Special Area of Conservation (SAC): Haisborough, Hammond and Winterton

SAC Selection Assessment

Version 6.0

Version Control

Version and date	Amendments made	Issued to and date
Version 6.0 (20th August 2010)	Text amendment for pSAC to cSAC status	Submission to Europe (20th August 2010)
Version 5.3 (11th May 2010)	Minor text amendments	Natural England Executive Board and JNCC Marine Sub Group (14th May 2010)
Version 5.2 (6th May 2010)	Text amended following internal & JNCC	Final QA
Version 5.1 (29th April 2010)	Text amended following internal review	Internal review
Version 5.0 (14th April 2010	Text amended following formal consultation and map revised	Internal review
Version 4.0 (10th November 2009)	Text amendment for dSAC to pSAC status	Formal consultation (27th November 2009)
Version 3.0 (4thJune 2009)	Text and map amendments. Removal of Appendix 2	Defra, Devolved Administrations, other Government departments; publicly available 17th September 2009
Version 2.0 (4th February 2009)	Text amended	JNCC Joint Committee (25th March 09), Chief Scientists Group (13th Feb, 09), NE advised Defra (4th Feb 09).
Version 1.0 (25thNovember 2008)	Text amended following internal and JNCC review	Natural England Board (11th Dec 2008)

1. Introduction

This document provides detailed information about the Haisborough, Hammond and Winterton site and evaluates its interest features according to the Habitats Directive selection criteria and guiding principles. The Haisborough, Hammond and Winterton site crosses the 12 nautical mile boundary; it lies partly in inshore and partly in offshore waters and is therefore being progressed jointly by Natural England and the Joint Nature Conservation Committee (JNCC).

The advice contained within this document is produced to fulfil requirements of Natural England under The Conservation of Habitats and Species Regulations 2010 and 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 species through identification of Special Areas of Conservation (SACs) in UK waters. Under these Regulations, Natural England and JNCC are required to provide advice to Defra to enable the Secretary of State and Competent Authorities to enable them to fulfil their obligations under the Regulations.

Sites eligible for designation as Special Areas of Conservation (SACs) are selected on the basis of the criteria set out in Annex III (Stage 1) to the Habitats Directive and relevant scientific information. SACs are considered only if they host a Habitats Directive Annex I habitat or Annex II species. Socio-economic factors are not taken into account in the identification of SACs to be proposed to the European Commission[1].

In addition to information on the Annex I habitats, this document contains i) a map of the site, ii) its name, location and extent, iii) the data resulting from application of the criteria specified in Annex III (Stage 1) to the Habitats Directive and iv) a glossary of terms mentioned in the text. Natural England and JNCC have adhered to the format established by the Commission for providing site information. This format is set out in the 'Natura 2000 Standard data form' (Commission of the European Community, 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).

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

2. Haisborough, Hammond and Winterton: SAC Selection Assessment

1. Site name Haisborough, Hammond and Winterton	**2. Site centre location** Degrees and minutes **1° 57' 58"E 52° 50' 27"N** (Datum: WGS84)
3. Site surface area **146,759 ha; 1467 sq km** (Datum: WGS84 UTM Zone 31 Northern hemisphere)	**4. Biogeographic region** Atlantic

3. Interest feature(s) under the EU Habitats Directive

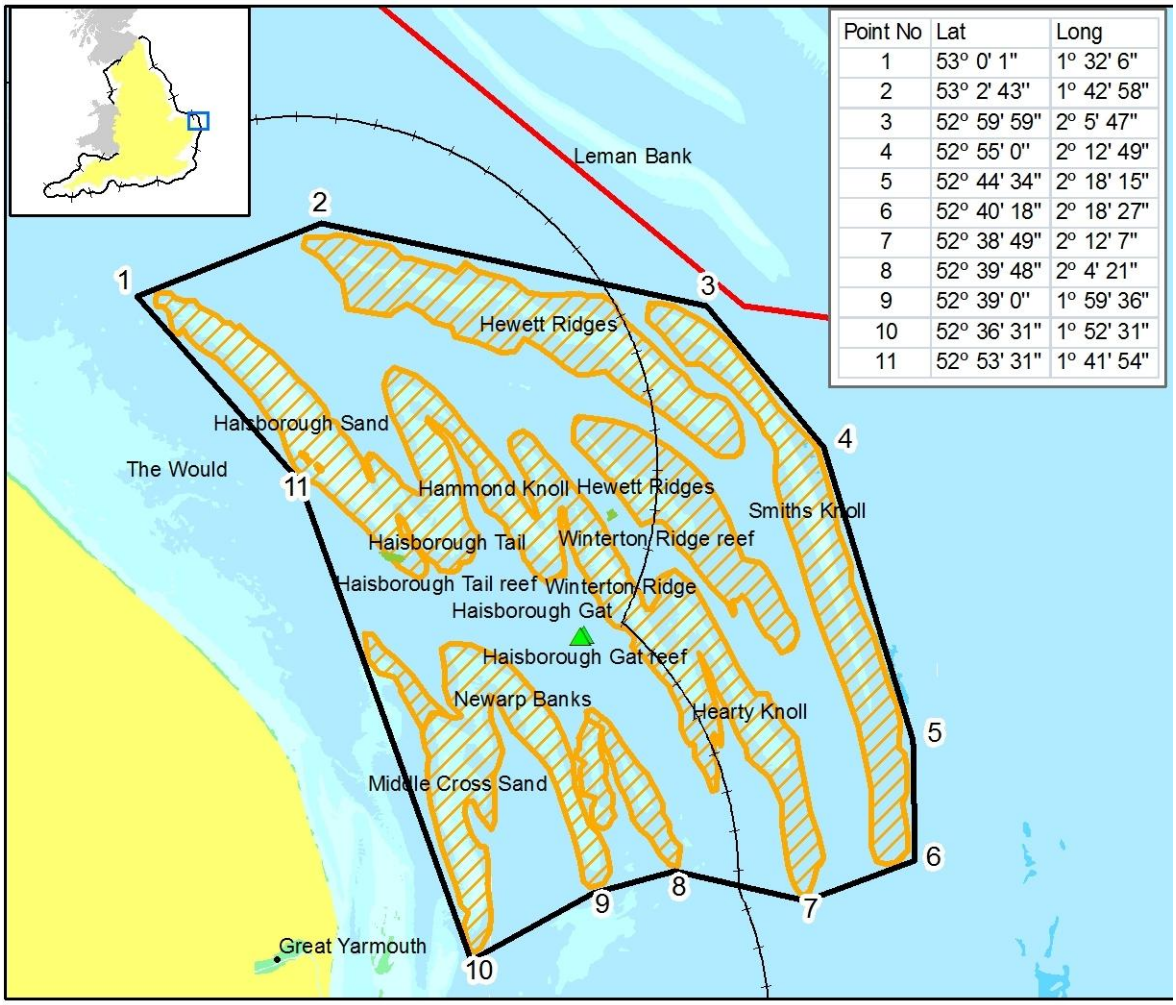
This site is listed for the features set out below. For further information please see European Commission, DG Environment, (2007): Interpretation Manual of European Union Habitats. EUR 27, July 2007:

http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/2007_07_im.pdf

1110 Sandbanks which are slightly covered by sea water all the time
1170 Reefs

1364 Grey seal (*Halichoerus grypus*) (non-qualifying)
1351 Harbour Porpoise (*Phocoena phocoena*) (non qualifying).

4. Map of candidate SAC boundary[2]



Point No	Lat	Long
1	53° 0' 1"	1° 32' 6"
2	53° 2' 43"	1° 42' 58"
3	52° 59' 59"	2° 5' 47"
4	52° 55' 0"	2° 12' 49"
5	52° 44' 34"	2° 18' 15"
6	52° 40' 18"	2° 18' 27"
7	52° 38' 49"	2° 12' 7"
8	52° 39' 48"	2° 4' 21"
9	52° 39' 0"	1° 59' 36"
10	52° 36' 31"	1° 52' 31"
11	52° 53' 31"	1° 41' 54"

candidate Special Area of Conservation
Haisborough, Hammond and Winterton

North Norfolk Sandbanks and Saturn Reef cSAC
candidate Special Area of Conservation (v 1.4)
Location of Annex I Sabellaria Biogenic reefs
England 12nM Territorial Seas Limit
Annex I Sabellaria Biogenic reef extent
Sandbanks which are slightly covered by sea water all the time
Land

Depth Areas
Drying
<=10m
<=20m
<=50m
<=100m

EU Site Code: UK0030369
Version number: 1.4
Longitude: 1° 57' 58" E
Latitude: 52° 50' 27"N
Projection: UTM 31N (WGS84)
Area of SAC: 1467.59 sq km 146759 ha

Theme ID: 1452093
Grid Ref: TG642317
Version: 7
Plotted: 12/08/2010
Plot ID: 5

Scale 1:500,000 Map 1 of 1
0 2.5 5 10 Kilometers

N

Candidate Special Area of Conservation Directive 92/43/EEC
Submitted to the EC by the Secretary of State for Environment, Food and Rural Affairs. Date: 20/08/2010

JNCC Joint Nature Conservation Committee NATURAL ENGLAND

[2] Larger copies of maps are available on request from Natural England, Regulatory Services, Floor 1 West, Northminster House, Peterborough. PE1 1UA

5. Site summary

The Haisborough, Hammond and Winterton site lies off the north east coast of Norfolk, and contains a series of sandbanks which meet the Annex I habitat description 'Sandbanks slightly covered by sea water all the time'. The central sandbank ridge in the site is composed of alternating ridge headland associated sandbanks (Dyer & Huntley, 1999). This ridge consists of the sinusoidal banks which have evolved over the last 5,000 years, originally associated with the coastal alignment at the time that the Holocene marine transgression occurred (Cooper *et al,* 2008). The bank system consists of: Haisborough Sand, Haisborough Tail, Hammond Knoll, Winterton Ridge and Hearty Knoll. Hewett Ridge and Smiths Knoll form an older (~7,000BP) sequence of sandbank ridges located along the outer site boundary. Inshore are the Newarp Banks and North and Middle Cross Sands which lie on the south west corner of the site. These banks are believed to be geologically recent, their genesis dating to around the 5th Century AD (Cooper *et al,* 2008).

The sandy sediments within the site are very mobile in the strong tidal currents which characterise the area (HR Wallingford *et al,* 2002). Large scale bank migration or movement appears to be slow, but within the sandbank system there is a level of sediment movement around, and also across, the banks. This is evidenced by megaripple and sandwave formations on the banks. Infaunal communities of the sandy bank tops are consequently of low biodiversity, characterised by mobile polychaetes (catworms) and amphipods (shrimp-like crustaceans) which are able to rapidly re-bury themselves into the dynamic sediment environments. Along the flanks of the banks, and towards the troughs between the banks the sediments tend to be slightly more stable with gravels exposed in areas. In these regions of the site, infaunal and epifaunal communities are much more diverse. There are a number of areas where sediment movements are reduced and these areas support an abundance of attached bryozoans, hydroids and sea anemones. Other tube-building worms such as keel worms *Pomatoceros* sp. and sand mason worms *Lanice conchilega* are also found in these areas, along with bivalves and crustaceans.

Sabellaria spinulosa reefs are located at Haisborough Tail, Haisborough Gat and between Winterton Ridge and Hewett Ridge. They arise from the surrounding coarse sandy seabed to heights of between 5cm to 10cm. The reefs are consolidated structures of sand tubes showing seafloor coverage of between 30 per cent to areas where reef occupies 100 per cent of the sediment. Some parts of the reefs appear to be acting as sediment traps, with exposed tube height accordingly reduced within the core parts of reefs.

A more detailed characterisation of the site is provided in section 10.

5.1 Haisborough, Hammond and Winterton cSAC Annex I Habitat Comparison

This site is located within the Southern North Sea Regional Sea (Defra, 2004). Listed below (Table 5.1) are existing SACs, pSACs and cSACs within the same area that also contain sandbanks as a qualifying Annex I habitat. A brief summary of the type of sandbank at each location is included. A number of sites for sandbanks in the Southern North Sea Regional Sea are proposed for designation in order to ensure sufficient sandbank habitat is represented with the Natura 2000 network of sites for the UK, and because sandbank habitat in UK waters is located primarily in the southern North Sea and Irish Sea. Several sites are proposed also to ensure representation of the range of sub-types of this habitat within the SAC network. The different sites represent different sub-types of sandbank habitat, from sheltered estuarine and sandbanks, vegetated sandbanks, to different physiographic types associated with headlands, and offshore shelf sandbanks. Each has a slightly different range of sediment types, salinity and exposure to tides and wave action which results in different ranges of associated biological communities.

In addition both Inner Dowsing, Race Bank and North Ridge cSAC and North Norfolk Sandbanks and Saturn Reef cSAC also contain Annex I *Sabellaria spinulosa* reef feature as does The Wash and North Norfolk Coast SAC (Table 5.2). There are also other sites in the region that contain reef feature and a brief summary of the type of reef at each site is included.

Table 5.1 SACs, pSACs and cSACs comprising sandbank habitat

Site	Description of relevant qualifying features
The Wash and North Norfolk Coast SAC	One of the largest expanses of inshore sublittoral sandbanks in the UK, and representative example of this habitat type on the more sheltered east coast of England. Headland associated, estuary mouth sandbanks and sandy mounds are all found at this site. The sandbanks vary in composition from coarse gravelly sand to muddy sand, and some support eelgrass beds. Salinity is variable/reduced and coastal influence is strong. Benthic communities on sandflats in the deeper, central part of the Wash are particularly diverse (brittlestar beds, polychaete *Lanice conchilega*, and the bivalve *Angulus tenuis* are present). The banks also provide nursery grounds for commercial fish species. This site is also designated for *Sabellaria spinulosa* biogenic reef interest feature.
Essex Estuaries SAC	Estuary mouth sandbanks in variable/reduced salinity and subject to strong coastal influence. These subtidal sandbanks are unvegetated and composed of gravelly and muddy sand.
Humber Estuary SAC	Estuary mouth sandbanks in variable/reduced salinity and subject to strong coastal influence. These subtidal sandbanks are unvegetated and composed of muddy sand.
North Norfolk sandbanks and Saturn reef cSAC	The North Norfolk Sandbanks are the most extensive example of the offshore linear ridge sandbank type in UK waters (Graham *et al*, 2001). They are subject to a range of current strengths which are strongest on the banks closest to shore and which reduce offshore (Collins *et al*, 1995). The outer banks are the best example of open sea, tidal sandbanks in a moderate current strength in UK waters. The banks support communities of invertebrates which are typical of sandy sediments in the southern North Sea. This site is also designated for *Sabellaria spinulosa* biogenic reef interest feature.
Dogger Bank pSAC	The Dogger Bank is the largest single continuous expanse of shallow sandbank in UK waters and was formed through glacial processes and submergence through sea-level rise. Its location in open sea exposes the bank to substantial wave energy and prevents colonisation of the sand by vegetation. Sediments range from fine sands containing many shell fragments on top of the bank to muddy sands at greater depths supporting invertebrate communities characterised by polychaete worms. Sand eels are an important prey resource found at the bank supporting a variety of species including fish, seabirds and cetacean,
Inner Dowsing, Race Bank and North Ridge sandbanks cSAC	The site contains a number of alternating ridge headland associated sandbanks. Inner Dowsing to the west of the site is a single large sandbank whereas the Race Bank/North Ridge to the east forms a series of sinuous sandbanks. A significant amount of *Sabellaria* is found in the troughs of these sandbanks along with a high diversity of attached epifauna such as bryozoans, hydroids, sponges and tunicates. This site is also being recommended for *Sabellaria spinulosa* biogenic reef interest feature.

Margate Sands and Long Sands cSAC	This site is characterised by two distinct areas of Estuary mouth associated sandbank features; Margate Sands banks which are composed of well sorted sandy sediments, with muddy and gravelly sediments in the troughs and the highly dynamic Long Sands sandbank which is composed of sand and gravel. The Margate Sands banks are more biologically diverse than the Long Sands bank and are dominated by polychaete worms and amphipods. The troughs of all the banks are more biologically diverse than the peaks.

Table 5.2. SACs and cSACs in the region containing Annex I reef habitat.

Site	Description of relevant qualifying features
Flamborough Head SAC	Bedrock and boulder chalk reefs which extend from the infralittoral to the circalittoral zone. The presence of many overhangs and vertical faces adds to the topographic complexity of the interest feature. These full salinity reefs are subject to strong coastal influence and high to moderate energy levels. Some typically northern species reach the edge of their range at this site (e.g. the northern alga *Ptilota plumosa*).
Thanet Coast SAC	Chalk bedrock reefs with associated chalk-boring fauna and flora. This inter-tidal and infralittoral feature has relatively high topographic complexity and is strongly influenced by coastal processes. It is in full salinity and exposed to moderate energy levels. The reefs are comparatively impoverished, owing to the harsh environmental conditions. Species present include an unusually rich littoral algal flora, essentially of chalk-boring algae.
The Wash and North Norfolk Coast SAC	The *Sabellaria spinulosa* reefs stand up to 30cm proud of the seabed and extend for hundreds of metres. The reefs are diverse and productive habitats which support many species that would not otherwise be found in predominantly sedimentary areas. Associated motile species include large numbers of polychaetes, mysid shrimps, the pink shrimp *Pandalus montagui*, and crabs.
North Norfolk sandbanks and Saturn reef cSAC	The Saturn *Sabellaria spinulosa* reef, first discovered in 2002, consisted of thousands of fragile sand-tubes made by ross worms which have consolidated together to create a solid reef structure rising above the seabed. More recent surveys have not found extensive reef structures in the same location. It is possible that the reef was damaged by anthropogenic activity, and as the site clearly provides favourable conditions for *Sabellaria* reef formation, the site is proposed with the possibility of allowing extensive reef structures to recover.
Inner Dowsing, Race Bank and North Ridge cSAC	The site contains a significant amount of *Sabellaria spinulosa* reef which is found in the troughs of sandbanks along with a high diversity of attached epifauna such as bryozoans, hydroids, sponges and tunicates.

6. Feature characterisation and delineation of site boundary

6.1 Sandbank data sources

An initial appraisal of the occurrence of Annex I sandbank habitat was completed on Natural England's behalf by Entec in 2008 (Entec UK Ltd, 2008a, b). This work examined data from a variety of sources including windfarm and aggregate surveys, dedicated survey and modelling (Table 10.1). After the assessment by Entec in 2008 more data became available via the SeaZone Digital Survey Bathymetry (DSB) (SeaZone Solutions, 2009b), digitised through funding from the

Marine Aggregate Levy Sustainability Fund. Further data was also provided by the aggregates industry (HAML, 2009) and through the consultation on a previous version of this document.

The DSB data provided good spatial coverage of Haisborough, Hammond and Winterton cSAC with the exclusion of the north-east corner of the site. In this latter area, supplementary data from the SeaZone coastal Digital Elevation Model was used (SeaZone Solutions Ltd, 2009a). From both datasets, an accurate delineation of Annex I sandbank features was undertaken using a slope analysis in GIS. Guidance by Klein (2006) on delineating sandbanks was applied using a slope angle of 0.5° for delineating the edges of the bank features. The main bank structures themselves were easily identifiable by viewing the 1° slope layer alongside the 0.5° slope layer. Once identified, these sandbank features were cross-referenced with sedimentological data to confirm that they consisted of sandy sediment, as defined in the Annex I sandbank definition (EU, 2007). Seismic (sub-bottom profile) data was reviewed and analysed to assess sandbank internal structure to assist with delineating bank extent.

6.2 *Sabellaria spinulosa* reef data sources

Following the formal consultation of a previous version of this document, two important datasets on the distribution of *Sabellaria spinulosa* reef were received; one from the Marine Aggregate Levy Sustainability Fund's East Coast Regional Environmental Characterisation (REC) survey (MALSF, 2010) and the other from the Baird gas storage & pipeline environmental characterisation (Gardline Environmental Ltd, 2010). Both datasets were of a high standard consisting of high resolution acoustic data ground-truthed with drop-down video and still photography (Table 10.1).

The acoustic data took the form of high resolution multibeam bathymetry and sidescan sonar data for the Baird pipeline corridor and high resolution swathe bathymetry for the REC data. The videos were reviewed and assessments of: tube height; aggregations; patchiness (percentage cover); extent; and associated fauna were recorded. The observations were tested using the reef assessment guidance from JNCC (Gubbay, 2007).

The sidescan data was plotted in GIS software and cross-referenced with known locations of reef, as identified by video transects. The multibeam bathymetry was viewed in a 3D visualisation software package (Fledermaus) in addition to being plotted in GIS. The acoustic signatures of the reef features were assessed allowing the extents of some reefs to be plotted.

Sabellaria spinulosa reef is distributed across the site. It is prevalent in the troughs between closely-spaced sandbanks and is not apparent on any banks. Three reefs have been identified within the site; Haisborough Gat, Haisborough Tail and Winterton Ridge reefs.

In the map (section 4) Haisborough Tail Reef is mapped on to the sandbank feature of Haisborough Tail. It is likely that the sandbank will have moved slightly from its originally mapped position and thus the reef appears on top of the sandbank. This is a data artefact due to the age of the data sets used to map each feature (with the reef data being more recent than the sandbank data) and reflects the mobility of central sandbanks. It is important therefore to be aware that the map in Section 5 is indicative and represents the best available evidence for each feature available at the time of publication.

It should be noted that the mapped extents of reef are currently restricted by the available acoustic data. For the Haisborough Tail and Winterton Ridge reefs the extents are mapped from data derived from a 500 metre-wide survey corridor running across the site east to west. It is likely (but not currently proven) that the reefs extend beyond the survey corridor bound by the narrow troughs of the Haisborough Tail bank and similarly between Winterton and Hewett Ridges. The Haisborough Gat reef is presently only indicated as point data, rather than having its extent mapped. This is a result of the MALSF EC REC acoustic data provided for review consisting only

of multibeam bathymetry data without accompanying side scan sonar data. The side scan data was not quality assured at the time of the evidence review (March 2010). Best practice for determining reef extent demonstrates that side scan sonar should be used to map the habitat feature (Gubbay, 2007; Limpenny *et al,* 2010). It is anticipated that the EC REC side scan sonar data will be available early summer 2010. When available it will be analysed and used to update reef extent.

6.3 Site boundary delineation

The boundary around the Haisborough, Hammond and Winterton cSAC has been drawn using the guidance provided by JNCC (2008) (see Appendix 1). The key parts of this guidance are that the site boundary should be defined as simply as possible with a minimum number of straight lines, and should include the minimum area necessary to ensure protection for the Annex I habitat of interest. More complex shapes drawn more tightly around feature of interest are favoured over simple square/rectangular boundaries, to reduce the area of 'non-interest-feature' included within the site boundary. Where it is justified to protect the features of the site from the effects of mobile gear on the seabed at some distance from a vessel on the surface, a margin in proportion to the water depth may be added to the extent of the feature when defining the site boundary. The cSAC contains Annex I sandbanks at depths of predominantly <25m BCD. Therefore, a margin of 100m was used around each sandbank feature except where a straight line between two points was the more sensible option to avoid an overcomplicated boundary following the guidance.

7. Assessment of interest feature(s) against selection criteria

A full explanation of the application of the site selection criteria can be found on JNCC's website at www.jncc.gov.uk/page-4165.

7.1 Sandbanks which are slightly covered by sea water all the time

Annex III selection criteria (Stage 1A):

7.1.1 Representativity (a)

The Haisborough, Hammond and Winterton site is located in the Southern North Sea Regional Sea and represents sandbank and biogenic reef. It contains a number of non-vegetated sublittoral headland associated sandbanks with alternating ridges. These sandbanks are curved and orientated parallel to the coast, composed of sandy sediment and lie in full salinity water with intermediate coastal influence.

The site contains a mosaic of different physical habitats with correspondingly different biological communities. The fauna of the sandbank crests is predominantly low diversity polychaete-amphipod communities which are typical of mobile sediment environments. The banks are separated by troughs which contain more gravelly sediments and support diverse infaunal and epifaunal communities with occurrences of reefs of the tube-building ross worm *Sabellaria spinulosa*. Aggregations of *S. spinulosa* provide additional hard substrate for the development of rich epifaunal communities.

The Haisborough, Hammond and Winterton site is graded A (excellent representativity).

7.1.2 Area of habitat (b)

The area of Haisborough, Hammond and Winterton Annex I sandbank habitat within the site,

based on slope analysis, occupies 66,900 ha. Approximately two thirds of this habitat area occurs in waters deeper than 20m.

The evaluation of relative surface area is approximate as it is not possible to calculate an accurate total extent figure for Annex I shallow sandbank habitat for UK waters. A best minimum estimate, based on the mapped area of sandy sediments in less than 20m water depth, of 1,720,000 hectares has been used to assess area of habitat, as these areas will always be part of the Annex I habitat. This figure gives the following thresholds for the grades of this criterion (CEC, 1995):

A – extents between 258,000 and 1,720,000 ha (15-100% of total resource)
B – extents between 34,400 and 258,000 ha (2-15% of total resource)
C – extents less than 34,400 ha (0-2% of total resource)

Haisborough, Hammond and Winterton Annex I sandbank habitat occupies a minimum area of 24,696 ha (based on the area of sandy sediments within the 20m contour, Chart Datum). This value is equivalent to 1.44% of the UK total resource (based on the area of sandy sediments within the 20m contour, CD) and is graded C.

The actual area of sandbank feature can extend below the 20m depth contour (CEC, 2007). Therefore an additional maximum estimate of UK sandbank resource has been calculated based on the mapped area of sandy sediments in less than 50m water depth that adjoin areas of sandy sediment in less than 20m water depth. This figure of 8,010,000 hectares is an over-estimate, used to provide an additional assessment of area of habitat, and is under review. This figure gives the following thresholds for the grades of this criterion (CEC, 1995):

A – extents between 1,201,500 and 8,010,000 ha (15-100% of total resource)
B – extents between 160,200 and 1,201,500 ha (2-15% of total resource)
C – extents less than 160,200 ha (0-2% of total resource)

Haisborough, Hammond and Winterton Annex I sandbank habitat occupies a maximum area of 66,900 ha (based on the actual area of Annex I sandbank habitat, which extends deeper than 20m). This value is equivalent to 0.84% of the UK total resource (based on the area of sandy sediments within the 50m contour, CD) and is graded C.

The site contains between 0-2% of the national Annex I sandbank resource, and is graded C.

7.1.3 Conservation of structure and functions (c)

Degree of conservation of structure
Within the Haisborough, Hammond and Winterton candidate SAC there are a number of human activities which have affected, and may continue to affect, the structure of the sandbanks.

A number of gas fields overlap the northern and eastern boundaries of the site, and pipelines carrying gas and chemicals cross the site. There are also subsurface structures associated with the pipelines present in the site, including rock armouring, and a number of surface structures associated with wellheads. Pipelines primarily run around the north western boundary and across the centre of the site although other pipelines from fields further offshore cross the southern part of the site. A number of submarine cables also pass through the site which, although are unlikely to have an effect on the site now, may have during laying/commissioning. Installation of structures

relating to the gas industry is invasive, and is likely to have affected the structure of the sandbanks during commissioning.

The south eastern corner of the site around Smiths Knoll is heavily fished by trawlers, probably for sandeel and pink and brown shrimp. Trawling the seabed with towed gear is known to disturb the surface sediments and disturb biological communities, leaving tracks which may slowly fill-in over time so previous seabed damage may not now be visible. Some static gear is used around Hammond Knoll and Hewett Ridges. To the north and west of the site, the key fishing activities are less damaging, and include gill netting, long lining and potting. The eastern part of the site is known to be a sandeel spawning area (Cefas, 2001).

Commercial aggregate extraction takes place along the site boundary. Whilst none of the licence areas are co-incidental with designated feature, three licence areas and two application areas are located within the southern part of the site.

Environmental impact monitoring of aggregate extraction adjacent to the proposed site is variable depending upon the type of licence that has been awarded. Older Government View licences (from the mid-1980) do not have statutory environmental monitoring requirements, whilst newer licences do. However, all extraction areas have geophysical data to allow assessment of bathymetric changes, sediment types and resource depths. Results indicate that there are localised effects on the bathymetry of the seabed but no significant impact on the sandbank systems or sediment transport pathways (Seiderer, 2005; HAML, 2009). The extraction activity is targeting relict deposits (post-glacial gravels) and does not directly coincide with any Annex I habitat features. Further the particle size composition of the deposits within the licence areas as a whole have remained unchanged (factoring for natural variations). As such apart from strictly localised lowering of the seabed in the actively-dredged zones, there is no evidence of effects on sediment composition, geomorphological structure or the benthic fauna of the sandbank features (Seiderer, 2005; HAML, 2009).

The Haisborough, Hammond and Winterton site has been graded II (structure well conserved) for the conservation of structure sub-criterion.

Degree of conservation of functions
The sandbanks within the Haisborough, Hammond and Winterton site are dynamic sediment environments and survey information, although limited, indicates that the locations of the sandbanks are relatively stable over time (UKHO, 2007). This indicates that the physical structure of the banks will be maintained in the absence of anthropogenic disturbance.

The key activities likely to affect the functioning of the sandbank systems in this area are trawling and activities associated with the extraction of gas within the site (including the maintenance or installation of pipelines crossing the site, and the maintenance and installation of surface infrastructure). Secondary impacts from marine aggregate dredging plumes have to be considered, but within the context of natural background suspended sediment concentrations. The prospects for this feature to maintain its functions in the future, taking into account known pressures and management of activities are good.

The Haisborough, Hammond and Winterton site is graded II (good prospects)

Restoration possibilities
As the site has been graded II for both the conservation of structure and the conservation of function sub-criteria, there is no requirement to assess the restoration possibilities sub-criterion.

Overall grade:
The Haisborough, Hammond and Winterton site has been graded II for the conservation of structure sub-criterion, and II for the conservation of function sub-criterion.

The overall grade for the conservation of structure and function criterion is grade B (good conservation value).

7.1.4 Global assessment (d)

Overall the site represents a large area of good quality sandbanks. Although the site has been affected by a number of human activities, it is considered to be in good condition overall. It supports a range of invertebrate infauna typical of such habitats found in the Southern North Sea region.

The sandbank feature is graded B for the global assessment criterion (good conservation value).

7.2 Reefs

Annex III selection criteria (Stage 1a)

7.2.1 Representativity (a)

Three *Sabellaria spinulosa* reefs have been identified within the site: Haisborough Tail reef, Haisborough Gat reef and Winterton Ridge reef. The site represents *S. spinulosa* reef occurring between closely-spaced sandbanks in the troughs and in open tide-swept sand habitat. The habitat feature is located in full salinity waters and separated from coastal influences by the series of sandbanks aligned along the coast. Remote (acoustic) sensing data and ground-truthing images of the reefs show the consolidated reef structures arising between 5 to 10cm above the seabed. The coverage of reef covers an area in excess of 90 ha (an under-estimate as the extent of Haisborough Gat reef is yet to be quantified) and shows a range of consolidation and patchiness ranging from 30 per cent through to 70-100 per cent coverage. Video and still photography indicate that the reefs are representative of those found elsewhere in the Southern North Sea region, most notably in The Wash and its approaches. Epifauna consisting of erect hydroids and anemones with mobile predators such as pink shrimp *Pandalus montagui* and velvet swimming crab *Necora puber* are evident. Despite the widespread occurrence of the species *S. spinulosa*, there are few known areas of well developed biogenic reef formed by this species in UK waters (and very few in other European territorial waters).

The Haisborough, Hammond and Winterton reefs have been graded A (excellent representativity)

7.2.2 Area of habitat (b)

An evaluation of relative surface area is approximate as no accurate total extent figure is available for Annex I reef habitat for UK waters. The closest approximation available for the entire resource (bedrock, cobble and biogenic reef) in UK waters is 7,180,000 hectares. This total extent figure

gives the following thresholds for the grades of this criterion (Commission of the European Community, 1995):

A – extents between 1,077,000 and 7,180,000 ha (15-100% of total resource)
B – extents between 143,600 and 1,077,000 ha (2-15% of total resource)
C – extents less than 143,600 ha (0-2% of total resource)

The current total mapped extent of reef is 90.56 ha and therefore represents less than 2% of the total resource.

The site contains between 0-2% of the national Annex I reef resource and is graded C.

7.2.3 Conservation of structure and functions (c)

Degree of conservation structure
The biological and physical structure of the biogenic reef in the site is largely intact. The Haisborough Tail and Winterton Ridge reefs both appear to be healthy showing no evidence of damage of deterioration. There is, however, some evidence of trawl scars associated with the Haisborough Gat reef. This has resulted in localised reef fragmentation and will likely have an effect on the community structure where this impact has occurred. The greatest pressure to *S. spinulosa* reefs is considered to be physical disturbance typically from bottom trawl fisheries or direct impact from aggregate dredging, and cable or pipeline installation.

The three reefs within the site are all outside any area of influence (either direct or secondary impacts) from marine aggregate extraction operations and no link to damaging effects is evidenced. Pipelines and cables are present in the site and where these already exist no effect is noted on reef structure. However new installations will potentially damage existing reef. In these cases further quantification of the extent of reefs will allow project-specific determinations of significance of interactions. At other sites best practice for cable installation has included micro-routing around reef locations. It may also be appropriate to apply this practice to pipeline installation. As previously stated there is evidence of bottom trawl gears impacts on part of the Haisborough Gat reef.

The Haisborough, Hammond and Winterton reef feature is graded II (structure well conserved)

Degree of conservation function
The recent surveys (MALSF 2010; Gardline Environmental Ltd, 2009) have detected three core areas of reef across the site. From the distribution of the reefs and visual assessment of their quality and condition it appears that the physical and biological systems supporting the habitat is functioning in a natural and healthy manner. It is important to note that there is no temporal data (beyond single survey events) for any of the reef so historical changes in extent and condition are unknown. However knowledge regarding the physico-chemical and geomorphological systems supporting the reefs indicate that the functioning of the wider system is good (HR Wallingford *et al*, 2002). The presence of the three reefs and high abundance of consolidated epifaunal crusts in the area indicates that the outer Great Yarmouth environs are particularly suitable for the development of substantial and extensive reef structures. *S. spinulosa* is also known to preferentially settle on suitable habitat where the species has been present before (Hendrick and Foster-Smith, 2006; UK Biodiversity Group, 1999; Wilson, 1970).

The Haisborough, Hammond and Winterton reef feature's conservation of function is graded II (good prospects)

Restoration possibilities
As the site has been graded II for both the conservation of structure and the conservation of function sub-criteria, there is no requirement to assess the restoration possibilities sub-criterion.

Overall grade:
The Haisborough, Hammond and Winterton reefs have been graded II for the conservation of structure sub-criterion, a score of II for the conservation of function sub-criterion.

The overall grade for the conservation of structure and function criterion is grade B (good conservation) for reefs

7.2.4 Global assessment (d)

The suggested grades for Stage 1A criteria a)-c) are A, C and B respectively.

The assessment of Area of Habitat (criterion b) is made with reference to the area of *all* sub-types of reef habitat combined (bedrock, cobble and biogenic). Because the *Sabellaria spinulosa* reef at this site occupies a relatively small area in relation to the total UK reef resource, its grade for this criterion is C as reefs overall are widely distributed and extensive in UK waters. The ross worm species *S. spinulosa* itself is widely distributed and common in UK waters, occurring as individuals and also forming 'crusts' of many individuals on sandy and mixed coarser sediments as well as rock. However, substantial reef structures formed by *S. spinulosa* could be considered rare as they are relatively small (less than 1000ha). Due to the scarcity of this sub-type of reef habitat in UK and European waters, a high proportion of the habitat should be protected.

Given the grades awarded for criteria a)-c), the scarcity of *S. spinulosa* biogenic reef in UK waters, and the large extent and good development of this reef subtype, the reef has been graded A ('excellent conservation value') for the global assessment.

The reef feature is graded A (excellent conservation value)

7.3. Summary of scores for Stage 1a criteria

Haisborough, Hammond & Winterton	Representativity (a)	Relative surface (b)	Structure and function (c)	Global assessment (d)
Sandbanks	**A**	**C**	**B**	**B**
Reefs	**A**	**C**	**B**	**A**

For the global assessment criteria the sandbank feature is graded B (good conservation value) and the reef feature is graded A (excellent conservation value). The reason for the difference in global assessment between the features is due to the fact that the sandbank Annex I habitat is good at a national level whilst the Annex I reef habitat is outstanding due to the rarity and conservation value of *Sabellaria spinulosa* reef in a European context.

7.4 Harbour porpoise *Phocoena phocoena*

Annex III selection criteria (Stage 1B):

7.4.1 Size and density of the population of the species present on the site (a)

Small numbers of harbour porpoise *Phocoena phocoena* are also regularly observed within the site boundary (Entec, 2008a). Due to the highly mobile nature of harbour porpoises and the small size of the candidate SAC, the Haisborough, Hammond and Winterton cSAC is considered to be grade D, i.e. a non significant presence, for this species. As such, no other indication is required for the additional evaluation criteria concerning this species within the site.

7.5 Grey Seals *Halichoerus grypus*

Annex III selection criteria (Stage 1B):

7.5.1 Size and density of the population of the species present on the site (a)

There is reported to be large breeding colony of 400 to 500 grey seals (*Halichoerus grypus*) adjacent to the site (Rick Southwood, pers. com.). There is currently no evidence of the SAC area being essential to the life and reproduction of grey seals, but due to the proximity of the colony and the use of the SAC area by the seals, the Haisborough Hammond and Winterton cSAC is considered to be grade D, i.e. a non significant presence for the species. As such, no other indication is required for the additional evaluation criteria concerning this species within the site.

8. Bordering sites

The northern edge of the site boundary is adjacent to the North Norfolk sandbanks and Saturn reef cSAC.

9. Supporting scientific documentation

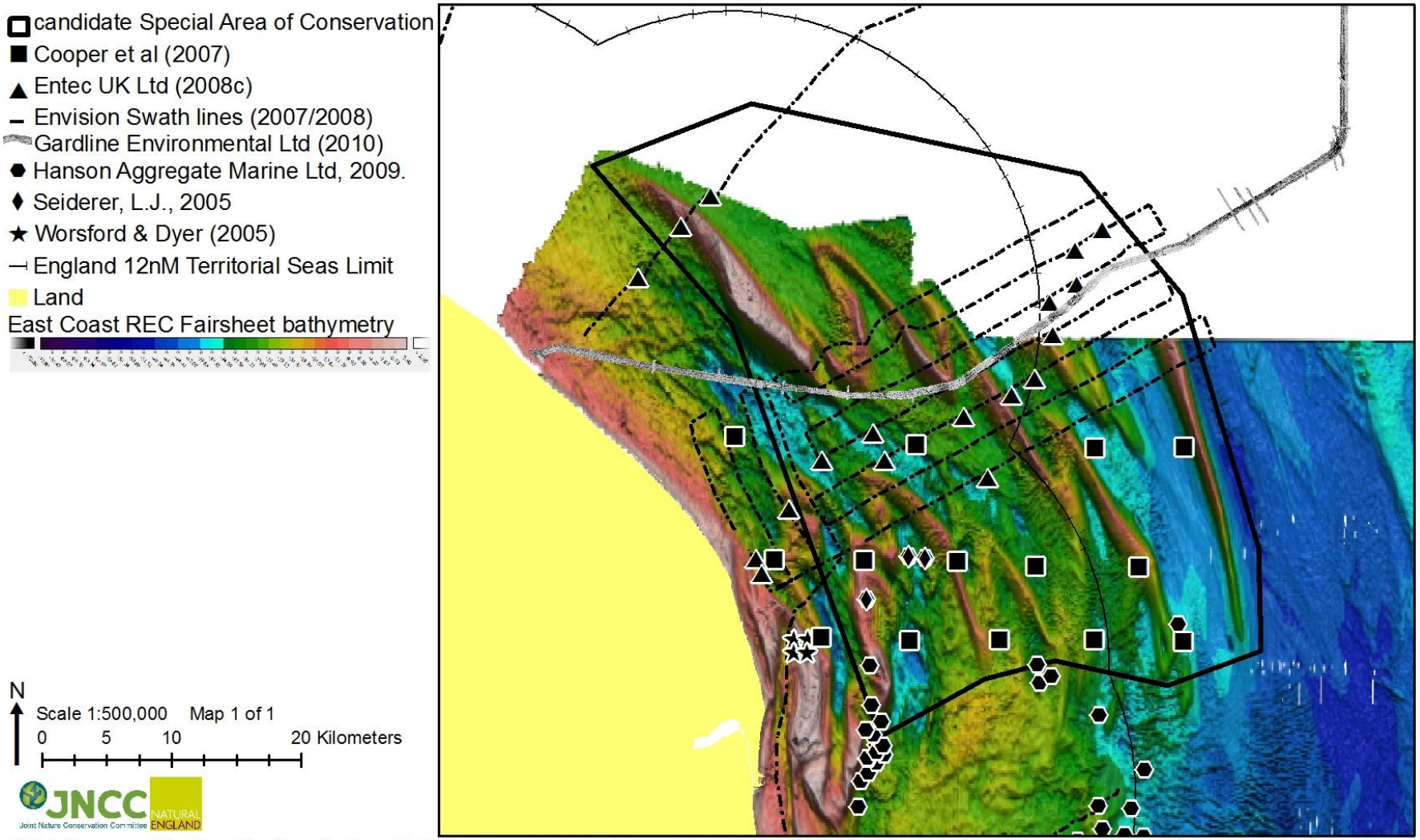
Scientific information on the topography, habitats and species present within the Haisborough, Hammond and Winterton candidate SAC boundary is available from a number of sources. These are listed in table 9.1 below and the location of survey samples in figure 9.1.

Table 9.1 Information sources used to underpin SAC designation

Reference	Description
COOPER, K., BOYD, S., ALDRIDGE, J., & REES, H., 2007. Cumulative impacts of aggregate extraction on the seabed macroinvertebrate community in the area off the east of the UK. Journal of Sea Research, 57, 288-302.	Scientific study of aggregate site.
ENTEC UK LTD., 2007. Summary of report on the data acquisition phase of the characterisation of possible marine SACs (outer Wash sandbanks and outer Thames Estuary). Report to Natural England as part of Contract FST20-18-030, April 2007.	Surveys to specifically identify Annex I interest features.
ENTEC UK LTD, 2008c. SAC selection Assessment: Outer Wash Sandbanks. Report to Natural England as part of Contract FST20-18-030.	Surveys to specifically identify Annex I interest features.
GARDLINE ENVIRONMENTAL LTD. 2010. Bacton to Baird Pipeline Route and Environmental Survey, October and November 2009, Habitat Assessment Report. 1578-0709-BSCL. February 2010.	Seafloor environmental characterisation survey data used to support an assessment of environmental impacts of planned gas pipeline installation.
HANSON AGGREGATE MARINE LTD (HAML). 2009. Licence Area 436/202 Cross Sands Monitoring Report.	Impact assessment monitoring data associated with 10 year review of aggregate dredging activity. Comparative multibeam bathymetry analyses of Cross Sands banks.
MARINE AGGREGATE LEVY SUSTAINABILITY FUND (MALSF). 2010. East Coast Regional Environmental Characterisation preliminary data. www.marinealsf.org.uk.	Survey data to set an environmental characterisation of the seafloor at a large regional scale.
SEAZONE SOLUTIONS LTD. 2009a. Coastal Digital Elevation Mode.	Bathymetric data used to map base of sandbanks.

Reference	Description
SEAZONE SOLUTIONS LTD. 2009b. Digital Survey Bathymetry for the East Coast REC study area	Bathymetric data used to map base of sandbanks.
SEIDERER, L.J., 2005. Government View Application - Area 202: Cross Sands Extension. An update of the Environmental Statement - 5 years post-dredging. Prepared for Hanson Aggregates Marine Limited by Marine Ecological Surveys Ltd.	Survey of aggregate site.
WORSFORD, T.M. & DYER, M.F., 2005. Benthic ecology of Scroby Sands windfarm site: results of July 2005 (post-construction) survey and comparison with 1998 (pre-construction) survey. Unicomarine Report EONSCR05 to E.On UK Renewables Offshore Wind Ltd.	Offshore windfarm monitoring report.

Figure 9.1 The distribution of survey sample sites for the surveys referred to in table 9.1



10. Site overview and conservation interest

10.1 Sediment Conditions and Bathymetry

The sandbanks within the site are generally referred to as the Great Yarmouth Banks and lie sub-parallel to the modern Norfolk coast (Cooper *et al,* 2008). The inner banks such as Caister Shoal, Cockle Shoal & the Scroby Sands banks, whilst Annex I qualifying habitat, are not included as Annex I sandbank for which this site is proposed as they represent a different sub-type of the habitat and are attached to the shoreface at the headland known as Caistor Ness. The Annex I sandbanks within the cSAC are all separated from shoreface geomorphological processes. The inner sandbanks of Newarp Banks and North Cross Sands occupy the south-west quadrant of the site and are the youngest of the banks aged at approximately 1,500BP (Cooper *et al,* 2008). These sandbanks have thus only relatively recently become separated from their shoreface-associated sister banks. The series of sandbank ridges that extend offshore across the middle of the site are curved and orientated parallel to the coastline, and show clear evidence of the S-shaped bank structure typical of alternating ridge headland associated banks (Dyer & Huntley, 1999). They are believed to have evolved following the marine transgression dated to 3,500BP and be derived from erosion of the Norfolk coast as it retreated westwards. Evolution of ebb and flood channels separated these banks from both the outer banks and the younger inner banks (Cooper *et al,* 2008). The outer banks form a clear procession of parallel ridges aligned north west/south east, and conform to the description of Open shelf ridges (Dyer & Huntley, 1999). These banks date to approximately 7,000 BP and are believed to originate from the coastal transgression following the last glacial retreat. At that time the coast was positioned much further offshore (from the modern location) and the point where the coast changes its orientation (from north-west to southerly) was much further north. The outer banks, Hewett Ridge and Smiths Knoll are now relatively immobile.

The series of banks associated with the middle of the site run north-west to south-east starting with Haisborough Sand and Haisborough Tail, then Hammond Knoll running into Winterton Ridge and finally Hearty Knoll. The northern end of Haisborough Sand is composed of medium and fine sand, with a steeper slope on the east flank. The bank is covered with megaripples and sandwaves. Winterton Ridge is also composed of sand and has large sandwaves which indicate that strong tidal currents run along the bank. Like Haisborough Sand, Winterton Ridge has a steeper slope on the east flank than the west flank. To the east of the ridge, sediments are more shelly and gravelly, often with large sandwaves.

Historically, the sediment supply for the sandbanks was associated with the retreating Norfolk coastline (approximately 5km in the last 5,000 years or at a rate of 1 metre per year), although this supply of sediment does not appear to support the banks now. A series of ebb and flood meanders isolated the designated sandbanks from the coastal and shoreface sediment transport processes (Cooper *et al,* 2008). The offshore sediment transport pathways are believed to move along the in a south-easterly direction along the North Norfolk coast as far as Winterton Ness. At this point they switch southwards. The inner sandbank system appears to be ebb-dominated and isolated from the outer southerly transport system. These inner banks, such as the Cross Sands and Newarp banks are migrating northwards. Studies of sediment transport and bedform evidence in the area do not appear to support a clear offshore transport of sediment to the outer banks (HR Wallingford *et al*, 2002).

The sandbanks within the site represent dynamic sediment environments, evidenced by fields of megaripples and sandwaves on the flanks of the banks, and sand ribbons showing across-bank movements. There is evidence of a clockwise movement of sediment around Haisborough Sand, which could take around 550 years to make a complete circuit (McCave & Langhorne, 1982). However, the sandbanks are not entirely closed sediment systems, and the bedforms present on the banks show an overall movement of sediment from the broad head of the bank to the narrow

tail, implying that sediment enters the area from the south east and leaves to the north west (Dyer & Huntley, 1999).

A detailed study of the movement of sediments on Haisborough Sand and Haisborough Tail (McCave & Langhorne, 1982) indicated that there is a level of across-crest movement in addition to the north west movement of the southern flank and the south easterly movement of the northern flank. The McCave and Langhome (1982) analysis also suggests that the main position of the Haisborough banks has been stable since 1886, and that the rate of lateral crest migration is in the order of 2.5m per year. Monitoring data from the aggregate dredging permission area 436/202 demonstrates that Middle and North Cross Sands banks are moving eastwards and northwards, respectively, by approximately 100m per year (HAML, 2009). The southern Newarp Banks are covered with megaripples and sandwaves which indicate constantly shifting sediments. However, recent survey data for this area (UKHO, 2007) indicates that the location of the bank has been reasonably stable over time, despite changes in the banks structure. The trend is one of shoaling towards the north west of the bank.

10.2. Benthic Invertebrate Communities

Tidal currents are strong within the site, and sediment mobility around the crests of sandbanks in the site is high as a result of the predominantly sandy sediments in the area. The infaunal and epifaunal communities found on the crests are relatively species-poor as a result of this highly dynamic sediment environment and the associated stresses of disturbance, smothering and scour. The north east corner of the site, between Smiths Knoll and Winterton Ridge, contains very low diversity communities in gravelly and sandy sediments (Figure 9.1 and Plate 1). Dominant fauna here are polychaetes (primarily *Nepthys cirrosa* and *Ophelia* spp.) and the amphipods *Bathyporeia elegans, Gastrosaccus* sp. and *Urothoe brevicornis*. Brittlestars *Ophiocten* sp. have also been recorded from this area. In the troughs the sediment is predominantly shelly/gravelly sand, with gravelly sand on bank crests. Similar communities have been recorded to the north of Newarp Banks, and at the northern end of Haisborough Sand (Entec, 2008a). The southern part of Smiths Knoll and the south eastern corner of the site also has a very low diversity mobile sand community, containing few individual polychaetes (primarily *Scoloplos armiger, Nephtys cirrosa, Ophelia borealis* and *Magelona mirabilis*) and amphipods *Bathyporeia tenuipes*, *Urothoe brevicornis* and *Caprella linearis* (Figure 9.1).

In the trough to the east of Haisborough Sand a similar but slightly lower diversity community is present, with little *S. spinulosa*. The barnacle *Balanus crenatus* is particularly abundant here (Entec, 2008a).

The area around Hammond Knoll and the inshore sections of Haisborough Gat contain more silty and gravelly sediments which support higher diversity communities including *S. spinulosa* reef and an attached epifauna of bryozoans and hydroids (Figure 9.1 & Plate 2). A wide variety of polychaetes are present in samples from this area, of which the most abundant are keel worms *Pomatorceros lamarki*, sand mason worms *Lanice conchilega* (Plate 3), *Spiophanes bombyx*, *Polydora caulleryi*, *Autolytus* sp. and *Harmothoe* sp. Sea anemones are also present, along with brittlestars *Ophiothrix* sp. (Plate 4), sea spiders and amphipods (the most abundant being *Unicola crenatipalma* and *Stenothoe marina*). A number of bivalve species are present, including *Mya truncata* and the mussel *Mytilus edulis* (Entec, 2008a).

The *Sabellaria spinulosa* reefs located at Haisborough Tail, Haisborough Gat and between Winterton Ridge and Hewett Ridge appear to be typical for the region. They arise from the surrounding coarse sandy seabed to heights of between 5cm to 10cm (Gardline Environmental Ltd, 2010). The reefs are consolidated structures of sand tubes showing seafloor coverage of between 30 per cent to areas where reef occupies 100 per cent of the sediment. Some parts of

the reefs appear to be acting as sediment traps, with exposed tube height accordingly reduced within the core parts of reefs. Species associated with the reefs include colonising fauna such as the hydroid *Nemerstesia antennina*, the bryozoan *Flustra foliacea* and the anemone *Sagartia elegans*. The crevices and nooks within the reef structure provide habitat for the squat lobster *Munida rugosa*, the velvet swimming crab *Necora puber* and the brittlestars *Ophiocomina nigra* and *Ophiothrix fragilis*. The pink shrimp *Pandalus montagui* was also present on and swimming around the reefs.

10.3 Fish and mammals

The Haisborough, Hammond and Winterton site is known to contain spawning grounds for sandeel *Ammodytes* spp., lemon sole *Microstomus kitt* and sole *Solea solea* (Cefas, 2001; Entec, 2008a), and provides nursery grounds for cod *Gadus morhua*, herring *Clupea harengus*, mackerel *Scomber scombrus*, sole, lemon sole and plaice *Pleuronectes platessa* (Cefas, 2001; Entec, 2008a).

11. Photographic plates

Plate 1: Medium rippled sand with sand eels *Ammodytes* sp

Plate 2: Fine sand and *Sabellaria spinulosa* crust

Plate 3: Fine sand colonised by sand mason *Lanice conchilega*

Plate 4:Medium sand with shell and silt; with brittlestars *Ophiothrix fragilis*

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13. Glossary

Abiotic Devoid of life

Aggregate dredging involves the removal of marine sand and gravel for use in construction or beach nourishment projects. The sediment resources are removed under a regulatory permission issued specifically for that purpose.

Amphipods are shrimp-like crustaceans ranging from 1 mm to 140 mm in length Marine amphipods may be pelagic (living in the water column) or benthic (living on the seabed). Pelagic amphipods are eaten by seabirds, fish, and marine mammals.

Banner Banks are generally only a few kilometres in length with an elongated pear-shaped form (Dyer and Huntley, 1999). They commonly lie in the lee of fixed obstacles such as headlands, islands, submerged rock shoals and gaps in rock ridges. They are sometimes paired on either side of the obstacle, with one larger than the other indicating a net direction of sand transport (Stride, 1982). Banner banks may also occur in areas with rapid deepening of water away from the coast and are less evident off coasts with a low offshore slope (Dyer and Huntley, 1999). Examples occur in the English Channel, Irish Sea and North Sea.

Bedforms Ripples moulded by a flow of water. Bedforms range in size from ripples in the sand, a few centimetres apart, to 'dunes' tens of metres in length.

Benthos Those organisms attached to, or living on, in or near the seabed.

Biotic Relating to, produced by, or caused by living organisms.

Biotope The physical habitat with its biological community; a term which refers to the combination of physical environment and its distinctive assemblage of conspicuous species.

Bivalves A class of molluscs which are laterally flattened and have a shell made of two hinged valves.

BP An abbreviation of Before Present used to represent time (measured in number of years) for historical or more distant events that have occurred in the past relative to the present day.

Bryozoans are tiny colonial animals that generally build stony skeletons of calcium carbonate, superficially similar to coral (although some species lack any calcification in the colony and instead have a mucilaginous structure).

Crinoids A class of echinoderms having a cup-shaped body with feathery arms, attached to the substratum, sometimes by a stalk.

Crustaceans A class of invertabrates which includes crabs, shrimps and barnacles.

Crustose Forming a thin crust on the substratum.

Dredging plumes

- **Fishing** Bottom trawling stirs up the sediment on the sea floor due to gear contact, resulting in plumes of suspended particulate matter potentially many kilometers long. These plumes will decrease light transmission through the water column and may also affect benthic fauna and flora when the particles settle. The effect of these plumes will decrease with time and distance.

- **Aggregate dredge plumes** Marine aggregate extraction can result in increased sediment concentrations in the water column – dredge plumes - either from the disturbance of the seabed by or through the return of excess water and associated suspended sediment from the dredging vessel itself through either overspill returns or screening. The most significant input will result from overspill/screening returns, however because the sediments being dredged are relatively coarse the majority of suspended sediment concentration will settle out relatively quickly – typically within 200m of the point of return. The remaining fine sediment component, along with associated organic matter, can extend considerably further, however the concentrations of these will also dissipate over time and distance.

Epifauna Animals living on the surface of the seabed.

Estuary mouth Dyer and Huntley (1999): "…in general linear sand ridges are associated with the mouths of macro-tidal estuaries (wide mouth), and tidal deltas are associated with meso-tidal or micro-tidal estuaries (narrow mouth)." The banks are generally "aligned with the tidal current flow and migrate away from their steeper face." Examples include Long Sand and Gunfleet Sand (in the Thames Estuary) and banks in The Wash.

Foliose Bearing leaves or leaf-like structures.

Fauna Animal life in an area.

GIS Geographic Information System.

Habitat The place in which a plant or animal lives.

Headland associated sandbanks Dyer and Huntley (1999): "Tidal eddies produced by headlands can create 'banner banks, but when the headland is retreating 'alternating ridges' can be formed which can become isolated from the coast as it recedes." "With very slow retreat the surplus sand will accumulate as a banner bank in a position of convergence. With coastline retreat, a series of alternating banks will result with each successive one more distant from the shoreline." Banner banks are only a few km in size and have an elongated pear-shaped form with the broad end being orientated towards the tip of the headland. Alternating ridges may be linear or V or S shaped.

Hydroids Solitary and colonial animals with a cylindrical; body which is closed at one end with a mouth surrounded by tentacles at the other.

Infauna Benthic animals which live within the seabed.

Linear Sandbanks are elongated banks which can be up to tens of kilometres long and less than ten kilometres wide. They lie generally parallel or at a slight angle to peak tidal currents. They can be found in open seas but are also common in large estuaries such as the Thames Estuary.

Long lining A commercial fishing technique that uses hundreds or even thousands of baited hooks hanging from a single line.

Maerl Twig-like unattached (free living) calcareous red algae, often a mixture of species and including species which form a spiky cover on loose small stones.

Megaripple Mounds or ridges of sand which are asymmetrical, and are produced under water by flowing water. The external morphology is similar to the smaller 'ripple' and larger 'sandwave, with

a gently sloping, upsteam side, and a steeper downstream side.

Nemerteans A phylum of invertebrate animals also known as *ribbon worms* or *proboscis worms*

Open shelf ridge Dyer and Huntley (1999): 'Nearly all shallow tidal seas, where currents exceed about 05m s-1 and where sand is present, have ridges. These can be up to 80km long, and typically average 13km width and tens of metres in height. Their spacing tends to be proportional to their width. The bank crests are flat in shallow water, but are sharp when water depth is large enough to limit wave effects.' Examples include South Falls and Indefatigables.

Polychaete A class of marine annelid worms.

Potting The setting of traps (pots) on the seabed to fish for lobsters, crabs etc.

Sand wave A large, ridge-like structure resembling a water wave on the upper surface of a sedimentary bed that is formed by water currents. Also known as sand ridge.

Sandy mounds Distinct sandbanks (i.e. elongated, rounded or irregular 'mound' shapes) which cannot be categorised as any of the other types.

Seagrass(es) Higher plants (angiosperms) that are adapted to living submerged in seawater.

Shoaling localized shallowing of water.

Sinuous Banks are 'S' or 'V' shaped sandbanks and are common off the Norfolk coast and in the southern North Sea. They are large scale features and may occur in extensive groups which can include linear banks. Good examples are Haisborough Bank and Winterton Shoal.

Sinusoidal having a succession of waves or curves

Static gear Any gear which is set in position and not moved during the fishing process. Examples include:

- Gill nets which are set at or below the surface, on the seabed, or at any depth in-between.
- Setting pots on the seabed to capture lobsters and crabs.
- Long lining when a single line is set to capture cod, skate, bass and whiting.

Submarine cables Cables which are laid beneath the seabed to carry telecommunications or power to offshore installations or different countries.

Trawling Towing equipment behind a vessel for commercial fishing principally for cod, plaice and sole. Bottom trawls collect demersal (living on or near the seabed) species and mid-water trawls collect pelagic (living in the water column) species. Examples of towed gears include beam trawls, dredges and trawl nets.

Turbidity This is a measure of the attenuation of light in the water column and can be caused by the light adsorption properties of the water, plankton, suspended particulate organic matter and dissolved colour.

Appendix 1

Guidelines on drawing boundaries (taken from JNCC, 2008)

1 Introduction

Previous UK guidance on defining SAC boundaries states that "as a general principle, site boundaries have been drawn closely around the qualifying habitat types … for which the sites have been selected, taking into account the need to ensure that the site operates as a functional whole for the conservation of the habitat type… and to maintain sensible management units". Further, "the seaward boundaries of the sites have been drawn as straight lines, to ensure ease of identification on charts and at sea" (Brown *et al*, 1997; McLeod *et al*, 2005). The guidance presented below is an expansion of previous guidance on defining boundaries for marine SACs, specifically for sites which are not connected to the coastline, and which may be in deep water (200m to more than 1000m).

2 Guidance

Actual site boundaries will be determined on a site specific basis, following the general guidance set out below.

2.1. The habitat area of interest will be identified and mapped. In many cases in waters away from the coast, this will involve some form of modelling, such as use of seabed geological data (interpolated from seismic tracks and samples), interpreted sidescan sonar, acoustic and/or bathymetric data.

2.2 The minimum area necessary in order to ensure the essential level of protection for the Annex I habitat of interest will be defined. More complex site shapes drawn more tightly around feature of interest are favoured over simple square/rectangular boundaries (to reduce the area of 'non-interest-feature' included within the site boundary). However, boundaries should still be as simple as possible, using a minimum number of straight lines and vertices. Contrary to previous JNCC boundary guidance (JNCC, 2004) site boundary co-ordinates do not have to be defined by whole degrees and minutes. It is recommended that site boundary coordinates will be provided in degrees, minutes and seconds.

2.3 Where habitat of interest occurs in a number of separate 'pieces' with 'non-interest-feature' habitat between, the preference is to include all 'pieces' within a site boundary to enable effective conservation of the feature of the site and to maintain its ecological function. However, where small, isolated instances of habitat occur at some distance from the main location of the habitat, these may be excluded from the site if their inclusion would result in large areas of 'non-interest-feature' being included within the site boundary.

2.4 The area defined under 2 above may then be extended if necessary in the following circumstances:

i). to ensure an essential level of protection from potentially damaging activities at the site, taking into account water depth at the site and possible location of mobile gear on the seabed in relation to location of a vessel at the sea surface. Activities which are location specific, always subject to prior consent and have clear reliable methods of enforcement are already controlled under existing procedures such as licensing of these activities. Mobile activities which may affect seabed habitats, such as fishing and anchoring, are not subject to prior consent procedures and therefore need special consideration. The length of warp used by boats when trawling is largely determined by water depth. The following table gives the

appropriate distance beyond the seabed extent of the habitat by which the site boundary at the sea surface may be extended (based on generalised trawl warp lengths, SERAD, 2001):

Water Depth	Ratio warp length: depth	Approx. length of trawl warp	Boundary extension to be added to the habitat area of interest
Shallow waters (≤ 25m)	4:1	100m at 25m depth	4 * actual depth
Continental shelf (50-200m)	3:1	600m at 200m depth	3 * actual depth
Deep waters (200 to over 1000m)	2:1	2000m at 1000m depth	2 * actual depth

Note that the margin is incorporated as a minimum measure to reduce the likelihood of habitat damage from demersal fishing. However, these boundaries are SAC boundaries, not management boundaries. Ultimately Competent Authorities are responsible for considering which management actions might need to be taken under the Offshore Marine Conservation (Natural Habitats, &c.) Regulations to reduce the risk of damage to the features associated with human activities, whether within or outside the site boundary. As a consequence, future management measure may have different boundaries to the SAC site boundary.

ii). For mobile habitats (for example, sandbanks), to ensure the minimum area necessary to allow conservation of the structure and functions of the habitat. Such extension will be determined on scientific understanding of the structure and functions of the habitat