Department for
Business, Energy
& Industrial Strategy

RECORD OF THE HABITATS REGULATIONS ASSESSMENT UNDERTAKEN UNDER REGULATION 5 OF THE OFFSHORE PETROLEUM ACTIVITIES (CONSERVATION of HABITATS) REGULATIONS 2001 (As Amended).

Tullow – Seabed Clearance Campaign: Horne and Wren, Orwell, Cameron (Updated November 2020)

Issued November 2020
Draft Rev 3.0

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

1.1 Council Directive 92/43/EC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and Council Directive 2009/147/EC on the conservation of wild birds (the Birds Directive) aim to ensure the long-term survival of certain habitats and species by protecting them from the adverse effects of plans and projects.

1.2 The Habitats Directive provides for the designation of sites for the protection of habitats and species of European importance. These sites are called Special Areas of Conservation (SACs). SACs form part of a network of protected sites across Europe called Natura 2000.

1.3 Before SACs are designated, the Government will undertake a public consultation. Prior to consultation the site is considered to be a draft SAC (dSAC). At the public consultation stage, the site is referred to as a possible SAC (pSAC). When a pSAC is submitted to the European Commission it becomes a candidate SAC (cSAC), at which point it is legally afforded the same protection as a SAC. Following adoption by the European Community the site becomes a Site of Community Importance until formal designation by the Government when the site becomes a SAC. The Southern North Sea SAC became designated as a SAC in February 2019 (JNCC 2019a).

1.4 Any plan or project, which either alone or in-combination with other plans or projects would be likely to have a significant effect on a qualifying site must be subject to an Appropriate Assessment to determine the implications for a site's integrity and conservation objectives. Such a plan or project may only be agreed after ascertaining that it will not adversely affect the integrity of a European Site unless there are imperative reasons of overriding public interest for carrying out the plan or project.

1.5 The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended) transpose the Directives into UK law for activities consented under the Petroleum Act 1998. The Offshore Petroleum Activities (Conservation of Habitats) (Amendment) Regulations 2007 extend certain provisions of the 2001 regulations.

1.6 Regulation 5(1) of the 2001 Regulations provides that: *The Secretary of State shall, before granting any Petroleum Act licence, any consent, any authorisation, or any approval, where he considers that anything that might be done or any activity which might be carried on pursuant to such a licence, consent, authorisation or approval is likely to have a significant effect on a relevant site, whether individually or in-combination with any other plan or project, including but not limited to any other relevant project, make an appropriate assessment of the implications for the site in view of the site's conservation objectives*.

1.7 Tullow Oil SK Limited (hereafter referred to as Tullow) submitted to the Department for Business Energy and Industrial Strategy (BEIS) three applications for marine licences to undertake seabed

clearance activities at Horne and Wren, Orwell and Cameron fields. Application numbers ML/628/0 (DCA/120, Horne and Wren), ML/629/0 (DCA/121 Orwell), and ML/630/0 (DCA/119, Cameron). The original applications were received from between 24 and 29 July 2020 and an HRA undertaken (BEIS 2020a). Subsequent to consent, Tullow have updated all three applications to include changes in the proposed start and end dates of the activities and the inclusion of over-trawl surveys at Horne and Wren and Orwell, but not at Cameron.

1.8 Advice received from the Joint Nature Conservation Committee (JNCC) during consultation on the original application was that '*there may be a likely significant effect on the Southern North Sea Special Area of Conservation (SAC). JNCC advise that an Appropriate Assessment (AA) should be undertaken, as required under Regulation 28 of The Conservation of Offshore Marine Habitats and Species Regulations 2017'* (JNCC 2020a,b,c). BEIS agreed with this advice that an Appropriate Assessment should be undertaken and, as the competent authority, undertook an assessment as required under the regulations (BEIS 2020a).

1.9 BEIS recognises that the subsequent changes to the project schedule and the addition of over-trawl surveys may cause a likely significant effect on the qualifying features of two designated sites, namely the Southern North Sea SAC and the Dogger Bank SAC. On this basis BEIS have revised the Habitats Regulations Assessment (HRA) previously undertaken in respect of proposed seabed clearance activities at the Horne and Wren, Orwell and the Cameron fields.

1.10 For the sake of continuity and completeness, relevant information presented in the previous revision of this assessment (Rev 2.0 September 2020 (BEIS 2020a)) has not been removed, including the assessment relating to the potential impacts from noise arising from the proposed activities on harbour porpoise during the summer period. However, where there are significant changes, e.g. the in-combination scenarios, information has been updated accordingly.

1.11 The proposed activities relevant to this assessment are not directly connected with, or necessary to, the management of any European sites but it may affect them. The purpose of this HRA is to determine whether the proposed activities will adversely affect the integrity of any European designated site.

2 PROJECT DESCRIPTION

2.1 The following is a brief summary of the proposed activities relating to the Marine Licence applications, ML/628/0 ML/629/0 and ML/630/0, further details may be found within the original applications and associated EIA justifications (TOSK 2020a,b,c) and the updated applications (TOSKd,e,f).

Horne and Wren

2.2 The proposed activities at the Horne and Wren location will be undertaken in licence Block 53/3 in the southern North Sea (Figure 1).

2.3 The infrastructure to be removed consists of:

- A 3.2 m length of the Horne and Wren 30 inch diameter conductor,
- A single concrete mattress (approximately 5 tonnes at 6 x 3 m) on the conductor,
- Grout from the grout mound.

2.4 The 30 inch diameter conductor is to be severed at a minimum depth of 3 m below the mudline, which will equate to a total length of 3.2 m. The conductor is part encased in over spill grout from when the conductor was first installed. The grout extends around approximately half of the conductor circumference at a height of 1.2 m off of the seabed. The grout mound is approximately 1.5 m in diameter (TOSK 2020a).

2.5 Explosives have been chosen as the removal method for the conductor, as previous cutting techniques by TOSK on this conductor have been unsuccessful. A maximum of 70 kg of explosives will be used to sever the conductor, which will be detonated as a single charge. The explosives will be placed into a charge case and 3 m below the seabed to ensure that the cut is made at the desired depth (TOSK 2020a).

2.6 It is anticipated that the explosives used during the severance of the conductor will also break the grout. However, in the event that this does not occur further, detonations using up to two 8 kg charges will be used to dislodge the grout. The pieces of grout mound are to be collected from the seabed and disposed of onshore.

2.7 A single 5 tonne mattress (6 x 3 m) partially covering the top of the conductor will be removed to gain access to the inside of the conductor. The mattress is to be recovered transported ashore for onshore disposal (TOSK 2020a).

2.8 The updated application includes an over-trawl survey aimed to remove debris from the seabed. The survey will impact on an area of seabed 1,000 m^2 and is located within the Southern North Sea SAC (TOSK 2020d).

2.9 Within the original application the earliest start date for the removal work was to be the 17 September, with the work scheduled to be between three to seven days on location, depending on weather conditions. Under the revised schedule work will commence no earlier than 6 November 2020 with completion no later than 31 January 2021 (TOSK 2020d).

Orwell

2.10 The proposed activities at the Orwell location will be undertaken in licence Block 50/26 in the southern North Sea (Figure 1).

2.11 The infrastructure to be removed consists of:

- A 6 m length of the Orwell 30 inch diameter conductor,
- 32 concrete mattresses (approximately 6 tonnes at 6 x 3m),
- A 4 m length of the export pipeline (16 inch diameter and 3.5 inch diameter, which is piggybacked),
- A 4 m length of the 5 inch diameter umbilical.

2.12 The 30 inch diameter conductor is to be severed at a minimum depth of 3 m below the mudline, which will equate to a total length of 6 m. The conductor was cut in 2019 but could not be recovered; consequently Tullow propose to use explosives to remove the conductor (TOSK 2020b). A maximum of 70 kg of explosives will be used to sever the conductor, which will be detonated as a single charge. The explosives will be placed into a charge case and 3 m below the seabed to ensure that the cut is made at the desired depth (TOSK 2020b).

2.13 The pipeline will be cut and recovered. All mattresses will also be recovered and returned to shore for onshore disposal (TOSK 2020b).

2.14 The updated application includes an over-trawl survey aimed to remove debris from the seabed. The survey will impact on an area of seabed 1,000 m^2 and is located within the Southern North Sea SAC (TOSK 2020e).

2.15 The earliest start date for the removal work to be the 6 November 2020, with the work scheduled to be between three to seven days on location, depending on weather conditions. The latest end date, accounting for a delayed start date, is anticipated to be 31 January 2021 (TOSK 2020e).

Cameron

2.16 The proposed activities at the Cameron location will be undertaken in licence Block 44/19 in the southern North Sea (Figure 1).

2.17 The infrastructure to be removed consists of:

- A 3.2 m length of the Cameron 30 inch diameter conductor,

- Grout from the grout mound.

2.18 The 30 inch diameter conductor is to be severed at a minimum depth of 3 m below the mudline, which will equate to a total length of 3.2 m. The conductor was cut in 2019 but could not be recovered; consequently Tullow propose to use explosives to remove the conductor (TOSK 2020c). A maximum of 70 kg of explosives will be used to sever the conductor, which will be detonated as a single charge. The explosives will be placed into a charge case and 3 m below the seabed to ensure that the cut is made at the desired depth (TOSK 2020c).

2.19 The 30 inch conductor is part encased in over spill grout from when the conductor was first installed. The grout extends around approximately half of the conductor circumference at a height of 1.2 m off of the seabed. The grout mound is approximately 1.5m in diameter. In the event that the detonation from the conductor removal does not break up the grout, up to two further detonations using 8 kg charges will be used to break the grout. The pieces of grout mound are to be collected from the seabed and disposed of onshore (TOSK 2020c).

2.20 There will be no over-trawl survey undertaken at the Cameron field (TOSK 2020f).

2.21 The earliest start date for the removal work to be the 6 November 2020, with the work scheduled to be between three to seven days on location, depending on weather conditions. The latest end date, accounting for a delayed start date, is anticipated to be 31 January 2021 (TOSK 2020f).

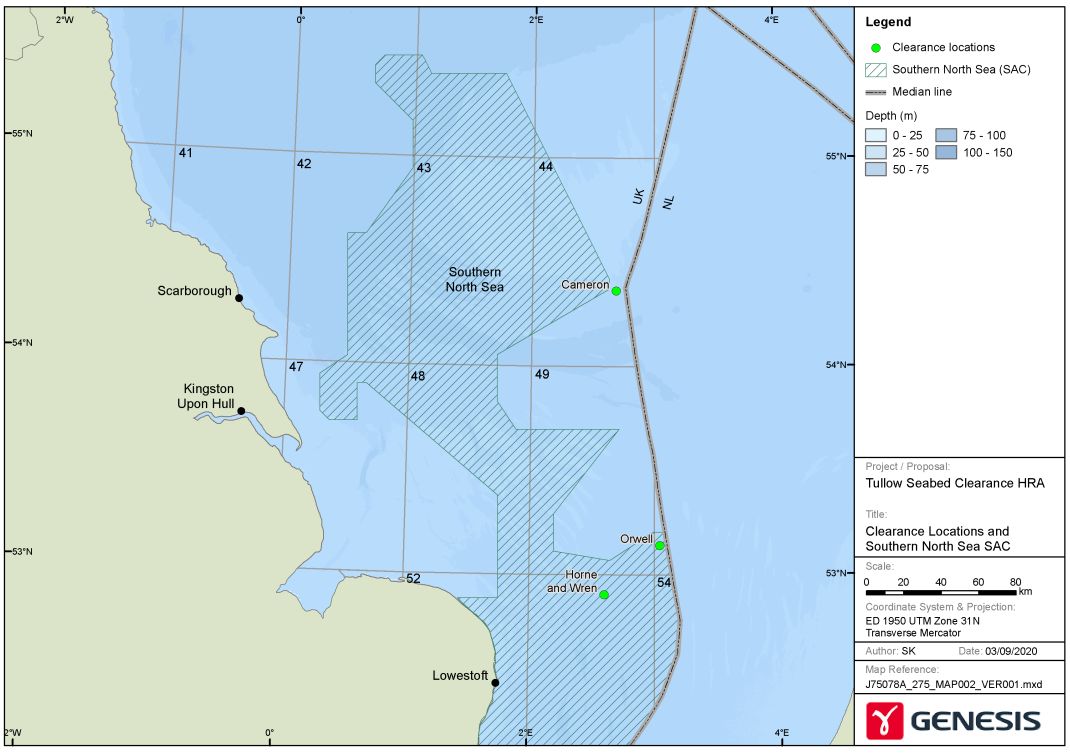


Figure 1: Location of the proposed Tullow seabed clearance activities.

3 DESIGNATED SITES

3.1 The proposed activities at Horne and Wren and at Orwell will be undertaken within the Southern North Sea SAC. The proposed activities to be undertaken at the Cameron field lies within 3.5 km of the Southern North Sea SAC boundary (Figure 2).

3.2 The proposed activities at the Cameron field will be undertaken within the Dogger Bank SAC (Figure 2).

3.3 Based on the information presented within the applications, including the results from the noise modelling undertaken in support of the applications and advice received during consultation it has been determined that there is potential of a likely significant effect on the qualifying species (harbour porpoise) of the Southern North Sea SAC and the qualifying habitats of the Dogger Bank SAC.

3.4 No other qualifying species or habitats have been identified as being potentially impacted by the proposed activities.

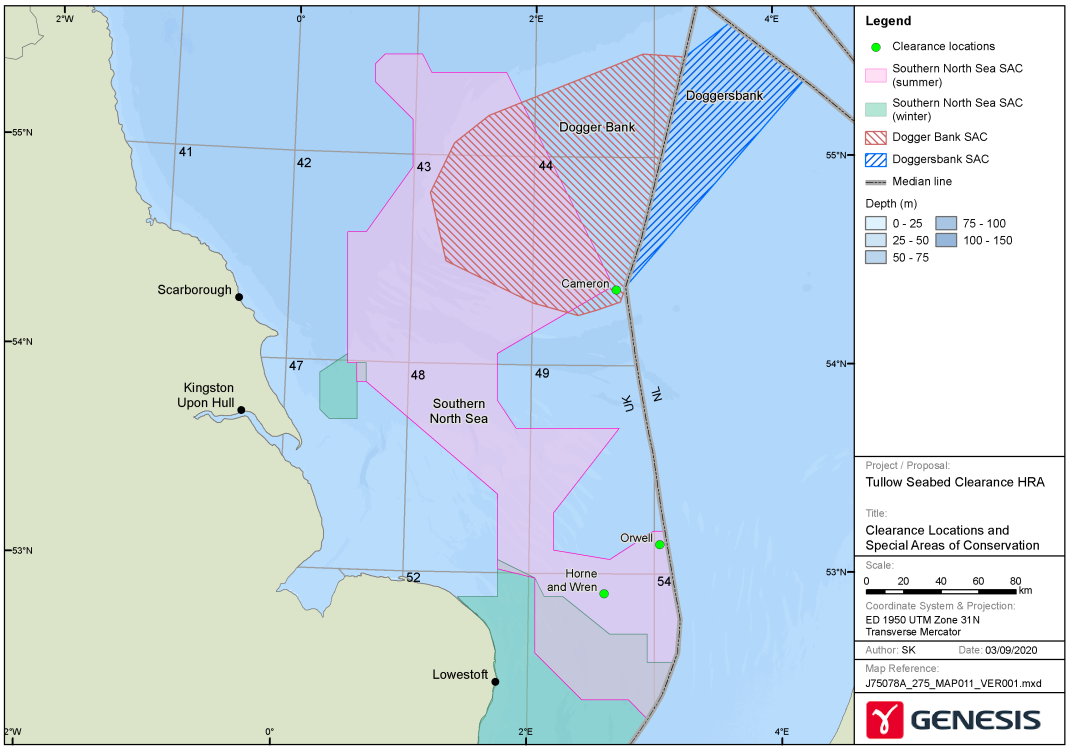


Figure 2: Location of proposed Tullow seabed clearance activities and Southern North Sea SAC and Dogger Bank SAC.

3.5 The qualifying sites and features relevant to this HRA are:

- Southern North Sea SAC (Harbour porpoise),
- Dogger Bank SAC (Sandbanks which are slightly covered by sea water all the time [Habitat code 1110]).

Southern North Sea SAC

Harbour porpoise

3.6 The harbour porpoise (*phocoena phocoena*) is a qualifying species for the:

- Southern North Sea SAC,

3.7 The harbour porpoise is the smallest and most abundant cetacean species in UK waters. They occur widely across shelf waters predominantly either individually or in small groups but larger aggregations have been reported (Defra 2015), with group sizes varying with season (Clark 2005). Harbour porpoise have a very broad distribution occurring predominantly over the continental shelf. Higher densities occur in areas of up-wellings and strong tidal currents and in water depths of predominantly between 20 and 40 m (Clark 2005, Whaley 2004). Their distribution may also be strongly correlated with seabed type, with areas of sandy gravel being preferred and this may be linked to prey availability (Clark 2005).

3.8 Harbour porpoise occur widely across the North Sea. Data from the three Small Cetacean Abundance in the North Sea (SCANS) surveys indicate that that there may have been a southward shift in the distribution of harbour porpoise in the North Sea. In the early 1990's harbour porpoise were widespread but appear to have occurred predominantly around eastern Scotland and the northern North Sea to the southern North Sea (Hammond *et al*. 2013). Since the 1990's harbour porpoise continue to be widespread across the North Sea but densities have increased in the southern and central North Sea. The cause of this apparent change in the distribution of harbour porpoises across the North Sea is unclear but may be related to changes in prey availability (IAMMWG *et al.* 2015).

3.9 Following the completion of the most recent SCANS survey (SCANS III), the latest estimated harbour porpoise populations within the whole of the SCANS survey area is 424,245 (CV 313,151 – 596,827). Since 1994 the population of harbour porpoises within the SCANS surveyed area has remained relatively stable (Figure 3) (Hammond *et al*. 1995, Hammond 2006, Hammond *et al.* 2017).

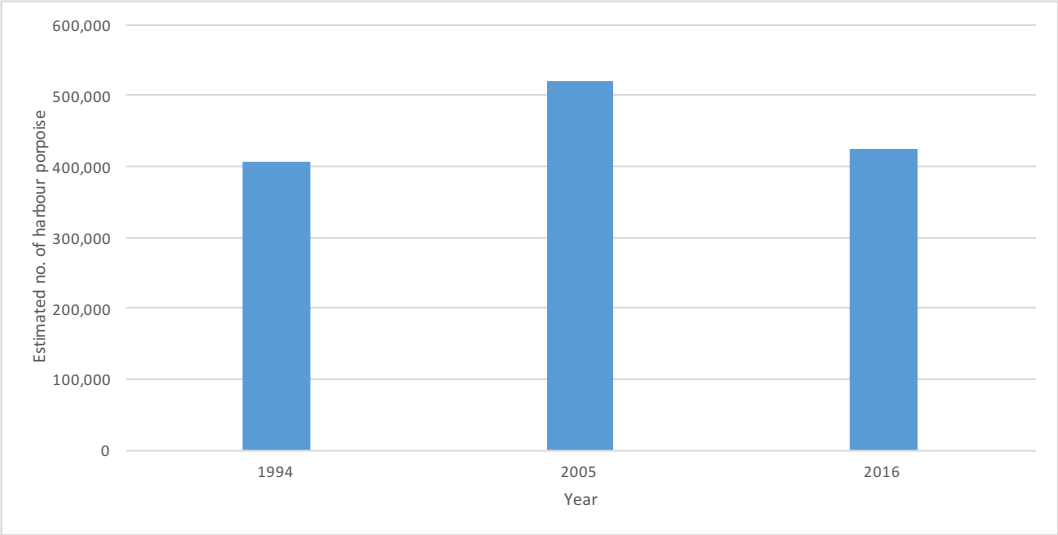


Figure 3: Estimated number of harbour porpoise within the SCANS survey area recorded during SCANS I, II and III surveys (Hammond *et al.* 2017).

3.10 There are three Management Units identified for harbour porpoise in the north-east Atlantic, of which, the Southern North Sea SAC lies within the North Sea Management Unit. The harbour porpoise population within the North Sea Management Unit was originally estimated to be 227,298 (176,360 – 292,948) (IAMMWG 2015). This estimated population of harbour porpoise is recognised to have been derived from data collected in 2005 and 2016 during a single month and that the harbour porpoise population within the SAC will vary across seasons and years. The population estimated from the Joint Cetacean Protocol (JCP), where abundance and distribution data from multiple sources collected over a period of time have been integrated, is 333,808 individuals (JNCC 2017b). This population estimate has been used for the purposes of this assessment.

3.11 The SAC selection assessment document estimates that the site holds 18,500 harbour porpoise (98% C.I. 11,864 – 28,899) (JNCC 2017c; 2019a), which was 8.1% of the North Sea Management Unit population at the time the estimate was made (Hammond *et al*. 2013, IAMMWG 2015).

3.12 Harbour porpoise densities vary seasonally and across the Southern North Sea SAC (Evans and Teilmann 2009). Site-specific surveys undertaken by wind farm developers have shown considerable variation in the spatial and temporal distribution of harbour porpoises across years (e.g. Forewind 2013, SMart Wind 2017). Typically, peak abundance has been reported to occur between May and July at sites across the Dogger Bank area and between September and April at sites further south (e.g. Forewind 2014, SMart Wind 2015, EAOWL 2015). Lowest reported abundance across nearly all wind farm surveyed areas occurs between November and February,

although the poorer survey conditions that occur predominantly during the winter months may be a contributing factor in the lower number of harbour porpoise recorded during this period.

3.13 Based on data in the JCP database highest densities in the central and northern area of the SAC occur during the summer period, with modelled harbour porpoise densities greater than 3.0 per km^2 occurring widely. During the winter period the distribution of harbour porpoise in the southern North Sea changes, with reduced densities over the central and northern area but an increase in densities in nearshore waters and the southern part of the SAC (Heinänen and Skov 2015).

3.14 Surveys undertaken across the southern North Sea, including areas within and encompassing the SAC, have reported lower densities of harbour porpoise than that estimated from JCP data. Densities reported from SCANS III surveys are from between 0.888 ind./km^2 in SCANS block O and 0.607 ind./km^2 in SCANS block L (Hammond *et al.* 2017). Similarly, data obtained across the Dogger Bank area including the Southern North Sea SAC in 2011 recorded a density of 1.88 ind./km^2 (Gilles *et al.* 2012). Data obtained from surveys undertaken at proposed offshore wind farms located within or adjacent to the SAC indicate densities vary across the site and across seasons. Mean densities reported from surveys undertaken by offshore wind farm developers range from 0.11 ind./km^2 at Triton Knoll offshore wind farm including a 1 km buffer to 2.87 ind./km^2 within the Hornsea subzone 3 wind farm area plus a 4 km buffer (TKOWFL 2011, SMart Wind 2017).

3.15 Tagging studies undertaken in Denmark indicate that harbour porpoises are highly mobile and range widely in the North Sea, with individuals tagged in the Skagerrak travelling up to 100 km per day, with a mean distance of 24.5 km per day (Sveegaard 2011). Individuals tagged in Danish waters were recorded off the east coasts of England and Scotland (Sveegaard 2011).

3.16 Harbour porpoise swimming speeds vary with the highest recorded swimming speeds being 4.3 m/s (Otani *et al.* 2000). Mean recorded speeds are typically around 1 m/s (Otani *et al.* 2000, Kastelein *et al.* 2018). When disturbed by noise harbour porpoise can increase swimming speeds with increasing sound levels. Studies using playback experiments of pile-driving sounds have reported increases in swimming speed from an average of 1.2 m/s to 2.0 m/s at sound levels of 154 dB re 1 µPa that were sustained for at least 30 minutes (Kastelein *et al*. 2018).

3.17 Although harbour porpoises may dive to depths of up to 226 m and remain submerged for up to five minutes, they more frequently undertake relatively shallow dives of a short duration, with a mean depth of 14 m and duration of 44 seconds (Santos and Pierce 2003, Otani *et al*. 1998, 2000). Studies undertaken on 14 tagged harbour porpoise in Danish and adjacent waters reported that on average harbour porpoise spend 55% of the time in the upper 2 m of the surface waters. The most frequent dive depths were between 14 m and 32 m, with the maximum depth dived of 132 m. The number of dives per hour increased from an average of 29 dives hr^{-1} between April and August to 43 dives hr^{-1} in October and November when it was presumed that

higher levels of foraging activity occurred to compensate for the higher energy requirements required during the cooler winter period (Teilmann *et al*. 2007).

3.18 Harbour porpoise use echolocation to detect and track individual prey and are opportunistic feeders, foraging close to the seabed or near the sea surface, preying on a wide range of fish species including, herring (*Clupea harengus*), whiting (*Merlandius merlangus*), Gadoids spp. sprats (*Sprattus sprattus*), gobi (*Pomatoschistus minutus*) and sandeels (*Ammodytes* spp.), and their prey will vary during and between seasons (DeRuiter 2008, Santos and Pierce 2003, IAMMWG *et al.* 2015). The prey of harbour porpoise may change over time with a reported long-term shift in prey from clupeid species to sandeels and gadoid species (IAMMWG *et al*. 2015), indicating that harbour porpoise may be opportunistic feeders capable of feeding on a variety of species.

3.19 Studies undertaken in Denmark indicate that their local distribution may be correlated with prey availability (Sveegaard 2011). Due to the relatively high metabolic rate of harbour porpoise and the relatively small size of their predominant prey it has been suggested that harbour porpoise require a reliable source of food and frequent food consumption in order to maintain their body weight, with increased consumption in cooler environments (Kastelein *et al*. 1997, Wisniewska *et al*. 2016, 2018).

3.20 Harbour porpoise have a maximum life expectancy of 24 years, with an average life expectancy of around 12 years in UK waters (Lockyer 2003, Learmouth *et al.* 2014). Females become sexually mature at between three and five years old (Lockyer 2003, Learmouth *et al*. 2014). Breeding is thought to occur primarily during the summer months between May and September, particularly in August, with calving 10 months later. Calves are nursed for eight to ten months but may remain with the mother until a new calf is born (Defra 2015, Lockyer 2003, Weir *et al*. 2007).

3.21 The range at which marine mammals, including harbour porpoise, may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Other factors that can affect the potential impact include ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and existing sources of human produced sound can also reduce the auditory range.

3.22 Porpoises are generally considered to be 'high frequency' or 'very high frequency' specialists with a relatively poor ability to detect lower frequency sounds (Southall *et al.* 2007, 2019). Studies undertaken on captive harbour porpoises indicate that porpoises have a functional hearing range of between 250 Hz and 180 kHz with their best hearing between 16 to 140 kHz and their maximum sensitivity between 100 and 140 kHz. It is within the frequency range of 130 to 140 kHz that harbour porpoise echolocate (Miller and Wahlberg 2013).

3.23 Their ability to detect sound below 16 kHz or above 140 kHz falls sharply (Kastelein *et al.* 2012, Southall *et al*. 2007). Harbour porpoise are therefore most sensitive to sound sources between 16 to 140 kHz and, although potentially audible, they are unlikely to be sensitive to sound either above or below those frequencies.

3.24 Harbour porpoise use echolocation to communicate and detect prey. Reported sound levels produced range from between 166 to 194 re: 1 µPa (rms SPL) and 178 and 205 dB re. 1 µPa (peak – peak SPL), with a mean level of 191 dB re. 1 µPa (peak – peak SPL) and within the peak frequency range of 110 to 150 kHz (Villadsgaard, *et al*. 2007, Miller and Wahlberg 2013, MMO 2015).

Prey species

3.25 Fish are not qualifying species for the Southern North Sea SAC. However, potential impacts on fish that are prey for harbour porpoise could affect the integrity of the sites by reducing their prey base. Harbour porpoise prey on a variety of fish species that could be impacted by the proposed activities including gobies, Sandeel Spp., whiting, herring and sprat (JNCC and NE 2019).

3.26 Sandeels are one of the main prey items for harbour porpoise and are also an important prey species for predatory fish such as whiting, cod and haddock, some of which may also be prey for harbour porpoise (Greenstreet *et al*. 2006).

3.27 Sandeels are one of the most abundant fish in the North Sea occurring widely over suitable sandy substrates where, once the larvae have settled, they remain in the area (Heath *et al.* 2011). Although widespread, sandeel distribution is highly substrate specific as they depend on seabed habitat comprising a high proportion of medium and coarse sands (particle size 0.25 - <2 mm) with low silt content (Holland *et al*. 2005).

3.28 Between September and April sandeels remain largely buried in the seabed except when spawning during December and January and when feeding during the late spring and summer (Greenstreet *et al.* 2006, Van der Kooij *et al*. 2008).

3.29 Within the Southern North Sea SAC sandeels occur across the site with their main spawning area over the Dogger Bank and a wider nursery area across most of the SAC (Judd *et al.* 2011).

3.30 Fish hearing is based on detecting particle motion directly stimulating the inner ear. However, those with swim bladders are also able to detect pressure waves and can detect a wider range of frequencies and sounds of lower intensity than fishes without swim bladders (Popper 2003). Fish with swim bladders that possess a coupling mechanism between the swim bladder and the auditory system, e.g. herring and sprats, are recognised to be hearing specialists. Fish that have swim bladders but lack a mechanised coupling mechanism or do not have swim bladders, e.g. sandeel spp. are considered hearing generalists and have a relatively lower sensitivity to sound than fish that have swim bladders and a coupling mechanism.

3.31 Studies on the behaviour of fish from noise, largely using play-back experiments, have reported a range of behavioural responses including avoidance behaviour, changes in swimming speed and direction (e.g. Hawkins 2014, Mueller-Blenkle *et al.* 2010) and reduced antipredator responses (Everley *et al.* 2016).

Dogger Bank SAC

3.32 The Dogger Bank SAC covers an area of 12,331 km^2 and lies entirely within UK territorial waters. The Dogger Bank is an extensive sandbank which was formed by glacial processes before being submerged through sea level rise and the site was formally classified as a SAC in September 2017 on account of its Sandbanks which are slightly covered by sea water all the time [Habitat code 1110]**.** The basis for the classification is set out in a Natura 2000 Standard Data Form (JNCC 2017c).

Sandbanks

3.33 Sandbanks which are slightly covered by seawater all the time are an Annex I habitat under the Habitats Directive and are described as *Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20 m below Chart Datum* (European Commission 2013). They are not Annex I priority habitats and occur widely in UK coastal and offshore waters. There are twenty designated sites in UK waters for which this habitat is a primary feature and a further 16 sites in which the habitat occurs but not identified as a primary reason for site selection (JNCC 2020d). There are five SACs in UK offshore waters for which this habitat is a primary feature, of which the Dogger Bank SAC is the largest.

3.34 Annex I Sandbanks are defined by their topography and substrate type rather than by a specific biological community, its range is determined by geological and/or hydrodynamic processes depending on the type of sandbank (JNCC 2019b). There has been no significant changes in the geographic extent and although there may have been localised declines the overall geographic spread and distribution of offshore sand banks have not been reduced (JNCC 2013).

3.35 The Dogger Bank is the largest sand bank feature in UK waters and comprises more than 70% of the UKs Annex I sandbank resource. Water depths across the site range from between 13 m and 58 m and the site is exposed to substantial wave energy that prevents the colonisation of the sand by vegetation on the shallower parts of the bank (JNCC 2019c).

3.36 The majority of sediments across the Dogger Bank are classified as sand to muddy sand, with patches of courser sediments. Patches of courser sediments occur across the site, with notable larger areas towards the western and southern edges. The underlying substrate comprise predominantly of clay material. Sand waves and mega ripples occur across the south-west and east central areas of the site (JNCC 2018b). The presence of mega ripples and sand waves indicates that some sediment transport arises from tidal currents. However, this maybe limited with the majority of sediment transport driven by storm waves (Van der Molen 2002).

3.37 Biological communities across the SAC vary depending on the substrate. The dominant biotope associated with the Dogger Bank is Ss.SSa.IFiSa.NcirBat (*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand). This biotope occurs in sediments subject to physical disturbance, as a result of wave action and occasionally strong tidal currents (EMU 2010, JNCC 2015). The species diversity and numbers of individuals are relatively low compared to less disturbed habitats. However, as a consequence to the dynamic nature of the environment disturbed communities recover relatively quickly and may be considered 'mature', often within a few days or weeks since the disturbance (MarLIN 2018).

Information Sources

3.38 This HRA draws on a number of information sources relating to the proposed project and the site designation which should be read in conjunction with this report including:

- Horne & Wren Seabed Clearance EIA Justification. TOSK (2020a,d).
- Orwell Seabed Clearance EIA Justification Document. TOSK (2020b,e).
- Cameron Removal Work EIA Justification Document. TOSK (2020c,f).
- Natura 2000 – Standard Data Form. Site: UK0030395. Southern North Sea SAC. JNCC (2019d).
- Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs. (England, Wales & Northern Ireland). JNCC (2020e).
- Harbour Porpoise (Phocoena phocoena) Special Area of Conservation: Southern North Sea Conservation Objectives and Advice on Operations March 2019 JNCC and NE (2019).
- Conservation Objectives for Dogger Bank Special Area of Conservation. JNCC (2018a).
- Supplementary Advice on Conservation Objectives for Dogger Bank Special Area of Conservation. JNCC (2018b).
- Dogger Bank Advice on Operations Workbook v1.0. JNCC (2018c).

3.39 References to technical papers and other documents are given in the text as necessary.

4 POTENTIAL IMPACTS

4.1 The potential impacts arising from the proposed activities are sound from the detonation of explosives and physical impacts on the seabed. No other sources of potential impact that could affect qualifying habitats or species have been identified.

Noise impacts

4.2 There is a substantial volume of literature describing the potential effects of sound on marine mammals, and summarised in e.g. Thomsen *et al.* (2006), Southall *et al.* (2007) and OSPAR (2009).

4.3 There are four main types of potential effect from noise that are recognised within the marine environment:

- *Fatal effects* caused by significant levels of noise in close proximity to the receptor.
- *Physical injury*, specifically hearing impairment, which can be permanent or temporary. These effects can impact on the ability of marine mammals to communicate, forage or avoid predators.
- *Behavioural effects* such as avoidance, resulting in displacement from suitable feeding or breeding areas, and changes in travelling routes.
- *Secondary impacts* caused by the direct effects of noise on potential prey causing a reduction in prey availability.

4.4 The range at which marine mammals may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Harbour porpoise are potentially more sensitive to high frequency sounds than other cetaceans or pinnipeds. Other factors which may affect the potential impact of sound on marine mammals includes ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and other existing sources of human produced sound, e.g. shipping, can also reduce the auditory range.

Fatal effects

4.5 If source peak pressure levels from the proposed operations are high enough there is the potential for a lethal effect on marine mammals. Studies suggest that potentially lethal effects can occur to marine mammals when the peak pressure level is greater than 246 or 252 dB re. 1 µPa (Parvin *et al.* 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 µPa.

Physical injury

4.6 Underwater sound has the potential to cause hearing damage in marine mammals, either permanently or temporarily. The potential for either of these conditions to occur is dependent on

the hearing bandwidth of the animal, the duty cycle of the sound source and duration of the exposure (Southall *et al*. 2019, OSPAR 2009).

Behavioural Change

4.7 Potential changes in behaviour may occur depending on the sound source levels and the species' and individuals' sensitivities. Behavioural changes can include changes in swimming direction, diving duration, avoidance of an area and reduced communication.

4.8 Masking effects may also cause changes in the behaviour as the level of sound may impair the detection of echolocation clicks and other sounds that species use to communicate or detect prey, thus causing them to alter their behaviour.

Secondary Effects

4.9 There is potential for impacts on prey species to affect marine mammals, in particular possible impacts of noise on fish species.

Physical impacts on the seabed

4.10 The use of explosives below or on the seabed could cause the formation of craters at the site of detonation and localised sediment plumes. Studies undertaken during Unexploded Ordnance Clearance (UXO) on the formation of craters in sandy / gravelly sand sediments indicates that, on average, bombs ranging in size from between 500 lbs and 1,000 lbs (226 kg – 453 kg) can form craters of approximately 1 m deep and up to 11 m in diameter (Ordtek 2018). Smaller charges may be predicted to have smaller impacts on the seabed.

4.11 The two over-trawl surveys to be undertaken will each impact an area of no more than 1,000 m^2, a total of 2,000 m^2 of seabed within the Southern North Sea SAC will be impacted.

5 NOISE MODELLING

5.1 To assess the potential environmental impacts from the proposed activities the applicant has undertaken noise modelling to assess the potential impacts from pile-driving (TOSK 2020a,b,c).

5.2 The noise modelling has been undertaken using the 'Faux Equation' and based on the detonation of 70 kg of explosive 3 m below the seabed. Results from the noise modelling undertaken to support the application indicate that the onset of PTS in harbour porpoise could occur within 2,200 m of the explosion.

5.3 Noise modelling undertaken in order to assess the potential impacts on prey species indicates that fish mortality could occur within 152 m of the detonation.

6 EFFECTIVE DETERRENT RADIUS / RANGE

6.1 The Effective Deterrent Radius / Range (EDR) has been proposed by the Statutory Nature Conservation Bodies (SNCBs) as a means to measure potential impacts on harbour porpoise within the SAC (JNCC 2017e,f; JNCC 2020e). The EDR is an empirically derived generic distance within which deterrence, i.e. displacement, of harbour porpoise is predicted to occur. The EDR are based on published studies that have monitored the effects on harbour porpoise from various activities and reflects the overall loss of habitat if all animals vacate the area (e.g. Defra 2015). It is an area of displacement as opposed to disturbance, which may be greater.

6.2 The published precautionary EDR are presented in Table 1 (JNCC 2020e). Relevant to this assessment is the EDR for unexploded ordnance which is published as being 26 km.

Table 1: Precautionary Effective Deterrent Ranges (EDR) (Source: JNCC 2020e).

Activity	Effective Deterrent Range (km)
Monopile	26
Unexploded Ordnance	26
Pin-pile	15
Monopile with noise abatement	15
Conductor piling	15
Seismic survey	12
High Resolution Geophysical Surveys	5

6.1 The SNCBs recognise that future data may require the suitability of the EDR to be reconsidered if it is found to be inappropriate (JNCC 2020e).

7 CONSERVATION OBJECTIVES

7.1 Conservation Objectives constitute a necessary reference for identifying site-based conservation measures and for carrying out HRAs of the implications of plans or projects (JNCC and NE 2019). They outline the desired state for any European site, in terms of the features for which it has been designated. If these features are being managed in a way which maintains their nature conservation value, they are assessed as being in a 'favourable condition'. An adverse effect on the integrity of a site is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of its designation (English Nature 1997).

7.2 The purpose of an Appropriate Assessment is to determine whether a plan or project adversely affects a site's integrity. The critical consideration in relation to site integrity is whether the plan or project affecting a site, either individually or in-combination, affects the site's ability to achieve its conservation objectives and favourable conservation status.

Southern North Sea SAC Conservation Objectives

7.3 The Southern North Sea SAC was designated as a SAC in 2019. The site covers an area of 36,951 km^2 and is designated for harbour porpoise.

7.4 Harbour porpoise are also protected throughout European waters under the provisions of Annex IV and Article 12 of the Habitats Directive, which are outwith the scope of this assessment. Harbour porpoise in UK waters are considered part of a wider European population and the mobile nature of this species means that the concept of a 'site population' is not thought to be appropriate for this species. Site based conservation measures therefore aim to complement wider ranging measures that are in place for the harbour porpoise (JNCC and NE 2019).

7.5 The Conservation Objectives for harbour porpoise are designed to ensure that human activities do not, in the context of maintaining site integrity:

- kill, or injure harbour porpoise (directly or indirectly),
- prevent their use of significant parts of the site (disturbance / displacement),
- significantly damage relevant habitats, or
- significantly reduce the availability of prey.

Southern North Sea SCI Conservation Objectives

To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters
In the context of natural change, this will be achieved by ensuring that:

1. Harbour porpoise is a viable component of the site;
2. There is no significant disturbance of the species; and
3. The condition of supporting habitats and processes, and the availability of prey is maintained..

Source: JNCC and NE 2019

7.6 Harbour porpoises are considered to be a 'viable component' of the site if they are able to survive and live successfully within it. The first Conservation Objective aims to minimise the risk from activities that cause unacceptable levels of impact on harbour porpoise using the site, specifically those that could impact on the Favourable Conservation Status of harbour porpoise (JNCC and NE 2016, 2019).

7.7 The '*integrity of the site*' is not defined in the Conservation Objectives. However, EU and UK Government guidance defines the integrity of a site as ''*the coherence of the site's ecological structure and function, across its whole area, or the habitats, complex of habitats and/or populations of species for which the site is or will be classified*' (EC 2000, Defra 2012). Therefore, the integrity of the site applies to the whole of the site and it is the potential impacts across the whole of the site that are required to be appropriately assessed. Pressures that would affect site integrity include:

- killing or injuring harbour porpoise (directly or indirectly),
- preventing their use of significant parts of the site (disturbance / displacement),
- significantly damaging relevant habitats,
- significantly reducing the availability of prey. (JNCC and NE 2019).

7.8 The second Conservation Objective states that there should be '*…no significant disturbance of the species'* and that '*Disturbance is considered significant if it leads to the exclusion of harbour porpoise from a significant portion of the site'* (JNCC and NE 2019).

7.9 *'Supporting habitats and processes'* relate to the seabed and water column along with the harbour porpoise prey.

7.10 JNCC advise that it is not appropriate to use the site population estimates in any assessments of effects of plans or projects (i.e. Habitats Regulation Assessments), as it is necessary to take into

consideration population estimates at the Management Unit level to account for daily and seasonal movements of the animals (JNCC and NE 2019).

7.11 There are no formal thresholds at which impacts on site integrity are considered to be adverse. However, a threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra 2003, ASCOBANS 2015). This threshold relates to impacts from fisheries by-catch on harbour porpoise where the impact on the harbour porpoise is permanent, i.e. up to 1.7% of the population may be caught as by-catch before a population decline is inevitable. An equivalent level of impact from disturbance, which is temporary and non-lethal, on a population will have a lower level of impact on the population compared to that from a fisheries by-catch.

7.12 The lack of agreed population thresholds either at the Management Unit level or site level, below which evidence demonstrates there would not be an adverse effect, does not prevent objective judgements to be made on site integrity.

7.13 Thresholds to assess and manage the effects of noise on site integrity have been proposed by the JNCC and NE (JNCC 2017e,f; JNCC and NE 2019, JNCC 2020e). The proposed approach is not based on a population level impact but is instead based on a temporal and spatial level where a proportion of the area (habitat) within the SAC may be affected over a period of time.

7.14 The JNCC and NE advice is that *'noise disturbance within the site should not exclude harbour porpoise from more than 20% of the site on any given day. Over a season, the advice is that an average loss of access to more than 10% of the SAC should be considered significant, recognising that within the SAC the abundance of harbour porpoise per unit habitat is generally higher than the equivalent sized habitat in the rest of the relevant Management Unit. Management of temporary habitat 'loss' to below defined area/time thresholds is therefore designed to ensure that it continues to contribute in the best possible way to the maintenance of the species at FCS.'* (JNCC 2020e).

7.15 The potential extent of noise causing disturbance that would meet these proposed thresholds and therefore impact on the integrity of the site are presented in Table 2. The results indicate that should the impact occur wholly inside the SAC that, within the 'summer' area a sound source alone or in-combination causing disturbance for one day over an area of 7,390 km^2 would risk impacting site integrity. This is equivalent to a circular radius of noise out to 41.5 km. To exceed the threshold for the 'winter' area, noise in any one day should not extend over an area of more than 2,537 km^2; equivalent to a circular radius of 28.4 km.

7.16 Over the course of a season the total extent of potential disturbance on average per day should, in the 'summer' area, not extend over an area of more than 3,695 km^2; equivalent to a radius of

noise of 29.3 km and in the 'winter' area should not extend over an area of more than 1,269 km^2, equivalent to a radius of 20.1 km.

Table 2: Estimated extent sound levels capable of causing displacement disturbance occur in order to impact on site integrity.

Site	Area (km^2)	1 day threshold		Seasonal threshold	
		20% of area (km^2)	Distance to threshold (km)	10% of area (km^2)	Distance to threshold (km)
Southern North Sea SAC	36,951	7,390	48.5	3,695	34.3
'summer' area April - September	27,028	5,406	41.5	2,701	29.3
'winter' area October - March	12,696	2,539	28.4	1,270	20.1

The 'Distance to threshold' presumes sound propagation is circular in shape, i.e. the distance is the equivalent to a radius of circular noise.

7.17 Unlike the daily threshold, the area of the SAC that can be affected over the course of a season is an average over the season. The seasonal average is calculated by summing the proportion of the site impacted (for the relevant season) over the number of days the impact will occur and then averaging across the total number of days within that season, i.e. 183 days in the summer period and 182 days in the winter period. This provides a seasonal average spatial effect.

7.18 This assessment is based on both the potential impact on the North Sea Management Unit population using both the ASCOBANS thresholds and the proposed SNCB threshold approach.

7.19 In order to undertake any meaningful assessment using the threshold approach accurate information on the timing, duration and extent of activities being undertaken is required. Where this information is lacking or where speculative 'worst-case' scenarios are used there is little or no confidence that the results will bear any resemblance to the true extent of impact within the SAC on any single day or across the course of a season. The threshold approach proposed by the SNCBs has not been agreed with the competent authorities. However, the thresholds have been noted within the assessment as a high-level management tool to limit the spatial distribution of noise from offshore activities within a large offshore SAC, such as the Southern North Sea SAC.

The Dogger Bank SAC Conservation Objectives

7.20 The following Conservation Objectives have been produced by the JNCC for the Dogger Bank SAC (JNCC 2018a).

For the feature to be in favourable condition thus ensuring site integrity in the long term and contribution to Favourable Conservation Status of Annex I Sandbanks which are slightly covered by seawater all the time.

This contribution would be achieved by maintaining or restoring, subject to natural change:

- The extent and distribution of the qualifying habitat in the site;
- The structure and function of the qualifying habitat in the site; and
- The supporting processes on which the qualifying habitat relies.

7.21 The 'extent' refers to the whole distribution of the qualifying feature within the site, which in the case of the Dogger Bank SAC is 12,331 km^2. A reduction in the extent of the sand bank feature has potential to impact on the physical and biological functioning of sedimentary habitat types. The distribution of a habitat influences the component communities present and can contribute to the health and resilience of the feature (JNCC 2018b).

7.22 The JNCC advise a 'restore' objective which is based on 'expert judgment'; specifically, their understanding of the feature's sensitivity to pressures which can be exerted by ongoing activities i.e. cabling and oil and gas industry activities on the extent and distribution of sandbank feature's sediment composition and consequently that of associated biological communities (JNCC 2018b).

7.23 The JNCC advise that '*Activities must look to minimise, as far as is practicable, changes in substratum within the site to minimise further impact on feature extent and distribution*' (JNCC 2018b).

7.24 The 'structure' refers to the physical structure of a habitat type together with the biological structure. The physical structure refers to the finer scale topography and sediment composition and distribution. The biological structure refers to the 'key and influential species' and 'characteristic communities' (JNCC 2018b). Based on 'expert judgement' the objective is to restore the structure of the site on the basis of there being impacts from oil and gas related activities as well as aggregates, dredging and cable laying within the site. However, it is not clear what the impacts from deposits on the seabed have on structure and function of the site (JNCC 2018b).

7.25 The 'function' of the site refers to the ecological processes within the site. '*The natural range of sandbank communities within the site should be conserved to ensure the functions they provide support the health of the feature and the provision of ecosystem services to the wider marine environment*' (JNCC 2018b). The functions identified within the site include:

- Nutrition – The site provides feeding grounds where prey is made available for a variety of species of commercial importance.
- Bird and whale watching - the site provides some supporting function for wider marine bird and mammal populations.
- Climate Regulation - the range of sedimentary habitats and associated communities in the site perform known ecological processes common to sandbanks such as deposition and burial of carbon in seabed sediments through bioturbation, living biomass and calcification of benthic organisms.

7.26 The JNCC advise that the objective for the, function, of the site should be to restore it.

7.27 The 'supporting processes' have been identified as being the hydrodynamic regime, water and sediment quality. It is unclear whether the physical presence of subsea infrastructure impacts on the movement of sediment across the sandbank. Based on the Environmental Quality Standards (EQS) there is no evidence to suggest that water or sediment quality across the Dogger Bank is below the standards. However, there is potential for contamination from produced water and drill cuttings. Based on 'expert judgement' a maintain objective has been advised by the JNCC (JNCC 2018b).

7.28 The HRA has been carried out in light of best scientific knowledge with reference to the Conservation Objectives of the SAC and the potential impacts on the integrity of the site.

8 IN-COMBINATION IMPACTS SOUTHERN NORTH SEA SAC

8.1 Under the Habitats Regulations, it is necessary to consider the in-combination effects of plans or projects on European Sites. These refer to effects, which may or may not interact with each other, but which could affect the same receptor or interest feature (i.e. a habitat or species for which a European site is designated).

8.2 The in-combination assessment includes plans or projects that are:

- Under construction,
- Permitted application(s), but not yet implemented,
- Submitted application(s), not yet determined,
- Projects identified in the relevant Development Plan (and emerging Development Plans),
- Sites identified in other policy documents, as development reasonably likely to come forward.

Renewable energy activity

8.3 A source of potentially significant in-combination underwater noise impact is from pile driving activity occurring during the construction of offshore renewable developments, particularly offshore wind farms.

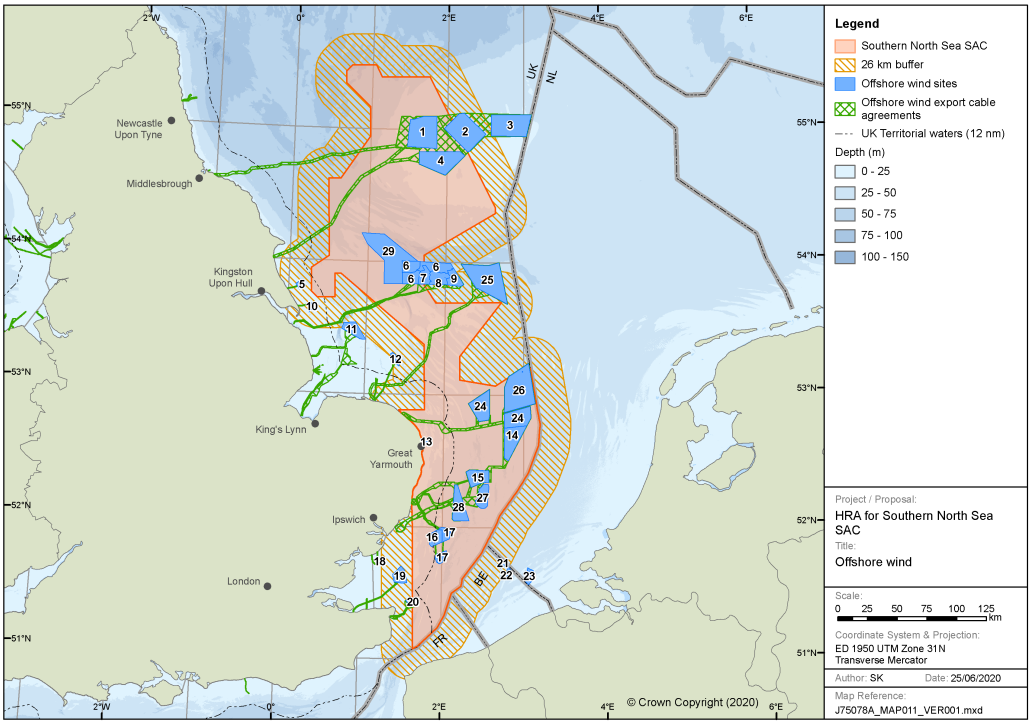
8.4 There are 21 UK offshore wind farms that lie wholly within the Southern North Sea SAC or are within 26 km of the boundary which is identified by the JNCC as an area that harbour porpoises may be displaced from by noise arising from pile-driving activities (JNCC 2017d, JNCC 2020e). (Table 3 and Figure 4). One wind farm (Triton Knoll) is currently undertaking offshore construction and Hornsea Two has started pre-construction activities offshore, including the clearance of UXO. All other wind farms are either operating, consented but not started offshore construction or have submitted applications and are awaiting determination.

8.5 There are further additional wind farms located in Dutch and Belgium waters that could impact on the Southern North Sea SAC when under construction. In the Dutch sector, offshore construction at the Borssele I and II wind farms has largely been completed and no piling is being undertaken. Offshore construction at the Borssele III and IV wind farms started in October 2019 and is on-going. Noise mitigation technology is being used at these wind farms during pile-driving activities.

8.6 In Belgium the SeaMade wind farms: Mermaid and Seastar are under construction and all the monopile foundations have been installed.

Table 3: Offshore wind farms located within 26 km of the Southern North Sea SAC.

Wind farm	Status
Round 1	
Scroby Sands	Operating
Round 2/2.5	
Dudgeon	Operating
Galloper	Operating
Greater Gabbard	Operating
Gunfleet Sands II	Operating
Humber Gateway	Operating
Thanet	Operating
Triton Knoll	Offshore construction started
Westermost Rough	Operating
Round 3	
Creyke Beck A	Onshore construction started
Creyke Beck B	Onshore construction started
East Anglia One	Operating
East Anglia Two	Application submitted
East Anglia Three	Consented
Hornsea Project One	Operating
Hornsea Project Two	Offshore construction started
Hornsea Project Three	Application submitted
Norfolk Vanguard	Consented
Teesside A (Sofia)	Consented
Teesside B	Onshore construction started
Belgium	
SeaMade (Mermaind and Seastar)	Offshore construction started
Netherlands	
Borssele I and II	Offshore completed
Borssele III and IV	Offshore construction started



1	Dogger Bank - Creyke Beck B	16	Greater Gabbard
2	Dogger Bank - Teesside B (Sofia)	17	Galloper
3	Dogger Bank - Teesside A	18	Gunfleet Sands II
4	Dogger Bank - Creyke Beck A	19	London Array
5	Westermost Rough	20	Thanet
6	Hornsea Project 2	21	THV Mermaid
7	Hornsea 1 (West)	22	Belwind I
8	Hornsea 1 (Centre)	23	Borssele II
9	Hornsea 1 (East)	24	Norfolk Vanguard East
10	Humber Gateway	24	Norfolk Vanguard West
11	Triton Knoll	25	Hornsea Project Three
12	Dudgeon	26	Norfolk Boreas
13	Scroby Sands	27	East Anglia One
14	East Anglia Three	28	East Anglia Two
15	East Anglia One North	29	Hornsea Project Four

Figure 4: Offshore wind farms located within 26 km of the Southern North Sea SAC.

8.7 Of the offshore wind farms that are relevant to the in-combination assessment, the Hornsea Two development could be undertaking pile-driving from September onwards (Ørsted 2020).

8.8 The Triton Knoll offshore wind farm has a licence to undertake pile-driving over a period of 23 days with completion by 13 June 2020 and is therefore completed.

8.9 An application to undertake UXO clearance from between 1 April 2019 to 31 December 2020 has been submitted to the MMO for Hornsea Two offshore wind farm (Ørsted 2018a). The application is for the clearance of up to 100 items of UXO which must be cleared from between July 2019 to 31 December 2019 and between 1 April 2020 and 31 December 2020 (Ørsted 2018b, MMO 2019a). UXO clearance during 2019 removed 26 items of UXO.

8.10 For items of UXO greater than 50 kg, bubble curtains must be used to mitigate against noise when undertaken in water depths of between 5 m and 40 m and when currents are less than 1.5 m/s (MMO 2019a). Bubble curtains were used for 23 of the 26 UXO clearances undertaken at Hornsea Two in 2019.

8.11 Ørsted have confirmed that the UXO clearance campaign has been completed, although there is potential for further items of UXO to be found during the current on-going seabed preparation activities. Consequently, there is potential for further items of UXO to be cleared during 2020. Ørsted have also confirmed that they believe bubble curtains were used during all UXO clearance activities undertaken during 2020 (Ørsted *pers. comm*. 2020).

Cable laying activity

8.12 The Viking Link project is a high voltage direct current (HVDC) electrical interconnector between Denmark and the UK. The 762 km long cable will be laid between Jutland in Denmark and Bicker Fen in Lincolnshire and crosses the Southern North Sea SAC (Figure 5) (NGVL 2018a).

8.13 An application was made for the clearance of up to 25 items of UXO between 1 April and 30 September 2019 some, or all, of which may occur within or adjacent to the SAC (NGVL 2018b). Following an HRA, consent was given by the MMO on 5 October 2018 (MMO 2018). Subsequent to consent, a variation to the application has been made for the clearance of 25 items of UXO to be detonated between 1 April 2020 and 1 September 2020 (NGVL 2019a, MMO 2020). BEIS have been informed that four items of UXO will be cleared in 2020, with one item within the Southern North Sea SAC and a further three within 26 km of the SAC boundary.

Aggregate extraction and dredging activity

8.14 Existing localised aggregate dredging occurs primarily in the southern half of the SAC, along the east coast (Figure 6). In 2019 there were 29 aggregate production areas and five Exploration and Option areas covering an area of 579.2 km^2. Five of the aggregate areas occur in the 'summer' area of SAC covering 77.7 km^2 and the rest occur in the 'winter' area of the SAC and cover an area 533.8 km^2, with some sites occurring in both the 'winter' and 'summer' areas.

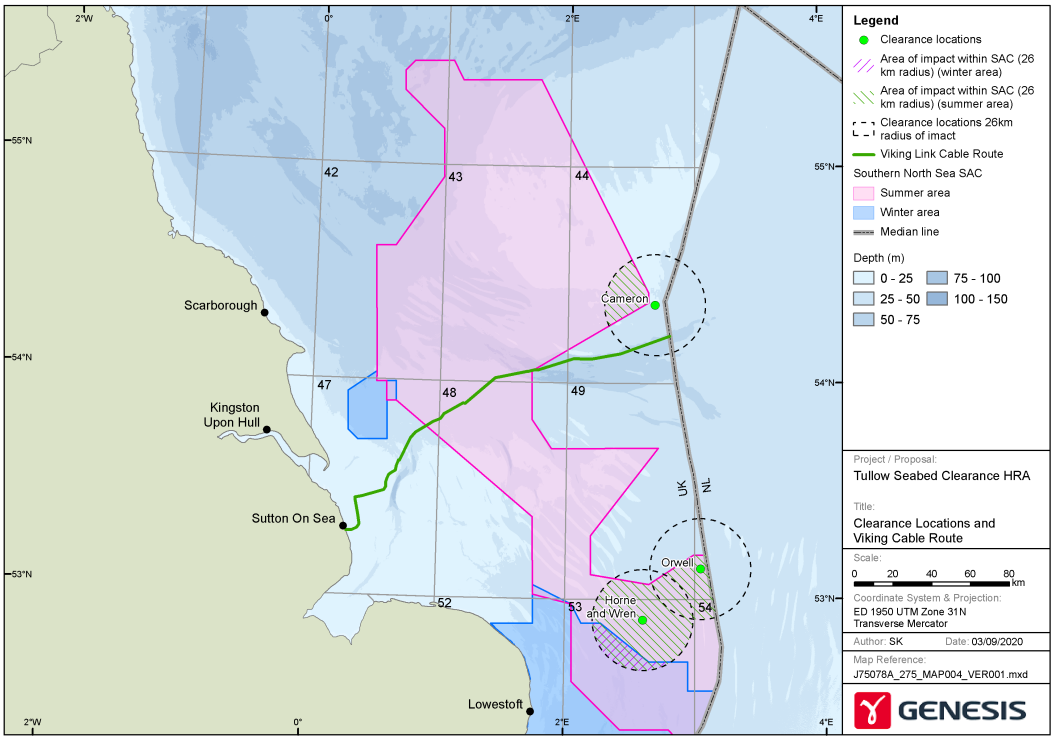


Figure 5: Viking Link Interconnector cable within UK waters and location of proposed Tullow seabed clearance activities.

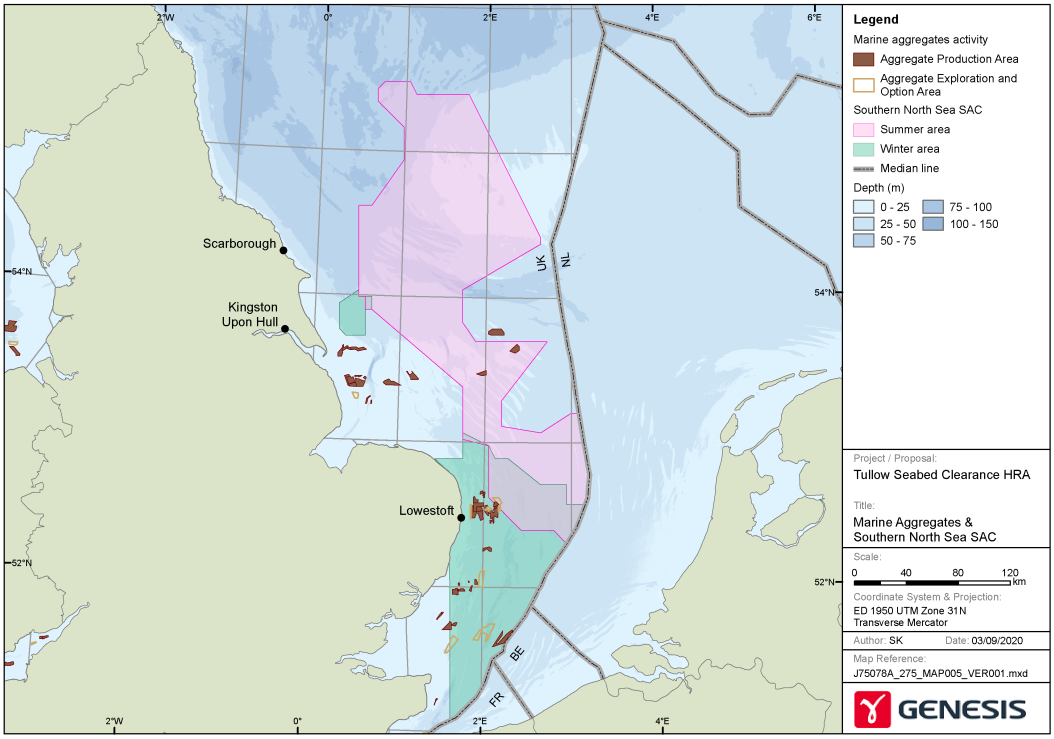


Figure 6: Existing marine aggregate activities in the Southern North Sea SAC.

8.15 Studies have indicated that harbour porpoise may be displaced by dredging operations within 600 m of the activities (Diederichs *et al*. 2010). Noise modelling previously undertaken for aggregate assessments have predicted significant levels of avoidance at ranges of 500 m from suction dredging (Parvin *et al* 2008 (referenced in Hanson Aggregates Marine Ltd 2013)).

8.16 On a precautionary assumption that there is a level of behavioural displacement out to 600 m, there is potential for an area of 1.13 km^2 to be affected at each active dredging location. There are currently three aggregate production areas in the 'summer' area and 26 in the 'winter' area. Although the level of dredging activity within each of the active licence areas is unknown, as a worst-case scenario, with dredging occurring within each dredging area, porpoise may be displaced from an area of 3.39 km^2 in the 'summer' area and 29.38 km^2 in the 'winter' area. Therefore, a very small proportion (0.01% of the summer area and 0.2% of the summer area) of the SAC may be impacted by noise arising from dredging activities.

Oil and gas activity

8.17 There is a long history of oil and gas activities within the boundaries of the Southern North Sea SAC. Since 1965, when the first well was spudded (first drilled), there has been extensive oil and gas development with a total of 117 installations installed within the SAC. The vast majority (94%) of all the installations within the boundary of SAC are located in the 'summer' area of the site (Figure 7) (OGA NDR 2020).

8.18 Seismic surveys have regularly been undertaken within the SAC over the last 50 years, with a total of 23 2D or 3D seismic surveys carried out within the SAC between 2008 and 2017. The majority of surveys during this period took place in the northern half of the SAC, where the most recent oil and gas activity has occurred (Figure 8).

8.19 BEIS are aware of a number of planned oil and gas related activities within the area during the period the proposed pile-driving will be undertaken that could cause an in-combination effect including a seismic survey to be undertaken by ION in licence Blocks UKCS Blocks 35/23, 35/24, 35/25, 35/28, 35/29, 35/30, 36/21 – 36/30, 37/16 – 37/30, 38/16, 38/17, 38/18, 38/21,38/22, 38/23, 38/26, 38/27, 38/28, 41/3 – 41/5, 42/1 - 42/5, 43/1 – 43/5, 44/1 – 44/3 (Table 4).

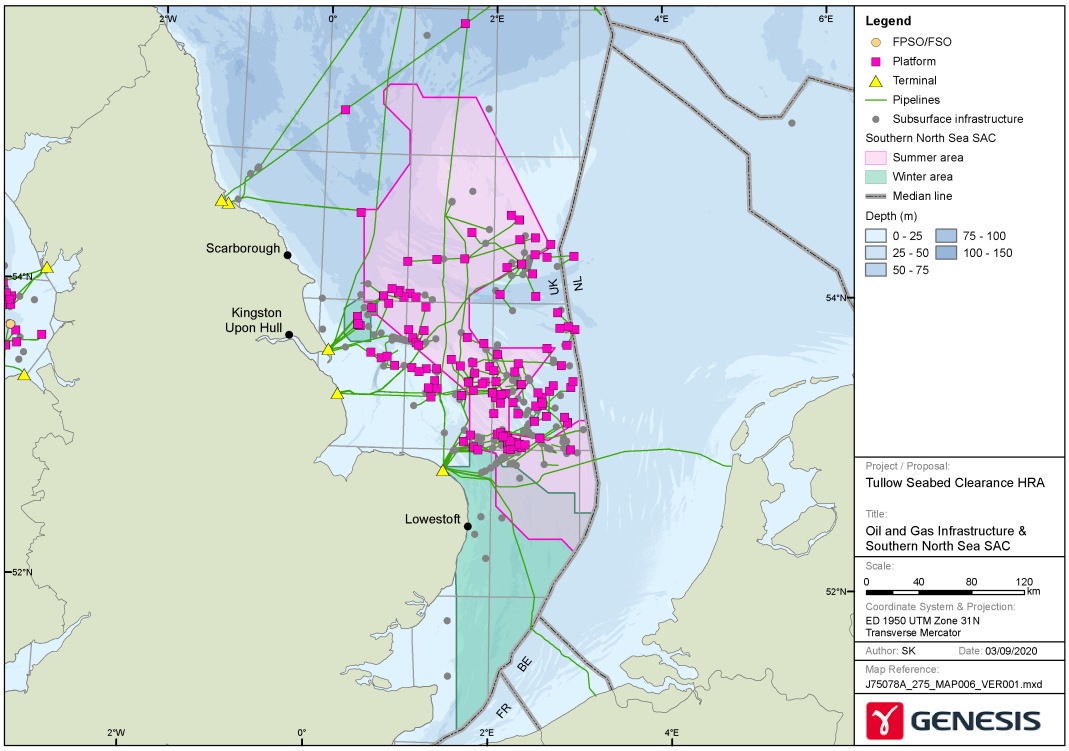


Figure 7: Existing oil and gas infrastructure within the Southern North Sea SAC.

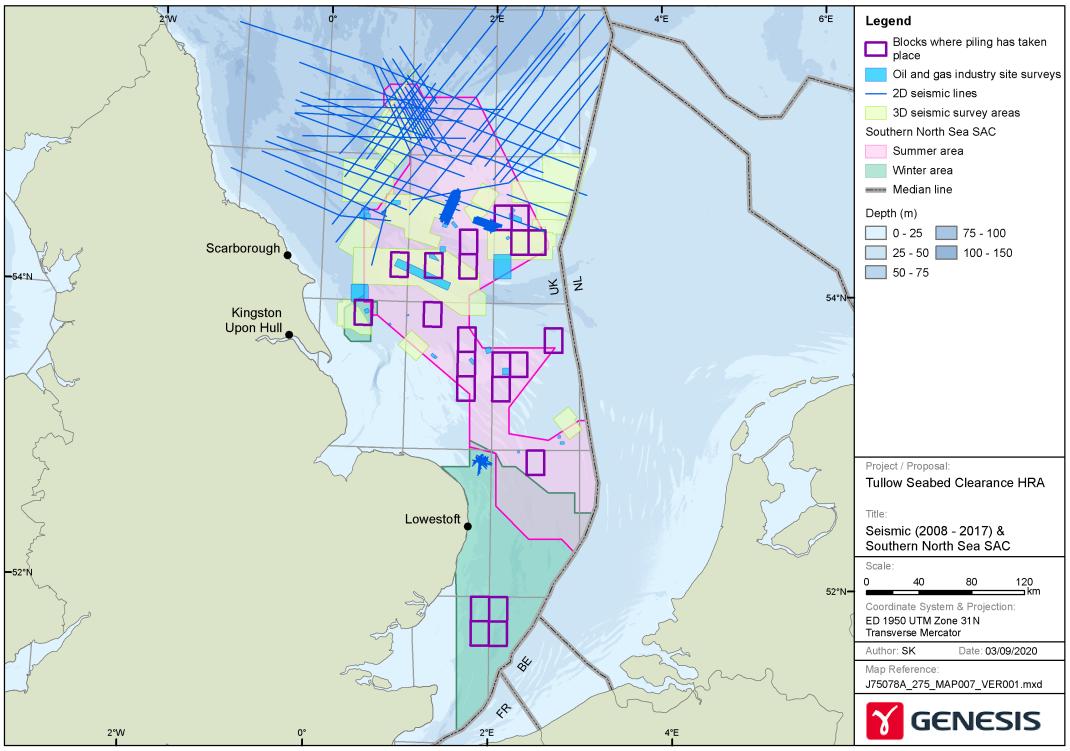


Figure 8: Oil and gas industry related seismic surveys undertaken within the Southern North Sea SAC between 2008 and 2017.

Table 4: Planned oil and gas activities within or adjacent to the Southern North Sea SAC that could cause an in-combination impact.

Applicant	Licence Reference No.	Licence Block(s)	Start and End Dates	Planned Activity
Chrysaor	ML/546/0	49/21	19 May 2020 – 31 December 2020	WIA using TCP guns and jet cutters
Chrysaor	ML/579/0	49/16	7 June – 31 December 2020	Removal of cut pipeline and mattresses. Relocation of existing rock.
Chrysaor	ML/585/0	49/16	14 June – 31 December 2020	Marine Licence
Tullow	ML/616/1	53/04	1 September 2020 – 31 January 2021	Marine Licence
Spirit Energy	GS/1071/0	42/3b	12 April – 1 April 2021 (delayed until October 2020)	Geophysical survey.
Spirit Energy	GS/1070/0	32/38	12 April – 1 April 2021 (delayed until October 2020)	Geophysical survey.
ION	GS/1074/0	Quadrants 35, 36, 37, 38, 41, 42, 43 and 44	1 April – 22 October 2020	Seismic survey
Neptune	GS/1086/0	42/24A	23 May – 30 November 2020	Geophysical survey
BP	GS/1124/1	42/25A	21 October – 30 November 2020	Geophysical survey
Perenco	GS/1139/0	49/18	13 October – 31 December 2020	Geophysical survey
Premier Oil	DRA/808	42/28	1 September 2020 - 16 June 2021	Batch drilling.
Premier Oil	DRA/810	42/28	1 September 2020 - 16 June 2021	Batch drilling.
Premier Oil	DRA/811	42/28	1 September 2020 - 16 June 2021	Batch drilling.
Premier Oil	DRA/812	42/28	1 September 2020 – 16 June 2021	Batch drilling
Perenco	DEP/1993/0	49/23 – 49/27	1 October 2020 – 31 March 2021	Deposit consent
Perenco	DEP/1981/0 DEP/1981/1	49/26	1 October 2020 – 31 March 2021	Deposit Consent

Shipping

8.20 Impacts from shipping on harbour porpoise within the SAC have been identified as arising from shipping noise and collision impacts. Shipping noise is the predominant anthropogenic source of noise within the marine environment and is reported to have a negative effect on harbour porpoise within the SAC when vessel traffic exceeds 80 vessels per day (JNCC 2017a). Shipping has been on-going in the southern North Sea for many hundreds of years and the area is important for shipping, with relatively high numbers of vessels occurring within it. Based on

vessel track lines, in 2015 a total of 269,018 vessels track lines were recorded transiting across the SAC; an average of 737 vessels per day (MMO 2017a).

8.21 The level of vessel activity across the 'summer' and 'winter' areas of the SAC differs (Figure 9). There is relatively widespread vessel activity in low densities across the 'summer' area, with 76% of the quadrants having less than seven vessels per week and 17% having less than one vessel per week. Compared with the 'winter' area of the SAC where 14% of the quadrants had, on average, less than seven vessels per week and only 1% had less than one vessel per week. In contrast 11% of the 'winter' area had more than 70 vessels per week compared with none in the 'summer' area. The areas with relatively higher levels of shipping (>24 vessels per day), occur over 4% of the 'winter' area. Therefore, the 'winter' area has relatively localised, higher density, areas of vessel traffic compared with the 'summer' area that has widespread but low density vessel traffic.

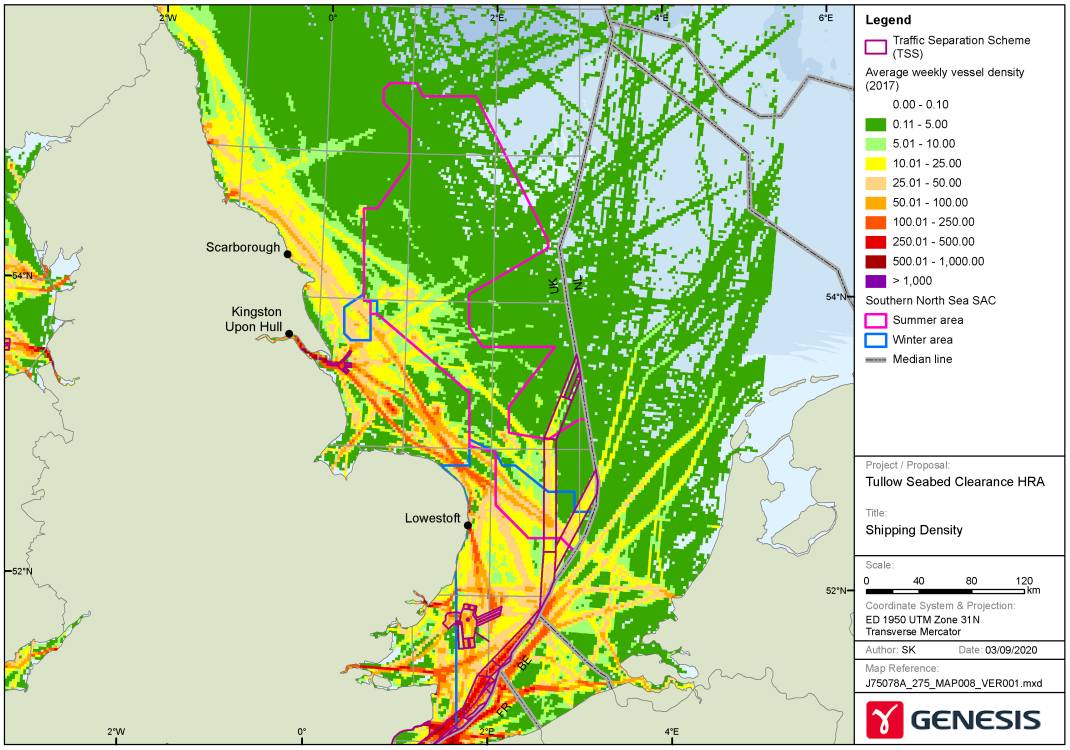


Figure 9: Shipping density within the SAC during 2015.

Fishing activity

8.22 Fishing occurs widely across the southern North Sea and has also been on-going in the area for many hundreds of years. The majority of current fish landings are obtained from areas adjacent to the SAC but there is widespread fishing activity in the southern half and north-eastern edge of the SAC and relatively moderate to high levels of fishing activity along the western edge of the central part of the SAC (Figure 10) (MMO 2017b). Note however, this does not include the

activities of non-UK registered vessels that will occur within the site or vessels greater than 15 m in length.

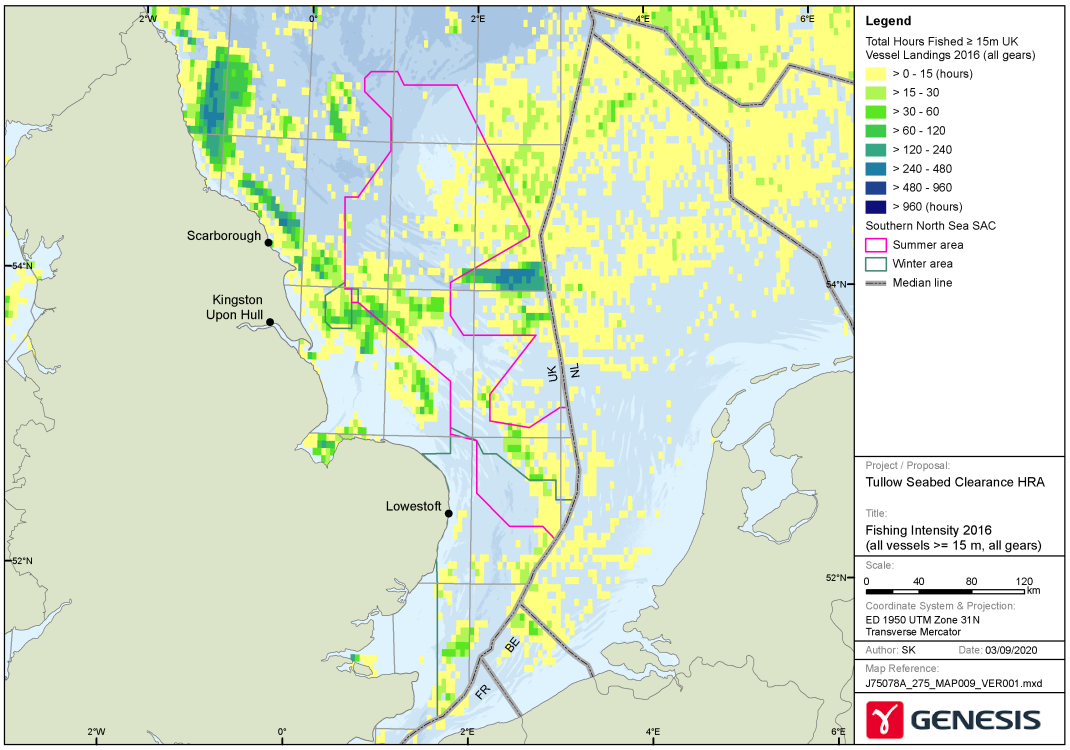


Figure 10: Fishing intensity across the SAC during 2016 by UK registered vessels.

8.23 There is a high risk of an impact from bycatch associated with the fishing industry to harbour porpoise across the North Sea, i.e. there is good evidence of a significant impact. There is a medium risk of an impact from removal of prey (JNCC and NE 2019).

8.24 The bycatch of harbour porpoise in fishing gear is reported to be one of the most significant anthropogenic pressures impacting on the harbour porpoise population (JNCC and NE 2019). It is estimated that between 1,235 and 1,990 harbour porpoise die each year in the North Sea due to bycatch, predominantly in gill nets (ICES 2016, Mitchell *et al*. 2018, OSPAR 2017). This is approximately 0.6% of the North Sea Management Unit population.

Southern North Sea SAC - In-combination conclusion

8.25 Following consideration of all known developments that may cause a likely significant effect, BEIS considers that there are plans or projects likely to cause an in-combination likely significant effect. The activities that may have potential to cause an in-combination impact considered within this HRA are:

- UXO clearance at Hornsea Two offshore wind farm,
- UXO clearance along Viking Link Interconnector cable,
- Construction pile-driving at Hornsea Two offshore wind farm,
- Planned oil and gas activities including seismic and geophysical surveys.
- On-going routine activities such as shipping, that could contribute to impacts on qualifying species, will also be being undertaken for the duration of the proposed seabed clearance.

9 IN-COMBINATION IMPACTS DOGGER BANK SAC

9.1 For the purposes of this assessment, on-going impacts from current activities have been included within the in-combination assessment even though for some on-going activities, e.g. fishing, shipping and dredging disposal, it is technically not possible to determine what the baseline conditions would be without the influence the impacts from these on-going activities have on the qualifying features of the sites. However, it is recognised that they may be having an effect on the qualifying features of the sites.

Fishing in Dogger Bank SAC

9.2 Demersal fishing has the potential to cause physical damage to sandbank features within the SAC and may be having an on-going effect on the characteristic communities of the site and is capable of causing a significant effect on the qualifying features of the site (JNCC 2018b,d).

9.3 Fishing occurs widely across the Dogger Bank and has also been on-going for many hundreds of years. The predominant fishing activity within the SAC is beam and demersal trawling undertaken mainly by UK, Dutch and Danish registered vessels targeting demersal species such as plaice, megrim and sole (Brown & May Marine 2013).

9.4 The level of fishing across the Dogger Bank SAC varies with less than 30 hours per year occurring within each of the oil and gas licence blocks. Based on VMS data for UK registered vessels, in 2016 fishing occurred over 8,701 km^2 within the SAC. That is fishing occurred over 70.5% of the SAC, the vast majority of which was demersal fishing and therefore would impact on the seabed. This does not take into consideration non-UK vessels which may contribute a significant proportion of fishing within the site.

Renewable energy

9.5 There are four consented offshore wind farms located within the Dogger Bank SAC: Dogger Bank A, B and C and Sofia Wind FarmsC[1].

9.6 The Dogger Bank A offshore wind farm covers an area of 515 km^2. The consented development comprises up to 200 wind turbines, four offshore HVAC collector platforms, one HVDC offshore converter platform and two accommodation platforms. Up to five meteorological masts may be installed (Infrastructure Planning 2015a, Forewind 2013).

9.7 The Dogger Bank B offshore wind farm covers an area of 599 km^2. The consented development comprises up to 200 wind turbines, four offshore HVAC collector platforms, one HVDC offshore converter platform and two accommodation platforms. Up to five meteorological masts may also be installed.

[1] Note the wind farms were formally known as Creyke Beck A, Creyke Beck B, Teesside A and Teesside B.

9.8 The offshore construction start dates for any of the developments are not currently known.

9.9 The Dogger Bank C offshore wind farm covers an area of 560 km^2 and the Sofia offshore wind farm covers an area of 593 km^2. Both developments comprise up to 200 wind turbines, four offshore HVAC collector platforms, one HVDC offshore converter platform and two accommodation platforms. Up to five meteorological masts may be installed (Infrastructure Planning 2015b, Forewind 2014).

9.10 Should all four consented wind farms be constructed an estimated 2.5 km^2 of seabed may be physically lost by the presence of turbines and a further 0.5 km^2 due to associated infrastructure (BEIS 2019). The area of the Dogger Bank SAC is 12,331 km^2 and the potential loss of 3.0 km^2 of habitat is 0.02% of the site. The habitats within wind farm areas are predominantly subtidal sands and gravels and are widespread habitats across the SAC (Forewind 2013, 2014).

9.11 There is potential for temporary seabed disturbance caused by trenching and laying of cables within the wind farm area and the along the export cable route. The total area estimated could be impacted within the SAC is 4.48 km2 from export cable laying and 50.8 km2 from inter array cable laying (BEIS 2019).

9.12 In total an estimated 0.4% of the seabed within the SAC may be physically disturbed and 0.12% may be physically lost by cable protection across the SAC (BEIS 2019).

Aggregate extraction and dredging activity

9.13 Aggregate extraction areas 466/1, 485/1 and 485/2 lie within the boundary of the SAC. Applications were made to extract aggregates from these licensed areas in 2013. No further information has been found on these sites and it is thought that no aggregate extraction activities are currently taking place within the SAC.

9.14 It is recognised that dredging within the SAC would cause significant disturbance to the subtidal sandbank communities but as the sediment is left *in situ*, no long-term loss of substrate will occur which would allow re-colonisation once extraction activities have ceased (Forewind 2013).

Existing oil and gas activity

9.15 Since the original wells were drilled in 1964 there has been existing oil and gas industry activity within the SAC. This historical activity may have caused permanent loss of habitat within the site and temporary impacts to the seabed.

9.16 Within the SAC there is subsea equipment on the seabed impacting an area estimated to be approximately 0.001 km^2 (BEIS 2019). The majority of the items may be subject to future decommissioning programmes.

9.17 Since 1964 a total of 171 wells (including 40 side-tracks) have been drilled in the Dogger Bank SAC. A total of 122 wells, including 23 side-tracks, have been plugged and abandoned and therefore no further activity will occur at these locations. There may be historical impacts on the site if rock was required for rig stabilisation. In the event that rock has been required at all well locations an estimated 0.52 km^2 of seabed may have been impacted by rock placement from well abandonment activities (BEIS 2019).

9.18 The total length of existing pipelines and piggy-backed umbilicals within the SAC is approximately 457.7 km, all of which, with the exception of the 34" Shearwater to Bacton export line, are reported to be buried. Therefore, a total of 76.72 km of pipeline is known to be on the seabed within the SAC. Assuming, as a worst-case scenario, that the physical presence of a surface laid pipeline has a physical effect on the seabed within 5 m either side of the line, an estimated 0.77 km^2 of the seabed could be impacted by the physical presence of existing pipelines.

9.19 A total 24 km of pipeline out of a total of 371 km of pipeline is known to have rock protection along it. Therefore, on average, 66 m of rock is placed along every 1 km of pipeline to reduce the risk of free spans occurring, i.e. 6.6% of the length of pipelines has required rock to be placed on it. In the absence of any additional data from existing pipelines within the SAC an estimate of the extent of existing rock within the SAC as a whole is based on the average extent of rock placed along known pipelines that are, at least, partially within the SAC. On this basis it is estimated that within the SAC a total length of 30.2 km of rock has been placed along the existing pipelines within the SAC[1].

9.20 Assuming that the rock placed along pipelines impacts 5 m either side of the pipeline then an estimated 0.3 km^2 of seabed could be impacted by existing rock along pipelines within the SAC; this is equivalent to 0.003% of the SAC.

Existing subsea cables within the Dogger Bank SAC

9.21 There are five subsea telecommunication cables passing through the Dogger Bank SAC. The combined total length of telecommunications cable within the SAC is 373.9 km, of which 198.6 km of cable is active and 175.3 km is disused. Assuming a maximum cable diameter of 50 mm the total area permanently impacted by existing cables is 0.018 km^2 (BEIS 2019).

Dogger Bank SAC - In-combination conclusion

9.22 There is potential for in-combination impacts to occur from proposed activities within the SAC that could cause physical impacts and loss of habitat to the qualifying features of the SAC.

9.23 The total area of physical loss of habitat arising from existing or planned activities within the SAC is estimated to be 19.7 km^2, a total of 0.16% of the SAC (Table 4).

[1] This is based on there being 457.7 km of pipeline and umbilical within the SAC and 6.6% of it is protected by rock deposits.

9.24 The total area of temporary seabed disturbance within the SAC is largely unknown owing to uncertainties over the extent demersal fishing occurs within the site. However, it is estimated that between 56.5 km^2 and 8,757 km^2 of seabed could be impacted each year, which is between 0.46% and 70.0% of the SAC (Table 6).

Table 5: Estimated area of seabed physically lost from in-combination impacts.

Activity	Total area of seabed impacted (km^2)
Renewables – Wind turbines and Infrastructure	3.0
Renewables – Cable protection	15.0
Existing oil and gas pipelines	0.77
Existing rock dump for rig stabilisation	0.52
Existing rock dump along pipelines	0.33
Existing Mattresses	0.02
Future Infrastructure (Pegasus)	0.06
Aggregate Extraction	0 [1]
Subsea cables	0.02
Total area of physical loss (km^2)	19.7
Proportion of SAC impacted	0.16%

Note that it is recognised that there are existing aggregate extraction sites located within the SAC. However, it is thought that they are currently inactive and therefore not contributing to the in-combination impacts.

Table 6: Estimated area of seabed within the Dogger Bank SAC physically impacted.

Activity	Total area of seabed impacted (km^2)
Fishing	Unknown but occurred over 8,701 km^2 of the SAC in 2016.
Renewables – Cable laying	55.3
Future Infrastructure (Pegasus)	1.18
Aggregate Extraction	unknown
Total area of physical impact (km^2)	56.5 – 8,757
Proportion of SAC impacted	0.46% – 71.0%

10 LIKELY SIGNIFICANT EFFECTS TEST

10.1 Regulation 5 of the 2001 Regulations requires the Competent Authority to consider whether a development will have a likely significant effect on a European site, either alone or in combination with other plans or projects. A likely significant effect is, in this context, any effect that may be reasonably predicted as a consequence of a plan or project that may affect the Conservation Objectives of the features for which the site was designated but excluding trivial or inconsequential effects. An Appropriate Assessment is required if a plan or project is likely to have a significant effect on a European site, either alone or in combination with other plans or projects. A judgement of likely significant effect in no way pre-supposes a judgement of adverse effect on site integrity.

10.2 There are no recognised criteria as to what can be considered to be trivial or inconsequential impacts. Where predicted impacts are relatively very small compared to either the population of the management unit or the area of the site or the duration of the impact, it is determined that the impact would not cause a likely significant effect.

10.3 In response to the original application the JNCC advised BEIS that there would be a likely significant effect from all three applications on the qualifying features of the Southern North Sea SAC, namely harbour porpoise (JNCC 2020a,b,c). This was on the basis that the proposed activities occurred within or adjacent to the 'summer' area of the SAC during the summer period (April to September). For seabed clearance activities at the Cameron field *'evidence presented in the application suggests that there may be Annex I habitats affected by the proposed operations. Operations occur within in the Dogger Bank SAC'* (JNCC 2020a).

10.4 The revised applications remove the potential for impacts to occur in the summer period but likely significant effects could arise within the winter period (October to March). In addition, over-trawl surveys at Horne and Wren and Orwell could impact on the seabed habitat within the SAC.

10.5 No other qualifying features for any other designated sites have been identified as being at risk of a likely significant effect.

Southern North Sea SAC Likely Significant Effect

10.6 BEIS agreed with the advice received at the time in that, based on the information presented within each of the applications, there was potential for a Likely Significant Effect on the qualifying features of the Southern North Sea SAC from the detonation of explosives at all three locations both alone and in-combination.

Dogger Bank SAC Likely Significant Effect

10.7 Proposed seabed activities at the Cameron field occur within the Dogger Bank SAC. The detonation of explosives within the site could impact on the seabed. Evidence from UXO

clearance indicates that there is potential for a crater to be formed that could be up to approximately 1 m deep and have a diameter of up to 11 m (See Para 4.10). However, this is based on evidence from much larger explosives that are positioned on the seabed as opposed to 3 m below the seabed, which will be the case for the largest detonation to be undertaken at the Cameron field. Consequently, it is predicted that the impact on the seabed will be no greater than have been reported elsewhere from UXO clearance and most likely will be smaller.

10.8 The impact on the seabed will persist depending on the rate of local sediment movement. Measurements suggest this may be as short as only a few days in high energy environments such as the Bristol Channel and North Norfolk Banks but can be as long as several years for more stable deposits (Cooper *et al*. 2005*,* Hitchcock & Bell 2004, Kenny and Rees 1996). Evidence from monitoring studies of anchor mounds in the Dogger Bank indicate that within four weeks of the anchors being removed there was no sign of any mounds present (ConocoPhillips 2006). Consequently, it is predicted that the seabed will progressively recover although the length of time this may take depends on the local conditions of the site. However, the physical impacts on the sandbank feature will be localised and temporary.

10.9 Within the revised application for seabed clearance activities at the Cameron field there will be no over-trawl survey undertaken (TOSK 2020f). Consequently, the predicted impacts on the qualifying features have not changed since the original application.

10.10 Due to the nature and scale of impacts within the Dogger Bank SAC from the proposed works to be undertaken at the Cameron field and that the conductor along with the associated grout are to be removed and taken ashore it has been determined that there will be no Likely Significant Effect on that site alone or in-combination and no further assessment has been undertaken.

11 APPROPRIATE ASSESSMENT

11.1 An Appropriate Assessment is triggered when the competent authority, in this case the Secretary of State, determines that a plan or project is likely to have a significant effect on a European site. Guidance issued by the European Commission states that the purpose of an Appropriate Assessment is to determine whether adverse effects on the integrity of the site can be ruled out as a result of the plan or project, either alone or in-combination with other plans and projects, in view of the site's conservation objectives (EC 2000).

11.2 The following sections assess whether there will be an adverse effect on the Southern North Sea SAC.

11.3 A dual approach based on outputs from noise modelling and supported by the use of EDR has been used for harbour porpoise in order to determine whether an adverse effect on the integrity of the Southern North Sea SAC will occur.

Southern North Sea SAC (Harbour porpoise)

Physical Injury

11.4 Noise modelling undertaken indicates that, based on the weighted SEL threshold, there is potential for sound levels from seabed clearance activities to cause the onset of PTS to harbour porpoise out to 2,200 m of the sound source (TOSK 2020a,b,c)

11.5 The peak harbour porpoise density across the SAC is estimated to be >3 per km^2 (Heinänen and Skov 2015). Based on this peak density up to 46 harbour porpoise could be impacted. However, densities based on survey results indicate that the density of harbour porpoise within the area of the proposed activities may be lower than that based on modelling with recorded densities within the area of between 0.79 ind.km^2 to 2.7 ind./km^2 (Vattenfall 2018, SMart Wind 2017). This indicates that the number of porpoise at risk of PTS could be between 12 and 40 individuals depending upon the location.

11.6 The North Sea Management Unit harbour porpoise population is 333,808 individuals and therefore the worst-case scenario of one harbour porpoise being impacted is <0.01% of the Management Unit population.

11.7 The estimated area of potential impact from PTS is within 2,200 m of the explosive detonation and therefore the mitigation measures proposed by the applicant, which includes the use of an Acoustic Deterrent Device (ADD) will minimise the risk of any marine mammals are within the range at which the onset of PTS is predicted to occur (See Section 13: Mitigation).

Disturbance

11.8 No assessment has been undertaken using noise modelling outputs on the predicted number of harbour porpoise that could be disturbed by the detonation of explosives. The applicant has

based the assessment on a 26 km EDR. On this basis up to 6,372 harbour porpoise could be disturbed using the maximum modelled density of 3.0 ind./km^2. Using results from survey data between 1,678 and 5,734 harbour porpoise could be disturbed at each location. Consequently, between 0.5% and 1.9% of the Management Unit population could be impacted by each detonation.

Threshold Approach

11.9 The JNCC advised that the assessment for harbour porpoise within the SAC should be undertaken by the proposed threshold approach whereby disturbance should not exceed 20% of the SAC 'summer' or 'winter' areas over the course of one day and on average 10% of an area over the course of a single season (see Section 7).

11.10 Based on information presented within the applications, BEIS have estimated the area of the SAC impacted by the explosive detonations based on a 26 km EDR for each of the three locations (Figure 11 and Table 7). Seabed clearance at Horne and Wren during the winter period could impact an estimated 2.7% of the 'winter' area.

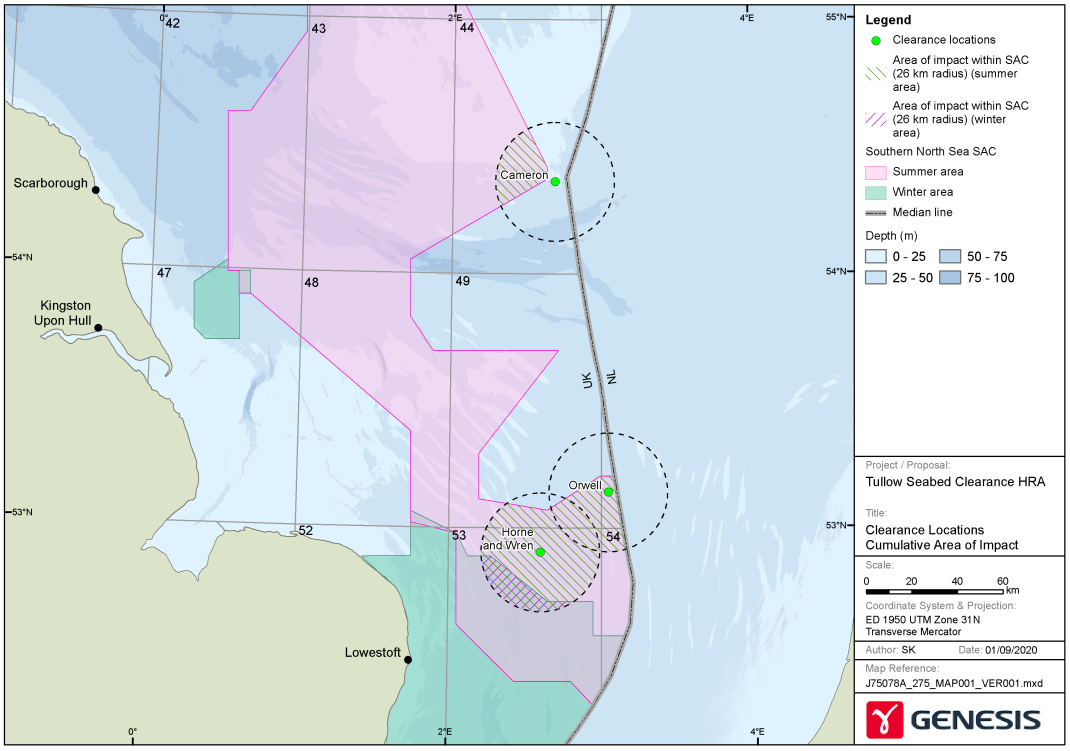


Figure 11: Tullow seabed clearance activities and 26 km EDR

11.11 Each detonation will last for one day. However, for the purposes of this assessment BEIS has allowed for an additional two days 'recovery' period during which time displaced harbour porpoise

may return to the area. Consequently noise from seabed clearance could contribute to 0.04% of the winter seasonal threshold (Table 7).

11.12 The proposed activities will now be undertaken no earlier than 6 November 2020 and be completed by 31 January 2020. Consequently, there will now be no impacts within the Southern North Sea SAC during the summer period and therefore the daily and seasonal thresholds from these activities during the summer period are zero.

11.13 Impacts within the 'winter' area of the SAC during the winter period will only arise at the seabed clearance activities to be undertaken at the Horne and Wren field.

Table 7: Daily and seasonal spatial overlap for Tullow seabed clearance.

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of days detonation	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Horne and Wren (Original application)					
'summer'	2,006	7.4	1	3	0.12
'Winter'	346	2.7	1	3	0.04
Horne and Wren (Revised application)					
'summer'	2,006	0	1	3	0
'Winter'	346	2.7	1	3	0.04
Orwell (Original application)					
'summer'	735	2.7	1	3	0.04
Orwell (Revised application)					
'summer'	735	0	1	3	0
Cameron (Original application)					
'summer'	470	1.7	1	3	0.03
Cameron (Revised application)					
'summer'	470	0	1	3	0

1 – This accounts for two days 'recovery time' following cessation of explosive detonations.

BEIS have calculated the area of impact within the SAC based on the coordinates presented within each of the applications. The area of impact within the SAC and consequently the daily thresholds differ from those presented in the applications. For both the Horne and Wren and Cameron fields that area calculated by BEIS is greater than calculated by the applicant. The BEIS calculations have been used in this assessment.

The seasonal threshold is not presented in any of the Tullow applications. It has therefore been calculated by BEIS for each activity.

Impacts on habitat

11.14 The revised applications for seabed clearance at Horne and Wren and at Orwell include over-trawl surveys. The over-trawl surveys will each impact an area of seabed 1,000 m^2 (TOSK 2020d, e). The impacts on the seabed could affect the prey species for harbour porpoise, e.g. sandeels.

11.15 The total area of the SAC is 36,951 km^2. Consequently, approximately 0.005% of the seabed within the SAC could be impacted by the two over-trawl surveys. There will be no impacts within the 'winter' area of the SAC and therefore no seasonal related impacts will occur. The impacts on the seabed and the associated prey species from the over-trawl surveys are predicted to be temporary, with the seabed and associated communities re-establishing themselves following completion of the surveys. The localised and temporary impacts will not cause an adverse effect on harbour porpoise.

Conclusion

11.16 Results from noise modelling indicate that between 12 and 46 harbour porpoise could be at risk of physical injury from noise arising from the explosive detonations. With proposed mitigation discussed in Section 13 there is a very low risk of any harbour porpoise being injured.

11.17 There is a risk of harbour porpoise being displaced or disturbed by the proposed seabed clearance activities. Based on a 26 km EDR up to 6,372 harbour porpoise may be disturbed based on the maximum densities within the SAC. However, site specific densities are predicted to be lower than this. The disturbance will be of short duration and once the activities have ceased harbour porpoise will return to the area and therefore the impacts are temporary.

11.18 The results from the threshold approach indicate that the revised timing of the proposed activities reduces the impacts within the 'summer' area from 7.4% to 0%. The area predicted to be impacted in the 'winter' area remains unchanged. The winter daily and seasonal thresholds are not exceeded.

11.19 The proposed activities will have a localised and temporary impact on the supporting seabed habitats and the supporting prey species. Once the proposed activities have ceased there will be no effect on the distribution, abundance and population dynamics of the species.

11.20 Based on the best available information and supported by results from noise modelling and the threshold approach, BEIS is satisfied that the proposed seabed clearance activities at Horne and Wren, Orwell and Cameron fields alone will not have an adverse effect upon the integrity of the Southern North Sea SAC with respect to harbour porpoise.

12 IN-COMBINATION ASSESSMENT

12.1 There is potential for in-combination impacts to arise due to noise from other known or planned activities and the proposed seabed clearance.

12.2 Activities identified as having potential to cause an in-combination impact within the 'winter' area of the SAC between 6 November 2020 and 31 January 2021 are:

- Hornsea Project Two offshore wind farm - UXO clearance,

12.3 Within the original HRA the following projects were also identified as having the potential to cause an in-combination impact. These projects have since either completed their activities or do not impact on the 'winter' area of the SAC and are therefore not considered within the in-combination assessment.

- Hornsea Project Two offshore wind farm – Pile-driving (will not impact on 'winter' area of the SAC).
- Viking Link Inter Connector – UXO clearance (will not impact on 'winter' area of the SAC).
- ION seismic survey – Airguns (will not impact on 'winter' area of the SAC),
- Triton Knoll offshore wind farm – Pile-driving (completed)
- Tolmount – Pile-driving (completed)
- BP Endurance Surveys – Airguns and Sub-bottom profiler (completed and did not impact on 'winter' area of the SAC).
- Spirit Energy – Ossian rig site survey (completed and did not impact on 'winter' area of the SAC).
- Spirit Energy - Bonnie Brae rig site survey (completed and did not impact on 'winter' area of the SAC).

Hornsea Project Two

12.4 The Hornsea Two offshore wind farm is located within Subzone 2 of the Round 3 Offshore Wind Farm Zone; Zone 4: Hornsea. At its closest point Hornsea Two lies 89 km from shore and covers an area of 462 km^2; of which 298 km^2 of the wind farm site lies within the SAC. In addition to the wind farm area an export cable route crosses the SAC. It is estimated that 36 km of the cable route is within the SAC (Figure 4).

12.5 Ørsted have a Marine Licence to undertake UXO clearance within the wind farm area and along the export cable route. The licence is for clearance by detonation of up to 100 items of UXO over a two year period: 40 items between July 2019 to 31 December 2019 and 60 items between 1 April 2020 to 31 December 2020 (MMO 2019b).

Hornsea Two UXO clearance

12.6 Noise modelling undertaken by Ørsted indicates that the onset of PTS in harbour porpoise could occur within 11.6 km from a detonation of an 800 kg charge (Ørsted 2018c,d).

12.7 Assuming circular propagation of noise, in the event that the onset of PTS extends 11.6 km from the source the onset of PTS could occur over an area of 422.7 km^2. The density of harbour porpoise across the Hornsea Zone plus a 10 km buffer is between 1.72 and 2.22 ind./km^2 (SMart Wind 2015). Based on the higher recorded density, an estimated 425 harbour porpoise are at risk of PTS in the event that an 800 kg UXO is detonated at Hornsea Two. This is 0.13% of the North Sea Management Unit.

12.8 No assessment has been made by Ørsted on the estimated number of harbour porpoise that could be displaced or disturbed by UXO clearance based on noise modelling outputs.

12.9 Ørsted have undertaken an assessment based on the proposed SNCB threshold approach with an EDR of 26 km (Ørsted 2020).

12.10 UXO clearance along the export cable route has the potential to impact on the 'winter' area of the SAC but UXO clearance within the wind farm area will not.

12.11 UXO clearance along the export cable route was completed in 2019 (Ørsted 2019). It is therefore unlikely that there will be any further impacts within the 'winter' area of the SAC during the winter period. However, Ørsted have licence to undertake UXO clearance during the winter period and could potentially clear, as yet, undiscovered UXO. For the purposes of this assessment it is presumed that one further item of UXO is identified that could impact on the 'winter' area of the SAC during the winter period (Table 8).

Table 8: Seasonal spatial overlap for Hornsea Two UXO detonations without bubble curtains.

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of detonations	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Single UXO detonation					
'Winter' [2]	99.04	0.78	1	3	0.01

1 – This accounts for two days 'recovery time' following cessation of UXO clearance.

2 – Ørsted completed UXO clearance activities but have licence to undertake additional UXO clearance in the event of undiscovered UXO is later identified during construction. For the purposes of this assessment it is presumed that one additional item of UXO will be cleared.

12.12 This assessment is based on the presumption that bubble curtains are not being used to reduce the risk of injury and extent of disturbance. During 2019 Ørsted cleared 26 items of UXO within the project area and used bubble curtains for 23 of them; therefore on 88% of occasions bubble curtains have been used. Ørsted have confirmed that bubble curtains were used for all UXO

clearance undertaken in 2020 (Ørsted *Pers. comm*. 2020). This significantly reduces the potential area of displacement or disturbance.

12.13 The use of bubble curtains for pile-driving reduces the EDR from 26 km to 15 km (JNCC 2020e) and although not stated in the recent guidance a similar level of effect for UXO clearance has been considered for the purposes of this assessment.

12.14 The closest the export cable corridor is to the 'winter' component of the SAC is 15.5 km (Ørsted 2018b). Consequently, with the use of bubble curtains, there will be no impact on the SAC during this period.

Shipping

12.15 There is potential for an in-combination impact with the proposed surveys and existing vessel activity.

12.16 The impacts of shipping on harbour porpoise within the SAC were assessed by BEIS in the Review of Consents HRA (BEIS 2018). The assessment estimated that across the SAC an average of 737 vessel movements were undertaken each day and at any one time harbour porpoises may be being displaced across an area of 369 km^2 within the SAC. Based on an average density of 0.71 ind./km^2 harbour porpoise across the SAC, an estimated 262 harbour porpoise may be temporarily displaced; 0.08% of the North Sea Management Unit population.

12.17 The number of vessels operating in the 'winter' area during the winter period each year is unknown and therefore it is not possible to calculate the potential daily or seasonal areas of impact required for the threshold approach. Although it is recognised that there will be localised areas of displacement surrounding vessels, the impacts will be very temporary with harbour porpoise predicted to remain in the areas following the departure of the vessel. Consequently, there will be no daily or seasonal disturbance equivalent to those arising from other activities.

In-combination scenarios

12.18 The in-combination assessment has been undertaken using outputs from both noise modelling and the threshold approach. In-combination Impacts on Southern North Sea SAC: Harbour porpoise.

Noise modelling

12.19 This section assesses the potential in-combination impacts based on the results from noise modelling undertaken for each of the applications.

Physical Injury

12.20 Based on the results from the noise modelling an estimated total of 467 harbour porpoise could be at risk of PTS from proposed activities affecting the Southern North Sea SAC (Table 9).

Consequently, it is estimated that up to 0.1% of the North Sea Management Unit could, in theory, be impacted.

Table 9: Estimated number of harbour porpoise at risk of PTS from proposed activities in Southern North Sea SAC without mitigation.

Activity	PTS
Tullow Seabed Clearance	42
Hornsea UXO Clearance	425
Total	**467**

12.21 For UXO clearance at Hornsea Two Ørsted have committed to incorporating mitigation measures in order to reduce the risk of injury (Ørsted 2018d 2020). Mitigation that may reduce the risk of injury include the use of MMO and the use of ADDs. The use of a bubble curtain has been used in all detonations during 2020. In the unlikely event further UXO is identified that could impact on the SAC during the winter period, it is highly likely that a bubble curtain will be used. Although the use of mitigation may reduce the risk of auditory injury it is recognised that it is not possible to totally prevent it and Ørsted have applied for European Protected Species (EPS) licences for both disturbance and injury.

12.22 The mitigation measures will significantly reduce the risk of physical auditory injury to harbour porpoises.

Disturbance

12.23 Due to the nature of the sound arising from the detonations, i.e. a number of single discrete events with each blast lasting for a very short duration, harbour porpoise are not predicted to be significantly displaced from an area. Should they occur, any changes in behaviour are predicted to be very short-lived. Existing guidance suggests that disturbance behaviour is not predicted to occur from explosive detonations if undertaken over a short period of time (JNCC 2010), which would be the case during the seabed clearance activities where there may be one subsurface detonation of 70 kg explosive and potential for up to two relatively small seabed detonations of 8 kg that may be required in order to dislodge any remaining grout. Similarly, it is not expected that any further UXO will be cleared along the Hornsea Two export cable route. In the event that it is required it will be a single discrete detonation and therefore not predicted to cause significant displacement or disturbance.

In-combination threshold approach

12.24 It is unlikely that UXO clearance along the Hornsea Two export cable route will be undertaken. It is even less likely that, if it is required, that it is undertaken on the same day as seabed

clearance activities are being caried out at Horne and Wren. In the improbable event that this does occur neither the daily or seasonal thresholds will be exceeded (Table 10).

Table 10: worst-case in-combination daily threshold (%).

Activity	Daily threshold each month			Winter seasonal threshold
	Nov	Dec	Jan	
Tullow Seabed Clearance at Horne and Wren	2.7	2.7	2.7	0.04
Hornsea Two UXO detonation (without bubble curtains)	0.8	0.8	0.8	0.01
Total %	3.5	3.5	3.5	0.05

In-combination assessment Southern North Sea SAC conclusions

12.25 Results from noise modelling indicate that up to 467 harbour porpoise could, in theory, be at risk of physical auditory injury in the form of PTS from planned activities within or adjacent to the SAC. This is 0.1% of the Management Unit population and therefore below either the 1% or 1.7% level at which a population level effect is predicted to occur. Mitigation measures that are secured through licence conditions significantly reduce the risk of any harbour porpoise receiving sound levels capable of causing the onset of PTS.

12.26 The results from the threshold approach indicate that neither the daily or seasonal thresholds will be exceeded in the event that UXO clearance along the Hornsea Two export cable route coincides with seabed clearance activities at Horne and Wren.

12.27 Based on the best available information and supported by results from noise modelling and the threshold approach, BEIS is satisfied that the proposed Tullow seabed clearance activities in-combination with other plans or projects will not have an adverse effect upon the integrity of the Southern North Sea SAC with respect to harbour porpoise.

13 MITIGATION

13.1 The following section presents a summary of the planned mitigation submitted by the applicant that will reduce the risk of an adverse effect occurring. Tullow have committed to following the JNCC guidelines *JNCC guidelines for minimising the risk of injury to marine mammals from using explosives* (JNCC 2010). This will include:

- Adherence to the JNCC guidelines for minimising the risk of disturbance to marine mammals from using explosives;
- Tullow will use trained Marine Mammals Observers (MMO) to conduct visual monitoring for marine mammals;
- The MMOs will have access to Passive Acoustic Monitoring (PAM) equipment throughout the operations;
- Acoustic Deterrent Devices will be used prior to detonation to discourage marine mammals from entering the vicinity;
- A suitable mitigation zone, the area where mitigation measures must be put in place to ensure that injury is avoided, with a radius of one kilometre will be established around the vessel;
- Prior to detonation, a visual watch, known as the 'pre-detonation search' will be carried out within the mitigation zone. The pre-detonation search should continue until the MMO advises that no marine mammals can be observed within the mitigation zone, and the detonation can begin;
- Explosive detonations will not be undertaken within 20 minutes of a marine mammal being detected within the mitigation zone. If a marine mammal is sighted, the animal(s) should be monitored until it moves out of range;
- Wherever practicable, the sequence and order of the denotations should be controlled, with the aim of reducing the environmental impact;
- A post detonation search will be conducted within the mitigation zone by the MMO to look for any evidence of injury to marine life, including fish kills. Any unusual events will be recorded.

14 CONCLUSIONS

14.1 The Secretary of State has carefully considered all of the information available in order to undertake a Habitats Regulations Assessment. He considers the proposed seabed clearance activities at the Horne and Wren, Orwell and Cameron fields to have the potential to cause a Likely Significant Effect alone and in-combination with other plans or projects on the qualifying features of the Southern North Sea SAC but not on the Dogger Bank SAC.

14.2 The Secretary of State has undertaken an Appropriate Assessment in respect of the site's Conservation Objectives to determine whether the project, either alone or in-combination with other plans or projects, will result in an adverse effect on integrity.

14.3 The Secretary of State has undertaken a robust assessment using all of the information available to him.

14.4 Having considered all of the information available to him the Secretary of State has concluded that the proposed seabed clearance activities will not have an adverse effect on the integrity of any European designated site either alone or in-combination with other plans or projects.

Author: Philip Bloor

Date: 01 November 2020

15 REFERENCES

ASCOBANS (2015). *Recommendations of ASCOBANS on the Requirements of Legislation to Address Monitoring and Mitigation of Small Cetacean Bycatch*. October 2015.

BEIS (2018). *Draft Habitat Regulations Assessment for Review of Consents in Southern North Sea SAC*. Draft issued for consultation October 2018.

BEIS (2019). *Record of the Habitats Regulations Assessment undertaken under Regulation 5 of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (As Amended): Dogger Bank SAC Oil and Gas Decommissioning Strategic HRA.* October 2019.

BEIS (2020a). *Record of the Habitats Regulations Assessment undertaken under Regulation 5 of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (As Amended): Tullow Seabed Clearance HRA.* Rev 2.0. BEIS September 2020.

BEIS (2020b). *Record of the Habitats Regulations Assessment undertaken under Regulation 5 of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (As Amended): ION seismic survey HRA*. BEIS June 2020.

BEIS (2020c). *Record of the Habitats Regulations Assessment undertaken under Regulation 5 of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (As Amended):* Premier Oil - Tolmount Pile-driving. BEIS June 2020

BEIS (2020d). *Record of the Habitats Regulations Assessment undertaken under Regulation 5 of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (As Amended): BP Endurance Surveys HRA*. BEIS *In prep.*

BP (2020a). *The Net Zero Teesside Project UKCS Block 42 and 43. Environmental Justification report.* 21 August 2020. Gardline.

BP (2020b). *Application GS/1124/0 (Version 2). Application to carry out a Marine Survey*. 21 August 2020.

Brown and May Marine (2013). *Commercial fisheries technical report*. In: Dogger Bank Creyke Beck Environmental Statement Chapter 15 Appendix A: Forewind 2013.

Clark, N. (2005). *The Spatial and Temporal Distribution of the Harbour Porpoise (P. phocoena) in the Southern Outer Moray Firth, NE Scotland*. Unpublished Master of Science Thesis. University of Bangor.

ConocoPhillips (2006). *Environmental Statement for the Kelvin Development*. ConocoPhillips October 2006.

Cooper, K.M., Eggleton, J.D., Vize, S.J., Vanstaen, K., Smith, R., Boyd, S.E., Ware, S., Morris, C.D., Cur s, M.I, Limpenny, D.S. & Meadows, W.J. (2005). *Assessment of the rehabilitation of the seabed following marine aggregate dredging-part II.* Cefas Science Series Technical Reports, Cefas Lowestoft, 130: 82pp.

Defra (2003). *UK small cetacean bycatch response strategy*. Department for Environment, Food and Rural Affairs. March 2003

Defra (2012). *The Habitats and Wild Birds Directives in England and its seas. Core guidance for developers, regulators & land/marine managers*. December 2012.

Defra (2015). *An analysis of potential broad-scale impacts on harbour porpoise from proposed pile driving activities in the North Sea*. Report of an expert group convened under the Habitats and Wild Birds Directives – Marine Evidence Group.

Diederichs, A., Brandt, M., and Nehls, G. (2010). Does sand extraction near Sylt affect harbour porpoises? *Wadden Sea Ecosystem*, 26:199–203.

DeRuiter, S.L. (2008). *Echolocation-based foraging by harbor porpoises and sperm whales, including effects of noise and acoustic propagation*. PhD Thesis. Massachusetts Institute Of Technology and the Woods Hole Oceanographic Institution. September 2008.

EAOWL (2015). *East Anglia Three offshore wind farm. Environmental Statement.* Scottish Power Renewables, Vattenfall.

EC (2000). *Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/CEE.* Luxembourg: Office for Official Publications of the European Communities, 2000 ISBN 92-828-9048-1.

EMU (2010). *Dogger Bank Zonal Characterisation Interim Report for Forewind Ltd*. Report no. 10/J/1/06/1587/1028.

English Nature (1997). *Habitats Regulations Guidance Note, HRGN 1.*

European Commission (2013). *Interpretation Manual of European Habitats*. EUR 28. European Commission. DG Environment. Nature ENV B.3. April 2013.

Evans, P.G.H. and Teilmann, J. (editors). (2009). *Report of ASCOBANS/HELCOM Small Cetacean Population Structure Workshop.* ASCOBANS/UNEP Secretariat, Bonn, Germany. 140pp.

Everley, K.A., Radfod, A.N., Simpson, S.D. (2016). *Pile-Driving Noise Impairs Antipredator Behavior of the European Sea Bass Decentrarchus labrax.* In: Popper A.N., Hawkins, A.D. (eds). The effects of noise on aquatic life, II. Springer Science Business Media, New York. pp. 273 – 279.

Forewind (2013). *Dogger Bank: Creyke Beck offshore wind farm Environmental Statement.* Forewind.

Forewind (2014). *Dogger Bank: Teesside A & B offshore wind farm Environmental Statement*. Forewind

Gilles, A., Peschko, V., Scheidat, M. and Siebert, U. (2012). *Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011*. 19th ASCOBANS Advisory Committee Meeting, 20-22 March 2012. AC19/Doc.5-08 (P).

Greenstreet, S., Armstrong, E., Mosegaard, H., Jensen, H., Gibb, I., Fraser, H., Scott, B., Holland, G. and Sharples, J. (2006). Variation in the abundance of sandeels *Ammodytes marinus* off southeast Scotland: an evaluation of area-closure fisheries management and stock abundance assessment methods. *ICES Journal of Marine Science* 63: 1530-1550.

Hammond, P. S. (2006). *Small Cetaceans in the European Atlantic and North Sea (SCANS II).* LIFE Project No. 04NAT/GB/000245.

Hammond, P.S., Benke, H., Borchers D.L., Buckland S.T., Collet A., Hiede-Jørgensen, M.P., Heimlich-Boran, S., Hiby, A.R., Leopold, M.F. and Øien, N. (1995). *Distribution and abundance of the harbour porpoise and other small cetaceans in the North Sea and adjacent waters*-Final report. Life 92-2/UK/027.

Hammond, P.S., Macleod, K., Berggren, P., Borchers, D.L., Burt, M.L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D., Gordon, J., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øien, N., Paxton, C.G.M., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M.L., Teilmann, J., Van Canneyt, O. & Vázquez, J.A. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. *Biological Conservation* 164: 107-122.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2017). *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys*. University of St Andrews. https://synergy.st-andrews.ac.uk/scans3/category/researchoutput/ (accessed August 2020).

Hanson Aggregates Marine Ltd. (2013). *Licence Renewal Environmental Statement for Area 401/2. Volume 1: Environmental Statement.* July 2013.

Hawkins, A.D., Roberts, L., and Cheesman, S. (2014). Responses of free-living coastal pelagic fish to impulsive sounds. *Journal of the Acoustical Society of America* 135: 3101 - 3116. PMID: 24926505.

Heath, M.R., Rasmussen, J., Bailey, M.C., Dunn, J., Fraser, J., Gallego, A., Hay, S.J., Inglis, M. and Robinson, S. (2011). Larval mortality rates and population dynamics of Lesser Sandeel (Ammodytes marinus) in the northwestern North Sea. *Journal of Marine Systems* 93, pp. 47- 57.

Heinänen, S. and Skov, H. (2015). *The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area*. JNCC Report No.544 JNCC, Peterborough.

Hitchcock, D.R. and Bell, S. (2004). Physical impacts of marine aggregate dredging on seabed resources in coastal deposits. *Journal of Coastal Research*, 20(1): 101-114.

Holland, G.J., Greenstreet, S.P.R., Gibb, I.M., Fraser, H.M. and Robertson, M.R. (2005). Identifying sandeel *Ammodytes marinus* sediment habitat preferences in the marine environment. *Mar. Ecol. Prog. Ser.* 303, 269– 282.

IAMMWG (2015). *Management Units for cetaceans in UK waters (January 2015).* JNCC Report No. 547, JNCC, Peterborough.

IAMMWG, Camphuysen, C.J. and Siemensma, M.L. (2015). *A Conservation Literature Review for the Harbour Porpoise (Phocoena phocoena).* JNCC Report No. 566, Peterborough. 96pp.

ICES (2016). *Working Group on Bycatch of Protected Species (WGBYC), 1–5 February 2016*, ICES HQ, Copenhagen, Denmark. ICES CM 2016/ACOM:27. 82 pp.

Infrastructure Planning (2015a). *The Dogger Bank Creyke Beck Offshore Wind Farm.* SI No. 318. UK2015021716 02/2015 19585. http://www.legislation.gov.uk/uksi/2015/318/contents/made (Accessed August 2020).

Infrastructure Planning (2015b). *The Dogger Bank Teesside A and B Offshore Wind Farm*. SI No. 1592. UK201508054 08/2015 19585. http://www.legislation.gov.uk/uksi/2015/1592/contents/made (Accessed August 2020).

ION (2020a). *UKS Southern North Sea 3D seismic survey*. Version01. ION Geophysical Corporation. 19 March 2020.

ION (2020b). *GX Technology/ION Southern North Sea Seismic Survey SA/1290 GS/1074*. E-Mail to BEIS. 30 March 2020.

ION (2020c). *Application GS/1074/0 (Version 1). Application to carry out a Marine Survey. SAT GS/1074/0 (Version 1).* MAT Reference SA/1290. 23 March 2020.

JNCC (2010). *JNCC guidelines for minimising the risk of injury to marine mammals from using explosives*. Joint Nature Conservation Committee. August 2010.

JNCC (2015). *The Marine Habitat Classification for Britain and Ireland Version 15.03.* http://www.jncc.gov.uk/marine/biotopes/biotope.aspx?biotope=JNCCMNCR00000785. (Accessed August 2020).

JNCC (2017a). *SAC Selection Assessment: Southern North Sea. January 2017. Joint Nature Conservation Committee, UK*. Available from: http://jncc.defra.gov.uk/page-7243.

JNCC (2017b). *Species abbreviations and Management Units (MU) abundance values, in "Instructions.doc".* Available from: http://jncc.defra.gov.uk/page-7201.

JNCC (2017c). Natura 2000 – Standard Data form. Site 0030352: Dogger Bank. http://jncc.defra.gov.uk/protectedsites/sacselection/n2kforms/UK0030352.pdf (Accessed August 2020).

JNCC (2017d). *Annex I sandbanks in offshore waters*. http://jncc.defra.gov.uk/page-1452. (Accessed August 2020).

JNCC (2017e). *A potential approach to assessing the significance of disturbance against conservation objectives of the harbour porpoise cSACs. Version 3.0.* Discussion document 14/02/2017. Workshop

Noise management in harbour porpoise cSACs. The Dome Room, New Register House, 3 West Register Street, Edinburgh, Scotland EH1 3YT. 27th February 2017.

JNCC (2017f). *Noise assessment and management in harbour porpoise SACs. Briefing note: Use of thresholds to assess and manage the effects of noise on site integrity*. Workshop Noise management in harbour porpoise cSACs. The Dome Room, New Register House, 3 West Register Street, Edinburgh, Scotland EH1 3YT. 27th February 2017.

JNCC (2017g). *JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys*. Joint Nature Conservation Committee, Aberdeen. April 2017.

JNCC (2018a). *Conservation Objectives for Dogger Bank Special Area of Conservation*. JNCC January 2018.

JNCC (2018b). *Supplementary Advice on Conservation Objectives for Dogger Bank Special Area of Conservation.* JNCC January 2018.

JNCC (2018c). *Dogger Bank Advice on Operations Workbook v1.0*. http://jncc.defra.gov.uk/page-6508. (Accessed August 2020).

JNCC (2018d). *Statements on conservation benefits, condition & conservation measures for Dogger Bank Special Area of Conservation*. JNCC 2018.

JNCC (2019a). *Southern North Sea MPA*. http://jncc.defra.gov.uk/page-7243. (Accessed April 2020).

JNCC (2019b). *European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC). Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018. Supporting documentation for the conservation status assessment for the habitat: H1110 - Sandbanks which are slightly covered by sea water all the time: UK Offshore*. Joint Nature Conservation Committee.

JNCC (2019c). *Dogger Bank MPA*. https://jncc.gov.uk/our-work/dogger-bank-mpa/. (Accessed August 2020). Joint Nature Conservation Committee.

JNCC (2019d). *Natura 2000 – Standard data form UK0030395. Southern North Sea*. Joint Nature Conservation Committee 26 March 2019.

JNCC (2020a). *Cameron, Tullow Oil SK Ltd, Marine Licence – Decommissioning*. JNCC Letter to BEIS. August 2020.

JNCC (2020b). *Horne & Wren, Tullow Oil SK Ltd, Marine Licence – Decommissioning*. JNCC Letter to BEIS. August 2020.

JNCC (2020c). *Orwell, Tullow Oil SK Ltd, Marine Licence – Decommissioning*. JNCC Letter to BEIS August 2020.

JNCC (2020d). https://sac.jncc.gov.uk/habitat/H1110/. Joint Nature Conservation Committee (Accessed August 2020).

JNCC (2020e). *Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (England, Wales & Northern Ireland).* JNCC Report No. 654, JNCC, Peterborough, ISSN 0963- 8091.

JNCC (2020F). *Tolmount Field, Premier Oil UK Ltd, Consent to Locate*. JNCC Reference: OIA 7227. Letter to BEIS dated 7 April 2020.

JNCC (2020b). *Initial response to ION seismic application*. Note to BEIS OPRED. April 2020.

JNCC and NE (2016). *Harbour Porpoise (Phocoena phocoena) possible Special Area of Conservation: Southern North Sea. Draft Conservation Objectives and Advice on Activities*. January 2016. Joint Nature Conservation Committee and Natural England.

JNCC and NE (2019). *Harbour Porpoise (Phocoena phocoena) Special Area of Conservation: Southern North Sea Conservation Objectives and Advice on Operations*. March 2019. Joint Nature Conservation Committee and Natural England.

Judd, A., Warr, K. and Pacitto, S. (2011). *Fisheries Sensitivity Maps in British Waters – Guidance for Pile-driving.* Cefas contract report <ME5403 Mod13>.

Kastelein, R.A., Hardeman, J. and Boer, H. (1997). *Food consumption and body weight of harbour porpoises (Phocoena phocoena).* In: The biology of the harbour porpoise (1997). Eds. Read, A.J., Wiepkema, P.R. and Nachtigall, P.E. pp.217-233. DeSpil Publishers, Woerden, The Netherlands, ISBN90-72743-07-5.

Kastelein, R. A., Gransier, R., Hoek, L. and Olthuis, J. (2012). Temporary threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4 kHz. *Journal of the Acoustical Society of America.* 132(5): 3525–3537.

Kastelein, R.A., Van de Voorde, S. and Jennings, N. (2018). Swimming Speed of a Harbor Porpoise (*Phocoena phocoena*) During Playbacks of Offshore Pile Driving Sounds. *Aquatic Mammals* 2018, *44*(1), 92-99, DOI 10.1578/AM.44.1.2018.92.

Kenny, A.J. & Rees, H.L. (1996). The effects of marine gravel extraction on the benthos: Results 2 years post dredging. *Marine Pollution Bulletin*, 32: 615-22.

Learmonth, J.A, Murphy, S., Luque, P.L., Reid, R.J., Patterson, I.A.P., Brownlow, A., Ross, H.M., Barley, J.P., Santos, M.B., Pierce, G.J. (2014). Life history of harbour porpoises (*Phocoena phocoena*) in Scottish (UK) waters. *Marine Mammal Science* 30: 1427-1455.

Lockyer C. (2003). Harbour porpoises (*Phocoena phocoena*) in the North Atlantic: biological parameters. *NAMMCO Scientific Publications*, 5, 71–89.

MarLIN (2018). *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand. https://www.marlin.ac.uk/habitats/detail/154/nephtys_cirrosa_and_bathyporeia_spp_in_infralittoral_sand. The Marine Life Information Network (Accessed August 2020).

Miller, L. A., and Wahlberg, M. (2013). Echolocation by the harbour porpoise: life in coastal waters. *Frontiers in Physiology*, 4, 52. http://doi.org/10.3389/fphys.2013.00052.

Mitchell, I., Macleod, K. and Pinn, E. (2018). *Harbour Porpoise bycatch. UK Marine Online Assessment Tool,* available at: https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/cetaceans/harbour-porpoise-bycatch/. (accessed August 2020).

MMO (2015). *Modelled mapping of continuous underwater noise generated by activities.* A report produced for the Marine Management Organisation, pp50. MMO Project No. 1097. ISBN 978-1-909452-87-9.

MMO (2017a). *Anonymised AIS derived track lines 2015.* https://data.gov.uk/dataset/anonymised-ais-derived-track-lines-2015. Marine Management Organisation.

MMO 2017b. https://data.gov.uk/dataset/4bd80f1a-4ead-44c5-b3fa-975da1cb4d7d/fishing-activity-for-uk-vessels-15m-and-over-2016. (Accessed August 2020).

MMO (2017c). *Record of Appropriate Assessment. Viking Link Interconnector.* Marine Management Organisation. MLA/2017/00106.

MMO (2018). *Marine and Coastal Access Act 2009 Application for a marine licence.* (Ref: MLA/2017/00106). MMO 5 October 2018.

MMO (2019a). *Case ref: MLA/2018/00503. Licence ref: L/2019/00266/1.* https://marinelicensing.marinemanagement.org.uk/mmofox5/fox/live/. (accessed August 2020).

MMO (2019b). *Marine Management Organisation Marine Licence. Licence number: L/2019/00266/1.* Case ref: MLA/2018/00503. 16 July 2019. https://marinelicensing.marinemanagement.org.uk/mmofox5/fox/live/. (Accessed August 2020).

MMO (2020). *MMO Licence Application: L/2018/00075/3 (Marine Licence). Variation request 3. L/2018/00075/3 (Marine Licence)* https://marinelicensing.marinemanagement.org.uk/mmofox5/fox/live/?thread_id=jfguhdr80tpu9np8m5pj3ntq9snfqqnkv2096gp5cgkg7opihf0hu60qcp5mu3cen1sf6omergs2t06c2cuquspgm91bgggs6qn2&resume=1 (Accessed August 2020).

Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D. T. and Thomsen, F. (2010). *Effects of Pile-driving Noise on the Behaviour of Marine Fish*. COWRIE Ref: Fish 06-08, Technical Report.

NGVL (2018a). *Offshore Environmental Statement: Volume 2*. National Grid Viking Ltd. August 2017.

NGVL (2018b). *Viking Link UXO clearance report to inform an Appropriate Assessment*. National Grid Viking Ltd. June 2018.

NGVL (2019a). *Viking Link UXO Clearance: Report to Inform an Appropriate Assessment – update 01* May 2019. National Grid Viking Ltd.

NGVL (2019b). *Viking Link Marine Mammal Mitigation Plan*. September 2019. National Grid Viking Limited.

OGA NDR (Oil and Gas Authority National Data Repository). https://ndr.ogauthority.co.uk/ (Accessed April 2020).

Ordtek (2018). *Strategic Unexploded Ordnance (UXO) Risk Management – Seabed Effects During Explosive Ordnance Disposal (EOD).* Norfolk Vanguard Limited. February 2018.

Ørsted (2018a). *Marine Licence Application*. MLA/2018/00503. https://marinelicensing.marinemanagement.org.uk/mmofox5/fox/live/. (Accessed August 2020).

Ørsted (2018b). *Hornsea Project Two Offshore Wind Farm: Report to Inform Appropriate Assessment for the Southern North Sea candidate Special Area of Conservation.* Ørsted.

Ørsted (2018c). *Hornsea Project Two Offshore Wind Farm: Marine License for Offshore UXO Clearance Supporting Environmental Information.* Ørsted.

Ørsted (2018d). *Marine Licence for Offshore UXO Disposal Marine Mammal Mitigation Protocol (MMMP).* Ørsted.

Ørsted (2019). *UXO Clearance Close-Out Report – Export Cable Route.* Ørsted.

Ørsted (2020). *Hornsea Project Two Offshore Wind Farm: Report to Inform Appropriate Assessment for the Southern North Sea Special Area of Conservation*. Ørsted. March 2020.

Ørsted *Pers. comm.* (2020). *Hornsea Project Two*. E-mail to BP. 20 August 2020.

OSPAR (2009) *Overview of the impacts of anthropogenic underwater sound in the marine environment*. OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (www.ospar.org).

OSPAR (2017). *Intermediate Assessment 2017: Harbour porpoise bycatch*. https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/marine-mammals/harbour-porpoise-bycatch/. (Accessed August 2020).

Otani S., Naito Y., Kawamura A., Kawasaki M., Nishiwaki S., and Kato A. (1998) Diving behavior and performance of harbor porpoises, *Phocoena phocoena*, in Funka Bay, Hokkaido, Japan. *Marine Mammal Science*, 14, 209–220.

Otani S. Naito Y., Kato A. and Kawamura A. (2000). Diving behaviour and swimming speed of a free ranging harbor porpoise, *Phocoena phocoena*. *Marine Mammal Science*, 16, 811– 814.

Parvin, S.J, Nedwell, J.R. and Harland. E. (2007). *Lethal and physical injury of marine mammals and requirements for Passive Acoustic Monitoring.* Subacoustech Report.

Parvin, S.J., Nedwell, J.R., Kynoch, J, Lovell, J. and Brooker, A.G. (2008). *Assessment of underwater noise from dredging operations on the Hastings shingle bank*. Report No. Subacoustech 758R0137. Subacoustech Ltd, Bishops Waltham, 81p.

Popper, A.N. (2003). Effects of anthropogenic sounds on fishes. *Fisheries 28*(10):24-31.

Premier Oil (2020). *EIA justification. A301533-S38*. Premier Oil March 2020.

Santos, M.B. and Pierce, G.J. (2003). The diet of harbor porpoise (*P. phocoena*) in the Northeast Atlantic. *Oceanography and Marine Biology: an Annual Review 2003*, 41, 355–390.

SMart Wind (2015). *Hornsea offshore wind farm. Project two environmental statement.*

SMart Wind (2017). *Hornsea Project Three Offshore Wind Farm. Preliminary Environmental Information*.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, Ro., Greene Jr., C., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J. and Tyack, P. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific recommendations. *Aquatic Mammals*. 33(4), 411-521.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Marine mammal noise exposure criteria: Updated Scientific recommendations for residual hearing effects. *Aquatic Mammals* 2019, *45*(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

Spirit Energy (2020a). *Spirit Energy Pegasus W Development Surveys. Environmental Justification*. Spirit Energy.

Spirit Energy (2020b). *Ossian Rig Site Survey Environmental Justification*. Spirit Energy. 20 March 2020.

Spirit Energy (2020c). *Bonnie Brae RIg Site Survey Environmental Justification*. Spirit Energy. 20 March 2020.

Spirit Energy *Pers. comm*. (2020). SE GS/1068 and GS/1067 application. E-mail to BEIS 28 April 2020.

Sveegaard, I. (2011). *Spatial and temporal distribution of harbour porpoises in relation to their prey*. Unpublished PhD Thesis, Aarhus University.

Teilmann, J., Larsen, F. and Desportes, G. (2007). Time allocation and diving behaviour of harbour porpoises (*Phocoena phocoena*) in Danish and adjacent waters. *J. Cetacean Res. Manage*. 9(3):201–210, 2007.

Thomsen, F., Lüdemann, K., Kafemann, R. and Piper, W. (2006). *Effects of offshore wind farm noise on marine mammals and fish*. Cowrie Report.

TKOWL (2011). *Triton Knoll Offshore Wind Farm Environmental Statement.* RWE npower renewables.

TOSK (2020a). *Horne & Wren Seabed Clearance EIA Justification*. Tullow Oil SK Limited. July 2020.

TOSK (2020b). *Orwell Seabed Clearance EIA Justification Document*. Tullow Oil SK Limited. July 2020.

TOSK (2020c). *Cameron Removal Work EIA Justification Document*. Tullow Oil SK Limited. July 2020.

TOSK (2020d). *Horne & Wren Seabed Clearance EIA Justification*. Tullow Oil SK Limited. October 2020. Doc Ref: P1214-05.

TOSK (2020e). *Orwell Seabed Clearance EIA Justification Document*. Tullow Oil SK Limited. October 2020. Doc Ref: P1214-05.

TOSK (2020f). *Cameron Removal Work EIA Justification Document*. Tullow Oil SK Limited. October 2020. Doc Ref: P1214-05.

Van der Kooij, J., Scott, B.E. and Mackinson S. (2008). The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. *Journal of Sea Research* 60: 201–209.

Van der Molen (2002). The influence of tides, wind and waves on the net sand transport in the North Sea. *Continental Shelf Research*, 22, 2739-2762.

Vattenfall (2018). *Norfolk Vanguard Offshore Wind Farm Chapter 12: Marine Mammals. Environmental Statement.* Norfolk Vanguard Ltd.

Villadsgaard A., Wahlberg M., Tougaard J. (2007). Echolocation signals of wild harbour porpoises, *Phocoena phocoena. J. Exp. Biol.* 210 56–64.

Weir, C.R., Stokin, K.A., and Pierce, G.J. (2007). *Spatial and Temporal Trends in the Distribution of Harbour Porpoises, White- Beaked Dolphins and Minke Whales Off Aberdeenshire (UK), North-Western North Sea*. J. Mar. Biol. Assoc. UK 87: 327-338.

Whaley, A.R. (2004). *The distribution and relative abundance of the harbour porpoise (P. phocoena L.) in the southern outer Moray Firth, NE Scotland*. Unpublished bachelor of Science thesis. School of Geography, Birkbeck College.

Wisniewska, D.M., Johnson, M., Teilmann, J., Rojano-Doñate, L., Shearer, J., Sveegaard, S., Miller, L.A., Siebert, U. and Madsen, P.T. (2016). Ultra-high foraging rates of harbor porpoises make them vulnerable to anthropogenic disturbance. *Current Biology* 26: 1441–1446, Elsevier Ltd.

Wisniewska, D.M., Johnson, M., Teilmann, J., Siebert, U., Galatius, A., Dietz, R. and Madsen, P.T. (2018). High rates of vessel noise disrupt foraging in wild harbour porpoises (*Phocena phocoena*). *Proc. R. Soc. B.* 285: 20172314. http://dx.doi.org/10.1098/rspb.2017.2314.