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).

Spectrum Seismic Survey

Issued April 2019
Rev 1.3

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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 an 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 An application to undertake a 3D seismic survey by Spectrum Geo Limited (hereafter Spectrum) was submitted to the Department for Business Energy and Industrial Strategy (BEIS) on 21 December 2018.

1.8 This is a record of the appropriate assessment in the form of a Habitats Regulations Assessment (HRA), undertaken by the Secretary of State for BEIS in respect of a proposed seismic survey that may cause a significant effect on the qualifying features of the Southern North Sea SAC (Site of Community Importance).

1.9 The proposed seismic survey relevant to this assessment is 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 seismic survey will adversely affect the integrity of any European designated site.

2 SURVEY DESCRIPTION

2.1 The following is a brief summary of the proposed Spectrum 3D seismic survey, further details may be found within the application (Spectrum 2018a).

2.2 The proposed regional survey will be undertaken across the Southern North Sea in quadrants 36, 37, 38, 42 and 43 off of the east coast of England. The planned survey is located within UKCS Blocks 36/20, 36/25, 36/29, 36/30, 37/11, 37/12, 37/13, 37/14, 37/15, 37/16, 37/17, 37/18, 37/19, 37/20, 37/21, 37/22, 37/23, 37/24, 37/25, 37/26, 37/27, 37/28, 37/29, 37/30, 38/11, 38/16, 42/4, 42/5, 42/8, 42/9, 42/10, 42/13, 42/14, 42/15, 42/17, 42/18, 42/19, 42/20, 43/1, 43/2, 43/3, 43/4, 43/6, 43/7, 43/8, 43/9, 43/11, 43/12, 43/13, 43/16, 43/17 and 43/18. The Permit area covers approximately 9,467 square kilometres, with the Survey Area covering 6,446 square kilometres (Figure 1). The closest point to the UK coastline is approximately 40 km (Spectrum 2018a).

2.3 The survey was scheduled to take place between April and October 2019 and is expected to last up to 160 days (Spectrum 2018a). However, since the application was made the start date has been delayed and will now start no sooner than 20 May 2019 (Spectrum *pers com.*).

2.4 The proposed survey will be undertaken by a seismic survey vessel (*Akademik Primakov*) towing ten 8,000 m streamers at a speed of approximately 4.5 knots (8.3 km/h). The width of each towed survey array is 875 m and each surveyed line will be 375 m apart (Spectrum 2018a). Two airguns will be deployed with a maximum total volume of 4,200 cu. in. with the airguns firing at intervals of every 8 seconds.

2.5 A total of 168 survey lines will be sailed. The total length of survey line wholly within the SAC is not presented in the application but has been calculated by BEIS to be 14,549 km and the maximum length of any single line within the SAC has been calculated to be 106 km.

2.6 The airguns will be switched off at the end of each survey line and prior to the commencement of using any airguns a 'soft-start' will be undertaken as per the JNCC guidance (JNCC 2017a).

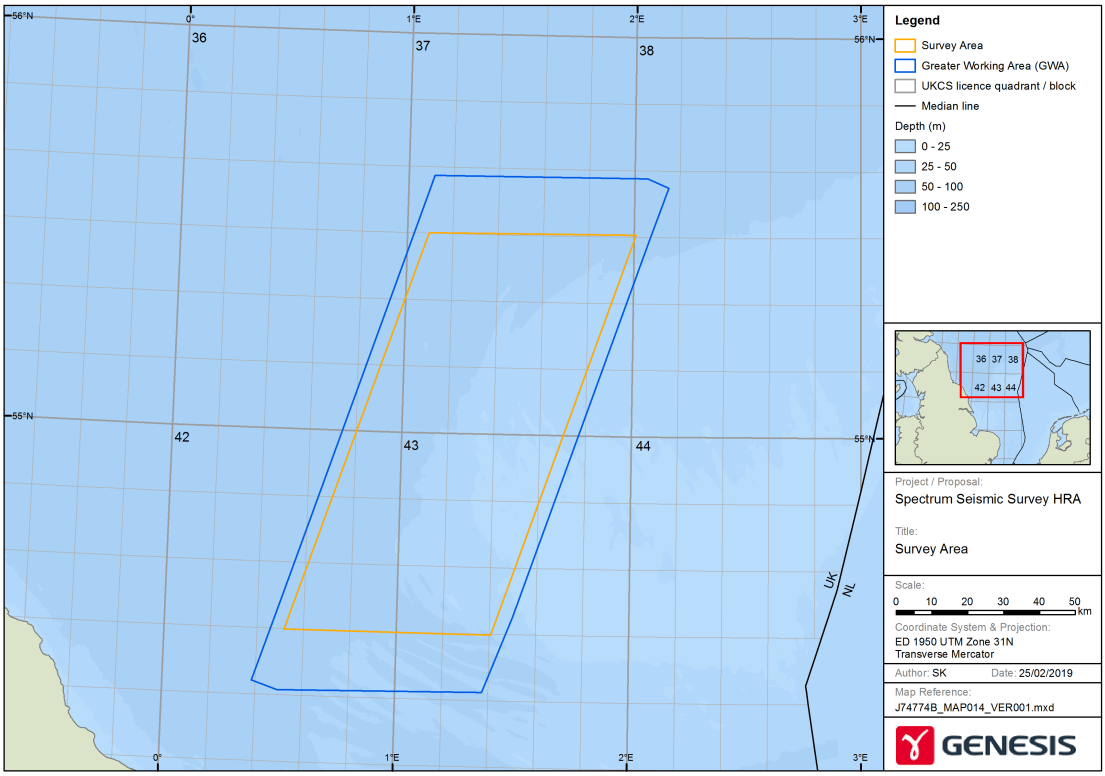

Figure 1: Location of the proposed Spectrum 3D seismic showing survey and greater working areas.

2.7 The specifications for the seismic array as presented in the application are presented in Table 1. The peak Sound Pressure Level (SPL) is 257 dB re 1 µPa at 1 m.

Table 1: Proposed seismic array parameters (Source - Spectrum 2008a, b).

Array Parameter	Value
No. of airguns	2
Total volume (cu. In).	4,200
Sound pressure - dB re 1 µPa (0-p)	257
Sound exposure level - dB re 1 μPa^2s	234
Peak frequency (Hz)	60
Pulse rate (Seconds)	8
Towed depth (m)	12
Vessel speed (knots)	4 - 4.5

3 DESIGNATED SITES

3.1 The proposed seismic survey is being undertaken in waters within or adjacent to a number of European designated sites and it is recognised that potential impacts that could cause a likely significant effect could occur to a number of qualifying species both within and outwith designated sites.

3.2 Based on the information presented within the application, including the results from the noise modelling undertaken in support of the application, two SAC/SACs and one SPA have been identified as having qualifying species at risk of a likely significant effect from the proposed survey (Figure 2).

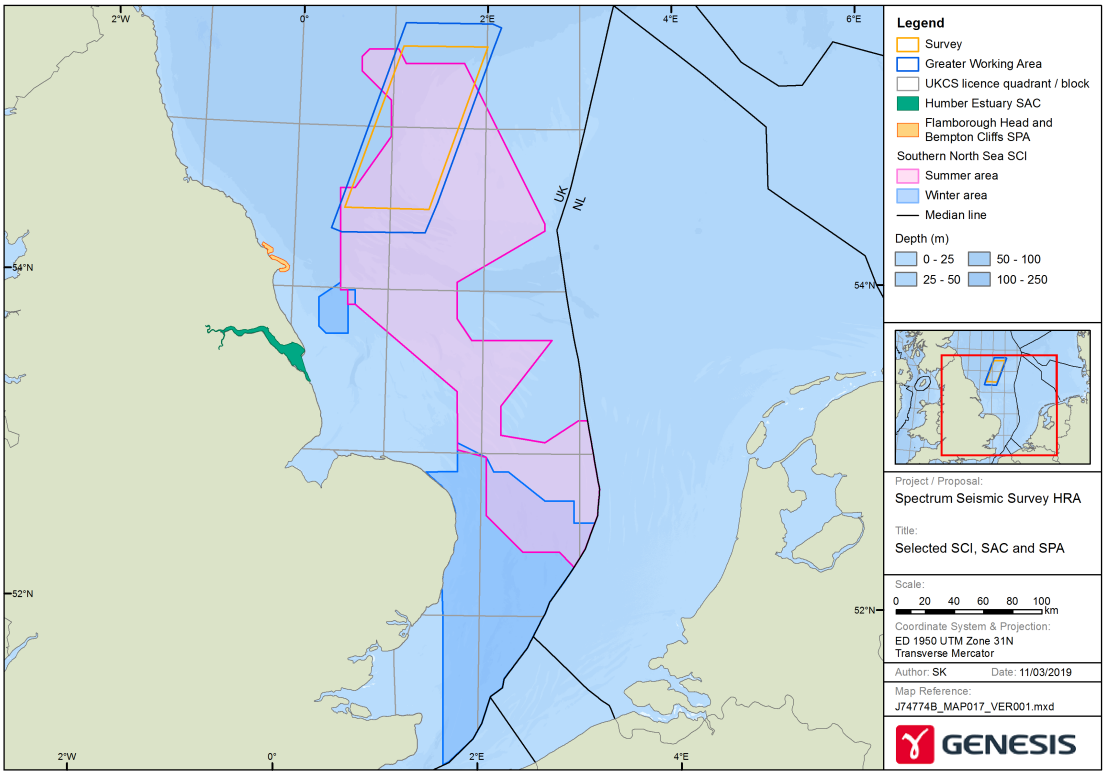

Figure 2: Location of proposed Spectrum survey and relevant designated sites.

3.3 The qualifying sites and species relevant to this HRA are:

- Southern North Sea cSAC (Harbour porpoise),
- Humber Estuary SAC and Ramsar (Grey seal, Sea lamprey),
- Flamborough and Filey Coast SPA (Gannet, Kittiwake, Herring gull, Puffin, Razorbill and Guillemot).

3.4 The proposed Survey and Permit areas overlap 6,688 km^2 of the Southern North Sea SAC, equivalent to 18.1% of the site as a whole. There is no spatial overlap with other designated sites that have qualifying species that could be impacted by the seismic survey. However, the qualifying species for the Humber Estuary SAC and Flamborough and Filey Coast SPA are known to occur within the Survey Area.

Qualifying features

3.5 Based on the information presented within the application and advice received from consultation (JNCC 2019b) it has been determined that the HRA should consider alone and in-combination the potential direct and indirect impacts on:

- Harbour porpoise,
- Grey seal,
- Seabirds (Gannet, Kittiwake, Herring gull, Puffin, Razorbill and Guillemot),
- Sea lamprey and River lamprey,
- Fish (prey) species.

Harbour porpoise

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

- Southern North Sea cSAC.

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). Although harbour porpoise have a very broad distribution across the United Kingdom Continental Shelf (UKCS) they occur 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 area 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 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 (Figure 3) (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).

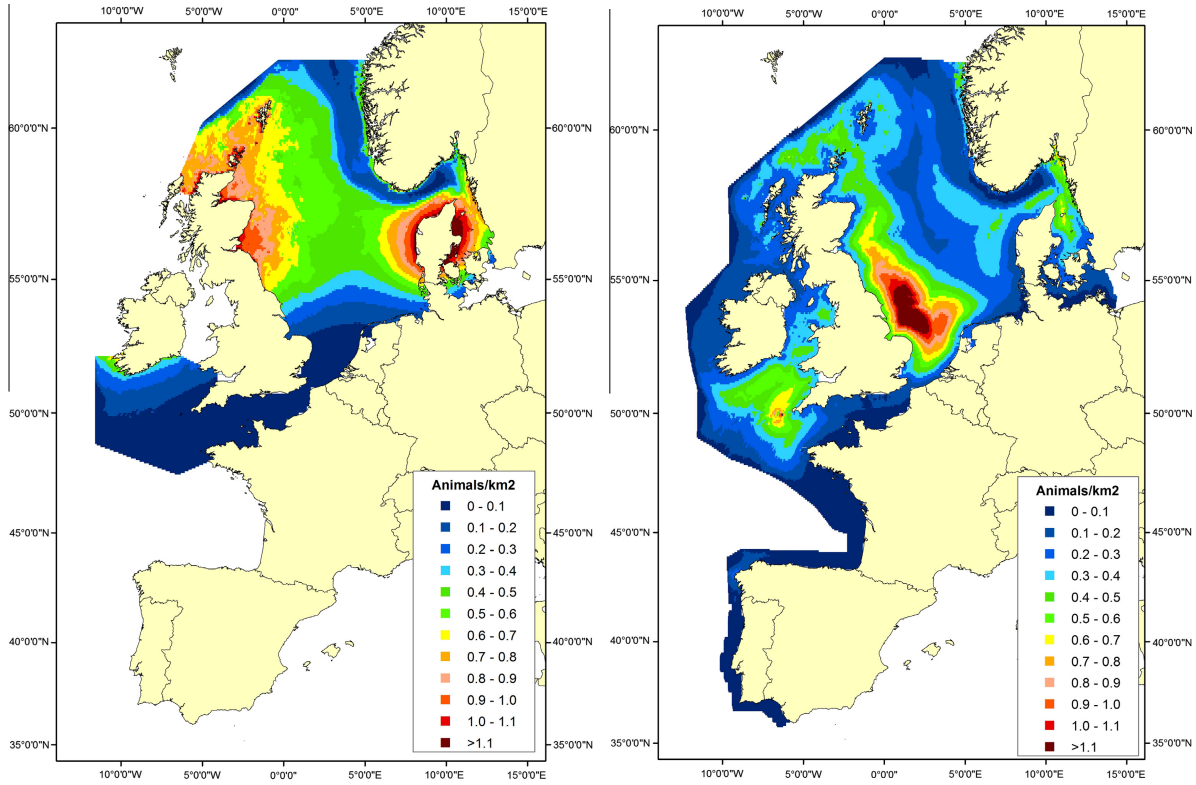

Figure a. Figure b.

Figure 3: a) Predicted surface density for harbour porpoise in 1994. b) Predicted surface density for harbour porpoise in 2005 (Source Hammond *et al.* 2013).

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 4) (Hammond *et al*. 1995, Hammond 2006, Hammond *et al.* 2017).

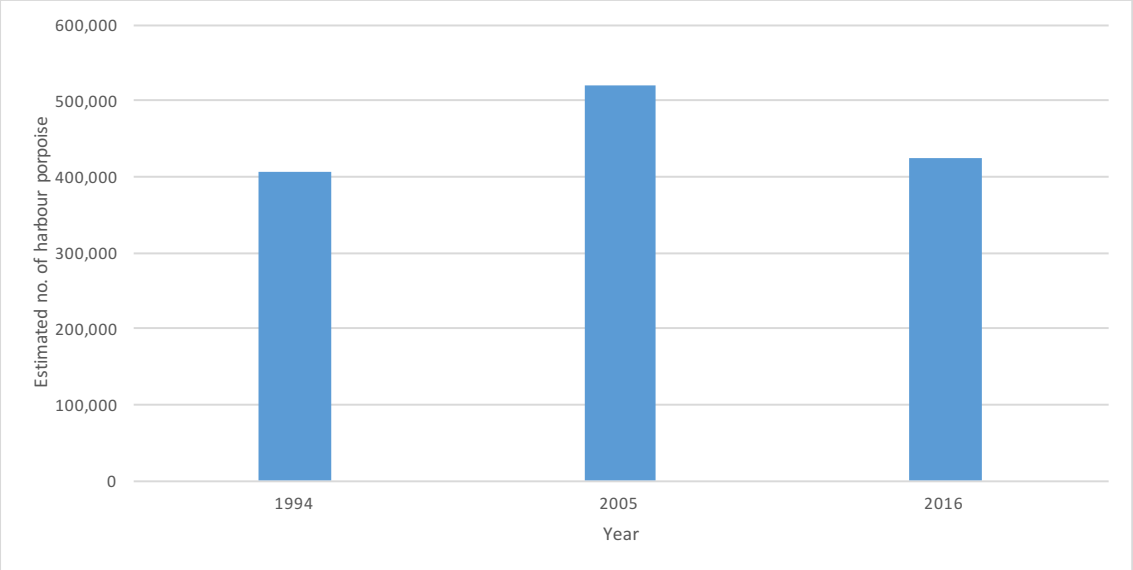

Figure 4: Estimated number of harbour porpoise within the SCANS survey area recorded during SCANS I, II and III surveys (Hammond *et al.* 2017).

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 North Sea Management Unit (Figure 5). The harbour porpoise population within the North Sea Management Unit was originally estimated to be 227,298 (176,360 – 292,948) individuals (IAMMWG 2015). However, following the revision of the regional SCANS harbour porpoise population, the population of harbour porpoise within the North Sea Management Unit has also been revised and is now estimated to be 333,808 individuals (JNCC 2017b).

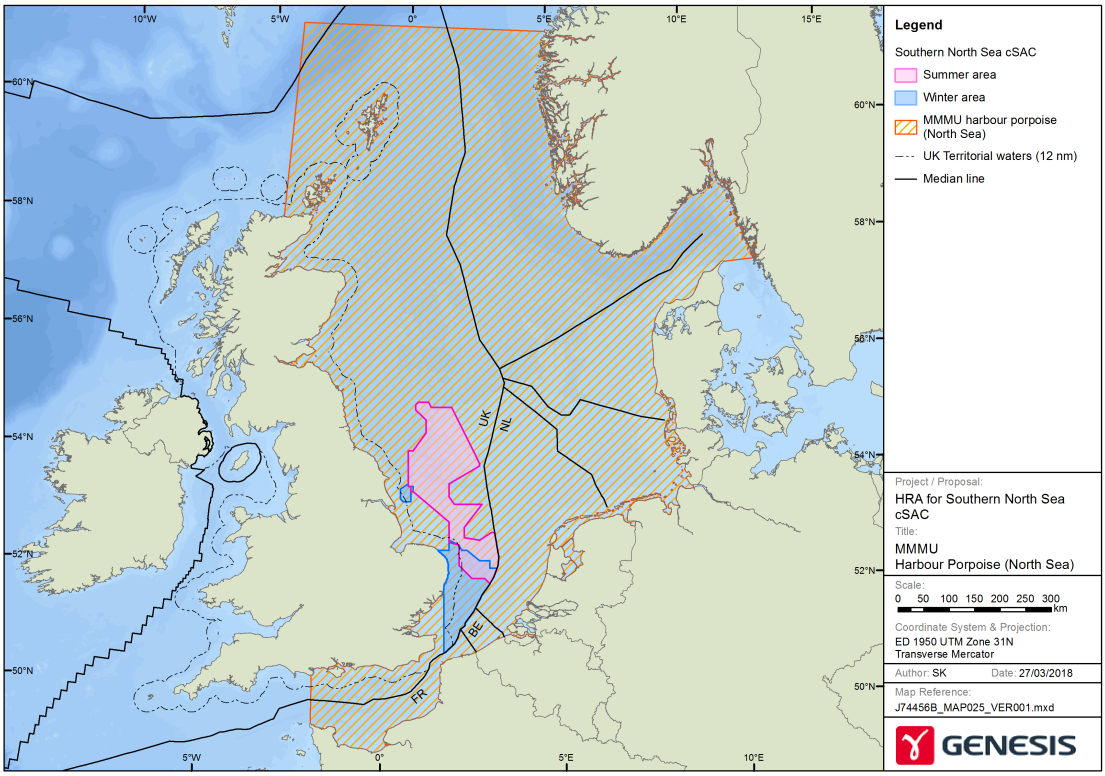

Figure 5: North Sea Management Unit for harbour porpoise as defined by the IAMMWG.

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), which was 8.1% of the North Sea Management Unit population at the time the estimate was made (Hammond *et al*. 2013, IAMMWG 2015). Based on the latest North Sea Management Unit population of 308,666 individuals the harbour porpoise population within the SAC may be 26,237 individuals. 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.

3.12 Harbour porpoise densities vary seasonally and across the site (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 sites 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 Joint Cetacean Protocol (JCP) 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 (Figure 6a). 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 (Figure 6b) (Heinänen & Skov 2015).

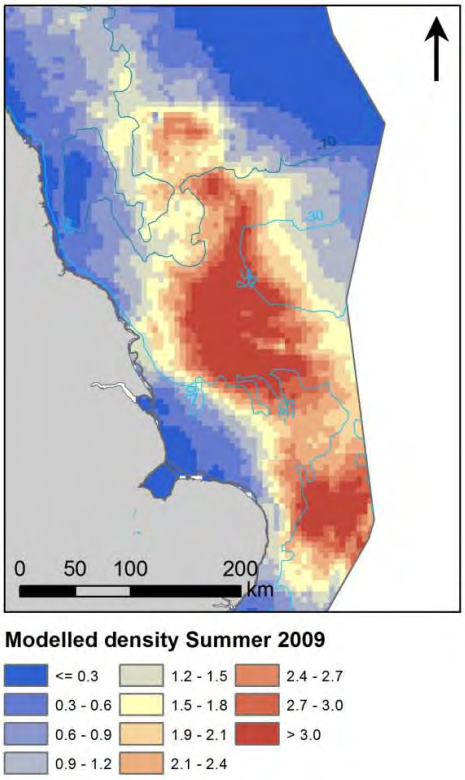

Figure a.

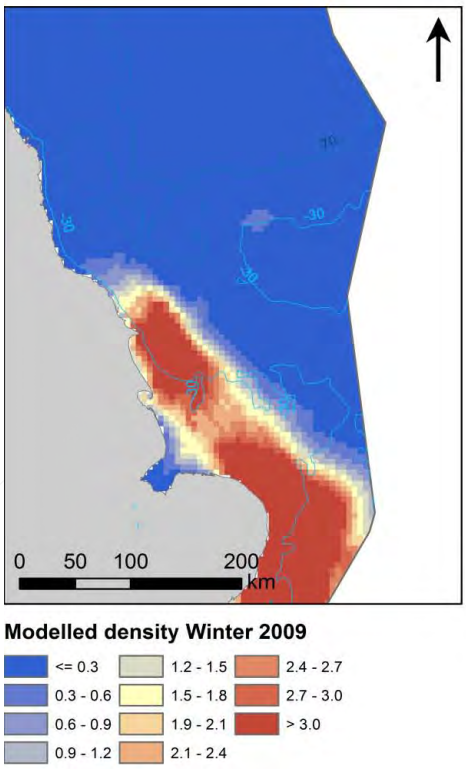

Figure b.

Figure 6: a) Estimated summer densities of harbour porpoise in the southern North Sea. b) Estimated winter densities of harbour porpoise in the southern North Sea. (Source: 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 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 offshore wind farm companies 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 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, 2018a).

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, 2015, 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 & Wahlberg 2013, MMO 2015).

Grey seal (Halichoerus grypus)

3.25 The grey seal (*Halichoerus grypus*) is an Annex II qualifying species for the:

- Humber Estuary SAC,

3.26 Grey seals occur widely around the waters off eastern England with the majority of activity in the nearshore waters to the south of the Humber Estuary, at Donna Nook, where a grey seal colony

is located within the Humber Estuary SAC (Russell *et al*. 2017). The latest counts within the SAC recorded 3,964 grey seals, giving an estimated population of 9,474[1] (SCOS 2017).

3.27 Their distribution offshore comprises predominantly of short-range return trips from haul-out sites to local foraging areas (Figure 7). However, longer movements between distant haul-out sites also regularly occur. Foraging trips from haul-out sites usually last between one and thirty days with most trips within 100 km of the haul out site, although they can go further and individuals often make repeated trips to the same region offshore (SMRU 2004, SCOS 2015, Russell 2016). Tagging study data indicates that grey seals from Donna Nook forage across a broad area and are not restricted to localised patches and their distribution has changed since 2005 with more regular foraging now occurring further offshore (SCOS 2016, Russell 2016). Offshore, grey seals prefer shallower waters in areas of increasing sand and decreasing levels of gravel (Jones *et al*. 2015, Russell 2016).

3.28 Densities of grey seals across the area vary, with highest densities located to the south and nearer shore. Within the Survey Area densities are relatively low and are less than 2.0 ind/km^2 (Figure 7). Densities of grey seals recorded at the Dogger Bank offshore wind farms (Creyke Beck A and B, Teesside A and B), across which the proposed survey will be undertaken, reported highest peak density of 0.93 ind/km^2 at Creyke Beck A, with peak densities across the wind farm zone as a whole of 0.25 ind/km^2 (Forewind 2013). Elsewhere densities of between 0.026 and 0.028 have been recorded within the Hornsea Wind Farm Zone (SMart Wind 2015) and densities of 0.28 ind/km^2 were reported from surveys undertaken at Triton Knoll offshore wind farm (TKOWFL 2011).

[1] As not all grey seals are at haul-out sites at the same time the counted population is adjusted using a scalar multiplier of 2.39 (SCOS 2015).

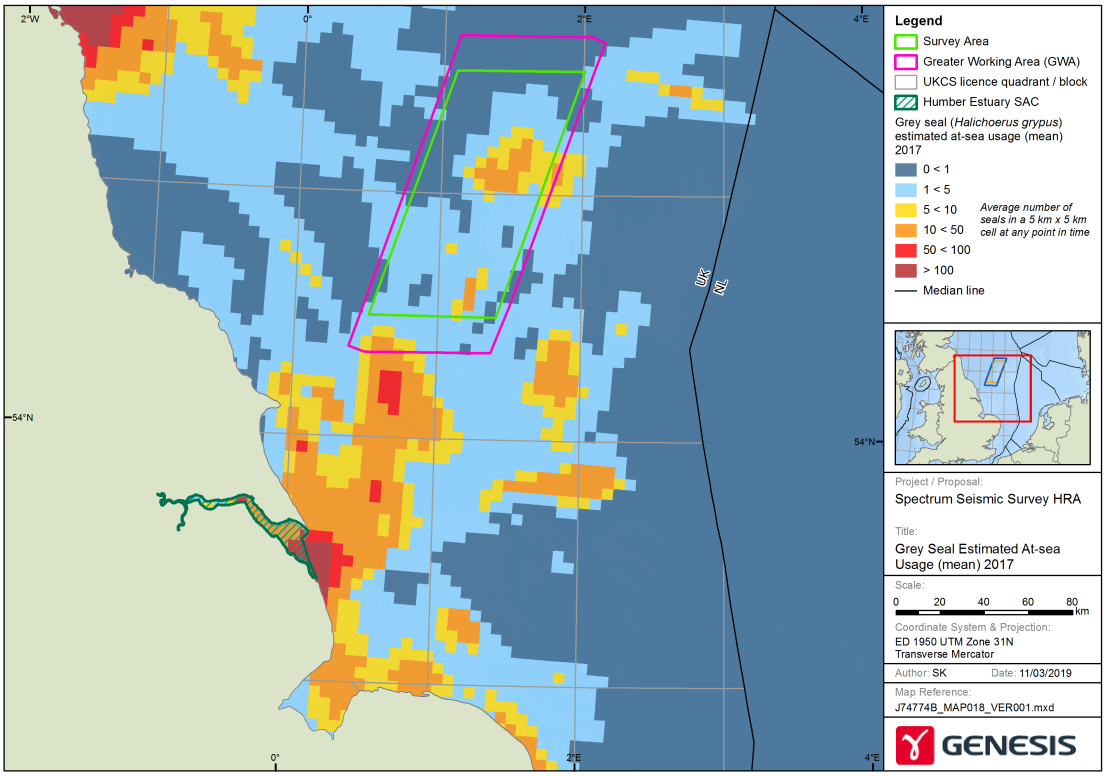

Figure 7: Distribution of grey seals in waters off Eastern England.

3.29 Grey seals breed in the region between late October and December when they will spend a greater proportion of time onshore compared with other times of year. Following pupping the females will remain onshore for approximately two weeks (SCOS 2015). Grey seals moult between December and April during which time they spend a greater proportion of their time at their haul out sites (SCOS 2015).

3.30 Grey seals forage on a range of fish species with sandeels, gadoids, flatfish and cephalopods being dominant prey items (SMRU 2011, Pierce *et al.* 1991).

3.31 Sound arising from the proposed seismic survey has the potential to significantly affect grey seals due to permanent or temporary physical hearing damage and or displacement and disturbance. Consequently, the proposed survey could affect grey seals or their prey outwith designated sites.

Seabirds (Gannet, Kittiwake, Herring gull, Puffin, Razorbill and Guillemot)

3.32 The survey is planned to occur in offshore waters during the seabird breeding season, during which time birds within the area of proposed survey may originate from SPAs designated for breeding seabirds. The mean maximum foraging ranges of seabirds that could be impacted by the proposed survey are presented in Table 2.

Table 2: Mean maximum foraging ranges of breeding seabirds relevant to the HRA.

Species	Mean maximum Foraging Range
Gannet	229.4 ± 124.3
Kittiwake	60.0 ± 23.3
Herring gull	61.1 ± 44
Puffin	105.4 ± 46.0
Razorbill	48.5 ± 35.0
Guillemot	4.2 ±50.1

3.1 Based on the mean maximum foraging ranges only birds from the Flamborough and Filey Coast SPA are identified as being at risk from the proposed survey during the breeding period. However, it is recognised that seabirds from other SPA colonies may also occur in the proposed Survey Area, particularly outwith the breeding period. However, it is not possible to determine which designated sites these birds may originate from and consequently the sites cannot be considered within this assessment.

3.2 The breeding season for seabirds varies between species but broadly extends from between April and August, with the core breeding period between May and July, during which time their distribution offshore is constrained by the requirement to return to their breeding sites. Following breeding, seabirds disperse away from their colonies to their wintering areas; either west into the Atlantic or southwards into the North Sea. Guillemots and razorbills disperse from the colonies during July and August. Adults become flightless during their post-breeding moult and the males are accompanied by flightless chicks. The highest numbers of flightless birds initially occur near the breeding colonies during July and early August. However, the birds rapidly disperse and can travel 50 km per day away from the coastal waters (Camphuysen 2002). From September onwards the number of Auks in nearshore waters decreases.

3.3 At sea, seabirds forage either predominantly by surface feeding, e.g. Gulls and Petrels; surface diving, e.g. Auks or plunge diving, e.g. Terns and Gannets. Surface feeders and plunge diving species are largely aerial and spend relatively short periods of time, if any, below the sea surface, e.g. plunge diving gannets spend on average 4.7 (±2.8) seconds below the sea surface, although individual dives may last longer with occasional dives recorded lasting up to 39 seconds (Ropert-Coudert. 2009, Cox *et al*. 2016). Surface feeders spend relatively longer periods of time below the sea surface. In shallow waters guillemots spend on average 46.4 (±27.4) seconds below the sea surface and shags 61 seconds (Thaxter *et al.* 2009, Wanless *et al.* 1993). Consequently, surface diving seabirds (e.g. guillemot, razorbill, puffin) are at more risk of impacts from underwater noise than other species of seabird predicted to be present in the proposed Survey Area. See Table 3 for reported dive durations for a range of relevant species.

Table 3: Predicted distance at which physical injury could occur to diving seabirds from the proposed seismic survey.

Species	Average dive duration (seconds)
Razorbill	24 [-1]
Puffin	40 [-2]
Gannet	4.7 [-3]
Shag	60 [-4]
Guillemot	119 [-5]

1 - Wanless *et al.* 1988, 2 - Thaxter *et al*. 2009, 3 - Ropert-Coudert 2009, 4 - Wanless *et al.* 1993, 5 - Thaxter *et al*. 2009.

3.4 Seabirds forage on a wide range of fish species. Sandeels are the dominant prey item in many areas (e.g. Monaghan 1992, Daunt *et al.* 2008). However, other fish species, particularly juvenile gadids (cod, whiting, haddock and Norway pout) may also be important components of their diets (Anderson *et al.* 2014).

3.5 It is recognised that the noise from the proposed survey could affect seabirds that dive below the sea surface when foraging and also their prey within and outwith designated sites. There is also a risk of disturbance to seabirds from the physical presence of the seismic survey vessel.

Lamprey (Sea lamprey, River lamprey)

3.6 Sea lamprey (*Petromyzon marinus*) and River lamprey (*Lampetra fluviatilis*) are qualifying features of the Humber Estuary SAC.

3.7 Sea lamprey spend their adult life in the sea or estuaries but spawn and spend the juvenile part of their life cycle in fresh water rivers. Adult sea lamprey migrate from the sea to the rivers during late spring and the young (ammocoetes) return to the sea from September onwards.

3.8 River lampreys occur in coastal waters, estuaries and rivers. After one to two years in estuaries river lampreys stop feeding in the autumn and move upstream from the river mouth between October and December (Maitland 2003).

3.9 Very little is known about the distribution of lampreys offshore but being parasitic, lampreys will occur wherever their host goes. They have a broad range of host species including marine mammals, basking sharks and other fish species so could occur over a very wide geographical area.

3.10 Sea lampreys have poor hearing ability. Studies indicate that sea lamprey respond to sound at frequencies of between 20 Hz and 100 Hz (Lenhardt and Sismour 1995) and show low sensitivity to low frequency sounds (Maes *et al*. 2004).

Prey species

3.11 Fish are not qualifying species for the Southern North Sea SAC or, aside from lampreys, are they qualifying features of the Humber Estuary SAC. However, potential impacts on fish that are prey for harbour porpoise and seabirds could affect the integrity of the sites by reducing their prey base (JNCC and NE 2016).

3.12 Sandeels are one of the main prey items for harbour porpoise, grey seals and seabirds 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 and seals (Greenstreet *et al*. 2006).

3.13 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 specific 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).

3.14 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).

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

3.16 Both harbour porpoise and grey seals, along with seabirds, prey on a variety of fish species that could be impacted by the proposed survey including gobies, Sandeel Spp., whiting, herring and sprat (JNCC and NE 2016).

3.17 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 and 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.

3.18 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).

3.19 Sandeels are not considered to have sensitive hearing (Popper *et al.* 2014). Studies undertaken using airguns indicate that sandeels have distinct but weak reactions to seismic airguns with initial

startle responses reducing in frequency with on-going noise, and no increased mortality was detected (Hassel *et al.* 2004).

3.20 There are limited studies assessing potential impacts on eggs and larvae. Results indicate that there is potential for increase in mortality when larvae are exposed to an airgun sound source with peak sound pressure levels of 220-242 dB re 1 μPa^2 (unknown measure), but only within 5 m of the airgun (Popper *et al*. 2014).

Information Sources

3.21 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:

- Spectrum (2018a). Environment Overview and Marine Mammal Risk Assessment for the proposed Q36, 37, 38, 42 and 43 Seismic Survey. Spectrum Geo Ltd.
- Spectrum (2018b). Application GS/858/0 (Version 1), Application to carry out a Marine Survey. Subsidiary Action Template. 21 December 2018.
- Natura 2000 – Standard Data Form. Site: UK0030395. Southern North Sea. JNCC (2016).
- Harbour Porpoise (Phocoena phocoena) possible Special Area of Conservation: Southern North Sea. Draft Conservation Objectives and Advice on Activities. JNCC and NE (2016).
- SAC Selection Assessment: Southern North Sea. JNCC (2017c).
- A potential approach to assessing the significance of disturbance against conservation objectives of the harbour porpoise cSACs. Version 3.0. Discussion document JNCC (2017ed.
- Noise assessment and management in harbour porpoise SACs. Briefing note: Use of thresholds to assess and manage the effects of noise on site integrity. JNCC. (2017e).

3.22 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 survey are sound from the airguns and the physical presence of the vessel. No other sources of potential impact that could affect qualifying habitats or species have been identified.

4.2 The airguns used in the seismic surveys are pneumatically-driven impulsive transducers that generate high intensity, low frequency, short duration sound pulses at regular intervals of typically between every 10 to 15 seconds. The seismic source geometry is designed to focus the output from the array vertically downwards minimising any horizontally propagating sounds (OGP/IAGC 2004). The level of sound generated by an airgun array depends on various factors including

gun volume, array design, the number of airguns, spacing and air pressure. Field measurements of the sound emitted by airgun arrays used by the oil and gas industry show that levels of source intensity expressed as peak SPL range from 235 to 259 dB re 1µPa- m (Richardson *et al*. 1995, OSPAR 2009). The frequency range of emitted energy is typically in the 5 Hz to 500 Hz range and strongest from 10 to 120 Hz, but with some energy in the 500 Hz to 1 kHz range (Richardson *et al*. 1995, Hermannsen *et al.* 2015).

Marine Mammals

4.3 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).

4.4 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.

4.5 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. Pinnipeds (seals) are potentially more sensitive to low frequency sounds than cetaceans and harbour porpoise may be more sensitive to relatively high frequencies. Other factors potentially affecting 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

4.6 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, Nedwell & Harland 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 µPa.

Physical injury

4.7 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

4.8 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.

4.9 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.

Seabirds

4.10 The physical presence of the seismic survey vessel could cause disturbance to seabirds with the potential behaviour of seabirds towards vessel activity varying across species. Gannets, shags, guillemots, razorbills and puffins are moderately tolerant of vessels (Furness and Wade 2012) but will largely avoid vessels at close distances by flying, swimming or diving. Evidence from offshore activities indicates that these species are not significantly impacted by vessel disturbance with Furness and Wade (2012) indicating a moderate sensitivity for Auk species towards vessel disturbance.

4.11 There are limited studies on the impacts from seismic surveys on seabirds. However, studies undertaken on African penguins during the breeding season indicate that birds may avoid areas within *c*. 70 km of a seismic survey, causing a change in foraging location and an increase in the distance birds forage (Pichegru *et al* 2017).

4.12 There is limited information on the ability of seabirds to hear underwater. Reviews undertaken indicate that birds may have relatively poor hearing ability below the sea surface with peak hearing sensitivity below 2 kHz (Dooling and Therrien 2013). However, studies on great cormorant indicate that at 2 kHz they have relatively good hearing ability (Hansen *et al*. 2016). Studies on two species of diving sea-duck, the long-tailed duck and surf scoter, indicated hearing ability underwater of between 0.5 and 2.86 kHz for long-tailed duck and a peak sensitivity at 1 kHz for surf scoter (Therrien 2014, James *et al*. 2018).

4.13 The US Fisheries and Wildlife Service have published recommended thresholds of 202 dB SEL at which hearing injury could occur for a species of Auklet (Marbled Murrelet) and 208 dB SEL at which barotrauma injuries may occur (USFWS 2011).

Lampreys

4.14 There is no information on the potential impacts sound from an airgun may have on Lamprey. However, they do not have any specialist hearing structures, they lack otolith organs and swim bladders and are likely to have poor hearing sensitivity. Therefore, behavioural or physiological effects are only likely to occur when they are very close to a powerful sound source (Franco *et al*. 2011).

Secondary Effects

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

5 NOISE MODELLING

5.1 To assess the potential environmental impacts from the proposed survey the applicant has undertaken noise modelling using outputs derived from a Gundalf airgun model and a directional propagation model (Spectrum 2018a).

5.2 Results from the modelling indicate the extent at which the onset of a Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS) or disturbance could occur from the seismic airguns during the proposed survey on marine mammals

5.3 The modelling indicates that there is a risk of the onset of PTS to harbour porpoise within 71 m of the array when undertaking a soft-start and 10 m for pinnipeds (Spectrum 2018a).

5.4 The results from the modelling indicate that there is a risk of disturbance to a marine mammal within an area of 12.4 km, based on an unweighted disturbance threshold and for harbour porpoise out to 3.9 km using a weighted SEL (Spectrum 2018a).

5.5 There has been no assessment made on the potential impacts from the proposed seismic survey to the prey species of marine mammals.

5.6 In order to undertake the HRA further information from existing noise modelling has been used to support the assessment. A comparison between the results from the modelling undertaken within the application and existing noise modelling results provides a greater degree of confidence in the conclusions drawn in this HRA.

5.7 Noise modelling has previously been undertaken for BEIS in order to assess the potential impacts to harbour porpoise from a seismic survey within the Southern North Sea cSAC (BEIS 2018). The modelling was undertaken at three locations within the cSAC and was based on a 3,000 cu. in. airgun array, comprising four sub-arrays each with eight individual airguns ranging in volume of between 40 cu in and 150 cu. in. The maximum SPL was 261 dB *re* 1 μPa^2s $_{(0\text{-peak})}$. The modelling undertaken previously by BEIS was therefore based on a smaller airgun array

than that proposed for the Spectrum seismic survey but with a higher maximum SPL of 261 dB *re* 1 μPa^{2}s $_{(0\text{-peak})}$ compared with 257 dB *re* 1 μPa^{2}s $_{(0\text{-peak})}$ used for the Spectrum survey (Table 1).

5.8 Noise modelling to assess potential impacts to grey seals from seismic surveys has not previously been undertaken in the area of the proposed survey. However, modelling has been undertaken on grey seals at three locations in nearshore waters around north-east Scotland, Orkney and Shetland (OGA 2016). Although not directly comparable due to the different geographic location, the previous modelling was based on a 5,000 cu. in. airgun array with a maximum SPL of 259 dB *re* 1 μPa^{2}s $_{(0\text{-peak})}$. Therefore, the airgun array is greater than that to be used in the proposed survey with a slightly higher sound pressure level.

5.9 The results from the two sets of noise modelling undertaken for harbour porpoise are presented in Table 4 and for grey seal in Table 5.

Table 4: Harbour porpoise estimated areas of physical injury and disturbance.

Harbour porpoise	Spectrum		BEIS	
	Distance (m)	Maximum area (km^2)	Distance (m)	Maximum area (km^2)
PTS	51 - 71	0.05	470	N/A
Disturbance	8,827 – 12,362	480	34,900	275

PTS Threshold weighted 155 re 1 μPa^{2}s.
Disturbance - 160 dB re: 1 μPa $_{(rms)}$.
N/A = Not available

Table 5: Grey seal estimated areas of physical injury and disturbance.

Grey seal	Spectrum		OGA	
	Distance (m)	Maximum area (km^2)	Distance (m)	Maximum area (km^2)
PTS	9 – 10	0.0003	99	0.031
Disturbance	8,827 – 12,362	480	32,000	1,541 [1]

PTS Threshold weighted 186 re 1 μPa^{2}s
Disturbance 150 dB re: 1 μPa $_{(rms)}$

The OGA noise result is based on modelling undertaken at three separate locations previously modelled and the worst-case has been selected.

1 – Note the noise modelling by OGA was based on a model with limited directionality capability. Subsequent developments to the model have shown that this causes a larger area of predicted disturbance than if directionality is included (compare with harbour porpoise in Table 4 where the extent of noise is predicted by BEIS is greater than that undertaken by the applicant but the overall area is smaller). Consequently, the predicted area of noise predicted by the OGA modelling undertaken for grey seal is considered precautionary.

Potential impacts on harbour porpoise

5.10 The results from the modelling indicate that noise levels that have the potential to cause the onset of auditory injury (PTS) to harbour porpoise occur out to between 71 and 470 m from the airguns (Table 4).

5.11 There is potential for levels of noise at which disturbance could occur to extend from between 12.3 and 34.9 km from the airguns and encompass an area of between 275 km^2 and up to 480 km^2 (Table 4).

Potential area of impact on grey seals

5.12 The results from the modelling indicate that noise levels that have the potential to cause the onset of auditory injury (PTS) to seals will occur between 10 m and 99 m from the airguns (Table 5).

5.13 There is potential for levels of noise at which disturbance could occur to extend 32 km from the airguns and encompass an area of between 480 km^2 and 1,541 km^2 (Table 5).

Potential impacts on fish

5.14 No noise modelling specifically to assess the potential impacts on fish has been undertaken by the applicant. Results from previous noise modelling on fish within the North Sea indicate that noise levels that have the potential to cause mortality to fish species with swim bladders could occur from between 275 m and 302 m depending on the location. For fish without swim bladders, e.g. Lampreys, mortality could occur from between 120 m and 140 m from the seismic survey (Table 6) (OGA 2016).

Table 6: Maximum distances at which mortality to fish, eggs and larvae could occur.

Location	Distance (m)		
	Fish: swim bladder involved in hearing [-1] Allis shad Twaite Shad,	**Fish: no swim bladder [-2]** Sea Lamprey, River lamprey Plaice, lemon sole	**Eggs and Larvae**
1	302	140	302
2	275	120	275
3	302	137	302

1 - 213 Unweighted peak SPL (dB re 1 µPa)

2 - 207 Unweighted peak SPL (dB re 1 µPa)

5.15 There are no data available to assess potential area of disturbance to fish species.

6 EFFECTIVE DETTERENT RADIUS

6.1 The Effective Deterrent Radius (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 2017d, e). The EDR is an empirically derived generic distance of 26 km within which deterrence, i.e. displacement, of harbour porpoise is predicted to occur from pile-driving. The EDR for pile-driving is based on published studies that have monitored the effects on harbour porpoise during pile-driving at offshore wind farms and reflects the overall loss of habitat if all animals vacate the area around a pile driver (Tougaard *et al.* 2014). It is an area of displacement as opposed to disturbance, which may be greater.

6.2 No EDR are available for other noise sources. However, the use of either a 5 km or 10 km EDR has been used to assess potential impacts from seismic surveys (e.g. BEIS 2018, EAOWL 2017). For the purposes of this assessment a 10 km EDR has been used as advised by the JNCC (JNCC 2019b). The use of a 26 km EDR for the detonation of Unexploded Ordnance (UXO) has been previously used and agreed with SNCBs (e.g. EAOWL 2017).

6.3 The SNCBs recognise that future data may require the suitability of the EDR to be reconsidered if it is found to be inappropriate (JNCC 2017e).

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 2016). 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 (JNCC 2016).

Southern North Sea SAC

7.3 The Southern North Sea SAC was designated as an SAC in 2017. 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.

7.8 The second Conservation Objectives 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 2017c).

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 Draft thresholds to assess and manage the effects of noise on site integrity have been proposed by the JNCC and NE (JNCC 2017d, e, JNCC and NE 2019). 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 within the SAC may be affected over a period of time.

7.14 The JNCC and NE approach to site integrity is:

- 'Ultimately, the purpose of the cSACs is to contribute to maintaining FCS for harbour porpoise and in order to do this, the site's integrity needs to be maintained in line with the site's Conservation Objectives.
- Noise disturbance within a cSAC from a plan/project individually or in combination will not exclude harbour porpoises from a maximum of 20% of the relevant area of the cSAC for a period of 1 day. and,

- Over a season, the noise disturbance within a cSAC from a plan/project individually or in combination per day will not exclude harbour porpoises from an average of 10% of the relevant area of the cSAC.'

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 7. 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 7: 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	27,000	5,400	41.5	2,700	29.3
'winter' area October - March	12,687	2,537	28.4	1,269	20.1

The range of disturbance presumes sound propagation is circular in shape, i.e. the range 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 approach.

7.19 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.

7.20 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 (EC 2010).

The Humber Estuary SAC

7.21 The Humber Estuary SAC was designated as a SAC in 2009. The site comprises a number of habitat types including sandbanks, mudflats and coastal lagoons and river lamprey, sea lamprey and grey seal are qualifying species for the site (Natural England 2018a).

7.22 The Humber Estuary SAC Conservation Objectives are:

Humber Estuary SAC Conservation Objectives

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;

- The extent and distribution of qualifying natural habitats and habitats of qualifying species,
- The structure and function (including typical species) of qualifying natural habitats,
- The structure and function of the habitats of qualifying species,
- The supporting processes on which qualifying natural habitats and habitats of qualifying species rely,
- The populations of qualifying species, and,
- The distribution of qualifying species within the site.

Source: Natural England 2018a

Flamborough and Filey Coast SPA

7.23 The Flamborough and Filey Coast SPA is located on the Yorkshire coast and covers an area of 78.57 km^2. The site comprises predominantly of sea cliffs with a seaward boundary extending out 2 km from the coast. The qualifying species for the site are: kittiwake, gannet, guillemot and razorbill and seabird assemblage (Natural England 2018b, 2019).

Flamborough and Filey Coast SPA Conservation Objectives

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- The extent and distribution of the habitats of the qualifying features,
- The structure and function of the habitats of the qualifying features,
- The supporting processes on which the habitats of the qualifying features rely,
- The population of each of the qualifying features, and,
- The distribution of the qualifying features within the site.

Source: Natural England 2019

8 IN-COMBINATION IMPACTS

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).

- 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

8.2 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.

8.3 There are eleven consented offshore wind farms that lie either wholly within or overlap the SAC: three are operating, two are under construction and six have been consented but are not currently under construction. There are a further ten wind farms that lie within 26 km of the SAC, which is identified by the JNCC as an area that harbour porpoises may be displaced by noise arising from pile-driving activities (JNCC 2017d). Of these, three are in non-UK waters: THV Mermaid,

Belwind I and Borssele II. Two of the wind farms: Triton Knoll and Teesside A, are within 26 km of the SAC boundary, have been consented but are not yet constructed (Figure 8).

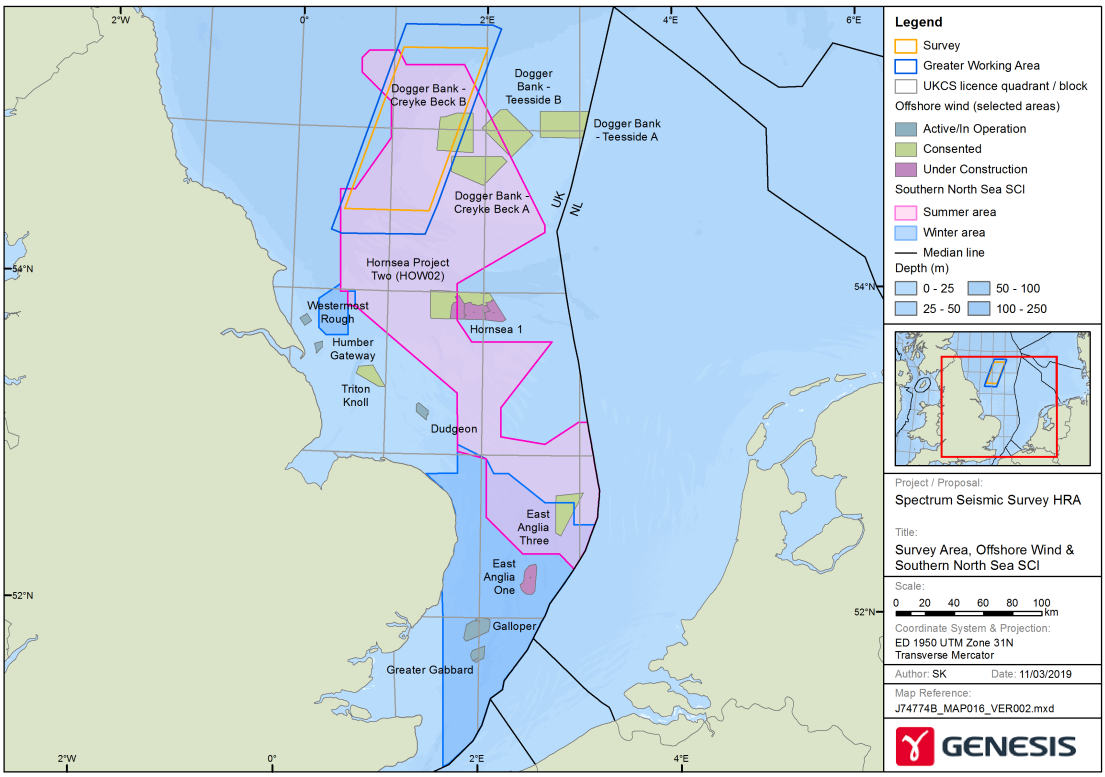

Figure 8: Offshore wind farms located within 26 km of the Southern North Sea SAC.

8.4 It is recognised that during construction, pile-driving will likely occur at all wind farm locations and that, if undertaken simultaneously as the proposed Spectrum seismic survey there is the potential to cause an adverse effect in-combination.

8.5 Of the offshore wind farms that are relevant to the in-combination assessment none are predicted to be pile-driving during the period of the proposed seismic survey in 2019.

8.6 Four wind farms currently have Contract for Difference (CfD) and therefore could be undertaking activities, other than pile-driving, over the same period as the planned seismic survey. The activity which has been identified as having the potential to cause an adverse effect is the clearance, by detonation, of UXO.

- Hornsea Project One offshore wind farm has completed the installation of the wind turbine foundations and has therefore completed pile-driving. No UXO clearance surveys are known to planned.

- East Anglia One offshore wind farm is located in the 'winter' area of the SAC and therefore, based on the SNCB threshold approach, will not have an in-combination impact on activities being undertaken in the 'summer' area. The installation of the 102 turbines started in 2018. It is not known when the installation of the jacket foundations will be completed. On-going UXO clearance is planned to be undertaken during 2019.
- Hornsea Project Two has a CfD and is planned to start offshore construction in 2021. An application to undertake UXO clearance from between 1 April 2019 to 31 December 2020 has been submitted to the MMO (Ørsted 2018a). The application is for the clearance of up to 120 items of UXO with a maximum of 60 items per year (Ørsted 2018b). It is understood that there will be no UXO clearance before June 2019 (Ørsted *pers comm*).
- Triton Knoll offshore wind farm lies outwith the SAC. The project has a CfD and construction is planned to commence during Q1 2020. An application has been submitted to the MMO to undertake UXO clearance during 2019. Up to 60 items of UXO may be cleared, of which no more than 25 items will be cleared within 26 km of the SAC boundary. The work may be undertaken between April and September 2019 (TKOWFL 2018a).
- East Anglia Three has planned to start pile-driving during Q4 of 2019. However, the development does not have a CfD and is therefore extremely unlikely to start construction by this time.

Cable laying activity

8.7 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 (NGVL 2018a).

8.8 An application has been 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).

8.9 It has subsequently been reported that since the application was made that no UXO clearance is planned during 2019.

Aggregate extraction and dredging activity

8.10 Existing localised aggregate dredging occurs primarily in the southern half of the SAC, along the east coast (Figure 9). In 2017 there were 28 aggregate production areas and three Exploration and Option areas covering an area of 540.5 km^2. Five of the aggregate areas occur in the 'summer' area of SAC covering 78.5 km^2 and the rest occur in the 'winter' area of the SAC and cover an area 495.3 km^2, with some sites occurring in both the 'winter' and 'summer' areas.

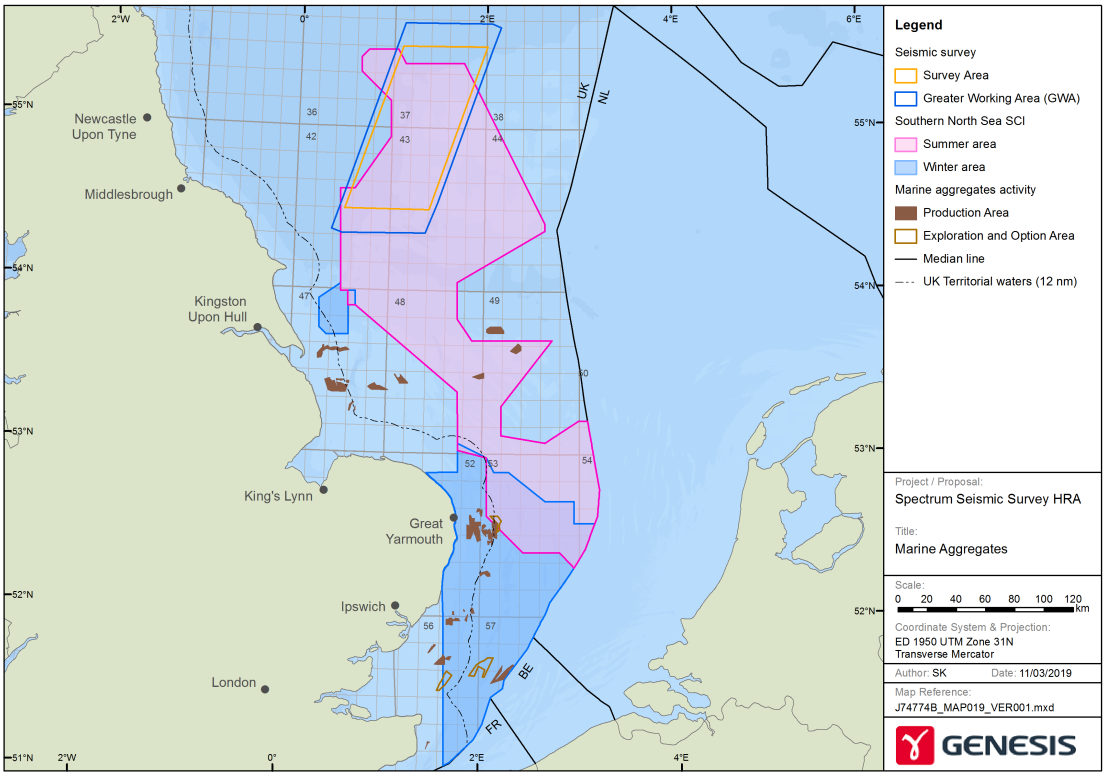

Figure 9: Existing marine aggregate activities in the Southern North Sea SAC.

8.11 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.)

8.12 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

8.13 There is 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 120 installations installed within the SAC. The vast majority

(94%) of all the installations within the SAC are located in the 'summer' area of the site and all those currently being planned are also in the 'summer' area (Figure 10) (UKoilandgas 2018).

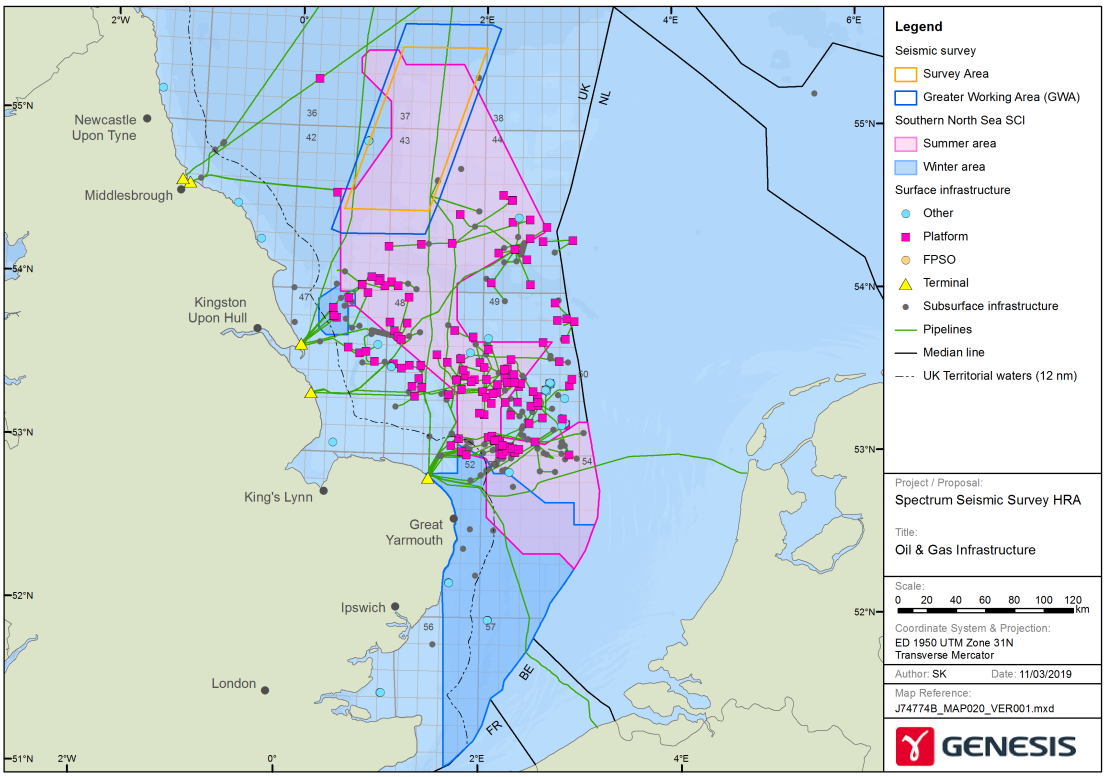

Figure 10: Existing oil and gas infrastructure within the Southern North Sea SAC.

8.14 Seismic surveys have regularly been undertaken within the cSAC over the last 50 years, with a total of 65 surveys carried out within the cSAC between 2005 and 2014. The majority of surveys during this period took place in the northern half of the cSAC, where the most recent oil and gas activity has occurred (Figure 11).

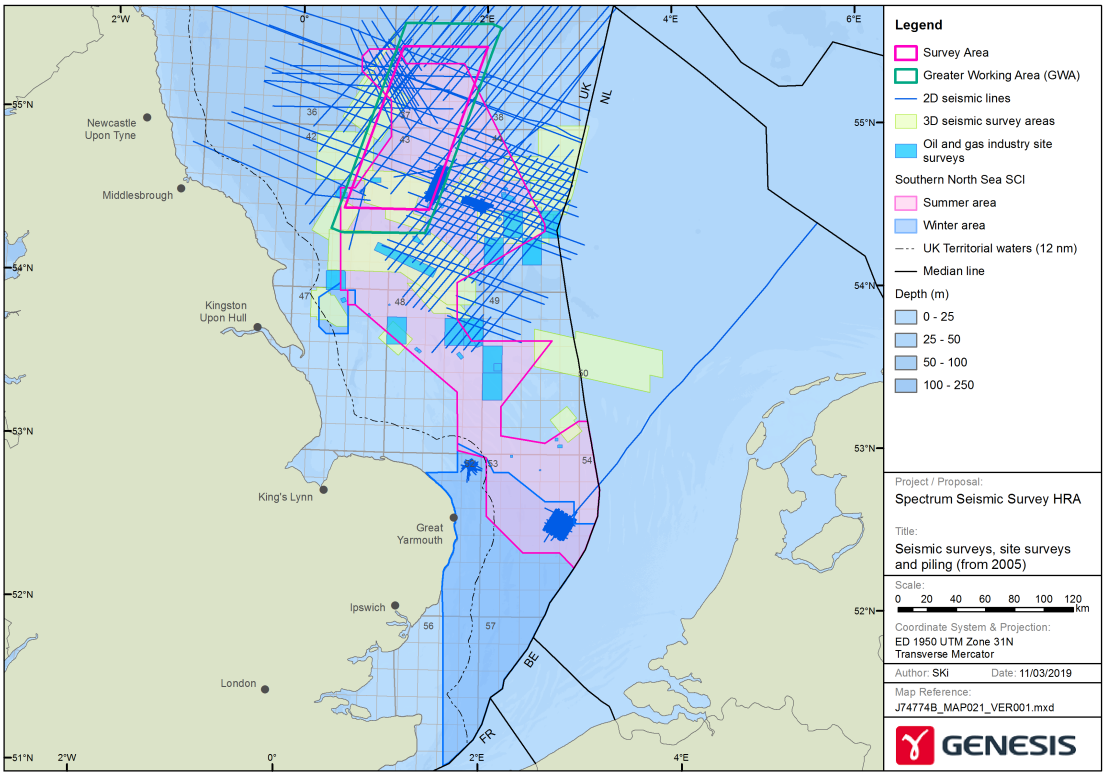

Figure 11: Oil and gas industry related seismic surveys undertaken within the Southern North Sea SAC between 2005 and 2014.

8.15 BEIS are aware of a number of planned oil and gas related activities within the area during the period the proposed survey will be undertaken that could cause an in-combination effect including a seismic survey within the Tolmount area (Table 8).

Table 8: Planned oil and gas activities within or adjacent to the SAC that could cause an in-combination impact.

Applicant	Licence Reference No.	Licence Block(s)	Start and End Dates (2019)	Planned Activity
ENI Hewett	PLA/647	48/29	15/03/2018 – 10/05/2019	Pipeline freespan rectification on PL 21 Hewett Field: Deposits of mattresses and grout bags along pipeline.
ConocoPhillips	PLA/649	44/17 44/21 44/22	04/04/2019 – 05/05/2019	Pipeline decommissioning at Caister Murdoch Schooner. Cleaning of pipelines, temporary deposits on seabed and removal of grout bags and spools.
Perenco	PLA/651	49/18 49/19 49/23 49/27	25/02/2019 – 30/04/2019	Pipeline freespan rectification on PL 22 between Inde and Leman fields: Deposits of mattresses and rock filter bags along the freespan.
ConocoPhillips	ML/415/2	44/21a	01/03/2019 – 05/04/2019	Decommissioning of Boulton - Contingency rock dump.
ConocoPhillips	ML/428/0	44/19b	10/05/2019 – 04/06/2019	Decommissioning of Katy - Contingency rock dump.
Spirit Energy	ML/431/0	49/11a	01/04/2019 – 30/04/2020	Decommissioning of Audrey B - Temporary storage of cutter riser sections.
Petrofac	ML/436/0	44/19	28/03/2019 – 31/05/2019	Cameron well - Removal of well head protection structure.
ENI Hewett	SA/957	48/29 48/30 52/5a	10/09/2018 - 31/05/2019	Hewett complex seabed survey. From 1 April to 31 May 2019 only use of RoV and CP.
Spirit Energy	SA/1052	43/12	15/03/2019 – 30/04/2019	Andromeda debris survey. Use of Multi-beam echosounder, Side-scan sonar for no more than one day.
ENI Hewett	SA/1085	48/29 48/30 52/5a	01/04/2019 – 31/05/2019	Multiple borehole survey at Hewett main complex and associated fields.
Premier	SA/1077	42/26 - 30 47/01 - 05	26/03/2019 – 31/07/2019	3D seismic survey within the Tolmount area using a 4,100 cu. in. airgun.
Petrofac	SA/1099	44/19	21/03/2019 – 31/05/2019	Cameron site survey. Use of: Multi-beam echosounder, Side-scan sonar, Sub-bottom profiler, Magnetometer. Located 3.5 km outwith the SNS SAC.
Petrofac	SA/1101	49/28	21/03/2019 – 31/05/2019	Deben site survey. Use of: Multi-beam echosounder, Side-scan sonar, Sub-bottom profiler, Magnetometer. Located 1.7 km outwith the SNS SAC.

Shipping

8.16 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 and NE 2016). 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).

8.17 The level of vessel activity across the 'summer' and 'winter' areas of the SAC differs (Figure 12). 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.

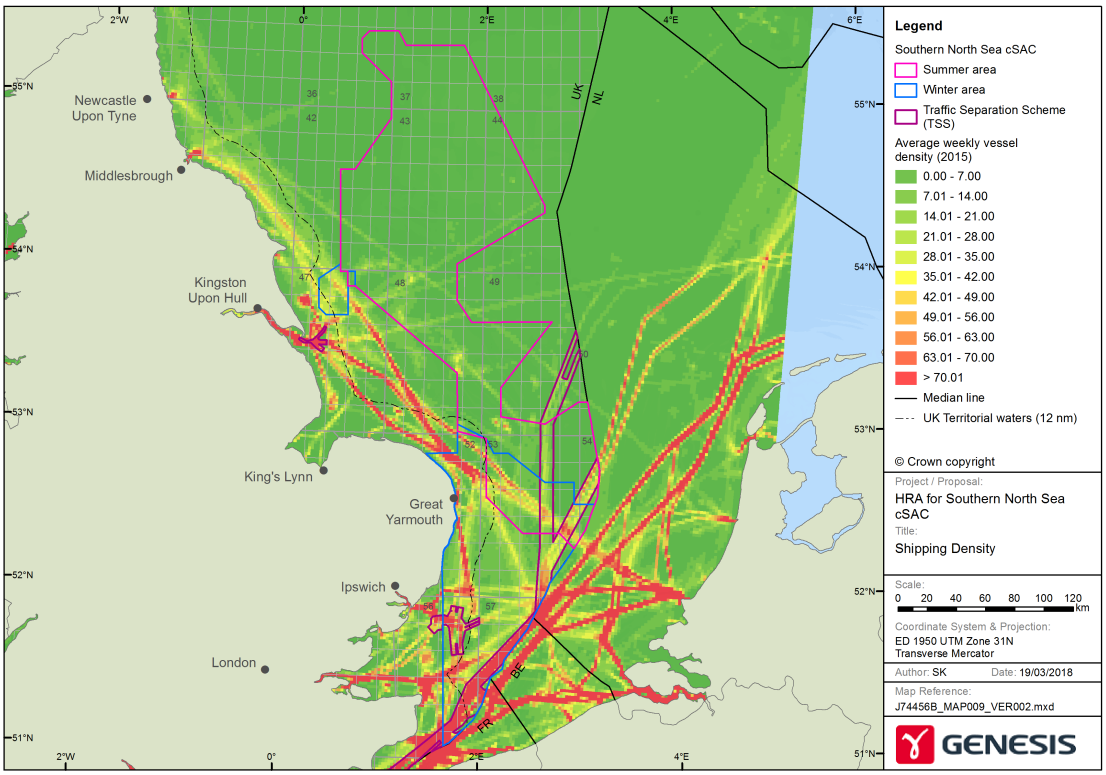

Figure 12: Shipping density within the SAC during 2015.

Fishing activity

8.18 Fishing occurs widely across the southern North Sea and has also been on-going 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 level of fishing activity along the western edge of the central part of the SAC (Figure 13) (MMO 2017b). Note however, this does not include the activities of non-UK registered vessels that will occur within the site or vessels less than 10 m in length.

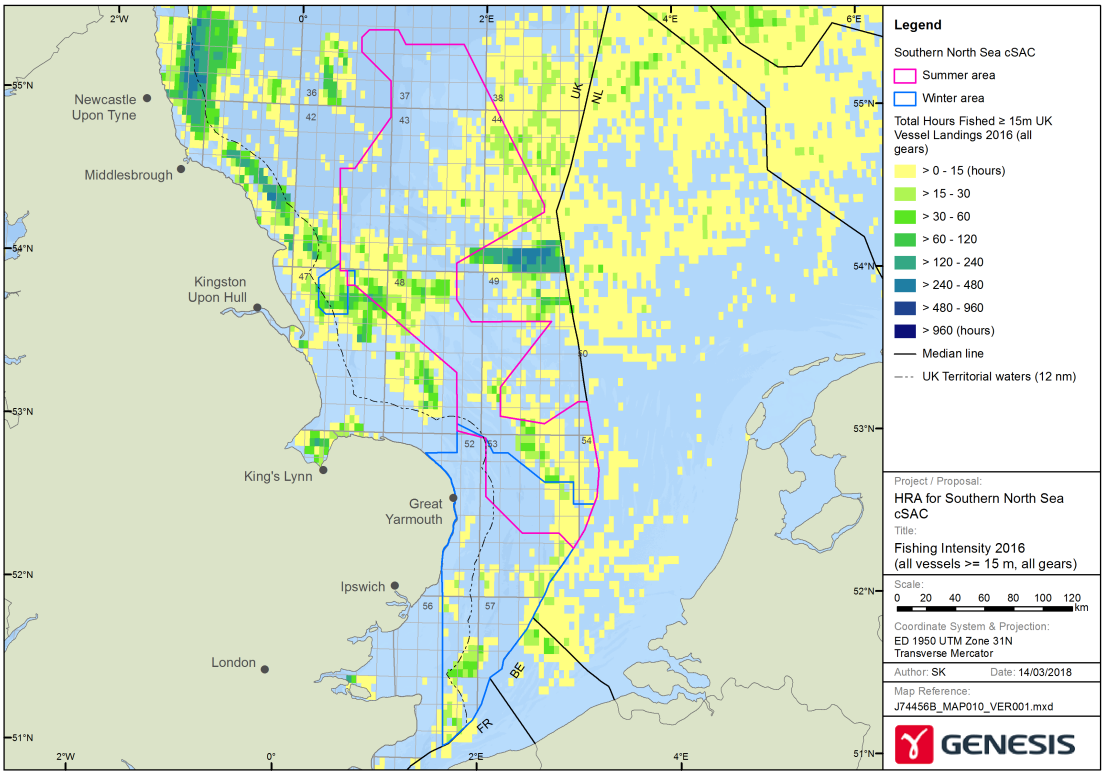

Figure 13: Fishing intensity across the SAC during 2014 by UK registered vessels.

8.19 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 2016).

8.20 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 2016). 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, OSPAR 2017). This is approximately 0.6% of the North Sea Management Unit population.

8.21 Noise modelling predicts, that the proposed seismic survey will not cause any direct mortality to any harbour porpoise and therefore there will be no in-combination impact between fishing and the survey.

In-combination conclusion

8.22 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 likely to cause an in-combination impact considered within this HRA are:

- UXO clearance at Hornsea Project Two,
- UXO clearance at Triton Knoll,
- Planned oil and gas activities including Tolmount 3D seismic survey.
- 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 seismic survey.

9 LIKELY SIGNIFICANT EFFECTS TEST

9.1 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.

9.2 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 was determined that the impact would not cause a likely significant effect.

9.3 This section addresses this first step of the HRA, for which BEIS has considered the potential impacts of the survey both alone and in combination with other plans and projects on each of the interest features of the relevant European sites to determine whether or not there will be a likely significant effect.

Harbour porpoise

9.4 Harbour porpoise are a qualifying species for the Southern North Sea cSAC. They are known to occur throughout the site, with particular concentrations in the northern 'summer' area over which the proposed seismic survey overlaps Noise modelling undertaken indicates that there is potential for auditory injury to occur within 470 m of the sound source and disturbance or displacement effects to occur 34.9 km from the airguns and extend over an area of 275 km^2 (Table 4).

9.5 Consequently, based on the predicted extent of potential impacts, it is concluded that there is potential for a likely significant effect on harbour porpoise from the proposed seismic survey within or adjacent to the cSAC and the impacts on harbour porpoise are therefore considered further in the appropriate assessment.

Grey seal

9.6 Results from noise modelling indicate that there is potential for levels of noise to cause physical injury or disturbance and displacement to grey seals.

9.7 Grey seals are a qualifying species at the Humber Estuary SAC. They are known to routinely forage within 100 km from their haul out sites and although will occur further offshore they do so less frequently. Noise modelling undertaken indicates that there is potential for auditory injury to arise within 99 m of the sound source. The potential extent of disturbance could extend to 32 km and encompass an area of 1,541 km^2 (Table 5).

9.8 The proposed survey will occur within 83 km of the SAC and based on the results from noise modelling and known behaviour of grey seals it is concluded that there is potential for a likely significant effect on grey seals from the Humber Estuary SAC.

Fish

9.9 The Sea lamprey and River lamprey are qualifying species for the Humber Estuary SAC. There is also potential for noise to impact on the prey species of harbour porpoise and seals from or within designated sites.

9.10 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, include prey species for seals such as herring, are recognised to be hearing specialists. Those without, e.g. sandeels, are considered to have a relatively low sensitivity to noise. Most fish with swim bladders are able to detect sound within the 100 Hz to 2 kHz range, those without swim bladders are unlikely to detect sound above 400 Hz (Popper 2014).

9.11 Results from the noise modelling indicate that noise levels capable of causing lethal effects on fish with swim bladders could occur out to 302 m from the airgun and for fish without swim bladders impacts could occur to 140 m (Table 6). The area of impact within which physical injury could occur is therefore relatively very small. However, the area within which disturbance could occur may be substantially greater. Modelling undertaken for piling operations at the Hornsea Two offshore wind farm within the SAC indicate a general behavioural response may occur out 25 km for 'hearing specialists' (DONG 2015). Although the sound profile from piling is different from that of a seismic survey it does indicate the potential extent of disturbance to fish beyond the area of physical injury.

9.12 Results from the noise modelling indicate that the there is potential for an impact on sea lamprey and river lamprey to within 140 m of the seismic survey. Based on the distance the seismic surveys from the SAC and the low risk of any Lamprey occurring in the Survey Area it is concluded that there will not be a Likely Significant Effect on sea lamprey or river lamprey from the proposed survey.

Seabirds

9.13 During the breeding season seabird distribution is constrained by the requirement to return to breeding colonies. However, their foraging ranges can be extensive and breeding birds from the Flamborough and Filey SPA could occur across the proposed Survey Area (Table 2). Outwith the breeding season seabirds are widely dispersed away from their colonies and it is not possible to determine from which SPA, if any, those present in the area may be from.

9.14 The results from the assessment of potential impacts presented in Section 0 indicates that the only possible risk of an impact occurring that could cause a likely significant effect on seabirds is from noise arising during seismic surveys. Seabirds that feed on or near the sea surface, e.g. fulmar, Skuas, Gulls and Terns are at very low risk of any impact from underwater noise. Any periods below the sea surface are of relatively short duration and the risk of any impact occurring is considered very low.

9.15 Previous noise modelling undertaken on seven species of seabird including: gannet, puffin, guillemot and razorbill indicate that the area within which there is the potential of a physical impact is very localised and extends no further than 42 metres from the airguns for any species that remain below the sea surface for periods of up to 2 minutes. For species that are below the sea surface for less than 30 seconds the potential extent of physical impact is less than 20 m from an airgun (BEIS 2016).

9.16 The physical presence of a seismic vessel will cause displacement of seabirds on the sea surface in advance of a vessel and a significant majority of seabirds on the sea surface will be displaced away in advance of an approaching vessel. Consequently, there is a very low risk of any seabird occurring within the range at which physical injury is predicted to occur.

9.17 Although it is not possible to model the area within which there is potential for disturbance from noise arising from the airguns, it is recognised that seabirds that forage below the sea surface may be disturbed over a potentially wider area. Should this occur, it is predicted that birds will remain on the sea surface and may avoid being underwater until the seismic vessel has moved away from the area or the birds will temporarily relocate away from the seismic survey.

9.18 The physical presence of vessels during any potential seismic or drilling activity will cause localised disturbance as birds avoid the vessel. The range at which birds may be displaced varies across species. The impact from disturbance is relatively localised and temporary and will have no measurable effect on the individuals impacted.

9.19 There is potential for the prey species of seabirds to be impacted by possible seismic survey or the drilling of an exploration well. Studies on the impacts to fish from seismic surveys indicate that any disturbance to fish is temporary and localised (Peña *et al*. 2013; Slotte *et al*. 2004; Wardle *et al*. 2001). Should fish be displaced, seabirds will either relocate to areas where prey species are present or remain until the seismic vessel has moved further away and the fish return to the area. Any potential impacts will be very localised and temporary and any effects will be inconsequential.

9.20 Results from noise modelling indicate a very localised area of potential risk of physical harm and recognising that any displacement impacts would be of short duration it is concluded that seabirds from the qualifying SPA are not at risk of a likely significant effect.

Habitats

9.21 Habitats listed in the SAC citations will not be impacted by the proposed seismic survey and are not considered to be at risk of a likely significant effect. They are therefore not considered further in this Appropriate Assessment.

Likely significant effects test - conclusions

9.22 Based on the information presented within the application relating to the proposed activities and the advice received during consultation it is concluded that it is not possible to exclude a Likely Significant Effect on the following designated sites and qualifying species:

- Southern North Sea SAC: Harbour porpoise.
- Humber Estuary SAC: Grey seal.

9.23 For all other designated sites and associated qualifying habitats or species it is concluded that there will not be a Likely Significant Effect from the proposed seismic survey either alone or in-combination with other plans or projects.

10 APPROPRIATE ASSESSMENT

10.1 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).

10.2 The following sections assesses whether there will be an adverse effect on any of the European sites identified as having qualifying species for which no Likely Significant Effect could not be ruled out from the project alone and in-combination.

10.3 A dual approach has been used in order to determine whether an adverse effect on the integrity of the South North Sea SAC.

10.4 The assessment on the potential impacts from the seismic survey is based on the results from noise modelling undertaken by the applicant and previously by BEIS. This approach takes into account project specific factors that can affect the level of sound produced and its propagation within the water column. From this it is possible to estimate the number of harbour porpoise that may be affected and the overall duration of the potential impacts. Based on the study published by ASCOBANS an annual reduction in the population of 1.7% could cause a population level decline (Para. 7.11). Consequently, a similar level of impact from disturbance is predicted to not cause a population level of decline.

10.5 Following advice received a second approach to the assessment has also been undertaken based on recommendations by the SNCBs. This approach is based on the use of a generic 10 km EDR for all seismic survey activities irrespective of their location and airgun size. The extent and duration of the survey is then measured against draft thresholds above which a likely significant effect cannot be ruled out, as described in Section 6.

Southern North Sea SAC

Physical Injury

10.6 Noise modelling undertaken indicates that, based on the M-weighted SEL threshold, there is potential for sound levels from seismic surveys to cause the onset of PTS to harbour porpoise out to 470 m of the sound source (Table 4).

10.7 The peak harbour porpoise density across the site is estimated to be >3 per km^2 (Figure 6) (Heinänen and Skov 2015). Based on this peak density and the worst-case scenario of PTS occurring out to 470 m of the survey, an estimated two harbour porpoise could be affected at the start of a seismic survey.

10.8 The North Sea Management Unit harbour porpoise population is 333,808 individuals and therefore the worst-case scenario of two harbour porpoise being impacted is <0.0001% of the Management Unit population.

10.9 The estimated area of potential impact from PTS is within 500 m of the airgun array and therefore within the radius which, if marine mammals are detected during a pre-shooting search, the commencement of the firing of the airguns must be delayed by a minimum of 20 minutes, as per the JNCC guidance (JNCC 2017a). Harbour porpoise will avoid the area of potential injury and move away from the seismic survey vessel as it approaches. Consequently, apart from when the operation of the airgun initially commences, there is a very low risk of physical injury to any harbour porpoise.

10.10 There is a low risk of harbour porpoise being physically impacted by seismic surveys. In the extremely unlikely event the onset of PTS does occur, it would only affect a very small proportion of the relevant population.

Disturbance

10.11 The greatest extent any noise likely to cause disturbance is estimated to propagate out to is 34.9 km from the airguns and cover an area of 275 km^2 (Table 4). Assuming that disturbance occurs entirely within the SAC, then approximately 0.7% of the SAC as a whole and 1.0% of the 'summer' area could be affected by the proposed seismic survey at any one time.

10.12 Based on a peak site density of 3.0 ind/km^2 an estimated 825 harbour porpoise could be disturbed by a seismic survey at the start of a survey. This is equivalent to 0.2% of the North Sea Management Unit harbour porpoise population being disturbed.

10.13 A seismic vessel will transit across an area and over the duration of a survey the total number of harbour porpoises disturbed will be greater. The application states that the seismic survey will be travelling at 4.5 knots (8.3 km/h) (Spectrum 2018a). As the vessel undertakes a survey, disturbance in any area will last less than 8 hours in any one location. Once the vessel has left the area, sound levels will reduce to background levels. The disturbance effects are therefore transient and once the vessel has moved away from an area there is, in effect, no disturbance on those porpoises previously impacted.

10.14 Studies undertaken in the Moray Firth during 10 days of 2D seismic surveys using a 470 cu in airgun with source levels estimated to be 242–253 dB re 1 µPa @ 1 m (peak to peak), reported a decrease in the relative densities of harbour porpoises within 10 km of the airgun and an increase in densities at greater distances. However, porpoises continued to occur at sites within the impacted area during the seismic survey and there was a decline in the level of displacement over the ten day period that surveys were undertaken, indicating an increasing level of acclimation during the surveys. Once the surveys had ceased the number of detections returned to baseline levels within a day (Thompson *et al.* 2013, Pirotta *et al.* 2014). Therefore, any

displacement effects caused by seismic surveys are predicted to be temporary, with porpoises returning to the area impacted within 24 hrs.

Threshold Approach

10.15 The JNCC have 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). No assessment has been undertaken within the application using the threshold approach and therefore this assessment has been undertaken by BEIS as part of this HRA.

10.16 Based on information presented within the application, BEIS have estimated the area of the survey within the SAC and within the SAC plus a 10 km buffer. Furthermore, by using GIS, BEIS have estimated the maximum length a single survey line may be within the SAC and the total length of line that may be surveyed within the SAC (Figure 14).

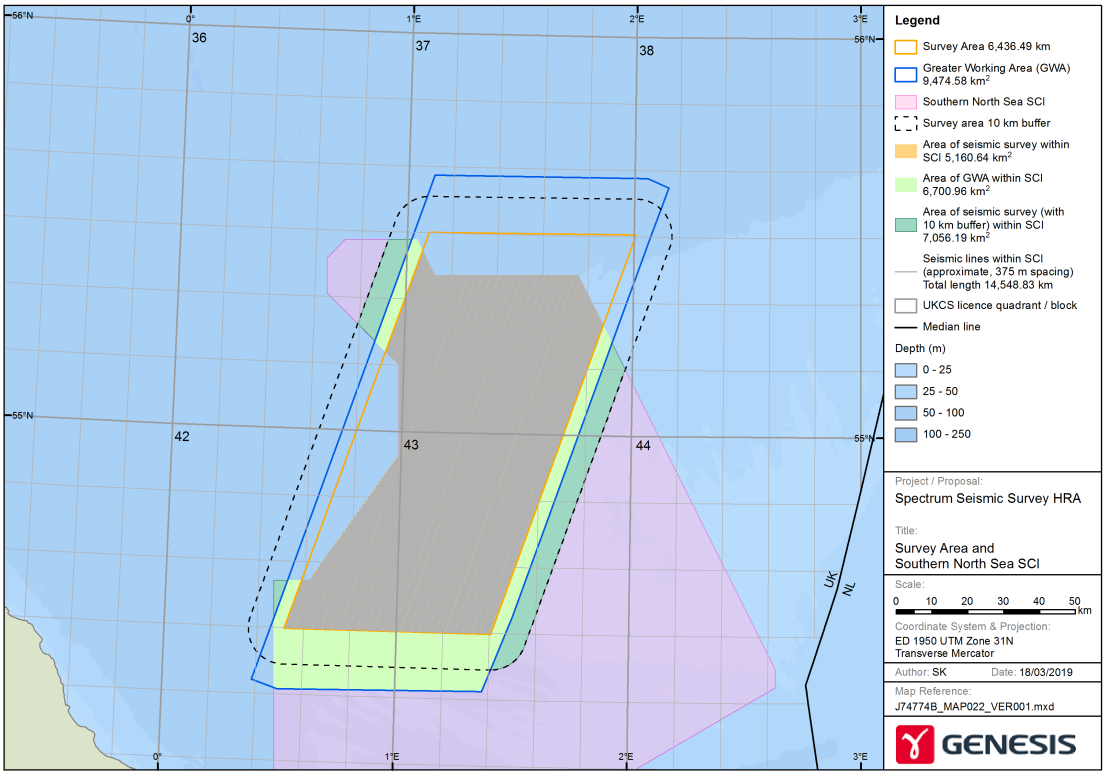

Figure 14: Area of seismic survey within the Southern North Sea SAC.

Daily Threshold

10.17 In order to calculate whether the daily threshold of 20% of the seasonal area is impacted an accurate estimate of the level of activity within the SAC is required in order to calculate the likely area impacted each day.

10.18 A total of 6,697 km^2 of the Permit Area (Greater Working Area) is within the Southern North Sea SAC[1] (Spectrum 2018a) and therefore overlaps 18.1% of the SAC as a whole and 24.8% of the 'summer' area. However, aside from the soft-start, airguns will not be operating within the Permit Area and will only be operating at maximum capacity within the Survey Area. The area of seismic survey to be undertaken within the Survey Area and within the SAC is therefore 5,161 km^2 (Figure 14). This overlaps with 13.9% of the SAC as a whole and 19.1% of the 'summer' area.

10.19 Noise arising from the proposed seismic survey will be transient as the vessel moves along the pre-determined survey lines. The extent of displacement over the period of one day will therefore be greater than if the survey was stationary. The JNCC have advised that the assessment should be based on the on an area covered by the seismic survey over a 24 hour period (JNCC 2019b).

10.20 When undertaking the seismic survey, the vessel will be travelling at 4.5 knots (8.3 km/h). Consequently, the maximum length of line that could, in theory, be surveyed over the course of a single day is 199 km. Assuming a 10 km EDR, the total area impacted over the course of 24 hrs would be 4,298 km^2 (Figure 15). This is equivalent to 11.6% of the SAC and 15.8% of the 'summer' area and is the maximum possible extent of impact within the SAC as it presumes that airguns are operating continuously throughout a 24 hr period and the whole impacted area is within the SAC. This is an unrealistic scenario as there will be breaks of three hours in airgun operations at the end of each line as the vessel turns before starting the next line (Spectrum 2018b). Consequently, airguns will not be operating throughout a 24 hr period. Furthermore, 29% of the Permit Area and 20% of the Survey Area are outwith the SAC and therefore any survey undertaken outwith the SAC will have less of an impact than activities within it.

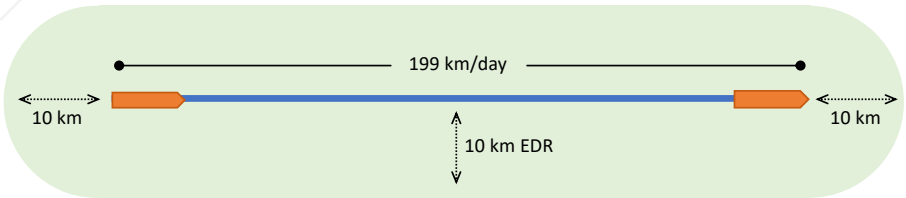

Figure 15: Worst-case theoretical area of impact from a seismic survey travelling at 4.5 knots using 10 km EDR.

[1] It is noted that the estimated Permit Area presented within the application is marginally smaller than that calculated for this assessment. However, the difference is so slight it makes no difference to any conclusions made in this assessment

10.21 Based on the configuration of the planned survey route (Figure 14), the maximum length of a single survey line wholly within the SAC is estimated to be 106 km. The airguns will be switched off at the end of each line, during which time the vessel will turn, before commencing a soft-start at the start of each preceding line. It is estimated that it will take three hours to undertake each line turn (Spectrum 2018b). Consequently, airguns will be operating for no more than 21 hours per day, as the vessel will undertake at least one line turn each day. If the vessel travels at 4.5 knots and the airguns operate continuously for 21 hrs, the maximum length of survey line undertaken during any single day could be 174 km, of which 150 km could be within the SAC (Figure 16). Consequently, the maximum length of survey line which will impact the area within the SAC is 152.8 km, of which 2.8 km will be during the soft-start within the SAC.[1]

10.22 The area within the SAC that is impacted each day also depends on the distance between successive survey lines. If survey lines are 20 km or greater apart the maximum area predicted to be impacted per day is 3,370 km^2. However, Spectrum have confirmed that successive survey lines will be 375 m apart (Spectrum. *Pers. Com.* 25 March 2019). Consequently, the maximum area within the SAC that will be impacted per day is 2,348.4 km^2. This is equivalent to impacting 6.3% of the SAC as a whole and 8.7% of the 'summer' area per day. Consequently, the daily thresholds will not be exceeded by the proposed seismic survey on its own.

10.23 This scenario assumes that the airguns are operating over the maximum possible time of 21 hrs during any single day with airguns switched off for a period of no less than three hours at the end of each line. It also assumes that the vessel will travel no faster than 4.5 knots when undertaking the survey and successive lines are no more than 375 m apart. It is therefore considered to be realistic worst-case scenario based on the information presented within the application.

[1] It is recognised that noise from airguns within 10 km of the SAC boundary could also impact within the SAC. However, although this increases the duration of noise within the SAC it does not increase the area of SAC impacted.

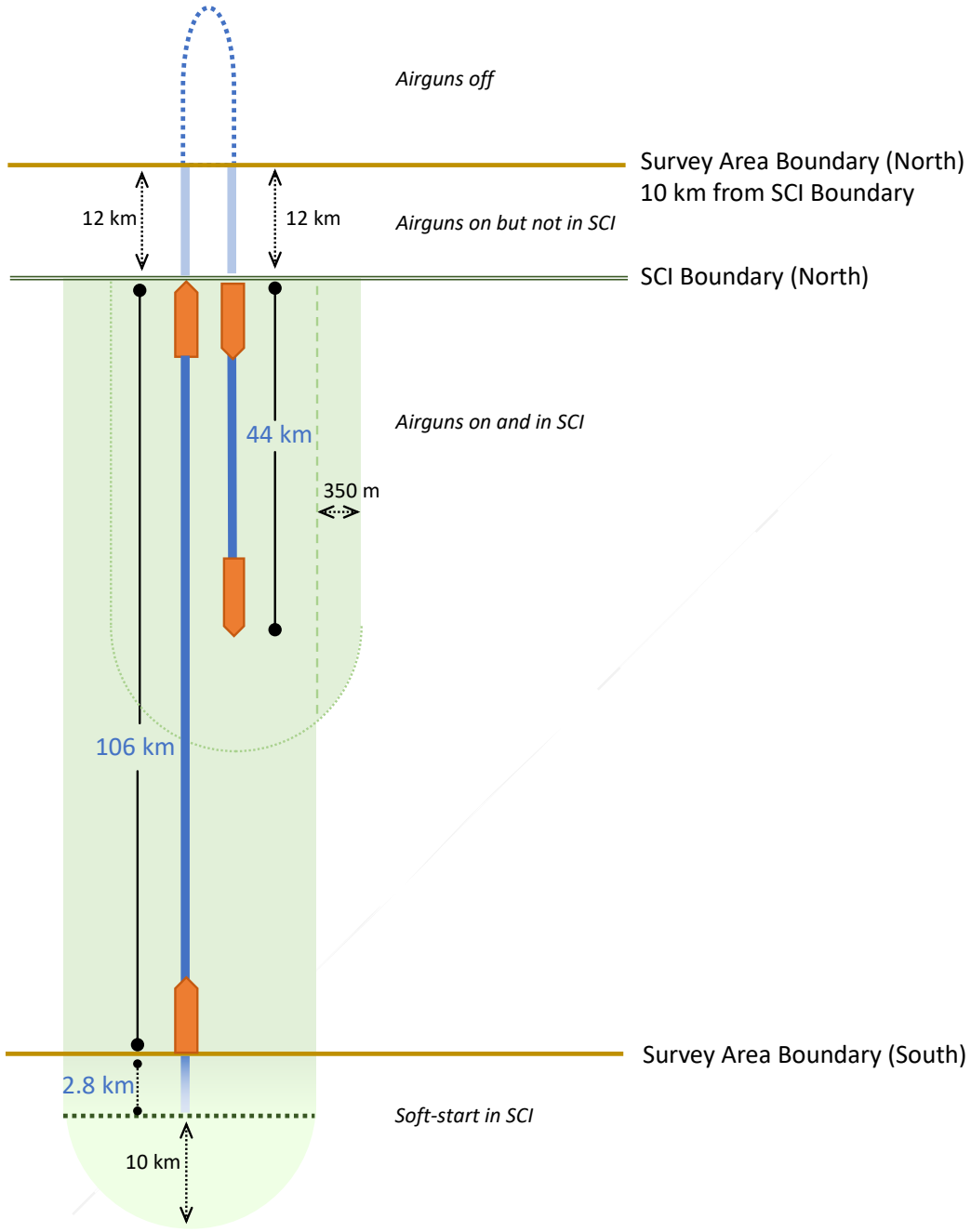

Figure 16: Realistic worst-case area of impact from proposed Spectrum seismic survey within the Southern North Sea SAC with line spacing of 375 m.

Seasonal Threshold

10.24 The survey is planned to be undertaken over a period of 160 days. Originally it was planned to commence in April 2019 with completion by 30 October 2019. However, the start has now been delayed to no earlier than 20 May 2019. It is therefore not now possible for the whole of the 160 day duration of the survey to be undertaken during the summer period.

10.25 In order to assess the worst-case seasonal spatial overlap it is presumed that the survey will start on 20 May 2019 and therefore of the 160 days of possible seismic survey to be undertaken, a 134 days will be during the summer period. It is also presumed that once the survey commences it will be undertaken for 24 hrs each day without a break (except for line turns), for the whole of the 134 days. It also assumes that the maximum area of impact within the SAC occurs for the duration of the survey. This is unrealistic as there will be inevitable breaks in the survey due to weather and technical issues during which airguns will not be operating and 1,285 km^2 of the Survey Area is also located outwith the SAC and therefore will have reduce area of impact within the SAC.

10.26 Based on the worst-case scenario the average seasonal spatial overlap would be 6.4% of the SAC (Table 9).

10.27 The worst-case scenarios presume that noise from the seismic survey is undertaken for the whole duration of 134 days in the summer period and impacts over the maximum possible area within the SAC each day. This will not be the case as 20% of the survey will be undertaken outwith the SAC and lines nearer to the site boundary will have a lower level of impact within the SAC.

10.28 Under the likely worst-case scenario the seasonal threshold is not exceeded by the proposed survey.

Table 9: Estimated extent of disturbance on harbour porpoise from proposed Spectrum seismic survey within the SAC.

SAC area	Maximum area of SAC impacted per day (km^2)	% of 'summer' area (Daily Threshold)	Estimated duration of impact (days)	% of 'summer' area Seasonal Threshold)
Likely Worst-case (134 days in summer period)				
'summer'	2,293	8.7	134	6.4

Conclusion

10.29 Results from noise modelling indicate that no more than two harbour porpoise are at risk of physical injury from noise arising from the airguns. With proposed mitigation discussed in Section 12 there is a very low risk of any harbour porpoise being injured.

10.30 There is a risk of harbour porpoise being displaced or disturbed by the proposed seismic survey. Noise modelling indicates that up to 825 harbour porpoise may be disturbed at any one time; this is 0.24% of the North Sea Management Unit population and therefore below the predicted level of disturbance that could cause a population level effect. The disturbance will be of short duration as the vessel transits through the Survey Area. Once the vessel has passed, porpoises are predicted to return to the area within 24 hrs.

10.31 The results from the threshold approach indicate that up to 8.7% of the 'summer' area may be impacted each day and up to 6.4% of the seasonal threshold. The daily and seasonal thresholds are not exceeded.

10.32 The proposed survey will not affect the supporting habitats and will have a temporary and localised impact on the supporting prey species, e.g. fish. Once the proposed survey has moved away or ceased there will be no effect on the distribution, abundance and population dynamics of the species.

10.33 Based on the best available information and supported by results from noise modelling and the threshold approach, BEIS is satisfied that the proposed survey alone will not have an adverse effect upon the integrity of the SNS SAC with respect to harbour porpoise.

Humber Estuary SAC

Grey seal

10.34 It is considered, based on the known distribution of grey seals from the Humber Estuary SAC and information presented in the application, that grey seals from Humber Estuary SAC are at risk of being impacted by noise arising from the proposed survey.

10.35 Densities of grey seal across the proposed seismic survey working area range from <1 individual per 5 km^2 and <50 individuals per 5 km^2, i.e. between <0.04 and 2.0 individuals per km^2 (Figure 7). Over the majority of the Survey Area densities of grey seals are relatively low with higher areas of usage to the south and closer to the coast.

Physical Injury

10.36 Results from noise modelling presented within the application indicate that there is a risk of physical injury in the form of PTS within 10 m of sound source (Table 5). Additional modelling undertaken for previous assessments indicates that this could extend to 99 m. (Although this is based on a larger airgun array and not within the Survey Area)

10.37 The potential area within which the onset of PTS is predicted to occur is very localised and covers an area of no more than 0.031 km^2 and is likely to be less. The presence of a Marine Mammal Observers (MMO) during the survey will ensure that the risk of any grey seals being present within the area at which the onset of PTS is predicted to occur is very low.

Disturbance and Displacement

10.38 When undertaking surveys the vessel will be travelling 4.5 knots (8.3 km/h). Noise capable of causing disturbance is predicted to occur out to no more than either 12.3 or 32 km (depending on modelled outputs) from the survey vessel. Consequently, as the vessel transits along a seismic transect, disturbance in any one area will last approximately between 3 and 8 hours based on the maximum area noise likely to cause disturbance is predicted to occur and the vessel

travelling at its slowest operating speed. Once the vessel has left the area, noise levels will reduce to ambient background levels.

10.39 The Humber Estuary SAC lies 83 km from the proposed seismic greater working area and the number of grey seals at risk of disturbance varies across the Survey Area. Approximately 86% of the Survey Area has densities of below 0.2 ind/km^2, although it is recognised that higher densities to the south of the Survey Area could be impacted by noise. On an average estimated density of 0.2 ind/km^2 (See Forewind 2013 and Figure 7) being disturbed across the proposed Survey Area an estimated 308 grey seals could be disturbed. This is equivalent to 3.2% of the SAC population of 9,474 individuals being disturbed at any one time.

10.40 There is potential for repeated levels of noise capable of causing displacement or disturbance to occur as the survey vessel undertakes the survey along pre-determined survey lines within the area. The duration of any potential impact depends on the total length of seismic survey line occurring within the area and the speed of the vessel.

10.41 It is likely that grey seals receiving levels of sound capable of causing disturbance will avoid the area. However, the duration of the impact for individual seals will be relatively short as the seismic vessel will move outwith the area and the seals are capable of temporarily relocating to areas away from the sound source.

10.42 Studies undertaken on seals indicate that they are not significantly impacted by seismic surveys. Harris *et al*. (2001) reported no significant difference in the number of ringed and bearded seals recorded when 1,320 cu. in. air guns with a sound source of 230 dB dB re 1 µPa (0-p) were operating compared to when they were not. However, the increase in the median distance at which they were observed from 144 m to 234 m was significant, indicating that seals did move away from the vessel when the airguns were operating. Other studies have indicated a level of displacement and potential increase in haul out behaviour when airguns have been operating but have also shown that the behaviour of seals quickly return to normal once the airguns have ceased operating (Thompson *et al.* 1998). Similar results have been reported from studies undertaken on harbour seals impacted by piling activities, where it has been shown that displacement effects can occur out to 25 km from the sound source but within 2 hours of the cessation of piling the distribution of seals returns to pre-piling scenarios (Russell *et al.* 2016).

10.43 The potential impacts on individual grey seals will vary, depending on individuals' sensitivities and habituation to noise. Furthermore, studies suggest that the response to noise may depend on whether the sound is sudden and causes a startle response or is more gradual and allows habituation to occur and therefore avoids a startle response. Where sound levels are increased more gradually, i.e. by soft-start, a reduced level of displacement is likely (Götz and Janik 2011).

10.44 The impacts from the proposed seismic survey may cause temporary displacement or disturbance behaviour that could reduce the ability of grey seals to forage. Grey seals are

opportunistic feeders and can, if prey availability changes, adapt to foraging on alternative prey. Noise modelling indicates a relatively localised effect on potential prey species but in the unlikely event that grey seals are unable to forage in the wider area then they will be able to survive the short period of time during which the survey will be causing an impact without food, surviving off their existing fat reserves.

Conclusion

10.45 It is predicted that there is a very low risk of any physical injuries to grey seals arising from the proposed seismic survey. However, grey seals from the Humber Estuary SAC and the wider area are at risk of being displaced or disturbed. Displaced grey seals will relocate to other areas and are predicted to return shortly after the sound levels are below that at which displacement occurs. Disturbance to grey seals may occur but results from noise modelling indicate that sound levels capable of causing disturbance will occur for less than eight hours at any one point and evidence from other studies indicate that the impacts from disturbance will be temporary and predicted to be of relatively short duration.

10.46 The duration and effect of any impact on grey seals is predicted to be temporary and although will cause a level of displacement and disturbance, it will not cause any direct or indirect mortality to grey seals and therefore will not impact on the population or effect its ability to maintain itself in the long-term.

10.47 The proposed survey will not affect the supporting habitats and will have a temporary and localised impact on the supporting prey species, e.g. fish. Once the proposed survey has moved away or ceased there will be no effect on the distribution, abundance and population dynamics of the species.

10.48 Based on the best available information and supported by results from noise modelling presented in the application, BEIS is satisfied that the proposed survey alone will not have an adverse effect upon the integrity of the Humber Estuary SAC with respect to grey seals.

11 IN-COMBINATION ASSESSMENT

11.1 There is potential for in-combination impacts to arise due to noise from other known or planned activities and the proposed seismic survey.

11.2 UXO clearance is planned to be undertaken at Hornsea Project Two offshore wind farm and Triton Knoll offshore wind farm. Planned or consented oil and gas activities within or adjacent to the site include geophysical surveys, decommissioning and pipeline protection. These activities have the potential to cause an in-combination impact. BEIS understand that the planned UXO clearance along the Viking Links Inter Connector during 2019 has been postponed until 2020 and is therefore not considered within this HRA (NGVL 2018b, MMO 2018).

Hornsea Project Two UXO Clearance

11.3 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 8).

11.4 Ørsted have applied for a Marine Licence to undertake UXO clearance within the wind farm area and along the export cable route. The application is for clearance by detonation of up to 120 items of 800 kg UXO over a period of 641 days between 1 April 2019 and 31 December 2020. The application states that there will be no more than 60 detonations during each year (Ørsted 2018c). A Marine Licence has not currently been issued and will be subject to an HRA to be undertaken by the MMO.

11.5 No UXO detection surveys have been undertaken and therefore there is considerable uncertainty on the number and type of UXO items that may be required to be detonated or where they may be in relation to the qualifying sites relevant to this assessment.

11.6 In order to reduce the potential in-combination effect associated with UXO clearance, Ørsted have proposed the following limitations when considering concurrent activities (Ørsted 2018b,c):

11.7 During the summer 2019 season (April to September, inclusive):

- A maximum of five detonations will occur in any 24-hour period when the Viking Link Interconnector is not undertaking any detonations within the SNS cSAC/SAC or a 26 km buffer surrounding the cSAC/SAC (during the same 24-hour period).
- A maximum of three detonations will occur in any 24-hour period when the Viking Link Interconnector is undertaking detonation activities within the SNS cSAC/SAC or a 26 km buffer surrounding the cSAC/SAC (during the same 24-hour period) and where it is confirmed that East Anglia ONE is not undertaking piling or UXO.

- A maximum of two detonations will occur in any 24-hour period when the Viking Link Interconnector is undertaking detonation activities within the SNS cSAC/SAC or a 26 km buffer surrounding the cSAC/SAC (during the same 24-hour period) and where it is confirmed that East Anglia ONE is only undertaking either piling or UXO.

11.8 During recent communications with Ørsted it has been determined that no clearance of UXO is to be undertaken prior to June 2019 (Ørsted *pers. com.*).

11.9 Based on the understanding that the Viking Link Interconnector project will not be undertaking any UXO clearance between the beginning of April and the end of September 2019, a maximum of five detonations may be undertaken over a period of 24 hours.

Hornsea Two UXO noise modelling

11.10 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).

11.11 Noise modelling by Ørsted indicates that the onset of PTS for pinnipeds, (grey seals) could arise within 2.7 km in the event that a 700 kg charge is detonated (Ørsted 2018c). No assessment has been made by Ørsted on the estimated number of harbour porpoise or grey seal that could be injured or disturbed by UXO clearance.

11.12 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 population.

11.13 The density of grey seals within Hornsea Zone were estimated to be less than 0.4 ind./km^2 but with higher densities of 2.0 ind./km^2 along the export cable route in nearshore waters (SMart Wind 2015). Assuming a circular propagation of noise capable of causing the onset of PTS extends to 2.7 km from each item of UXO then between 9 and 46 grey seals could be at risk of hearing injury depending on where the UXO is cleared, with higher numbers predicted to be impacted within the Humber Estuary SAC.

11.14 Ørsted have committed to including mitigation measures including the use of ADD and bubble curtains. Therefore, there is a low risk of any grey seals being within the range at which the onset of PTS is predicted to occur.

Hornsea Two UXO threshold approach

11.15 Ørsted have undertaken an assessment based on the proposed SNCB 'threshold approach' with an EDR of 26 km.

11.16 The worst-case scenario for a single detonation within the SAC will impact a maximum area of 2,009 km^2 within the SAC, equivalent to 7.44% of the 'summer' area. In the event that up to five detonations are undertaken per day, the worst-case scenario is that an area within the SAC of 3,801 km^2, equivalent to 14.1% of the 'summer' area of the SAC could be impacted (Ørsted 2018b).

11.17 Ørsted have advised that it is not practical to undertake less than three detonations per day in which case the maximum daily threshold would be 11.3% (Ørsted pers. com.)

11.18 In the event that up to 60 UXO detonations are undertaken during the 'summer' period with one detonation per day the seasonal average is 2.4%. In the event that three detonations per day occur the seasonal spatial overlap is 1.9% and for five detonations per day it is 0.9% (Table 10).

Table 10: Seasonal spatial overlap for Hornsea Two UXO detonations.

SAC area	Maximum area of SAC impacted (km^2)	% of 'summer' area (Daily Threshold)	No. of detonations	Estimated duration of impact (days)	% of 'summer' area (Seasonal Threshold)
Single UXO detonation per day					
'summer'	2,009	7.4	60	60	2.4
Three UXO detonations per day					
'summer'	Unknown	11.3	60	20	1.2
Five UXO detonations per day					
'summer'	3,801	14.1	60	12	0.9

11.19 The potential impact from UXO detonations using the threshold approach is unrealistically worst-case as it assumes that there will be 60 detonations undertaken during the summer period. This figure is speculative and considered to be maximum worst-case. It is not based on any survey data within the Hornsea Two Project area and the actual number of detonations will likely be less than this. For example, the adjacent Hornsea One project cleared a total of 26 items of UXO during the course of its UXO clearance campaign. Furthermore, the assessment also assumes that all 60 detonations not only occur within the SAC but are located where the maximum area of effect will arise. This scenario is highly precautionary and not technically possible over the course of a season. It is highly probable that detonations undertaken during a single day will be undertaken in relatively close proximity to each other, thus significantly reducing the daily threshold and consequently the seasonal threshold.

11.20 In the absence of any further information currently available these thresholds have been considered within this HRA. However, BEIS recognises the highly precautionary nature of the figures being used and that with further information they could be significantly reduced.

Triton Knoll UXO Clearance

11.21 The Triton Knoll offshore wind farm is a Round 2 offshore wind farm. At its closest point the Project site lies 32 km off the coast of Lincolnshire and covers an area of approximately 145 km^2 (TKOWFL 2018a). The project lies wholly outwith the SAC but partially within 26 km of the SAC boundary.

11.22 TKOWFL have applied for a Marine Licence to undertake UXO clearance within the wind farm area and along the export cable route. The application is for detonation of up to 60 items of 770 kg UXO, between 1 February 2019 and 31 December 2021, with no more than 25 UXO clearance within 26 km of the SAC boundary and all these being undertaken between April and September 2019 (TKOWFL 2018a, b).

11.23 It is anticipated that on average up to 45 UXO detonations may be required. However, a precautionary assumption is made in the application that a maximum 60 detonations may be required (TKOWFL 2018a). Surveys undertaken to-date indicate the presence of some UXO within the wind farm array area and along the export cable route. Although the exact number of UXO items that may be required to be detonated is unknown.

Triton Knoll UXO noise modelling

11.24 Noise modelling undertaken by TKOWFL in support of the Marine Licence application indicates that the onset of PTS to harbour porpoise could occur within 11.5 km of the detonation of a 770 kg UXO charge. Assuming a circular propagation of noise the area across which the onset of PTS to harbour porpoise is predicted to occur is 415.5 km^2.

11.25 The density of harbour porpoise across the Triton Knoll wind farm area is 0.11 ind/km^2, consequently an estimated 46 harbour porpoise are at risk of the onset of PTS from UXO detonations (TKOWFL 2011). Were this to occur then an estimated 0.01% of the North Sea Management Unit population could be affected. This estimate is based on the largest UXO charge predicted to occur and no mitigation in place to reduce the risk of harbour porpoise being in the area and therefore is considered a worst-case scenario.

11.26 Noise modelling undertaken for pinnipeds indicates that the onset of PTS will occur within 2.7 km from the detonation of 770 kg charge. The area across which the onset of PTS in grey seals is predicted arise is 22.9 km^2. The estimated density of grey seals at Triton Knoll is 0.21 ind/km^2 (TKOWFL 2011). Therefore, an estimated five grey seals are at risk of the onset of PTS from the clearance of a 770 kg UXO charge. However, this estimate is based on there being no effective mitigation in place. TKOWFL have committed to including mitigation measures including the use of ADD and bubble curtains (TKOWFL 2018c). Therefore, there is a low risk of any grey seals being within the range at which the onset of PTS is predicted to occur.

Triton Knoll UXO EDR

11.27 The location of the Triton Knoll wind farm is such that a relatively small area is within 26 km of the SAC boundary. Within the application TKOWL have not undertaken an assessment based on the proposed SNCB 'threshold approach' with an EDR of 26 km.

11.28 Previous assessments for Triton Knoll using a 26 km EDR (for pile-driving) have reported that no more than 61.1 km^2 lies within 26 km of the wind farm array area, of which 47.8 km^2 is within the 'summer area' (BEIS 2018). This is the same area that is predicted to arise from the detonation of a single item of UXO.

11.29 In the event that up to 25 UXO detonations are undertaken during the 'summer' period with one detonation per day the seasonal average is 0.02% (Table 11).

Table 11: Seasonal spatial overlap for Triton Knoll UXO detonations.

SAC area	Maximum area of SAC impacted (km^2)	% of 'summer' area (Daily Threshold)	No. of detonations	Estimated duration of impact (days)	% of 'summer' area (Seasonal Threshold)
Single UXO detonation per day					
'summer'	47.8	0.17	25	25	0.02

11.30 The potential impact from UXO detonations using the threshold approach is worst-case as it assumes that 25 detonations will occur in an area where the maximum area of effect will arise and that there is only one detonation per day. If more than one detonation is undertaken per day then the seasonal spatial overlap will be reduced.

11.31 There is no EDR for grey seals and therefore no assessment made using this approach.

Oil and gas industry activities

11.32 There are currently 13 planned or consented oil and gas related activities that could have the potential to cause an in-combination impact including one seismic survey (Table 8).

Tolmount 3D Seismic Survey

11.33 The Tolmount 3D seismic survey has been undertaken in Licence Blocks 42/26 to 42/30 and 47/1 to 47/5. The application was for the survey to be undertaken over period of 40 days between April and 31 July 2019 ((PremierOil 2019a, b). The survey commenced on 31 March and was completed on 30 April 2019 and therefore lasted for 30 days (PremierOil *Pers com.*). The Greater Working Area is 1,266 km^2 and the Survey Area is 607 km^2. The survey comprises the operation of a 4,100 cu. in. airgun along lines spaced 250 m apart. At the end of each line the airguns will be switched off while the vessel turns, this is reported to take 150 minutes. The vessel speed when undertaking survey will be 4.5 knots (PremierOil 2019a, b).

11.34 Noise modelling has been undertaken by Premier to assess the potential impacts from the seismic survey. The results from the modelling indicate that for harbour porpoise there is potential for the onset of PTS to arise within 388 m of the seismic survey vessel and disturbance will occur out to 1,451 m (PremierOil 2019a). Both these modelling outputs are lower than have previously been predicted by similar noise modelling undertaken by BEIS. In particular, the noise modelling undertaken for the application indicates a relatively limited extent that disturbance is predicted to arise from the proposed survey (see Table 4).

11.35 For grey seals the noise modelling undertaken by PremierOil indicates the onset of PTS could occur within 85 m of the sound source. Disturbance is predicted to occur out to 1,451 m and encompass an area of 6.6 km^2 (PremierOil 2019a). Previous noise modelling undertaken for the OGA for seismic surveys indicate similar areas at which the onset of PTS is predicted to occur but a larger extent over which disturbance may arise (Table 5).

11.36 For the purposes of this in-combination assessment the results from modelling undertaken by BEIS and OGA have been used. Although these modelled outputs are for different airgun arrays operating in different areas, their outputs, in particular for disturbance, reflect what may be reasonable predicted to arise from an airgun array and are more precautionary than those in the application.

11.37 There is no assessment within the application using the threshold approach for assessing the potential impacts on harbour porpoise within the SNS SAC. BEIS has undertaken its own assessment using this approach to support this in-combination assessment.

Tolmount 3D Seismic survey - noise modelling

11.38 Noise modelling previously undertaken by BEIS indicates that noise capable of causing the onset of PTS in harbour porpoise could occur out to 470 m from the sound source. The density of harbour porpoise within the Survey Area is unknown but the SCANS III surveys recorded densities of 0.88 ind/km^2 within the wider area (Hammond *et al*. 2017). Based on this peak density and the worst-case scenario of PTS occurring out to 470 m from the survey, it is estimated that less than one harbour porpoise is will be at risk of the onset of PTS at the start of operating the airguns.

11.39 Based on an area of disturbance at the start of operations of 275 km^2 and a harbour porpoise density of 0.88 ind/km^2 an estimated 244 harbour porpoise could be disturbed by a seismic survey at the start of a survey. This is equivalent to 0.07% of the North Sea Management Unit harbour porpoise population being disturbed.

11.40 The density of grey seals within the Survey Area of 0.6 ind./km^2 are derived from Russell *et al*. (2017) and presented within the application (PremierOil 2019a). It is estimated that less than one grey seal may be at risk from the onset of PTS and up to 924 may be at risk of disturbance. If all

the seals disturbed originate from the Humber Estuary SAC, an estimated 9.7% of the SAC grey seal population could be disturbed.

Tolmount 3D Seismic survey – threshold approach

11.41 The Tolmount seismic survey partially overlaps both the 'summer' and 'winter' areas of the SNS SAC. However, as the Spectrum survey will not impact on the 'winter' area, only the potential impacts over the 'summer' area have been considered for this in-combination assessment. Following the approach used for the Spectrum seismic survey (See Section 10) the daily threshold and seasonal thresholds have been calculated for the 'summer' area of the SNS SAC.

11.42 In order to undertake this assessment the parameters presented in Table 12 have been used based on information presented within the application, calculations made by BEIS using GIS and a number of presumptions based on a previous survey undertaken in the area (Polarcus 2017a, b). The realistic worst-case scenario is presented in Figure 17.

Table 12: Parameters used in order to undertake the threshold approach assessment for Tolmount seismic survey.

Parameter		Source
Survey duration	30 working days	PremierOil *pers com*.
Greater Working Area	1,266 km^2	Application
Greater Working Area within SAC	673.7 km^2	Calculated
Greater Working Area within 'summer' area of SAC	580.2 km^2	Calculated
Survey Area	607 km^2	Application
Survey Area within SAC	291.6 km^2	Calculated
Survey Area within 'summer' area of SAC	241.4 km^2	Calculated
Longest survey line	33.6 km	Calculated
Longest survey line within 'summer' area of SAC	14.3 km	Calculated
Total length of survey line within 'summer' area of SAC	974.0 km	Calculated
Total length of survey line within 'summer' area of SAC + 10 km buffer	1,763.7 km	Calculated
Number of survey lines within SAC	73 – 74	Application/Calculated
Line turn duration	150 minutes	Application
Vessel speed	4.5 knots (8.3 km/h)	Application
Line spacing	250 m	Application
Successive survey line spacing	8 km	Polarcus (2017a, b)
Line orientation	East/West	Polarcus (2017a, b)

Application = PremierOil 2019a, b

Calculated = A calculation made by BEIS in order to undertake the assessment

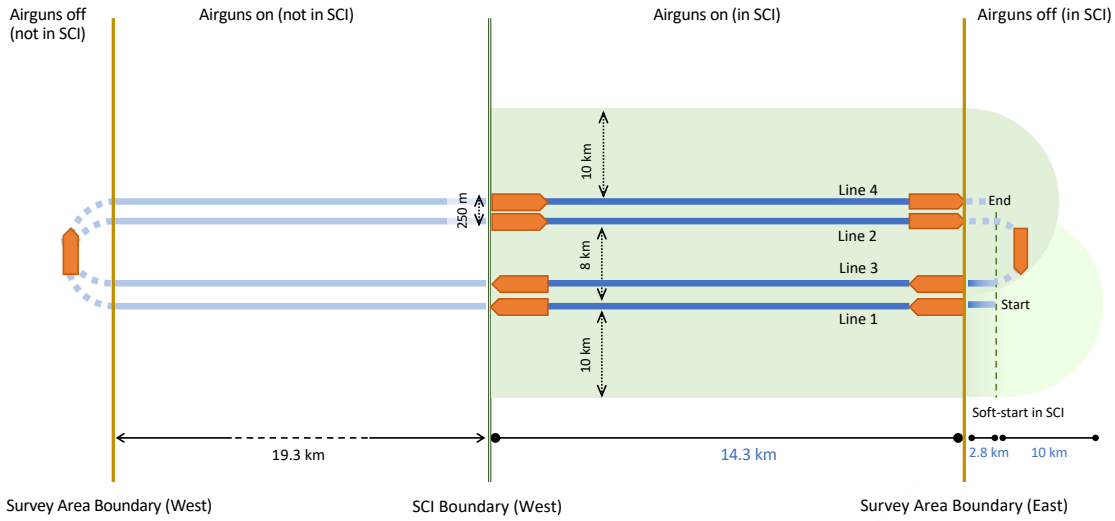

Figure 17: Realistic worst-case area of impact from Tolmount seismic survey within the Southern North Sea SAC with successive lines 8 km apart and adjacent line spacing of 250 m.

11.43 In order to assess the seasonal spatial overlap the whole of the 30 days of survey was undertaken during the summer period commencing in March 2019 with completion in April 2019. For the purposes of this assessment it is presumed that the maximum area of impact within the SAC occurs for the duration of the survey. This is unrealistic and precautionary as there will be inevitable breaks in the survey due to weather and technical issues during which airguns will not be operating and an estimated 315 km^2 of the Survey Area is located outwith the SAC

11.44 Based on the configuration of the survey route (Figure 17), the maximum length of a single survey line undertaken in a single day within the SAC is estimated to be 62.8 km, of which 5.6 km will be during the soft-start. The maximum area within the SAC that is estimated could be impacted each day is 774.6 km^2, which is 2.1% of the SAC as a whole and 2.9% of the 'summer' area per day. Consequently, the daily thresholds will not be exceeded by the Tolmount seismic survey on its own.

11.45 This scenario assumes that the airguns are operating over the maximum possible time each day, with airguns switched off for a period of no less than 2.5 hours at the end of each line. It also assumes that the vessel will travel no faster than 4.5 knots when undertaking the survey and successive lines are 8 km apart [1]. Adjacent lines are spaced no more the 250 m apart. It is therefore considered to be a realistic worst-case scenario based on the information presented within the application and a number of presumptions that have had to be made in order to undertake this assessment.

[1] There is no information on the distance between the successive line spacing within the PremierOil application. The 8 km line spacing is based on the previous seismic survey undertaken over the same area in 2017 and using the same line orientation (Polarcus 2017a ,b).

11.46 Based on known duration of the survey and estimated spatial overlap, the average seasonal spatial overlap has been estimated to be 0.5% of the SAC (Table 13).

Table 13: Estimated extent of disturbance on harbour porpoise from Tolmount seismic survey within the SAC.

SAC area	Maximum area of SAC impacted per day (km^2)	% of 'summer' area (Daily Threshold)	Estimated duration of impact (days)	% of 'summer' area (Seasonal Threshold)
Realistic worst-case (30 days in summer period)				
'summer'	774.6	2.9	30	0.5

Other oil and gas applications

11.47 Applications for Pipeline freespan rectification have been made by Perenco and ENI Hewitt (Licence Ref No. PLA 409, 647 and 651). Activities associated with these applications are planned to be completed no later than 10 May 2019. Freespan rectification is required to be undertaken in order to ensure the safe integrity of a pipeline and reduce the risk of fishing gear snagging on the pipeline. Activities associated freespan rectification include the use of a vessel to place mattresses, grout bags or rock filters over and along the freespan. The only sound arising is from the vessels used to undertake the work. Vessel noise does have the potential to cause localised area of disturbance for harbour porpoise within the SAC. The additional few vessels required to undertake the work is not considered likely to contribute significantly to the current levels of shipping occurring within the SAC and therefore not cause an in-combination impact.

11.48 Two applications for contingency rock-dump have been made by ConocoPhillips (Licence Ref. No. ML/415/2 and ML/428/0). If required, activities will take place either before 5 April or 4 June 2019. The deposit of rock as a contingency safety requirement is required in the event that rigs being used during decommissioning become unstable. Noise will arise from rock dumping, however, noise measurements taken from a fall pipe rock dumping vessel found no evidence that the rock placement itself contributed to the noise level from the vessel (Nedwell and Edwards, 2004). Consequently, noise arising from rock-dumping will not cause an in-combination impact over and above that from existing vessel noise.

11.49 A number of surveys are planned to be undertaken within the SAC. Applications for two sites surveys have been made by Petrofac for between 21 March and 31 May 2019 (Licence Ref. No. SA/1099 and SA/1101). The surveys will use a range of geophysical equipment including side-scan sonar, multi-beam echosounders and sub-bottom profilers. Both surveys will be undertaken outwith the SAC with the Cameron site survey being 3.5 km from the SAC boundary and the Deben site survey being 1.7 km. In relatively shallow waters, such as those found across the SAC, side-scan sonar and multi-beam echosounders are operated at relatively high frequencies,

typically greater than 200-300 kHz and therefore outwith the range at which harbour porpoise or grey seal can detect sound.

11.50 Sub-bottom profilers operate within the hearing range of marine mammals including harbour porpoise and grey seal. Noise modelling undertaken for the applications indicate that PTS in harbour porpoise may arise within 13 m of the sub-bottom profiler and for grey seal within 2 m. Disturbance may arise out to 1.5 km (Petrofac 2019a, b). Consequently, disturbance from the proposed geophysical surveys will be localised and not occur within the SNS SAC and not cause an in-combination impact to harbour porpoise within the SNS SAC. The location of the proposed surveys in Licence Blocks 49/28 and 44/19 are 67 km and 182 km from the nearest coastline and in areas not frequently used by grey seals. Due to the distance from the Humber Estuary SAC and the localised area of disturbance there will be no in-combination impact from either of the surveys on grey seals from the Humber Estuary SAC.

11.51 The Andromeda debris survey (Licence Ref. No. SA/1052) is planned to be undertaken between 15 March and 30 April 2019 and last for no more than one day, during which time multi-beam echosounder and side-scan sonar will be used. The equipment will be operated at frequencies above which harbour porpoise and grey seals are able to hear and therefore there will be no impact on them and no in-combination impacts.

11.52 The Hewett complex seabed survey (Licence Ref. No. SA/957) is consented but a variation has been submitted to extend the survey to the 31 May. Between 1 April and 31 May 2019 only RoV and CP equipment will be used. As neither of these make any sound capable of causing disturbance there will be no in-combination impact from this survey.

11.53 The multiple borehole survey (Licence Ref. No. SA/1085) is planned to be undertaken between 1 April and 31 May 2019. The survey comprises drilling a single shallow borehole at 12 locations as part of the Hewett Field decommissioning. Each borehole will be a maximum of 40 m in depth and have a diameter of 12.7 cm. The level of sound arising from drilling is relatively low and occurs predominantly at a low frequency and is a continuous sound source (Greene 1986; McCauley 1998; Nedwell and Edwards 2004). Sound arising from drilling is outwith the main hearing frequencies for harbour porpoise and studies using Passive Acoustic Monitoring (PAM) at platforms located on the Dogger Bank did not record any decrease in harbour porpoise activity at the platforms when drilling was being undertaken, compared to when there was no drilling (Todd *et al.* 2007). Therefore, there will be no in-combination impact on harbour porpoise from drilling activities within the SNS SAC.

11.54 Two applications have been made for temporary storage of items on the seabed (Licence Ref. No. PLA/649 and ML/431/0) and one application for the removal of items from the seabed (Licence Ref. No.ML/436/0). These activities will not require any additional equipment likely to

cause an in-combination impact with the only noise arising from vessels used to undertake the work.

Shipping

11.55 There is potential for an in-combination impact with the proposed Spectrum seismic survey and existing vessel activity.

11.56 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.

11.57 The number of vessels operating in the 'summer' area during the summer 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

11.58 The in-combination assessment has been undertaken using outputs from both noise modelling and the threshold approach.

11.59 Due to the number of current and planned activities being undertaken within the SAC and the level of uncertainty surrounding them, there are a number of potential in-combination scenarios. This section assesses the potential levels of in-combination impact that could arise.

11.60 The timelines for each of the activities identified as having the potential to cause an in-combination impact are presented in Figure 18. There is potential for the greatest daily impact to occur during June 2019 when, in theory, all four planned projects could be being undertaken. Between July and September there is, currently, potential for three projects to be undertaken each day.

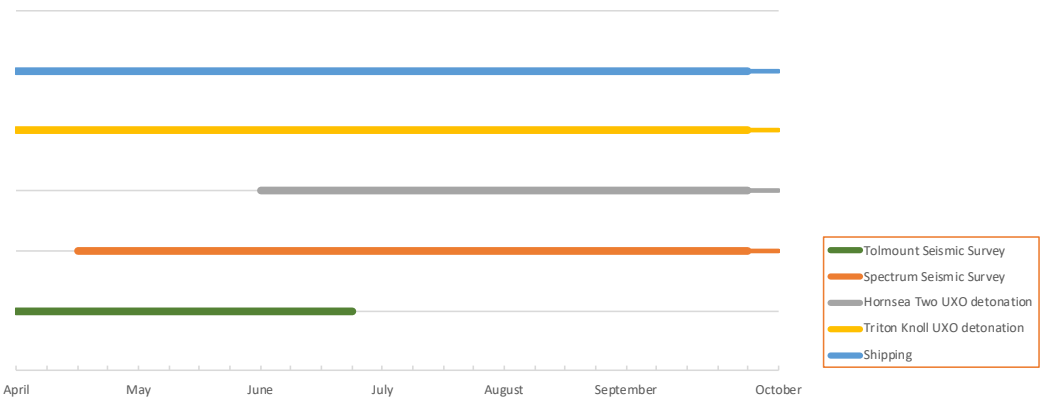

Figure 18: Timeline of activities within the SNS SAC that may have an in-combination impact.

In-combination Impacts on Southern North Sea SAC: Harbour porpoise.

Noise modelling

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

Physical Injury

11.62 Based on the results from the noise modelling a total of two harbour porpoise are at risk of PTS from the proposed Spectrums survey and one by the Tolmount seismic survey. The number of harbour porpoise at risk of injury from UXO clearance at Hornsea Two and Triton Knoll are not presented within the applications but, for the purposes of this assessment, have been estimated to be up to 425 individuals per detonation at Hornsea Two (Para. 11.12) and 46 individuals per detonation at Triton Knoll (Para. 11.25). Consequently, without any mitigation it is estimated that up to 474 harbour porpoise could be impacted, which is 0.14% of the North Sea Management Unit population.

11.63 For UXO clearance at Hornsea Two and Triton Knoll, both Ørsted and TKOWL have committed to incorporating mitigation measures in order to reduce the risk of injury (Ørsted 2018a, c, d, TKOWLa, b, c). Mitigation that may reduce the risk of injury include the use of Marine Mammal Observers (MMOb) and the use of Acoustic Deterrent Devices (ADDs). Under certain conditions both developers may also use 'scare charges' and bubble curtains to help reduce the extent of injurious noise (See Section 12: Mitigation). Although the use of mitigation may reduce the risk of injury it is recognised that it is not possible to totally prevent it and both developers have applied for European Protected Species (EPS) licences for both disturbance and injury.

Disturbance

11.64 The number of harbour porpoise predicted to be disturbed by the proposed Spectrum seismic survey is 825 individuals and 244 individuals by the Tolmount survey. Although, the mobile nature of the seismic surveys will cause a wider area to be disturbed and consequently increase the number of harbour porpoise potentially affected.

11.65 Due to the nature of the sound arising from the detonation of UXO, i.e. a number of single discrete events undertaken over an extended period of time 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 UXO clearance if undertaken over a short period of time (JNCC 2010). It is also recognised that frequent UXO clearance in a single area could cause displacement and disturbance although it is not possible to estimate the number of harbour porpoise that could be disturbed from either of the two proposed UXO clearance programmes.

11.66 As discussed in Section 10 the potential impacts from displacement or disturbance will be temporary. If displaced, harbour porpoise will be able to relocate elsewhere and evidence from studies indicate that they will return to the area with 24 hrs of the noise ceasing.

In-combination threshold approach

11.67 In-order to assess the worst-case in-combination scenario the maximum daily threshold has been used for each of the four activities considered as part of this assessment. The results indicate that the daily threshold could be exceeded between June and September (Table 14). This is based on there being five UXO detonations per day being undertaken by the Hornsea Two project.

11.68 It may be possible for the Hornsea Two project to undertake fewer UXO detonations per day. Based on the potential for no more than three UXO detonations per day the daily threshold is very marginally exceeded between June and September (Table 16). However, this is based on the maximum area of potential disturbance from all activities occurring all on the same day. This is unrealistic as it is unlikely that the detonation of three UXO will be undertaken at distances furthest apart at the same time as the maximum possible extent of impact from a seismic survey is being undertaken.

11.69 Finally, if one item of UXO is detonated per day the daily thresholds are not exceeded during any month (Table 16). However, Ørsted have advised that the clearance of only one item of UXO per day is not feasible and therefore this scenario is unlikely to arise (Ørsted *pers.com.*).

Table 14: Worst-case in-combination scenarios – Daily threshold.

Activity	Apr	May	Jun	Jul	Aug	Sept
Spectrum Survey	0	8.7	8.7	8.7	8.7	8.7
Tolmount Survey	2.9	0	0	0	0	0
Hornsea Two UXO detonation (5/day)	0	0	14.1	14.1	14.1	14.1
Triton Knoll UXO detonation	0.17	0.17	0.17	0.17	0.17	0.17
Total	3.1	8.9	23.0	23.0	23.0	23.0

Table 15: Realistic worst-case in-combination scenario – Daily threshold

Activity	Apr	May	Jun	Jul	Aug	Sept
Spectrum Survey	0	8.7	8.7	8.7	8.7	8.7
Tolmount Survey	2.9	0	0	0	0	0
Hornsea Two UXO detonation (3/day)	0	0	11.3	11.3	11.3	11.3
Triton Knoll UXO detonation	0.17	0.17	0.17	0.17	0.17	0.17
Total	3.1	8.9	20.2	20.2	20.2	20.2

Table 16: Potential best-case in-combination scenario – Daily threshold.

Activity	Apr	May	Jun	Jul	Aug	Sept
Spectrum Survey	0	8.7	8.7	8.7	8.7	8.7
Tolmount Survey	2.9	0	0	0	0	0
Hornsea Two UXO detonation (1/day)	0	0	7.4	7.4	7.4	7.4
Triton Knoll UXO detonation	0.17	0.17	0.17	0.17	0.17	0.17
Total	3.1	8.9	16.3	16.3	16.3	16.3

11.70 The seasonal threshold is not exceeded under any scenario if the proposed Spectrum seismic survey does not start before 20 May 2019 (Table 17). In the event that the start of the Spectrum survey is further delayed the in-combination seasonal threshold will be further reduced.

Table 17: In-combination seasonal thresholds

Activity	% of 'summer' area (Seasonal Threshold)		
	Scenario 1	Scenario 2	Scenario 3
Spectrum Survey	6.4	6.4	6.4
Tolmount Survey	0.1	0.1	0.1
Hornsea Two UXO detonation	2.4	1.2	0.9
Triton Knoll UXO detonation	0.02	0.02	0.02
Total	8.9	7.7	7.4

Scenario 1 = Spectrum survey starts no earlier than 20 May 2019, One UXO detonation per day at Hornsea Two.
Scenario 2 = Spectrum survey starts no earlier than 20 May 2019, Three UXO detonations per day as Hornsea Two.
Scenario 3 = Spectrum survey starts no earlier than 20 May 2019, Five UXO detonations per day at Hornsea Two.

11.71 There are varying levels of uncertainty that affect the daily and seasonal thresholds and this assessment is based on a number of precautionary assumptions. In particular:

- It presumes that noise from the Spectrum seismic survey will occur throughout the duration of the permit. This is considered unlikely as the duration of the permit that is applied for is invariably longer than the actual survey to allow for unforeseen delays.
- The extent of all impacts across the season are the maximum possible.
- The number of UXO detonated at Hornsea Two is for the maximum requested and that all detonations occur during the summer period. It is possible, although unlikely, that there may be no UXO detonations required to be undertaken during the summer period of 2019. Previous experience at the adjacent Hornsea One development where a total of 26 items of UXO were detonated indicates that the predicted 120 items at Hornsea Two is a maximum worst-case scenario.
- That UXO clearance at both Triton Knoll and Hornsea Two occur on the same day.

11.72 Due to the precautionary nature of the assessment and the uncertainties described above It is highly likely that under the realistic worst-case scenario (Scenario 2), where three detonations per day are undertaken, that the daily or seasonal thresholds will not be exceeded.

In-combination assessment Southern North Sea SAC conclusions

11.73 Results from noise modelling indicate that up to 474 harbour porpoise could, in theory, be at risk of physical injury in the form of PTS from all planned activities within or adjacent to the SAC. This is 0.14% of the management unit population and therefore below the level of 1.7% at which a population level effect is predicted to occur. There is recognised to be uncertainty over the

potential impacts from UXO detonation. Proposed and potential mitigation presented in Section 12 reduces the risk of impacts on harbour porpoise.

11.74 The results from the threshold approach indicate that between 3.1% and 23.0% of the 'summer' area may be impacted each day and seasonally between 7.4 and 8.9%, depending on the extent of UXO clearance undertaken.

11.75 Due to the precautionary approach taken in the assessment it is predicted that the seasonal thresholds will not be exceeded. However, there is a risk of the daily threshold being exceeded under certain scenarios. To minimise the risk of exceeding the daily threshold, the number of UXO detonations per day may need to be managed. However, due to the highly precautionary nature of the estimated area of impact from UXO detonation the precise number of detonations per day that could be undertaken before the daily threshold is exceeded is uncertain but predicted to be three or less.

11.76 The proposed UXO clearance will be subject to an HRA and further information supporting the application may be available presenting further information on the estimated area of impact from UXO clearance each day under different scenarios.

11.77 Based on the best available information and supported by results from noise modelling and the draft threshold approach, BEIS is satisfied that by following an activity managed approach, the proposed Spectrum survey in-combination with other plans will not have an adverse effect upon the integrity of the SNS SAC with respect to harbour porpoise.

In-combination assessment on Humber Estuary SAC: Grey seals

11.78 There is potential for an in-combination impact on grey seals from the proposed Spectrum seismic survey and the three proposed projects: Tolmount seismic survey, Hornsea Two UXO clearance and Triton Knoll UXO clearance.

11.79 The assessment for the proposed Spectrum survey on its own concludes that there will be a very low risk of any grey seals within the range at which the onset of PTS is predicted to occur (Table 5 and Para. 10.37). Consequently, there will be no in-combination impact on grey seals with respect to physical injury.

11.80 There is potential for in-combination impacts arising from displacement or disturbance. It is estimated that up to 308 grey seal could be impacted by the proposed Spectrum survey (Para. 10.39). It is estimated that 924 grey seal may be disturbed or displaced by the proposed Tolmount seismic survey (Para. 11.40).

11.81 There is potential for displacement or disturbance to arise in the event that UXO detonations are repeatedly undertaken over a period of time. The extent of any displacement, should it occur is unknown. However, it is predicted that there is a low risk of any displacement behaviour occurring should UXO detonations be undertaken over a period of time with, for example, one detonation

per day. This level of noise may incite a startle response to individuals within the area but due to the very short duration of noise from a single detonation it is predicted that any behavioural response will be of very short duration and not cause displacement behaviour.

11.82 It is therefore estimated that up to 1,232 grey seals could be displaced or disturbed by the proposed seismic surveys which is 13% of the SAC grey seal population. Over time, as seismic surveys are transient, the number of grey seals disturbed or displaced may be higher, although the duration of the impact is consequently lower as the vessel moves away from the area.

11.83 Although the number of grey seals that could be impacted by the proposed surveys is relatively high compared with the Humber Estuary SAC population, for reasons presented in Section 10, it is predicted that any disturbance or displacement of grey seals will be temporary and not cause a population level effect.

In-combination assessment Humber Estuary SAC conclusions

11.84 Results from noise modelling indicate that there is a very low risk of any physical injury, in the form of PTS, to grey seals from the proposed Spectrum survey and therefore there is no in-combination impact with other plans or programmes.

11.85 There is potential for an in-combination impact from seismic surveys to cause displacement or disturbance. Due to the predicted short duration of impacts arising from UXO detonation it is concluded that there will be no in-combination impact with respect to planned UXO clearance at Hornsea Two and Triton Knoll.

11.86 It is estimated that up to 13% of the grey seal population could be disturbed by the two seismic surveys. However, any displacement or disturbance impacts will be temporary with seals capable of relocating away from an area without causing a population level effect.

11.87 Based on the best available information and supported by results from noise modelling and the threshold approach, BEIS is satisfied that the proposed Spectrum survey in-combination with other plans will not have an adverse effect upon the integrity of the Humber Estuary SAC with respect to grey seal.

12 MITIGATION

12.1 The following section presents a summary of the planned mitigation presented in the applications that will reduce the risk of an adverse effect occurring.

Spectrum seismic survey mitigation

12.2 Spectrum have committed to following the JNCC guidelines for *minimising the risk of injury to marine mammals from geophysical surveys* (JNCC 2017a, Spectrum 2018b). This will include:

- A minimum of 20 minutes soft-start undertaken every time the airguns are switched on,

- The use of two dedicated marine mammal observers.
- The use of Passive Acoustic Monitoring (PAM).
- Observations will be undertaken for at least 30 minutes prior to the soft-start and there will be a minimum of a 20 minute delay from the time of the last marine mammal detection within the 500 m mitigation zone and the commencement of the soft-start.

12.3 In addition to the commitments made within the application the JNCC have advised that airguns should be switched off at the end of each line and in the event that the survey is suspended for more than 10 minutes, a 30 minute pre-shoot search and 20 minute soft-start must be undertaken.

12.4 In addition to the mitigation the assessment is based on information presented within the application that if changed could affect the conclusions of this assessment. In particular:

- The survey will start no earlier than 1 May 2019.
- The vessel will travel at 4.5 knots and line turns are 180 minutes (during which time the airguns are switched off). Consequently, no more than 150 km of survey (excluding soft-start) is undertaken within the SAC each day.
- The successive survey lines are no greater than 375 m apart.

PremierOil Tolmount seismic survey mitigation

12.5 PremierOil committed to mitigation in relation to the Tolmount seismic survey. These included following the JNCC guidance on geophysical surveys whilst undertaking the survey (PremierOil 2019). The airguns will be switched off at the end each line unless the line turn is less than forty minutes.

12.6 In addition to the mitigation presented in the application, the assessment undertaken to inform the in-combination impacts is based on a number of parameters that if exceeded would affect the conclusions of this assessment. In particular,

- The survey lasted no longer than 30 days.
- During the survey the survey vessel travelled at 4.5 knots and the line turns were 150 minutes (during which the airguns are switched off). Consequently, no more than 57.2 km of survey line (excluding soft-start) were undertaken within the SAC each day.
- The successive survey lines were no greater than 8 km apart.

Ørsted Hornsea Two UXO clearance mitigation

12.7 Ørsted have committed to a number of mitigation measures to reduce the risk of injury to marine mammals from UXO detonation and are presented in detail within the Marine Mammal Mitigation Protocol (MMMP) (Ørsted 2018d). These include:

- The use of two marine mammal observers undertaking monitoring within the 1 km mitigation zone for a minimum of one hour prior to detonation.
- The use of an acoustic deterrent device for at least 40 minutes prior to detonation.
- The use of small 'scare-charges' at regular intervals for 20 minutes prior to detonation. However, this is contingent on it being possible and safe to do so. Therefore, there may be occasions when this mitigation is not undertaken.

12.8 Under certain conditions Ørsted have committed to the use of bubble curtains to reduce the risk of injury and extent of disturbance when detonating UXO (Ørsted 2018a, b). It is not known how often all the conditions required for the use of a bubble curtain will be met and therefore how frequently the use of bubble curtains will be carried out.

12.9 The relocation of UXO will be considered by Ørsted where it is confirmed that it is safe to do so (Ørsted 2018a). There is no information on the frequency that this might be and it is not known whether this mitigation would be undertaken.

Triton Knoll UXO clearance mitigation

12.10 Triton Knoll Offshore Wind Limited has committed to undertaking a number of mitigation measures presented within the MMMP (TKOWL 2018c). These are similar to those presented for Hornsea Two.

13 CONCLUSIONS

13.1 The Secretary of State has carefully considered all of the information available in order to undertake a Habitats Regulations Assessment. He considers the proposed Spectrum seismic survey to have the potential to cause a Likely Significant Effect alone and in-combination with other plans or projects on the qualifying species of the Southern North Sea SAC, Humber Estuary SAC and Flamborough and Filey Coast SPA.

13.2 The Secretary of State has undertaken an Appropriate Assessment in respect of the sites' 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.

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

13.4 Having considered all of the information available to him and the proposed mitigation measures including those that are required in order to reduce the risk of the Southern North Sea SAC daily or seasonal thresholds to be exceeded. The Secretary of State has concluded that the proposed Spectrum seismic survey will not have an adverse effect on integrity on any of the designated sites either alone or in-combination with other plans or projects.

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