (MDAC). These MDAC structures range from ‘low relief’ (elevation of up to 20cm above the surrounding seabed) to ‘high relief’ (elevation over 20cm above the surrounding sediment, and often up to 2m). A cliff feature up to 8m in elevation and 500m long has also been recorded, created by the action of the surrounding coarse seabed sediments being scoured away at the base of the high relief MDAC by currents (Whomersley *et al*, 2010; Judd, 2005). The seabed habitats created by these MDAC structures are distinctive, supporting a diverse range of marine species that are absent from the surrounding seabed characterised by coarse sediment (Judd, 2005). Areas of ‘high relief’ MDAC support a diverse range of soft corals, erect filter feeders, sponges, tube worms and anemones whilst the ‘low relief’ MDAC is colonised with scour-resistant hydroids and bryozoans (Whomersley *et al*, 2010). The surrounding sediment is highly mobile and consists of poorly sorted sand (from fine to coarse grained) with a large proportion of broken shell gravel and whole shells interspersed with rippled sand. A blue-grey clay has also been observed towards the southern end of the site. The Croker Carbonate Slabs is located in the Irish Sea regional sea (Defra, 2004; JNCC, 2004). In this regional sea, there is one other location where the Annex I habitat ‘Submarine structures made by leaking gases’ has been recorded; ‘Holden’s Reef’ within the Pen Llyn a’r Sarnau European marine site in Welsh territorial waters. There are also two SACs (Braemar Pockmarks and Scanner Pockmarks) within the Northern North Sea regional sea (Defra, 2004) where the Annex I habitat ‘Submarine structures made by leaking gases’ is a qualifying feature⁴, encompassing an area of approximately 45ha of Annex I habitat.

Candidate SACs	Notable characteristics of interest feature
Braemar Pockmarks	Large blocks, pavements slabs and smaller fragments of methane derived authigenic carbonate are present in two pockmarks and on the seabed nearby. These submarine structures made by leaking gases provide a habitat for marine fauna usually associated with rocky reef as well as very specific chemosynthetic organisms which utilise the methane seeping from beneath the sea floor (and its by-product, hydrogen sulphide). Larger blocks of carbonate also provide shelter for large fish species such as wolf-fish and cod (Dando, 2001).
Scanner Pockmark	The carbonate blocks lie in the base of the Scanner pockmark and are colonised by fauna more typically associated with rocky reef. These submarine structures made by leaking gases are notably colonised by large numbers of anemones (<i>Urticina felina</i> and <i>Metridium senile</i>) and squat lobsters. Also present is the gutless nematode <i>Astomonema southwardorum</i> which may have a symbiotic relationship with chemosynthetic bacteria. Fish (hagfish, fourbeard rockling, haddock, wolf-fish and small redfish) also appear to be using the pockmark depressions and the carbonate structures for shelter (Hartley, 2005).

³ An authigenic sedimentary rock deposit is one that was generated where it is found or observed. Authigenic sedimentary minerals form in situ during sedimentation by precipitation or recrystallization. Sedimentary authigenic minerals include [calcium carbonate](#).

⁴ Braemar Pockmarks SCI and Scanner Pockmarks SCI

Therefore, the Croker Carbonate Slabs site makes a significant contribution to maintaining this Annex I habitat at favourable conservation status within its natural range in the UK marine area.

8. Site boundary

The site boundary for the Croker Carbonate Slabs has been defined using JNCC's marine SAC boundary definition guidelines (JNCC, 2012). The site was originally submitted to the European Commission in 2012 (see Appendix I). Additional data was gathered in 2012 and 2013 which confirmed that the MDAC feature extended outside of the original boundary to the east and so the boundary was amended to better reflect the more recent information relating to the presence and extent of the feature. The cSAC boundary is a polygon enclosing the minimum area necessary to ensure protection of the Annex I habitat, following the new extent of the habitat feature as closely as possible.

The habitat feature is delineated from acoustic and ground truthing data collected during surveys in 2004, 2008 and more recently in 2012 and 2013 (see section 11). In the 2008 survey 'corridors' of data were gathered over some areas of the site. In the gaps between these corridors, methane-derived authigenic carbonate (MDAC) was expected to occur, but at the time had not mapped explicitly. In addition, areas of coarse sediment were enclosed within the site boundary where bathymetric and backscatter data has shown that MDAC underlies the shifting sediment bodies (Whomersley *et al*, 2010). The 2012 and 2013 surveys of North St Georges Channel rMCZ (a potential MPA which spatially overlaps with Croker Carbonate Slabs SAC) provided additional information on the Croker Carbonate Slabs site, with the collection of full coverage MBES bathymetry and backscatter data and multiple ground truthing data. Sampling included 14 PSA samples and 80 video tows with the new boundary. Over 200 images from 40 stations (shown in Figure 1) contained circalittoral rock, with 16 of the video tows classified as Moderate energy circalittoral rock. This included data collected to the east of the known extent of the MDAC feature at the time, which indicated that the feature extended much further to the east outside of the original SAC boundary.

This was a MCZ verification survey focussing on MCZ features and any data collection relating to the occurrence and extent of methane-derived authigenic carbonate (MDAC) was opportunistic as it is not an MCZ feature. Consequently, the survey products focussed on identifying and mapping the extent of MCZ features, particularly broad-scale habitat features. MDAC forms a hard layer on the seabed supporting biological assemblages similar to rock habitats. Consequently the data that actually show the presence of MDAC, was classified into the broadscale habitat 'A4.2 Moderate energy circalittoral rock'. The survey found that 'A4.2 Moderate energy circalittoral rock' was most 'evident in the vicinity of the Croker Carbonate Slabs Special Area of Conservation, and is likely to represent methane-derived authigenic carbonate' (DEFRA, 2013). The rMCZ site report habitat suggests that approximately 55km² of continuous MDAC (classified by employing bathymetric roughness used in conjunction with classified ground truthing samples) occurs within and surrounding the current SAC site boundary (DEFRA, 2013). A full coverage off acoustic multibeam bathymetry and backscatter data was gathered in 2012/2013 by the JNCC/Cefas survey of North St Georges Channel rMCZ, which fully encompasses the site boundary of Croker Carbonate Slabs cSAC/SCI. High and low relief MDAC features can be seen clearly in the multibeam data, with patches of seabed showing a similar acoustic signature extending outside of the current site boundary. These acoustic data suggest a continuous layer of MDAC extending to the north east of the current SCI boundary, and the existing features extending to the south west and south east. Sampling from the area comprised 14 sediment samples for Particle Size Analysis (PSA) and 138 video tows. Over 200 images from 40 stations contained circalittoral hard substrata, with 16 of the video tows classified as 'Moderate energy circalittoral rock'. JNCC reviewed these ground truthing data (video sequences and still images) and concluded that the images showing 'rock' contained the same characteristics as the MDAC within the existing site boundary. These multibeam sonar data in combination with ground truthing data have been used by Cefas to generate a broad scale habitat map of the region that shows approximately 55km² of hard substrate. These patches of hard substrate are inferred to be MDAC based on previous data from within the Croker Carbonate Slabs SCI.

Two small areas of potential Annex I habitat feature (MDAC) were mapped to the north and west of the new site boundary (see site map in section 6). However, as ground truthing did not occur in these areas and as the incorporation of these areas within the site boundary would have resulted in a large area of non-Annex I habitat being included, these areas were omitted from the site boundary.

The boundary definition guidelines indicate that where interest features are at risk from bottom trawling, a margin should be included in the boundary to ensure their protection. As this feature is both sensitive to these kinds of activities and bottom trawling occurs in the region, the boundary has been drawn to include a margin to allow for mobile gear on the seabed being at some distance from the location of a vessel on the sea surface. The maximum depth of water around the feature is 120m, however only very small portion of the feature occur in areas where the depth exceeds 100m; therefore, an average depth of 80m was used, and assuming a ratio of 3:1 fishing warp length to depth on the continental shelf, the boundary is defined to include a margin of 240 m from the mapped MDAC features. The boundary was however delineated to provide a 300m buffer in the southern portion of the site where the feature can occur in depths of over 100m.

Note the boundary is for the SAC only. Any future management measures required under the Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (as amended) will be determined by Competent Authorities in consultation with JNCC, and may have different boundaries to the SAC site boundary.

9. Assessment of interest feature against selection criteria

9.1. Submarine structures made by leaking gases

Annex III selection criteria (Stage 1A)

a) Representativity

The Croker Carbonate Slabs is wholly located within the Irish Sea Regional Sea. This site is characteristic of the habitat 'submarine structures made by leaking gases' under the subtype "bubbling reefs". Within the site, blocks of methane-derived authigenic carbonate (MDAC) up to 2m in height, platforms up to 2 km long by 500 m across and a 6 – 8 m high cliff occur (Whomersley *et al*, 2010; Judd, 2005). These structures form a complex seabed topography providing a diverse habitat for a range of marine life. In other parts of the site, thin slabs of MDAC form 'pavements', which are often overlain with a thin veneer of mobile sand and gravel (see Figure 1). These pavements are often undercut by tidal currents, providing shelter for species such as the long-clawed squat lobster *Munida rugosa* (Whomersley *et al*, 2010).

While no evidence of active gas leaks were recorded from surveys undertaken in 2004, 2008 analysis of samples gathered during the surveys in 2004 and 2008 demonstrated that the carbonates are MDAC in origin (Judd, 2005; Whomersley *et al*, 2010). As the 2012/2013 survey was focused on collecting information on MCZ features, data was not collected on the occurrence of gas seeps.

The known occurrence of the Annex I habitat 'submarine structures made by leaking gases' is limited within UK waters. Therefore, the MDAC structures within the Croker Carbonate Slabs make a valuable contribution to representativity of this habitat in UK waters.

The grade for the feature is A (excellent representativity).

b) Area of habitat

An evaluation of the area of the site covered by submarine structures made by leaking gases in relation to the total area covered by this interest feature in UK waters is not possible, since all occurrences of this habitat are not known. However, evidence from known occurrences of the habitat shows that the extent at each occurrence (Braemar and Scanner pockmarks) are relatively small (approximately 45 ha). The grades for this criterion are Grade A (site contains '15-100%' of total resource of Annex I habitat), Grade B (site contains '2-15%' of total resource of Annex I habitat) and Grade C (site contains '0-2%' of total resource of Annex I habitat) (CEC, 1995). As the area of Annex I habitat within the Croker Carbonate Slabs site is 5,500ha (55km²), it is likely that it comprises between 15 and 100% of the total extent of submarine structures made by leaking gases in the UK.

The grade for this criterion is therefore A (site contains '15-100%' of total resource of Annex I habitat).

c) Conservation of structure and functions

Degree of conservation of structure

Static fishing gear was encountered during the survey (Whomersley *et al*, 2010) indicating a fishery for crab (*Cancer pagurus*) and/or lobster (*Homarus gammarus*). Other species are known to be exploited and include cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*), herring (*Clupea harengus*) and the Norway lobster (*Nephrops norvegicus*) (Whomersley *et al*, 2010). There is moderate to high intensity *Nephrops norvegicus* fishing occurring to the north-west of the site (CEFAS, 2010) but not close to enough to exert a damaging impact on the feature. Beam trawling occurs at low intensity (approximately 50 hrs effort per year) at the northern and southern peripheries of the site's boundary. However, VMS 'Ping' data for 2009-2013 provides a better spatial resolution to determine the level of fishing activity occurring over a feature. This information shows that whilst fishing activity largely avoids the feature, in 2012, a number of pings suggest fishing activity occurred directly over the mapped extent of MDAC feature in the north east of the site. Though, trawlers aim to avoid fishing on the feature to prevent damage to their fishing gear, natural erosion (Whomersley *et al*, 2010) could be augmented by nearby fishing practices. The exposure level has been assessed to be moderate.

The grading for this sub-criterion is therefore II: structure well conserved.

Degree of conservation of functions

The prospects of this feature to maintain its structure in the future, taking into account unfavourable influences and reasonable conservation effort, are good. A mechanism is available through the European Commission's Common Fisheries Policy regulations to modify fishing activity in the area if this is deemed to be necessary. In addition, regulations are in place to regulate oil and gas activity in and around SACs in the UK Continental Shelf Designated Area, should hydrocarbon exploration/exploitation occur in this area. Cables are largely an unregulated activity in offshore waters depending upon the type of cable being laid (or maintained), where it is being laid between and whether the cable is part of a larger development (which may be regulated). Any cable not directly associated with an energy installation does not require a marine licence beyond 12 nautical miles. The feature is distant from terrestrial sources of pollution.

The grading is I: excellent prospects.

Restoration possibilities

Restoration methods in the offshore area focus on the removal of impacts which should allow recovery where the habitat has not been removed. Restoration of the biological communities within the Croker

Carbonate Slabs site may be possible where the submarine structures have not been destroyed. However where physical damage to the substratum has occurred, the restoration potential is unknown. This is because the MDAC is accreted naturally (and over long time periods) and further accretion is dependent on sufficient gas seepage as well as the presence of specific chemosynthetic micro-organisms. There is no evidence to suggest that gas seepages in the immediate area are still active (Judd, 2005; Whomersley *et al*, 2010). Data on the presence or absence of gas seeps at the site was not collected in the MCZ verification survey in 2012/2013.

The grade is III: restoration difficult or impossible.

Overall grade

Due to the first sub-criterion of this criterion being graded II: structure well conserved, and the second sub-criterion being I: excellent prospects, the overall grading is A: excellent conservation, regardless of the grading of the third sub-criterion.

d) Global assessment

The suggested grades for Stage 1A criteria a)-c) are A, A and A. Given these evaluations, and taking into account the rarity of this habitat in UK waters, the Global Assessment grade is A ('excellent conservation value').

Summary of scores for Stage 1a criteria

Habitat type	Representativity (a)	Area of habitat (b)	Structure and function (c)	Global assessment (d)
Croker Carbonate Slabs	A	A	A	A

9.2. Harbour porpoise (*Phocoena phocoena*)

Annex III selection criteria (Stage 1B)

a) Proportion of UK population

Harbour porpoise (*Phocoena phocoena*) are found throughout the majority of UK continental shelf waters (Reid *et al*, 2003; SCANS II, 2008). The species is widespread in the Irish Sea, with the species having been recorded in the area of the cSAC (Reid *et al*, 2003, SCANS II, 2008; Baines and Evans 2009; WWT, 2009). There is no indication that the size and density of the population within the site's boundaries are particularly significant in relation to other areas within the Irish Sea. It is therefore considered to be grade D, i.e. a non qualifying feature. As such, no other indication is required for the additional evaluation criteria concerning this species within the site.

The assessment above for Harbour Porpoise has not been changed since the assessment presented in the original SAD in 2012.

9.3. Bottlenose dolphin (*Tursiops truncatus*)

Annex III selection criteria (Stage 1B)

a) Proportion of UK population

This species is found in many parts of UK waters, on the continental shelf and further offshore (Evans *et al*, 2003; Reid *et al*, 2003; SCANS II, 2008). There are no records of bottlenose dolphin occurrences within the cSAC boundary (Reid *et al*, 2003; Baines and Evans, 2009; WWT, 2009) therefore the species is not considered a feature of the site. However, they have been recorded in the vicinity of the site (Evans *et al*, 2003) and are highly mobile, so this assessment may change if new data becomes available.

The assessment above for Bottlenose Dolphin has not been changed since the assessment presented in the original SAD in 2012.

9.4. Grey seals (*Halichoerus grypus*)

Annex III selection criteria (Stage 1B)

a) Proportion of UK population

From satellite telemetry work, grey seals (*Halichoerus grypus*) appear to forage in or very near the area (Baines and Evans, 2009; WWT, 2009) and haul-out sites are found on the mainland north of Anglesey. At this time, however, it is not possible to estimate what proportion of the population utilises the area, or how important the area is with respect to the physical and biological factors essential to their life and reproduction. Additionally, there is no evidence that the Croker Carbonate Slabs site is any more important for this species than other areas in the Irish Sea. Therefore, grey seals are considered to be grade D, i.e. a non-qualifying feature. This grading may be revised at a later date depending on the outcome of data analyses to be commissioned by JNCC that will enable a more detailed assessment of the importance of areas for seals at sea.

The assessment above for Grey Seals has not been changed since the assessment presented in the original SAD in 2012.

10. Sites to which this site is related

None

11. Supporting scientific documentation

The information to support this SAC designation comes from a number of sources. Seismic surveys carried out in the western part of the Irish Sea found extensive acoustic turbidity within the seabed to the north-west of the site in the Western Irish Sea Mud Belt (Yuan *et al*, 1992), indicative of shallow gas. Meanwhile, seismic data gathered during a cable route survey (Croker, 1995) west of Anglesey recorded further acoustic turbidity within the sediment, again indicative of shallow gas. During the Strategic Environmental Assessment (SEA) 6 survey of the Irish Sea in 2004, two areas, Texel 10 and Texel 11, were surveyed using multibeam echo-sounder, sidescan sonar, sub-bottom profiling, video and stills imagery and grab sampling. Analysis of this data showed that carbonate structures were present on the seabed within the Texel 11 survey area, and that these were formed by methane-derived authigenic carbonate (MDAC) (Judd, 2005).

In May 2008, JNCC commissioned a more extensive survey of the area, CEND 11/08, aboard the *R/V Cefas Endeavour* where multibeam echo-sounder and sidescan sonar data were collected along with seabed imagery and Hamon grab samples (Whomersley *et al*, 2010). Initially, corridors of multibeam and sidescan acoustic data were gathered across a broad area. Infill lines were then surveyed to obtain 100% coverage in areas where potential MDAC acoustic signatures were detected. Extensive MDAC structures were identified across the site (see Figure 1), confirmed following analysis of the acoustic data along with petrographical/x-ray diffraction analysis of the physical samples (Whomersley *et al*, 2010).

In February 2012 and April 2013, two verification surveys of the North St Georges Channel recommended Marine Conservation Zone (rMCZ) were undertaken by Cefas in partnership with JNCC under the Defra MB0120 data gathering contract. The location of North St Georges Channel rMCZ overlaps with Croker Carbonate Slabs SAC entirely, and therefore the data collected on these surveys is of relevance for the SAC. Although the surveys were focussed on the rMCZ, they collected full coverage multibeam with associated ground truthing data (sediment Particle Size Analysis (PSA) data and video imagery) (DEFRA, 2013) over the area of the SAC.

High and low relief MDAC features can be seen clearly in the multibeam, with a similar acoustic signature extending outside of the current site boundary. The survey found that 'A4.2 Moderate energy circalittoral rock' was most 'evident in the vicinity of the Croker Carbonate Slabs SAC, and is likely to represent methane-derived authigenic carbonate' (DEFRA, 2013).

Over 100 video tows were recorded within Croker Carbonate Slabs SAC and the surrounding area; these provided over 200 images of moderate energy circalittoral rock from 40 stations which suggested the presence of MDAC beyond the original site boundary. These images were reviewed to determine if they contained the same characteristics of MDAC seen within the original site boundary.

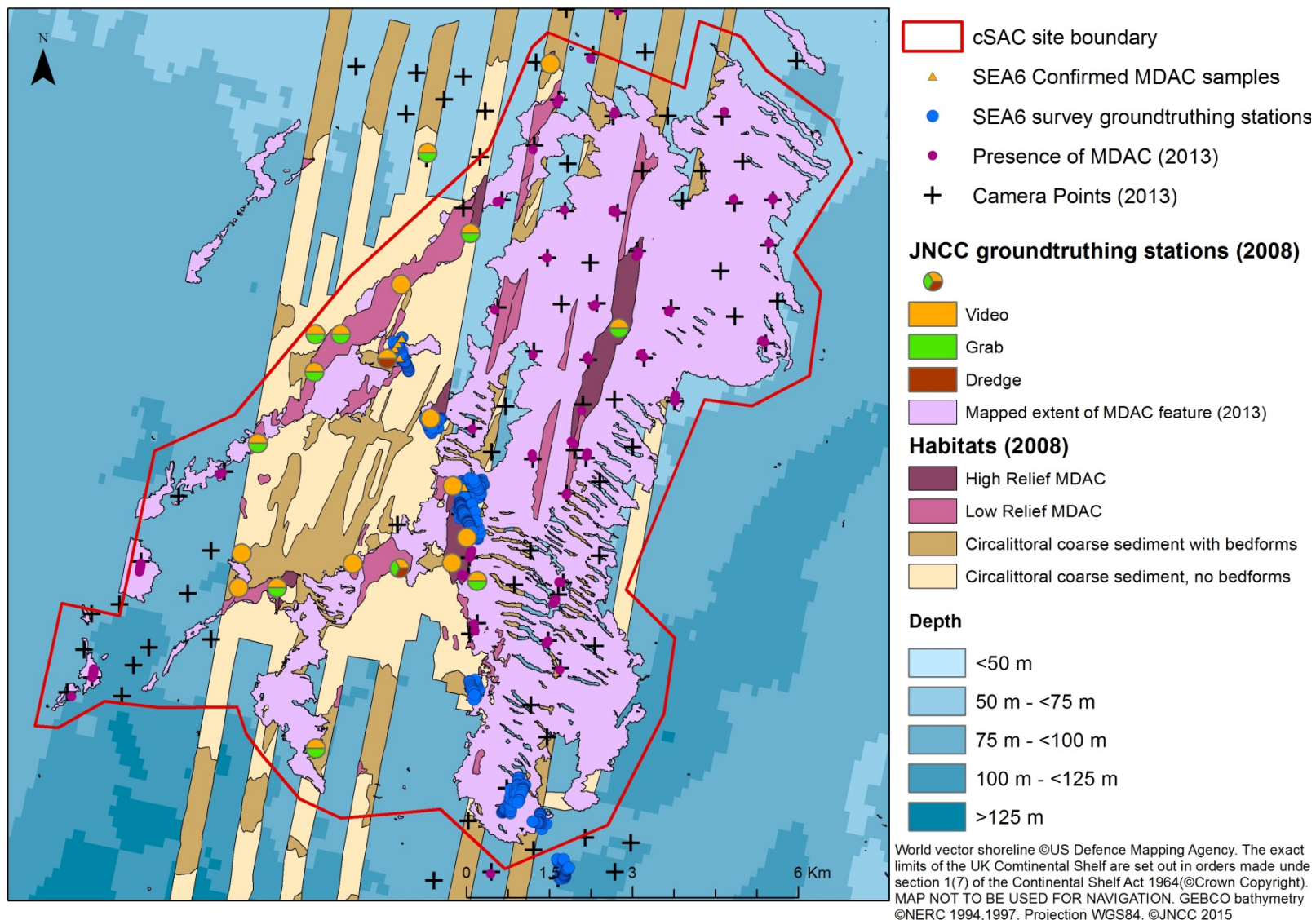


Figure 1: Map showing distribution of different seabed habitats within the SAC boundary, including areas of Annex I habitat “Submarine structures made by leaking gases” and the location of biological sampling undertaken.

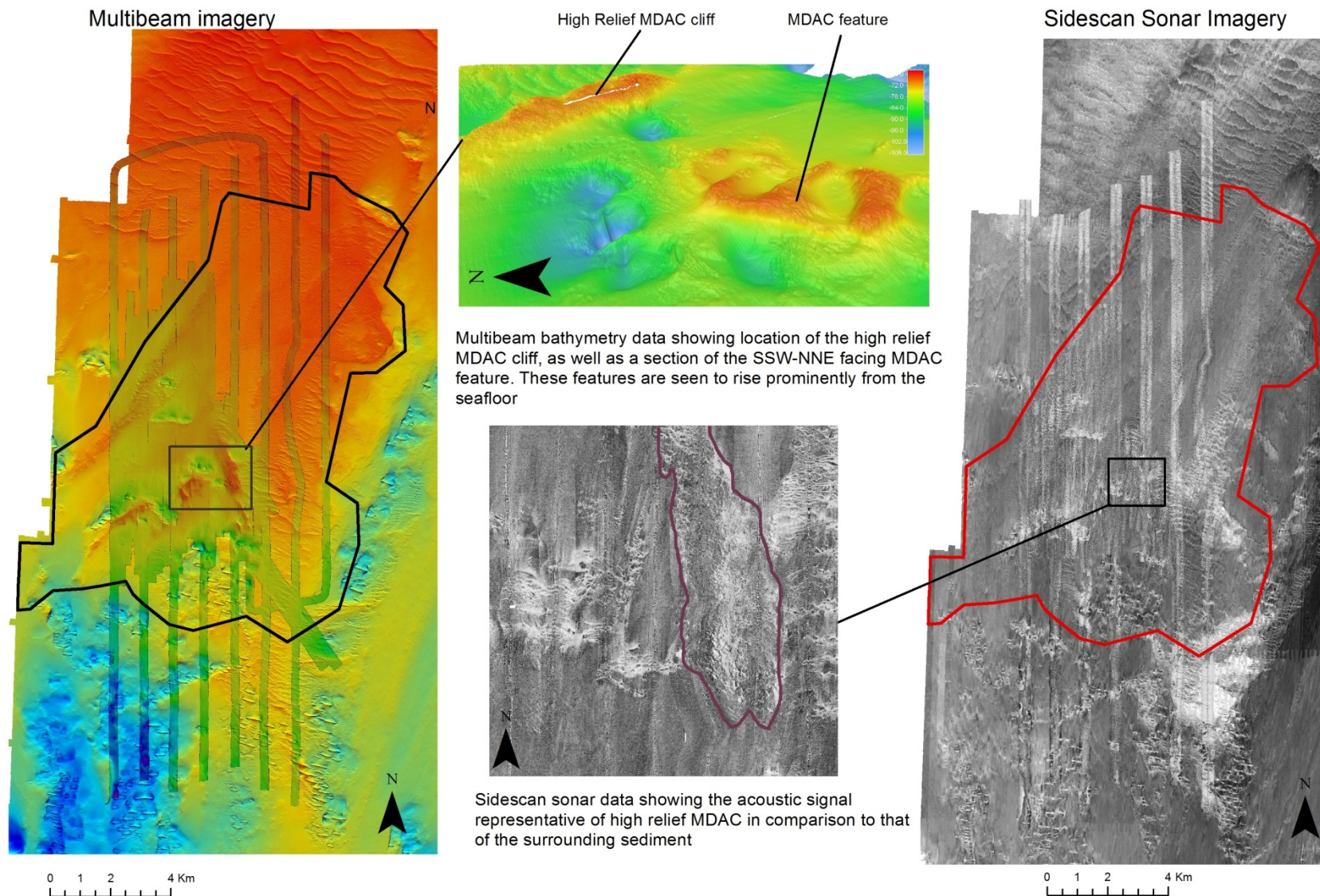


Figure 2: Acoustic data (2004, 2008 & 2013 surveys) showing imagery of seabed and example area of methane-derived authigenic carbonate (MDAC) (with purple outline) delineated from sidescan sonar data.

12. Site overview and conservation interest

This site is being recommended for inclusion within the Natura site network for its Annex I habitat “Submarine structures made by leaking gases”. This habitat is associated with methane-derived authigenic carbonate (MDAC). MDAC forms when methane rising through the upper part of the sediment column is oxidised and the pore waters become supersaturated with calcium carbonate (calcite) (Jorgensen, 1992; Judd, 2001). The calcite precipitates and infills the pore spaces between the sand grains, creating a layer or crust that can form carbonate ‘pavements’ and ‘chimneys’; significant hard ground compared to the surrounding sediment. Analysis of the cement recovered from within the site boundary showed it to be carbonate, high magnesium calcite or aragonite (Milodowski *et al*, 2009).

Earlier surveys by Judd (2005) confirmed the existence of MDAC. Acoustic data indicated a generally flat seabed with large depressions up to 500m in diameter, with steep sides, alongside small mounds and sediment waves. In addition, a cliff structure 6-8 m high and up to 500m long was recorded. Ground truthing of this area found cemented rocks providing a firm substrate for a diverse range of fauna (Judd *et al*, 2007). Chemical analysis of carbonate samples collected during this survey indicated they were methane-derived and thermogenic in origin.

Further survey work undertaken in 2008 (Whomersley *et al*, 2008) established the presence of MDAC over a wider area. MDAC features were mapped using high resolution acoustics (multibeam echosounder and sidescan sonar) and then validated using seabed imagery and grab samples. Within the site, the MDAC structures took two key forms, extensive MDAC ‘pavement’ or ‘slabs’ up to 20mm thick (termed ‘low relief’ MDAC) and larger structures over 20mm thick and up to 2m high (termed ‘high relief’ MDAC). Surrounding these features, extensive areas of circalittoral coarse sediment (consisting of shelly, mobile and rippled sand, frequently >20% shell gravel and >5% whole shell) was observed along with sediment bedforms including sand wave fields, indicating a dynamic seabed with evidence of sediment transport (Whomersley *et al*, 2010). The extent of MDAC coverage (based on existing data at this time) had been estimated at over 100km², but information on the underlying geology suggests that MDAC could extend further west of the site (Whomersley *et al*, 2010); further survey work would still be needed to confirm this.

The rMCZ site verification surveys of North St George’s Channel rMCZ undertaken by Cefas in February 2012 and April 2013 have provided data on a large area of previously unknown MDAC adjacent to the east of the original SAC boundary. This data was analysed to produce a broad scale habitat map of MCZ search feature, of which MDAC is not one. Therefore, any hard substrate which occurs in the vicinity of the SAC is classified as Moderate energy rock, rather than MDAC. The survey report explains that Bedrock outcrops and MDAC were both classified as BSH ‘A4.2 Moderate energy circalittoral rock’ and that this was most evident in the vicinity of the Croker Carbonate Slabs Special Area of Conservation, and is likely to represent methane-derived authigenic carbonate with ground truthing from the area supporting this assumption. The rMCZ site report suggests that 55km² of continuous MDAC (classified by employing bathymetric roughness used in conjunction with classified ground truthing samples) occurs within and surrounding the current SAC site boundary (DEFRA, 2013).

The original extent of exposed MDAC was observed forming two longitudinal features with a SSW-NNE orientation (see Figure 2). Several reasons for these two features having such prominent relief have been suggested (Whomersley *et al*, 2010); either they represent areas of flexure within the underlying Quaternary raising the MDAC sufficiently to allow greater weathering, or the features may be indicators of bedrock structure. When exposed at the seabed surface, MDAC appears to be broken down and eroded rapidly both through biological activity (boring by bivalve molluscs) and by water currents into sand and gravel sized fragments.

MDAC such as that found in the Croker Reefs, have been described from natural hydrocarbon seeps worldwide (Judd and Hovland, 2007). At most seeps, including the Scanner Pockmark SCI in the UK North Sea, MDAC occurs as slabs, crusts and blocks (most commonly <1 m across) scattered across

the site, but in the immediate vicinity of individual seepage pathways, while the 'Bubbling Reefs' of the Danish Kattegat are MDAC chimneys. Descriptions of more extensive MDAC 'reefs', such as Holden's Reef in Tremadog Bay (part of the Pen Llŷn a'r Sarnau SAC), are rare and none are thought to compare in extent to the Croker Reefs. Consequently these reefs are considered to be of international importance (A. Judd 2011, pers. comm.)

The hard substratum provided by the MDAC provides an ideal physical habitat for a range of marine life, in stark contrast to the surrounding coarse sediment. Information on the biological communities was gained through analysis of the seabed imagery; over 79 species were identified. The MDAC substratum was categorised into three classes, based upon visual appearance and colonising epifauna (Whomersley *et al*, 2010):

- 'High relief' MDAC (see Plate 1): raised at least 20 cm and often up to 2m high above the surrounding sediment. Extensively colonised with the soft coral *Alcyonium digitatum* and a dense hydroid turf of *Eucratea loricata* and *Diphasia pinaster*. The abundance of the robust hydroid *Tubularia indivisa* is indicative of the strong currents in the area. Sponges such as the yellow boring sponge *Cliona celata* and *Lophonopsis nigricans* were present along with tubeworms such as *Sabella pavorina* and *Sabellaria spinulosa*. The anemone *Sagartia troglodytes* was also frequently found on these raised MDAC structures.
- 'Low relief' MDAC (see Plate 2): less than 20 cm above the surrounding sediment and colonised by more scour resistant species such as the bryozoans *Flustra foliacea* and *Vesicularia spinosa*. The robust hydroids *Tubularia indivisa* and occasionally *Nemertesia* spp. and *Diphasia pinaster*, were also associated with this substratum. Notably the tubeworm *Sabellaria spinulosa* was often found to entirely cover the exposed MDAC in large numbers. Boring by bivalves such as *Hiatella arctica* was clearly evident in samples gathered by Hamon grab.
- Uncolonised MDAC: MDAC that had been recently uncovered by the mobile shifting sediments and had not yet been colonised by visible epifauna. The uncolonised MDAC was generally of very low relief and distinct from other substratum types.

A biotope describing the MDAC habitat recorded within the site is not yet represented in either the JNCC Marine Habitat Classification for Britain and Ireland (Connor *et al*, 2004) or the EUNIS habitat classification. Two new biotopes have been proposed by Whomersley *et al* (2010) within the CR.MCR.SfR biotope complex⁵, and will be considered for inclusion in the JNCC classification as part of a project being undertaken in 2015-2016 to update the Classification.

For the purposes of the study, the MDAC classes were labelled as follows:

- 'High relief' MDAC – Proposed new biotope CR.MCR.SfR.MDAC.1 (A4.23v1 EUNIS class)
- 'Low relief' MDAC - Proposed new biotope CR.MCR.SfR.MDAC.2 (A4.23v2 EUNIS class)

In addition to epifaunal communities observed from the seabed imagery, infaunal communities were identified from a suite of grab samples obtained. Two types of seabed habitat were targeted by Hamon grab; (1) thin MDAC crust ('low relief' MDAC) with associated sediment and (2) sediment located away from areas of observed MDAC. Seabed samples in the vicinity of MDAC crust contained infaunal communities with a significantly higher number of individuals than in adjacent sediments. However, there was no significant difference in the number of species, species richness or diversity (Whomersley *et al*, 2010). Key differences in the communities were due to encrusting and boring species in the MDAC crust but not the surrounding sediments, such as bivalve *Hiatella arctica*.

Species not previously associated with habitats in the Irish Sea were also recorded at the site during the 2008 survey. These included the hydroid *Lytocarpia myriophyllum* and a newly described species of

⁵ For full description see: <http://jncc.defra.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00002126>

Polymastid sponge *Polymastia* cf. *agglutinans* (B. Picton, *pers. comm.*). The Ross coral *Pentapora fascialis* which is rarely found in the Irish Sea was also observed at this site. The presence of these species highlights the Croker Carbonate Slabs as an important site for protection of these species' habitat within the Irish Sea regional sea (Defra, 2004).



Plate 1. A block of high relief MDAC colonised with soft corals (*Alcyonium digitatum*), hydroids including *Nemertesia antennina* and *Tubularia indivisa*, and *Henricia* sp. starfish (Station 1; © JNCC)

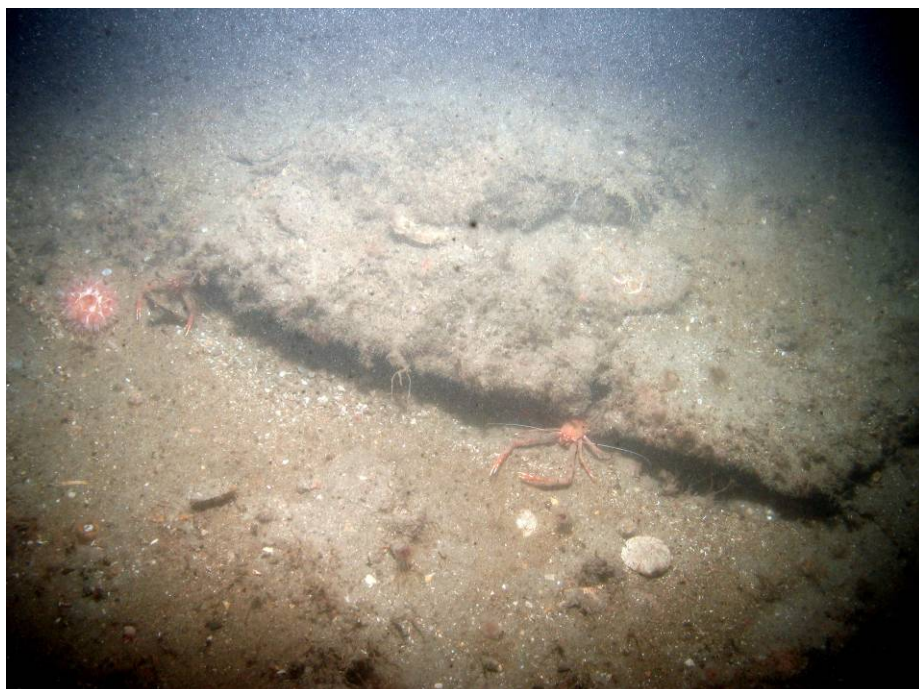


Plate 2. A thin slab of low relief MDAC 'pavement' with coarse sediment and Dahlia anemone (*Urticina* sp.), creating a refuge for long clawed squat lobsters (*Munida rugosa*) (Station 6; © JNCC)

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