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).

ION Southern North Sea Seismic Survey

Issued May 2020
Rev 2.0

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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 a SAC in February 2019 (JNCC 2019a).

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

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

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

1.7 An application to undertake a 3D seismic survey by GX Technology / ION Geophysical Corporation (hereafter ION) was submitted to the Department for Business Energy and Industrial Strategy (BEIS) on 23 March 2020.

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.

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 ION 3D seismic survey, further details may be found within the application (ION 2020a).

2.2 The proposed regional survey will be undertaken across the Southern North Sea in quadrants 35, 36, 37, 38, 41, 42, 43 and 44 off of the east coast of England. The planned survey is located within UKCS Blocks 35/23, 35/24, 35/25, 35/28, 35/29, 35/30, 36/21 – 36/30, 37/16 – 37/30, 38/16, 38/17, 38/18, 38/21,38/22, 38/23, 38/26, 38/27, 38/28, 41/3 – 41/5, 42/1 - 42/5, 43/1 – 43/5, 44/1 – 44/3. The Permit area covers approximately 22,980 km^2, with the Survey Area covering 13,269 km^2 (Figure 1).

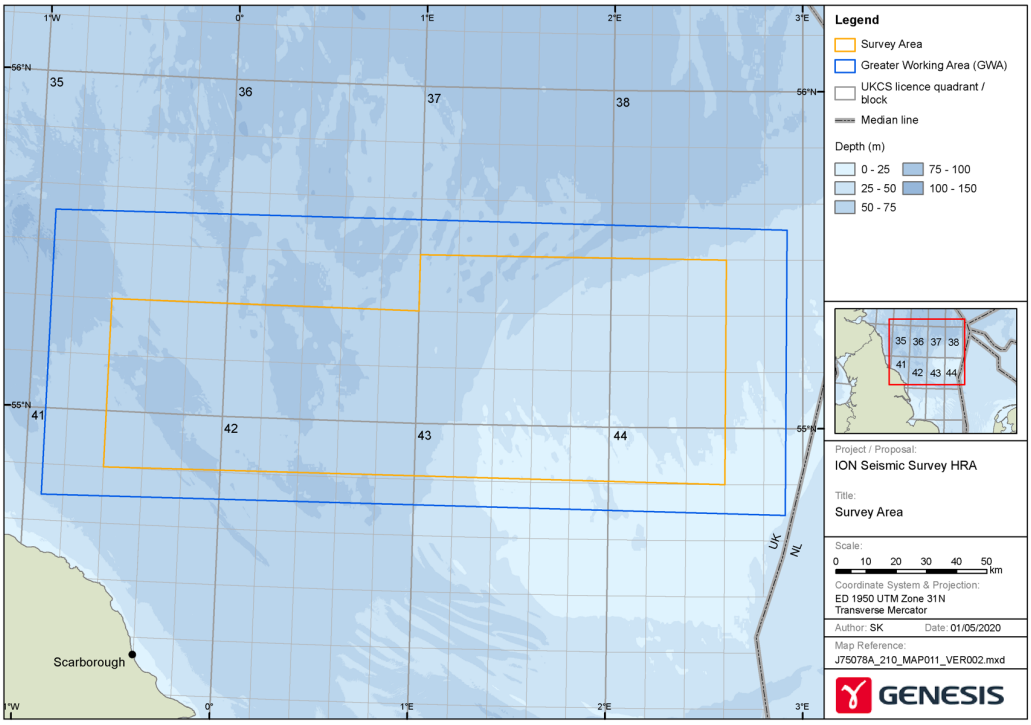


Figure 1: Location of the proposed ION 3D seismic showing survey and greater working areas.

2.3 The survey was scheduled to take place between 1 April and 22 October 2020 and expected to last up to 165 days (ION 2020c). However, since the application was made the start date has been delayed and will now start no sooner than 1 June 2020.

2.4 The proposed survey will be undertaken by a seismic survey vessel (*BGP Prospector*) towing eight or ten 9,500 m streamers at a speed of approximately 5 knots (9.3 km/h). The width of each towed survey array will be approximately 950 m and each surveyed line will be either 300 m or 375 m apart (ION 2020a,c). The airgun volumes have still to be finalised but the three options in

the application are for 3,070 cu. in., 4,240 cu. in. and 8,000 cu. in. The airguns will be firing at intervals of every 7.2 or 10.8 seconds depending on the option chosen.

2.5 The total length of line to be surveyed is between 15,392 km and 36,109 km and will be undertaken over either 198 and 128 survey lines (ION 2020c). The total length of survey line wholly within the SAC is not presented in the application but has been calculated by BEIS to be a maximum of 11,513 km, with a maximum length of any single line within the SAC of 89 km. A summary of the proposed survey specifications is presented in Table 1.

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).

Table 1: Survey parameters.

Survey Parameter	Application
Start date and End date	1 June – October/November 2020
Total duration of survey (days)	165
Greater Working Area (km^2)	22,980
Survey Area (km^2) [1]	13,269
Total length of survey line (km)	36,109
No. of survey lines (km)	198
Line spacing (m)	300 or 375
Consecutive line gap (km)	9.4
Line Direction	272° – 90°
Area in SAC (km^2)	4,330
Length of line in SAC (km)	11,513

1 – excludes the Greater Working Area where no airguns will be operated

2.7 The specifications for the seismic array, as presented in the application, are presented in Table 2. The peak Sound Pressure Level (SPL) for the 4,240 cu. in. airgun array is 260 dB re 1 µPa $_{(0\text{-}P)}$ at 1 m.

Table 2: Proposed seismic array parameters (Source: ION 2020a,c).

Array Parameter	Array Option		
Arrays x sub-arrays	3 x 2	2 x 3	2 x 1
Total volume (cu. In).	3,070	4,240	8,000
Sound pressure - dB re 1 µPa (0-p)	257	260	243
Sound exposure level - dB re 1 μPa^2s	231	235	223
Pulse rate (Seconds)	7.2	10.8	10.8
Towed depth (m)	7	7	7
Vessel speed (knots)	5	5	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, four SACs and three SPAs have been identified as having qualifying species at risk of a likely significant effect from the proposed survey (Figure 2).

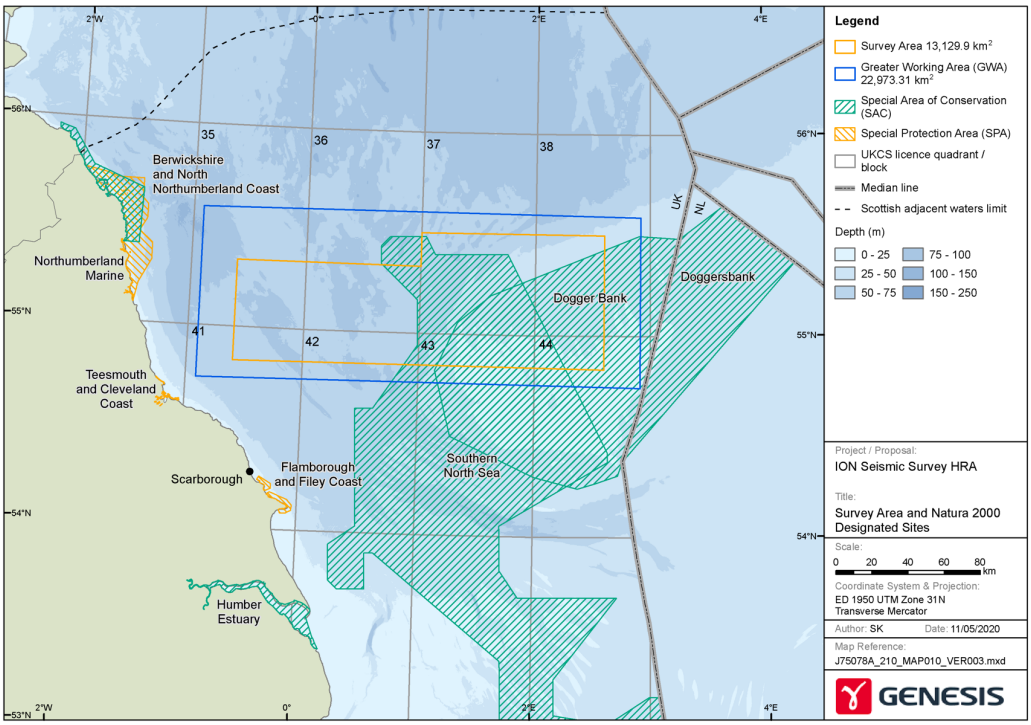


Figure 2: Location of proposed ION survey and relevant designated sites.

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

- Southern North Sea SAC (Harbour porpoise),
- Humber Estuary SAC (Grey seal, Sea lamprey, River lamprey),
- Berwickshire and North Northumberland Coast SAC (Grey seal),
- Doggersbank SAC (Harbour porpoise, Grey seal, Common seal),
- Teesmouth and Cleveland Coast SPA (Little tern, Sandwich tern),

- Flamborough and Filey Coast SPA (Gannet, Kittiwake, Herring gull, Puffin, Razorbill and Guillemot, plus seabird assemblage),
- Northumberland Marine SPA (Arctic tern, Common tern, Little tern, Roseate tern, Sandwich tern, Guillemot, Puffin, plus seabird assemblage).

3.4 The proposed Greater Working Area overlaps 5,583 km^2 of the Southern North Sea SAC, equivalent to 15.1% 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 the other designated sites listed above could occur within the Greater Working and Survey Areas.

3.5 The Greater Working Area overlaps a total of 6,620 $km^2$of the Dogger Bank SAC. However, the site is designated for habitat features that will not be impacted by the proposed seismic survey.

Qualifying features

3.6 Based on the information presented within the application and advice received from consultation (JNCC 2020a) 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, Arctic tern, Common tern, Little tern, Roseate tern, Sandwich tern Puffin, Razorbill and Guillemot),
- Sea lamprey and River lamprey,
- Fish (prey) species.

Harbour porpoise

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

- Southern North Sea SAC,
- Doggersbank SAC.

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

3.9 Harbour porpoise occur widely across the North Sea. Data from the three Small Cetacean Abundance in the North Sea (SCANS) surveys indicate that that there may have been a southward shift in the distribution of harbour porpoise in the North Sea. In the early 1990's harbour porpoise were widespread but appear to have occurred predominantly around eastern Scotland and the northern North Sea to the southern North Sea (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).

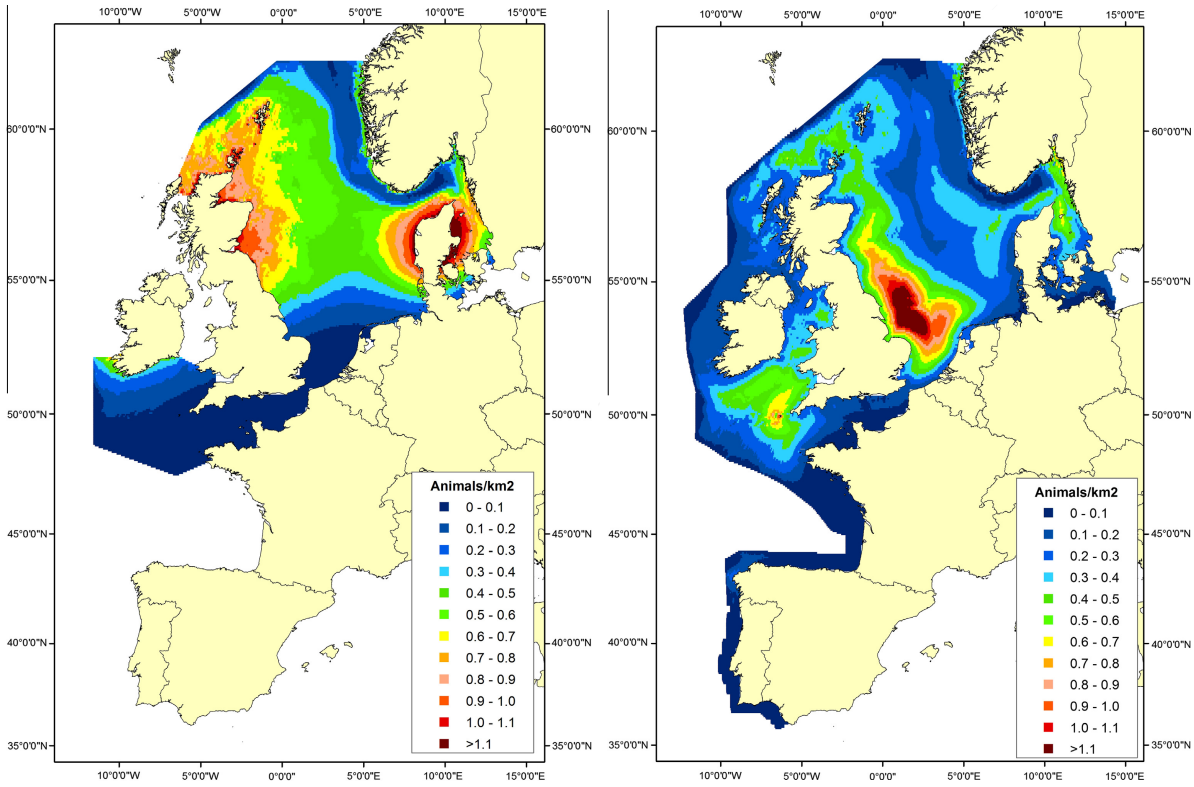


Figure a. Figure b.

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).

3.10 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).

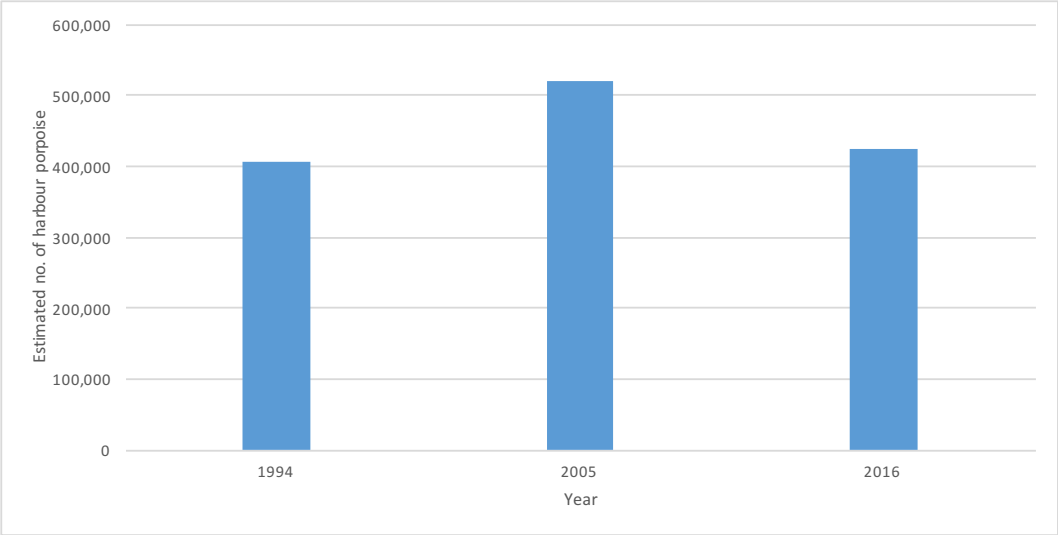


Figure 4: Estimated number of harbour porpoise within the SCANS survey area recorded during SCANS I, II and III surveys (Hammond *et al.* 2017).

3.11 There are three Management Units identified for harbour porpoise in the north-east Atlantic, of which, the Southern North Sea SAC and the Doggersbank SAC lie within the 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).

3.12 The SAC selection assessment document estimates that the site holds 18,500 harbour porpoise (98% C.I. 11,864 – 28,899) (JNCC 2017c 2019a), which was 8.1% of the North Sea Management Unit population at the time the estimate was made (Hammond *et al*. 2013, IAMMWG 2015). 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. The population estimated from the Joint Cetacean Protocol (JCP), where abundance and distribution data from multiple sources collected over a period of time have been integrated, is 333,808 individuals (JNCC 2017b). This population estimate has been used for the purposes of this assessment.

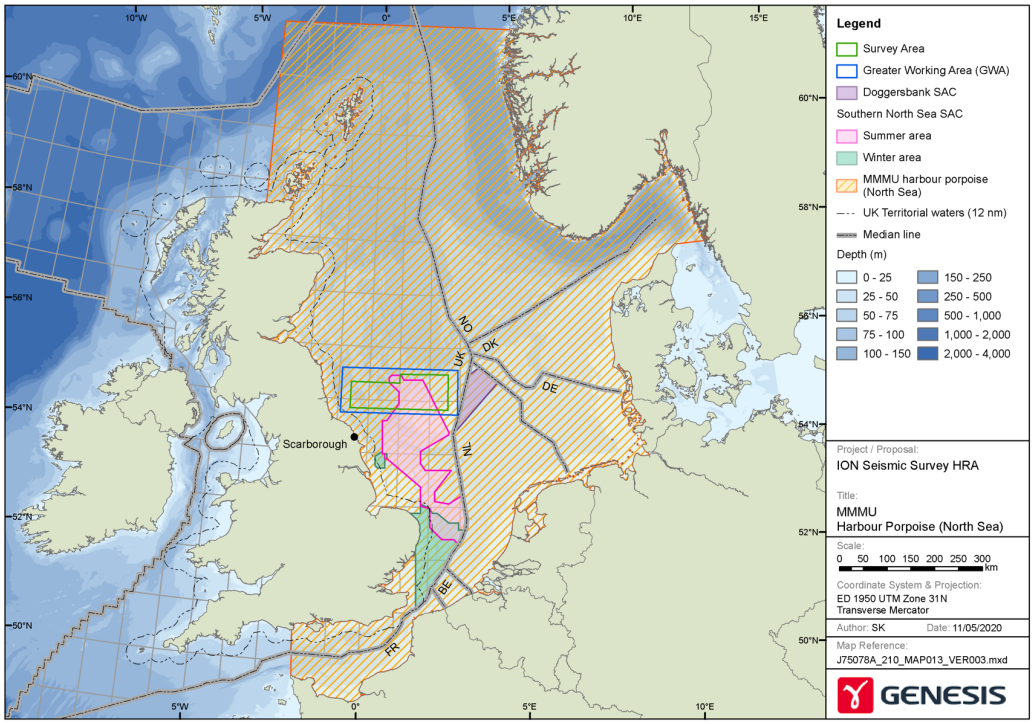


Figure 5: North Sea Management Unit for harbour porpoise as defined by the IAMMWG.

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

3.14 Densities of harbour porpoise within the Doggersbank SAC also vary seasonally with highest reported densities of 1.029 ind./km^2 recorded during March and lower densities of 0.396 ind./km^2 and 0.391 ind./km^2 recorded in July and October respectively (Geelhoed *et al*. 2013).

3.15 Based on data in the JCP database highest densities in the central and northern area of the SAC occur during the summer period with modelled harbour porpoise densities greater than 3.0 per km^2 occurring widely (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 and Skov 2015).

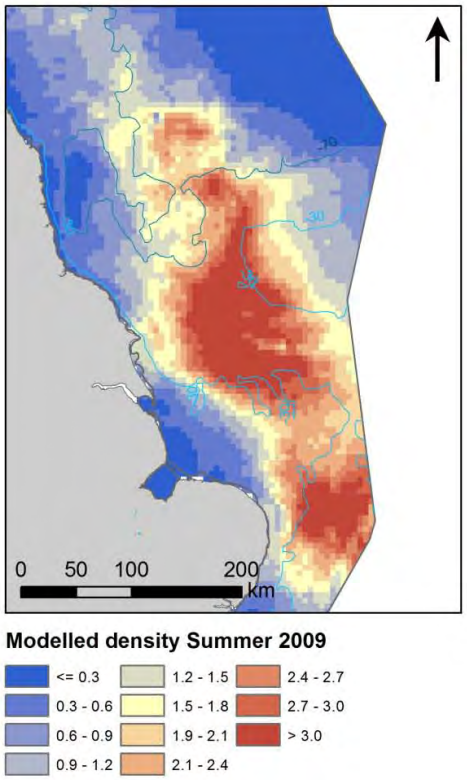


Figure a.

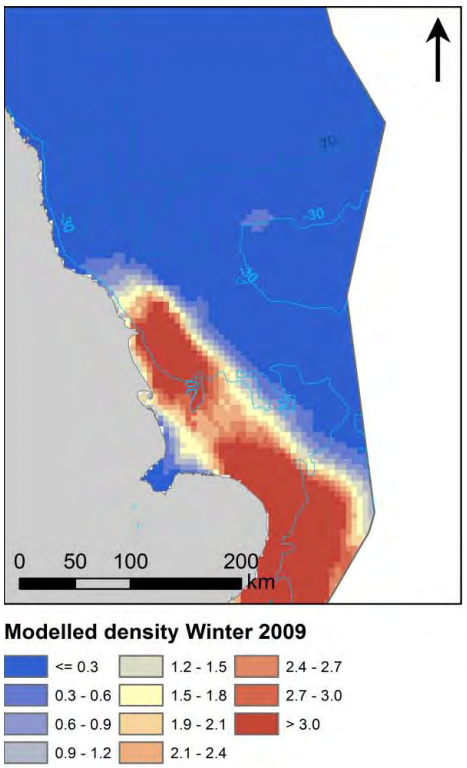


Figure b.

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).

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

3.17 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).

3.18 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).

3.19 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).

3.20 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.

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

3.22 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).

3.23 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.

3.24 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).

3.25 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.

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

Grey seal

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

- Humber Estuary SAC,
- Berwickshire and North Northumberland Coast SAC,
- Doggersbank SAC.

3.28 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 Humber Estuary SAC recorded 6,526 grey seals, giving an estimated population of 15,597[1]

[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).

(SCOS 2018). The latest count for the Berwickshire and North Northumberland Coast SAC is 6,900 individuals (from 2014) (Natural England 2020) and therefore an estimated population of 16,491 individuals.

3.29 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).

3.30 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).

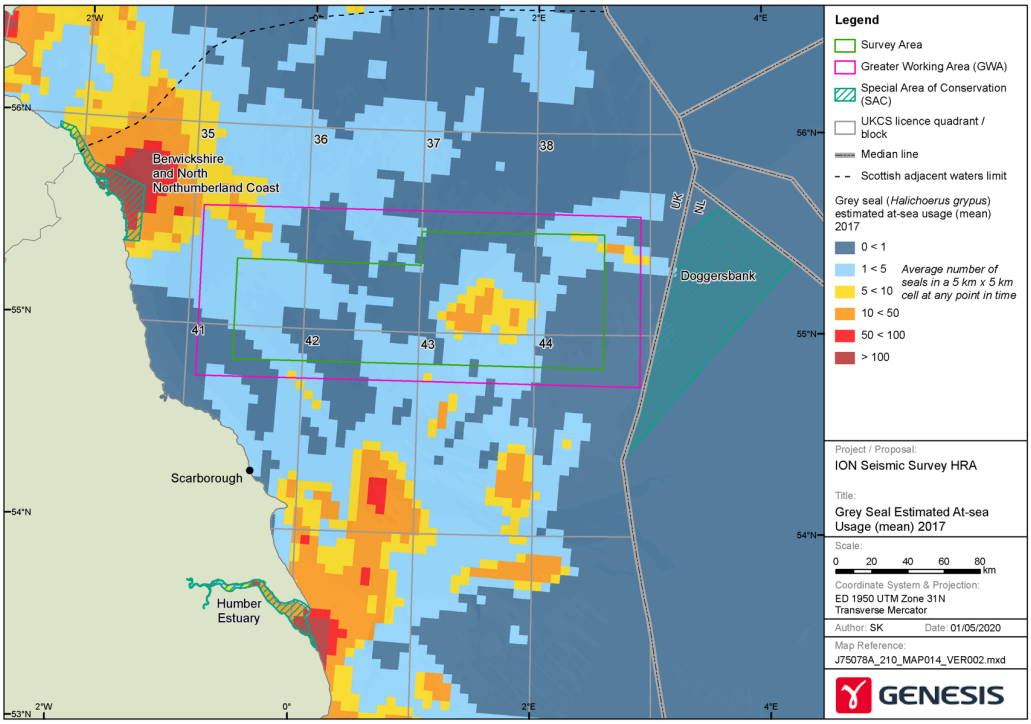


Figure 7: Distribution of grey seals in waters off Eastern England.

3.31 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).

3.32 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).

3.33 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.

Harbour seal

3.34 The harbour seal (*Phoca vitulina*) is an Annex II qualifying species for the:

- Doggersbank SAC.

3.35 Harbour seals occur widely around the waters off eastern England and in Dutch waters with the majority of activity in the nearshore waters (Figure 8 and Figure 9).

3.36 Harbour seals occur in sheltered bays, inlets and enclosed estuaries and foraging trips are not as extensive as those of grey seals, remaining largely in nearshore waters. Breeding in the region takes place between June and July and pups are nursed for a few weeks. During this period harbour seals will remain predominantly within nearshore waters.

3.37 Tracking studies undertaken on harbour seals in the UK indicate that they occur primarily in nearshore waters but can travel up to between 50 km and 100 km offshore Figure 8. Tracking of 229 harbour seals in Dutch waters between 2007 and 2015 showed that nearly all movements were within 100 km of the coast and between April and October over 90% of movements were less than 60 km (Figure 9). Longer movements offshore occurred primarily between December and March (Aarts *et al*. 2016).

3.38 Harbour seals are opportunistic feeders preying on a wide range of fish species including sandeels, gadoids, flatfish, scorpion fish, sandy benthic fish, pelagic fish and also cephalopods (SCOS 2015).

3.39 Sound arising from the proposed seismic survey has the potential to effect harbour seals due to displacement or disturbance. Consequently, the proposed survey could affect harbour seals or their prey.

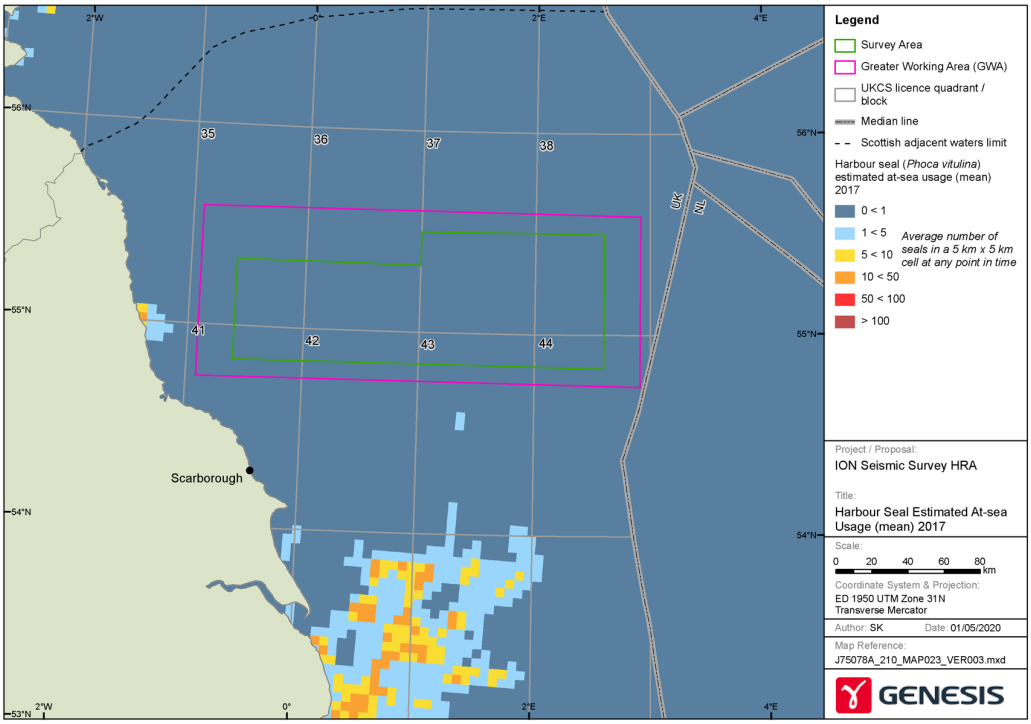


Figure 8: Distribution of harbour seals in waters off Eastern England.

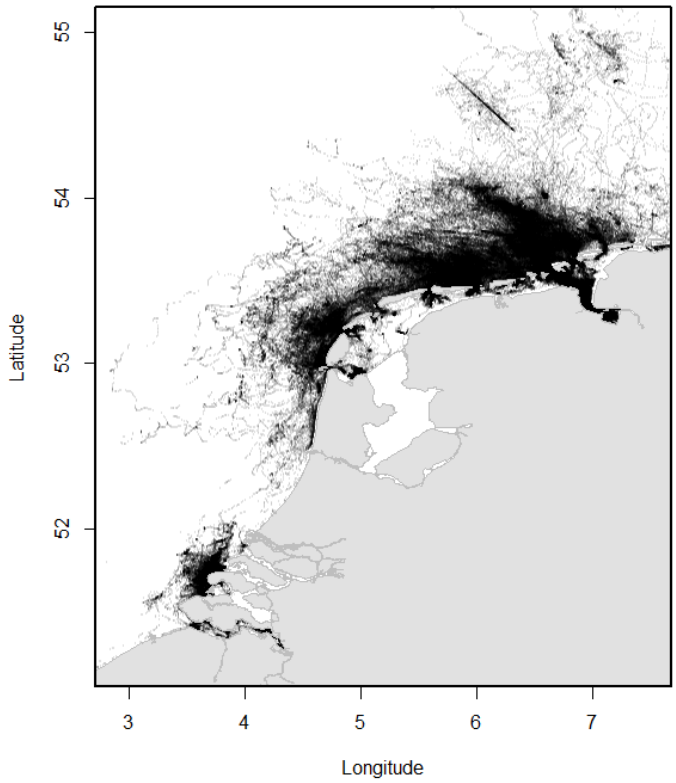


Figure 9: Distribution of tagged harbour seals in Dutch waters (Source: Aarts *et al*. 2016).

Seabirds

3.40 The survey is planned to occur in offshore waters during the seabird breeding season, during which time birds within the area of the 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 3 (Woodward 2019).

3.41 Based on the mean maximum foraging ranges, seabirds from three SPAs are identified as being at risk from the proposed survey during the breeding period. The SPAs are:

- Teesmouth and Cleveland Coast SPA (Little tern, Sandwich tern),
- Flamborough and Filey Coast SPA (Gannet, Kittiwake, Herring gull, Puffin, Razorbill and Guillemot, plus seabird assemblage),
- Northumberland Marine SPA (Arctic tern, Common tern, Little tern, Roseate tern, Sandwich tern, Guillemot, Puffin, plus seabird assemblage).

3.42 It is also 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.

3.43 The breeding season for seabirds varies between species but broadly extends 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.

Table 3: Mean maximum foraging ranges of breeding seabirds relevant to the HRA

Species	Mean maximum Foraging Range (km)	SPA
Gannet	315.2 ±194.2 3	Flamborough and Filey Coast
Kittiwake	156.1 ±144.5	Flamborough and Filey Coast
Herring gull	61.1 ± 44	Flamborough and Filey Coast
Little tern	5	Teesmouth and Cleveland Coast, Northumberland Marine
Roseate tern	12.6 ± 10.6	Northumberland Marine
Common tern	18.0 ± 8.9	Teesmouth and Cleveland Coast, Northumberland Marine
Arctic tern	25.7 ± 14.8	Northumberland Marine
Sandwich tern	34.3 ± 23.2	Teesmouth and Cleveland Coast, Northumberland Marine
Puffin	137.1 ± 128.3	Flamborough and Filey Coast, Northumberland Marine
Razorbill	88.7 ± 75.9	Flamborough and Filey Coast
Guillemot	73.2 ± 80.5	Flamborough and Filey Coast, Northumberland Marine

3.44 The breeding season for seabirds varies between species but broadly extends 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.

3.45 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 4 for reported dive durations for a range of relevant species.

Table 4: Reported seabird dive durations.

Species	Average dive duration (seconds)
Tern Spp.	1 to 2 [1]
Gannet	4.7 to 6 [2, 6]
Razorbill	19 to 40 [3,6]
Puffin	40 [4, 6]
Shag	47 to 96 [,5 - 6]
Guillemot	35 to 119 [6,7]

1 Eglington and Perrow 2014, 2 - Ropert-Coudert 2009, 3 - Wanless *et al.* 1988, 4 - Thaxter *et al*. 2009, , 5 - Wanless *et al.* 1993, 6 – MeyGen 2011, 7 - Thaxter *et al*. 2009.

3.46 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).

3.47 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)

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

3.49 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 (ammococetes) return to the sea from September onwards.

3.50 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).

3.51 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.

3.52 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

3.53 Fish are not qualifying species for the Southern North Sea SAC nor, aside from lampreys, are they qualifying features of the other designated sites subject to this assessment. 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).

3.54 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).

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

3.56 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).

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

3.58 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 2019).

3.59 Fish hearing is based on detecting particle motion directly stimulating the inner ear. However, those with swim bladders are also able to detect pressure waves and can detect a wider range of frequencies and sounds of lower intensity than fishes without swim bladders (Popper 2003).

Fish with swim bladders that possess a coupling mechanism between the swim bladder and the auditory system, e.g. herring and sprats, are recognised to be hearing specialists. Fish that have swim bladders but lack a mechanised coupling mechanism or do not have swim bladders, e.g. sandeel spp. are considered hearing generalists and have a relatively lower sensitivity to sound than fish that have swim bladders and a coupling mechanism.

3.60 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).

3.61 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).

3.62 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

3.63 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:

- ION (2020a). UKS Southern North Sea 3D seismic survey. Version01. ION Geophysical Corporation. 19 March 2020
- ION (2020b). GX Technology/ION Southern North Sea Seismic Survey *SA/1290 GS/1074*. E-Mail to BEIS. 30 March 2020.
- ION (2020c). Application GS/1074/0 (Version 1). Application to carry out a Marine Survey. SAT GS/1074/0 (Version 1). MAT Reference SA/1290. 23 March 2020.
- Natura 2000 – Standard Data Form. Site: UK0030395. Southern North Sea. JNCC (2019b).
- Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs. (England, Wales & Northern Ireland). JNCC, NE and DAERA (2020).
- Harbour Porpoise (*Phocoena phocoena*) possible Special Area of Conservation: Southern North Sea. Draft Conservation Objectives and Advice on Activities. JNCC and NE (2019).

- A potential approach to assessing the significance of disturbance against conservation objectives of the harbour porpoise cSACs. Version 3.0. Discussion document JNCC (2017d).
- 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).

3.64 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 which may affect the potential impact of sound on marine mammals includes ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as

weather and sea state and other existing sources of human produced sound, e.g. shipping, can also reduce the auditory range.

Fatal effects

4.6 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 *et al.* 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 µPa.

Physical injury

4.7 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

4.1 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.

4.2 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).

4.3 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 2012). 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).

4.4 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

4.5 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

4.6 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 (ION 2020a).

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 no risk of PTS to harbour porpoise from any of the airgun array options based on the SEL metric. The onset of PTS in pinnipeds only arises within 9 m of the airgun when a 4,240 cu. in. airgun is operated with a soft-start. For all other airgun options PTS is not predicted to occur (ION 2020a).

5.4 The results from the modelling indicate that there is a risk of behavioural effects, e.g. displacement and disturbance to a harbour porpoise within an area of 12 km, based on the use of a 4,240 cu. in. airgun (ION 2020a).

5.5 Injury to fish is expected to arise between 8 m and 167 m depending on species group and behavioural impacts out to 3,485 m depending on airgun array.

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 been undertaken for BEIS in order to assess the potential impacts to harbour porpoise from a seismic survey within the Southern North Sea SAC (BEIS 2018, 2020). The modelling was undertaken at three locations within the SAC and was based on a 3,220 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 ION survey but with a similar maximum SPL of 261 compared with 260 dB *re* 1 μPa^2s $_{(0\text{-peak})}$ from the 4,240 cu. in. airgun option in the ION application. The results from both sets of noise modelling are presented in Table 6.

Table 5: Harbour porpoise estimated areas of physical injury and disturbance.

Harbour porpoise	ION (4,240 cu. in. airgun)		BEIS (3,220 cu. in. airgun)	
	Distance (m)	Maximum area (km^2)	Distance (m)	Maximum area (km^2)
PTS (SEL)	23	0.002	320	0.32
Disturbance	12,000	452	7,800	301

PTS Threshold weighted 155 re 1 μPa^2s.

Disturbance - 145 dB re: 1 µPa $_{(rms)}$.

Note – the BEIS modelling is based on depth averaged results, it is not clear whether a similar approach has been undertaken by ION.

5.8 Noise modelling to assess potential impacts to grey seals from seismic surveys has not previously been undertaken by BEIS 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^2s $_{(0\text{-peak})}$.

5.9 The results from the two sets of noise modelling undertaken for grey seal are presented Table 6.

Table 6: Grey seal estimated areas of physical injury and disturbance.

Grey seal	ION		OGA	
	Distance (m)	Maximum area (km^2)	Distance (m)	Maximum area (km^2)
PTS	32	0.003	99	0.031
Disturbance	13,300	555.43	17,000	383

PTS Threshold weighted 186 re 1 μPa^2s

Disturbance 160 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. The disturbance threshold has been selected to match that used in the application.

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 23 and 320 m from the airguns (Table 5).

5.11 There is potential for levels of noise at which disturbance could occur to extend from between 7.8 km and 12.0 km from the airguns and encompass an area of between 301 km^2 and up to 452 km^2 (Table 5).

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 32 m and 99 m from the airguns (Table 6).

5.13 There is potential for levels of noise at which disturbance could occur to extend between 13.3 km and 17.0 km from the airguns and encompass an area of between 383 km^2 and 555 km^2 (Table 6).

Potential impacts on fish

5.14 Results from the noise modelling undertaken by ION for the application and previously be BEIS are presented in Table 7. Noise levels that have the potential to cause mortality to fish species with swim bladders could occur from between 167 m and 302 m. For fish without swim bladders, e.g. Lampreys, mortality could occur from between 98 m and 140 m from the seismic survey (OGA 2016, ION 2020a).

Table 7: 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**
ION	167	98	167
BEIS	302	140	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 the potential area of disturbance to fish species.

6 EFFECTIVE DETERRENT RADIUS / RANGE

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

6.2 The published precautionary EDR are presented in Table 8 (JNCC, NE and DAERA 2020). Relevant to this assessment is the EDR for seismic surveys which is published as being 10 km. However, following the advice received the EDR has, for the purposes of this assessment, been increased to 12 km (JNCC 2020a). This is based on recent evidence indicating that harbour porpoise can be displaced further than the 10 km originally considered to be an appropriate EDR (Sarnocińska *et al*. 2020).

6.3 The use of a 26 km EDR has been used for pile-driving and the detonation of Unexploded Ordnance (UXO) and 5 km for the geophysical surveys when considered in the in-combination assessment. For the purposes of this assessment a 15 km EDR has been used for UXO with bubble curtains, this follows the EDR proposed for pile-driving with noise abatement.

Table 8: Precautionary Effective Deterrent Ranges (EDR) (Source: JNCC, NE and DAERA 2020).

Activity	Effective Deterrent Range (km)
Monopile	26
Unexploded Ordnance	26
Pin-pile [1]	15
Monopile with noise abatement	15
Conductor piling	15
Seismic survey	10
High Resolution Geophysical Surveys	5

[1] Pin-piles are '*smaller diameter piles that secure jacket structures'* although no definition as what diameter a pin-pile should be has been provided in published advice (JNCC, NE and DAERA 2020).

6.4 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 2019). They outline the desired state for any European site, in terms of the features for which it has been designated. If these features are being managed in a way which maintains their nature conservation value, they are assessed as being in a 'favourable condition'. An adverse effect on the integrity of a site is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of its designation (English Nature 1997).

7.2 The purpose of an Appropriate Assessment is to determine whether a plan or project adversely affects a site's integrity. The critical consideration in relation to site integrity is whether the plan or project affecting a site, either individually or in-combination, affects the site's ability to achieve its conservation objectives and favourable conservation status (JNCC 2015).

Southern North Sea SAC

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

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

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

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

Southern North Sea SCI Conservation Objectives

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

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

Source: JNCC and NE 2019

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

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

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

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

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

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

consideration population estimates at the Management Unit level to account for daily and seasonal movements of the animals (JNCC 2017c; JNCC and NE 2019), .

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

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

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

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 9. 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 9: Estimated extent sound levels capable of causing displacement disturbance occur in order to impact on site integrity.

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

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

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

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

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

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

Berwickshire and North Northumberland Coast SAC

7.23 The Berwickshire and North Northumberland Coast SAC was designated as a SAC in 2005. The site covers an area of 652 km^2 and comprises a number of habitats primarily of marine areas, sea inlets, tidal rivers, estuaries mudflats sand flats and lagoons. Grey seal is a qualifying species and the site supports 2.5% of the annual pup production (JNCC 2020b).

7.24 The Berwickshire and North Northumberland Coast SAC Conservation Objectives are the same as those for the Humber Estuary SAC.

Doggersbank SAC

7.25 The Doggersbank SAC lies within Dutch waters encompassing an area of 4,735 km^2. The site became a SAC in 2016. Qualifying species for the site include harbour porpoise, grey and harbour seals (Jak *et al.* 2009).

7.26 The Conservation Objectives are:

Doggersbank SAC Conservation Objectives

- Maintain the distribution, extent and quality of habitat for the purposes of maintaining the population.
- Maintain the extent and quality of habitat in order to maintain the population.

Source; Jak et al. 2009

Flamborough and Filey Coast SPA

7.27 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

Teesmouth and Cleveland Coast SPA and Ramsar

7.28 The Teesmouth and Cleveland Coast SPA and Ramsar was designated in 2019. Qualifying species include the seabirds: Sandwich tern, little tern and common tern.

7.29 The Conservation Objectives of the site are the same as those for Flamborough and Filey Coast SPA.

Northumberland Marine SPA

7.30 The Northumberland Marine SPA was designated in 2017. Qualifying species include the seabirds: Sandwich tern, roseate tern, common tern, Arctic tern and little tern, guillemot and puffin, plus seabird assemblage.

7.31 The Conservation Objectives of the site are the same as those for Flamborough and Filey Coast SPA.

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).

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

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

Renewable energy activity

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

8.4 There are 21 UK offshore wind farms that lie wholly within the Southern North Sea SAC or are within 26 km of the boundary which is identified by the JNCC as an area that harbour porpoises may be displaced from by noise arising from pile-driving activities (JNCC 2017d, JNCC, NE and DAERA 2020). (Table 10 and Figure 10). One wind farm (Triton Knoll) is currently undertaking offshore construction and Hornsea Two has started pre-construction activities offshore. All other wind farms are either operating, consented but not started offshore construction or have submitted applications and are awaiting determination.

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

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

Table 10: Offshore wind farms located within 26 km of the Southern North Sea SAC.

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

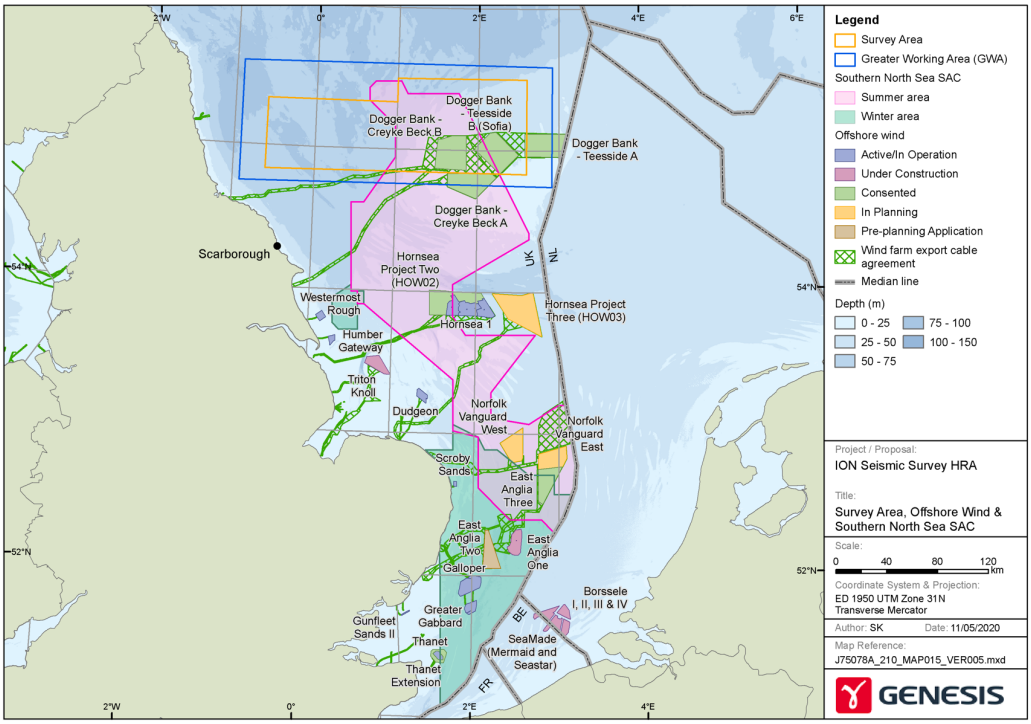


Figure 10: Offshore wind farms located within 26 km of the Southern North Sea SAC.

8.7 It is recognised that during construction, pile-driving will likely occur and that, if undertaken simultaneously as the proposed ION seismic survey, there is the potential to cause an adverse effect in-combination.

8.8 Of the offshore wind farms that are relevant to the in-combination assessment the Triton Knoll and Hornsea Two offshore wind farms could be pile-driving during the period of the proposed seismic survey in 2020. The Triton Knoll offshore wind farm has a licence to undertake pile-driving over a period of 23 days with completion by 13 June 2020. The Hornsea two offshore wind farm plans undertake pile-driving between July and October 2020 (Ørsted 2020a). However, BEIS have been informed the pile-driving will not commence before September 2020.

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

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

Cable laying activity

8.11 The Viking Link project is a high voltage direct current (HVDC) electrical interconnector between Denmark and the UK. The 762 km long cable will be laid between Jutland in Denmark and Bicker Fen in Lincolnshire and crosses the Southern North Sea SAC (Figure 11) (NGVL 2018a).

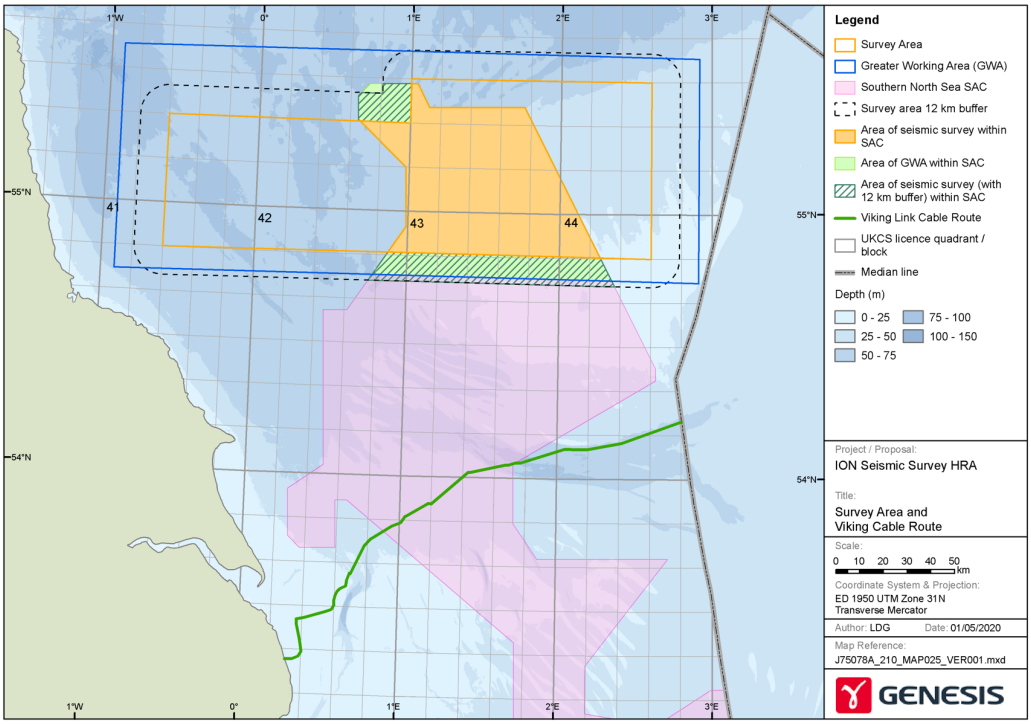


Figure 11: Viking Link Interconnector cable within UK waters.

8.12 An application was made for the clearance of up to 25 items of UXO between 1 April and 30 September 2019 some, or all, of which may occur within or adjacent to the SAC (NGVL 2018b). Following an HRA, consent was given by the MMO on 5 October 2018 (MMO 2018). Subsequent to consent a variation to the application has been made for the clearance of 25 items of UXO to be detonated between 1 April 2020 and 1 September 2020 (NGVL 2019a). Consent has been issued but is currently subject to a further variation with a revised planned start date of no sooner than 31 May 2020 (MMO 2020). BEIS have been informed that four items of UXO will be cleared in 2020, with one item within the Southern North Sea SAC and a further three within 26 km of the SAC boundary.

Aggregate extraction and dredging activity

8.13 Existing localised aggregate dredging occurs primarily in the southern half of the SAC, along the east coast (Figure 12). In 2019 there were 29 aggregate production areas and five Exploration and Option areas covering an area of 579.2 km^2. Five of the aggregate areas occur in the

'summer' area of SAC covering 77.7 km^2 and the rest occur in the 'winter' area of the SAC and cover an area 533.8 km^2, with some sites occurring in both the 'winter' and 'summer' areas.

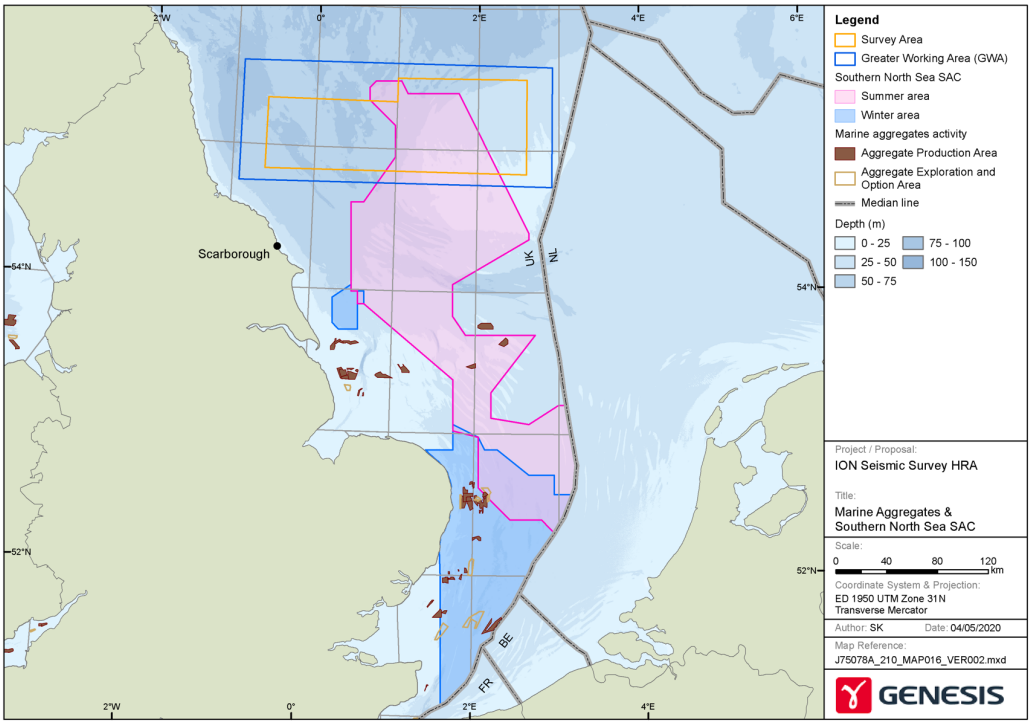


Figure 12: Existing marine aggregate activities in the Southern North Sea SAC.

8.14 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).

8.15 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

8.16 There is a long history of oil and gas activities within the boundaries of the Southern North Sea SAC. Since 1965, when the first well was spudded (first drilled), there has been extensive oil and gas development with a total of 117 installations installed within the SAC. The vast majority

(94%) of all the installations within the boundary of SAC are located in the 'summer' area of the site (Figure 13) (OGA NDR 2020).

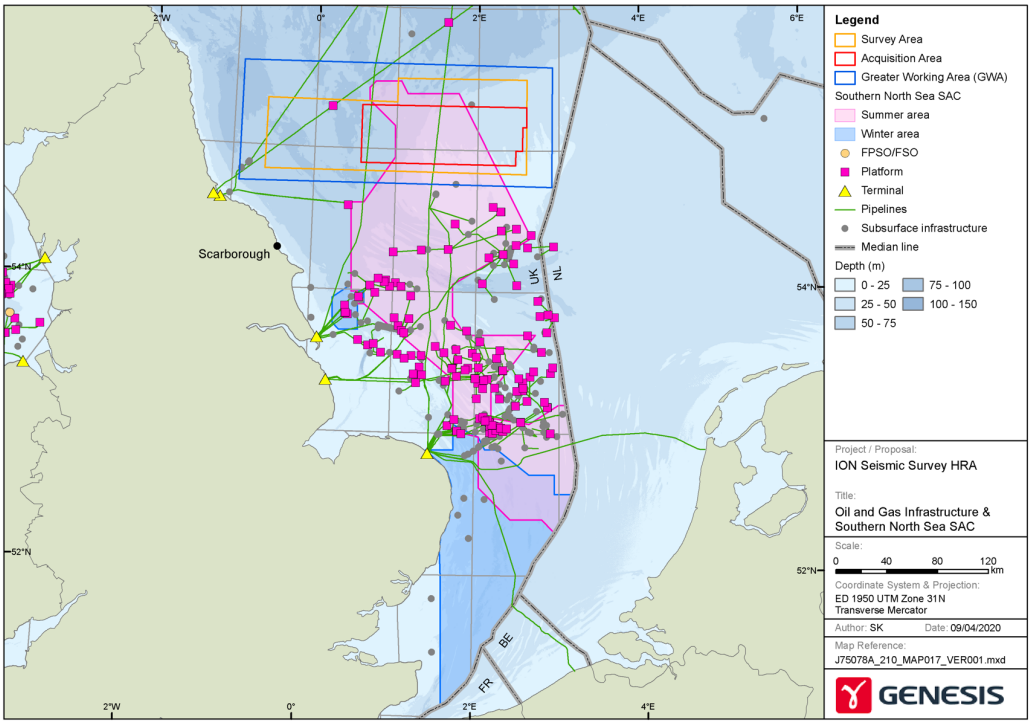


Figure 13: Existing oil and gas infrastructure within the Southern North Sea SAC.

8.17 Seismic surveys have regularly been undertaken within the SAC over the last 50 years, with a total of 23 2D or 3D seismic surveys carried out within the SAC between 2008 and 2017. The majority of surveys during this period took place in the northern half of the SAC, where the most recent oil and gas activity has occurred (Figure 14).

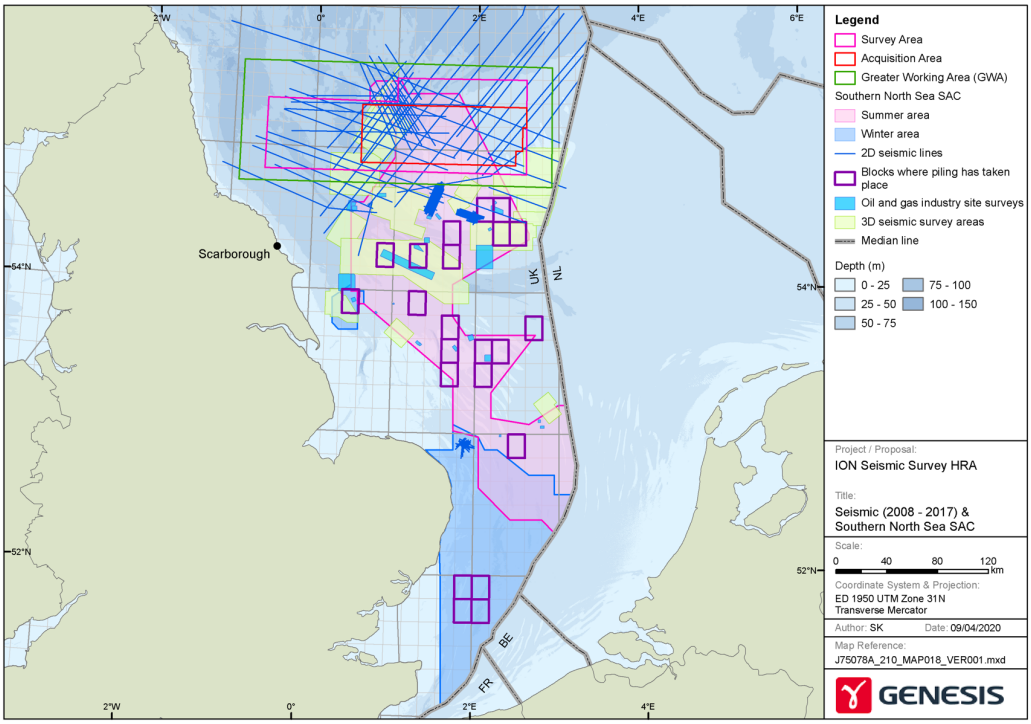


Figure 14: Oil and gas industry related seismic surveys undertaken within the Southern North Sea SAC between 2008 and 2017.

8.18 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 geophysical survey in Blocks 42/3, 32/38 and 43/13 (Table 11).

Table 11: 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	Planned Activity
Chrysaor	ML/386/4	49/17	2 October 2019 – 30 June 2020	Removal of Viking GD jacket and risers.
Spirit Energy	ML/411/2	49/11a	23 November 2018 and 31 October 2020	Removal and temporary deposit of risers at Audrey B installation.
Spirit Energy	ML/431/1	49/11a	10 July 2019 – 30 April 2020	Removal and temporary deposit of risers at Audrey B installation.
Tampnet AS	ML/495/0	44/22	26 July 2019 – 30 June 2020	Deposit of two mattresses and telecommunications branching unit.
Chrysaor	ML/546/0	49/21	19 May 2020 – 31 December 2020	WIA using TCP guns and jet cutters
Premier	ML/551/0	42/28d – 47/11	6 March – 30 September 2020	Pipeline seabed preparation and trenching.
Chrysaor	ML/553/0	49/22	31 March -	Decommissioning
Chrysaor	ML/570/0	49/16	8 April – 31 October	Pipeline disconnect
Chrysaor	ML/574/0	49/22	10 April – 31 October 2020	Permanent deposits
Chrysaor	ML/579/0	49/16	1 May – 30 October 2020	Removal of cut pipeline and mattresses. Relocation of existing rock.
Shell	DEP/1709/2	48/8	10 December 2019 – 31 August 2020	Deposits
Perenco	DR/1818/0	42/30	16 January – 31 August	Drilling.
Perenco	DR/1819/0	42/30	16 January – 31 August	Drilling.
Premier	DEP/1837/0	42/28d – 47/11	6 March – 30 September	Pipelaying operations and associated seabed deposits.
ODE Asset management	DEP/1892/0	52/3 – 49/26	19 April – 31 July 2020	Deposits
Spirit Energy	GS/1068/0	43/13b	7 April – 31 May	Shallow drilling.
Spirit Energy	GS/1071/0	42/3b	12 April – 1 April 2021 (delayed until October 2020)	Geophysical survey.
Spirit Energy	GS/1070/0	32/38	12 April – 1 April 2021 (delayed until October 2020)	Geophysical survey.
Premier	CL/1095	42/28	15 May-(life)	Construction activities including pile-driving for 2 days.
Premier	DRA/808	42/28	1 June 2020 - 16 June 2021	Batch drilling.
Premier	DRA/810	42/28	1 June 2020 - 16 June 2021	Batch drilling.
Premier	DRA/811	42/28	1 June 2020 -16 June 2021	Batch drilling.
Premier	DRA/812	42/28	1 June 2020 - 16 June 2021	Batch drilling

Shipping

8.19 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).

8.20 The level of vessel activity across the 'summer' and 'winter' areas of the SAC differs (Figure 15). 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.

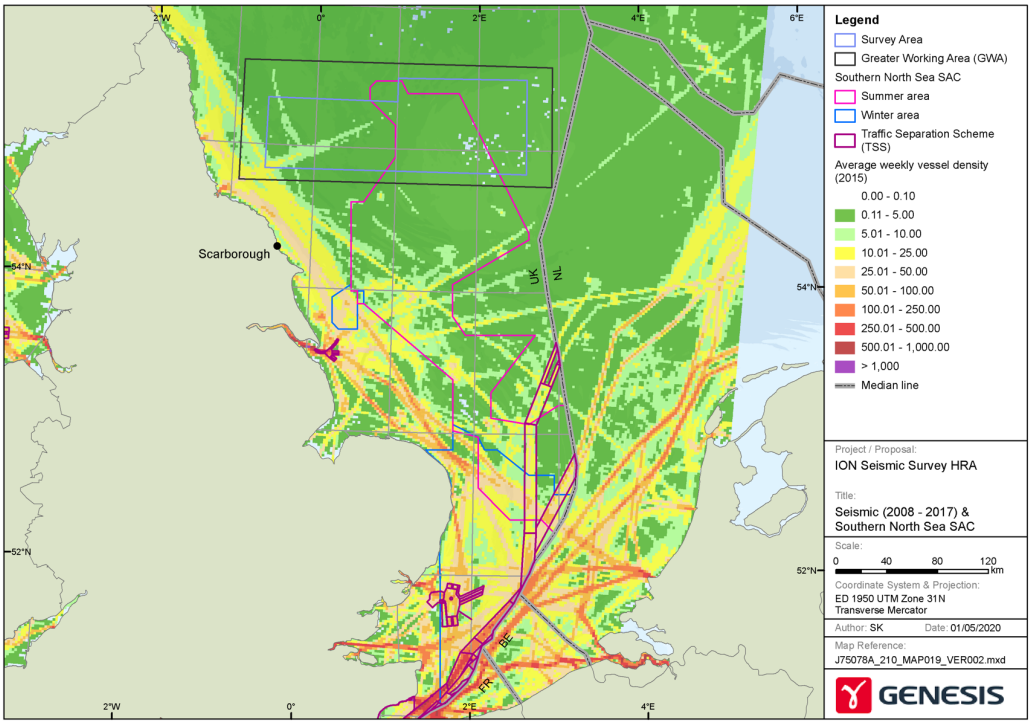


Figure 15: Shipping density within the SAC during 2015.

Fishing activity

8.21 Fishing occurs widely across the southern North Sea and has also been on-going in the area for many hundreds of years. The majority of current fish landings are obtained from areas adjacent

to the SAC but there is widespread fishing activity in the southern half and north-eastern edge of the SAC and relatively moderate to high levels of fishing activity along the western edge of the central part of the SAC (Figure 16) (MMO 2017b). Note however, this does not include the activities of non-UK registered vessels that will occur within the site or vessels greater than 15 m in length.

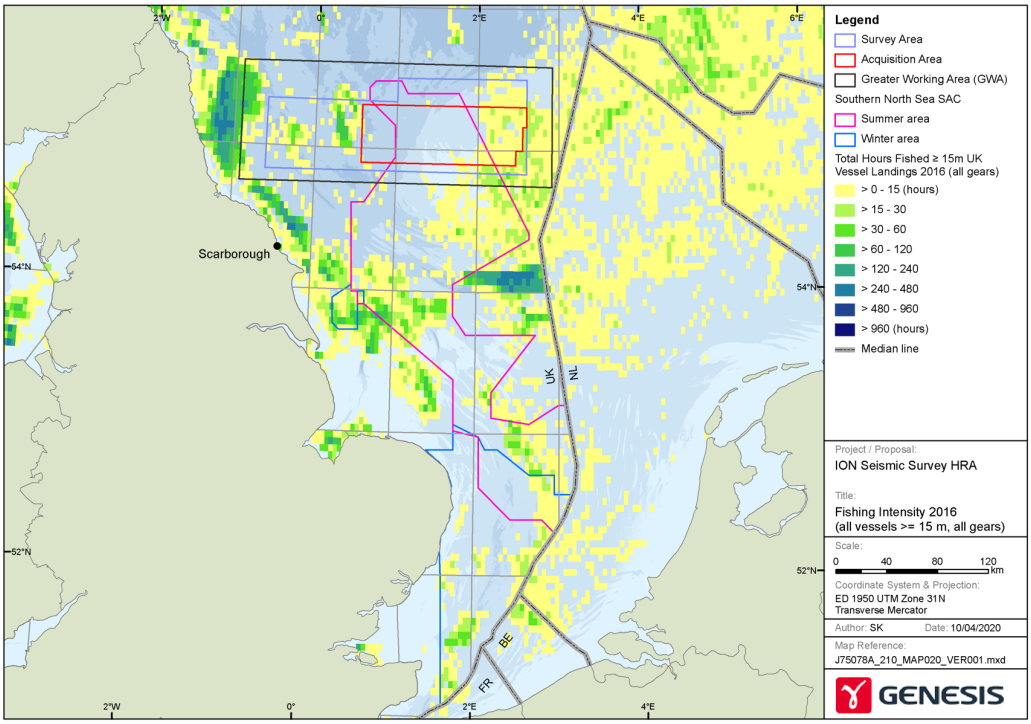


Figure 16: Fishing intensity across the SAC during 2016 by UK registered vessels.

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

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

8.24 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

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

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

9.5 Within the Southern North Sea SAC harbour porpoise 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 320 m of the sound source and disturbance or displacement effects to occur 12 km from the airguns and extend over an area of 452 km^2 (based on combined worst-case modelling outputs) (Table 5).

9.6 The Doggersbank SAC is 24 km from the Survey Area and therefore beyond the range noise from which the seismic survey is predicted to cause disturbance. Consequently, the proposed seismic survey will not cause a likely significant effect on harbour porpoise from the Doggersbank SAC.

9.7 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 Southern North Sea SAC; the potential impacts on harbour porpoise are therefore considered further in the Appropriate Assessment.

Grey seal

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

9.9 Grey seals are a qualifying species at the Berwickshire and North Northumberland Coast SAC, the Humber Estuary SAC and Doggersbank SAC.

9.10 Grey seal are known to routinely forage within 100 km from their haul out sites and although they 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 17 km and encompass an area of 555 km^2 (based on combined worst-case modelling outputs) (Table 6).

9.11 Based on the results from noise modelling, the known offshore distribution of grey seals (Figure 7) and their behaviour, it is concluded that there is potential for a likely significant effect on grey seals from the Humber Estuary SAC and the Berwickshire and North Northumberland Coast SAC; the potential impacts on grey seal are therefore considered further in the Appropriate Assessment.

9.12 The Doggersbank SAC is 24 km from the Survey Area and therefore beyond the range noise from the seismic survey is predicted to cause disturbance (Table 6). Consequently, the proposed seismic survey will not cause a likely significant effect on grey seals in the Doggersbank SAC.

Harbour Seal

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

9.14 Harbour seals are a qualifying species for the Doggersbank SAC.

9.15 Noise modelling undertaken indicates that there is potential for auditory injury to arise within 99 m of the sound source and levels of noise capable of causing disturbance could extend to 17 km and encompass an area of 555 km^2 (based on combined worst-case modelling outputs) (Table 6).

9.16 Tracking of harbour seals in UK and Dutch waters indicate that they do not routinely travel further than 60 km from their haul out sites from between April and October. Therefore densities of harbour seal within the SAC are predicted to be relatively very low.

9.17 The Doggersbank SAC is 24 km from the Survey Area and therefore noise from the seismic survey is not predicted to cause disturbance to harbour seals within the SAC.

9.18 Based on the results from noise modelling and known behaviour of harbour seals it is concluded that there will not be a likely significant effect on harbour seals within the Doggersbank SAC.

Fish

9.19 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.

9.20 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 harbour porpoise and 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 *et al*. 2014).

9.21 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 7). 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.

9.22 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 of 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

9.23 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 a number of SPAs could occur across the proposed Survey Area (Table 3). 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.

9.24 The results from the assessment of potential impacts presented in Section 4 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.

9.25 Previous noise modelling undertaken on seabird species 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 estimated to be less than 20 m from an airgun (BEIS 2016).

9.26 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.

9.27 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.

9.28 The physical presence of vessels during any potential seismic survey 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.

9.29 There is potential for the prey species of seabirds to be impacted by possible seismic survey. 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.

9.30 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

9.31 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

9.32 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,
- Berwickshire and North Northumberland Coast SAC: Grey seal.

9.33 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 assess 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 based on outputs from noise modelling and supported by the use of EDR has been used for harbour porpoise in order to determine whether an adverse effect on the integrity of the Southern North Sea SAC will occur. There are no EDRs for other species of marine mammal and therefore noise modelling results have been used to support the assessment on grey seals.

10.4 The assessment of the potential impacts from the seismic survey is based on the combined results from noise modelling undertaken by the applicant and 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 (2015) an annual reduction in the population of 1.7% could cause a population level decline (Para. 7.11). However, 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 JNCC and NE. This approach is based on the use of a generic EDR for all seismic survey activities irrespective of their location and airgun size. Following published evidence and advice received from the JNCC, for the purposes of this assessment a 12 km EDR has been used for the seismic survey, as opposed to the previously published 10 km range (JNCC 2020a, Sarnocińska *et al*. 2020). The extent and duration of the survey is then measured against draft thresholds above which an adverse effect on site integrity could arise, as described in Section 6.

Southern North Sea SAC (Harbour porpoise)

Physical Injury

10.6 Noise modelling undertaken indicates that, based on the weighted SEL threshold, there is potential for sound levels to cause the onset of PTS to harbour porpoise out to 320 m of the sound source (Table 5).

10.7 The peak harbour porpoise density across the SAC 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 320 m of the survey, an estimated one harbour porpoise could be affected at the start of the seismic survey.

10.8 The North Sea Management Unit harbour porpoise population is 333,808 individuals and therefore the worst-case scenario of one harbour porpoise being impacted is <0.0001% 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 the proposed seismic survey. In the extremely unlikely event the onset of PTS does occur, it would only affect a very small proportion of the relevant population.

Disturbance

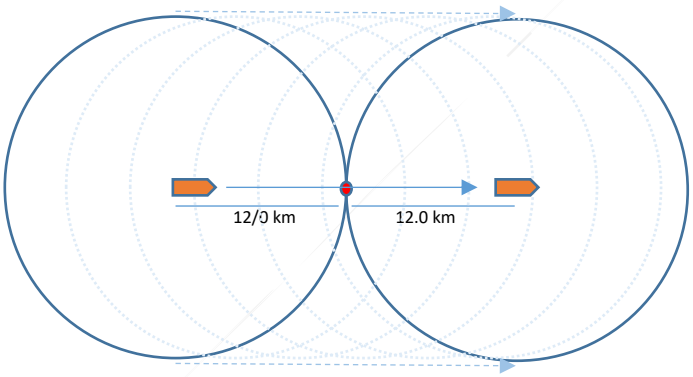
10.11 The largest distance any noise likely to cause disturbance is estimated to propagate out to is 12 km from the airguns, covering an area of 452 km^2 (Table 5). Assuming that disturbance occurs entirely within the SAC, then approximately 1.2% of the SAC as a whole and 3.7% of the 'summer' area could 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 1,356 harbour porpoise could be disturbed by a seismic survey. This is equivalent to 0.4% 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 5 knots (9.26 km/h) (ION 2020a). As the vessel undertakes a survey, disturbance in any area will last less than three hours in any one location (Figure 17). 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 Danish sector of the Central North Sea reported disturbance out to 12 km from a 3,570 cu. in. airgun, although the duration of the disturbance is not reported (Sarnocińska *et al*. 2020). Similar studies undertaken in the Moray Firth 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.



● = Location of harbour porpoise in order for maximum duration of disturbance to occur.
Maximum extent of disturbance from seismic survey at 145 dB re 1 µPa at 1 m – 12.0 km.
Total distance – 24.0 km.
Vessel speed – 9.26 km/h.
Total duration of disturbance impact = 2.6 hrs (2hrs and 40 mins).

Figure 17: Diagram showing potential maximum duration of disturbance to harbour porpoise from seismic survey.

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). An assessment has been undertaken within the application using the threshold approach but is based on a stationary sound source. To

calculate the extent of noise within the SAC using the threshold approach the extent of disturbance from a moving sound source over the course of 24 hrs and the season is required. 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 12 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 18).

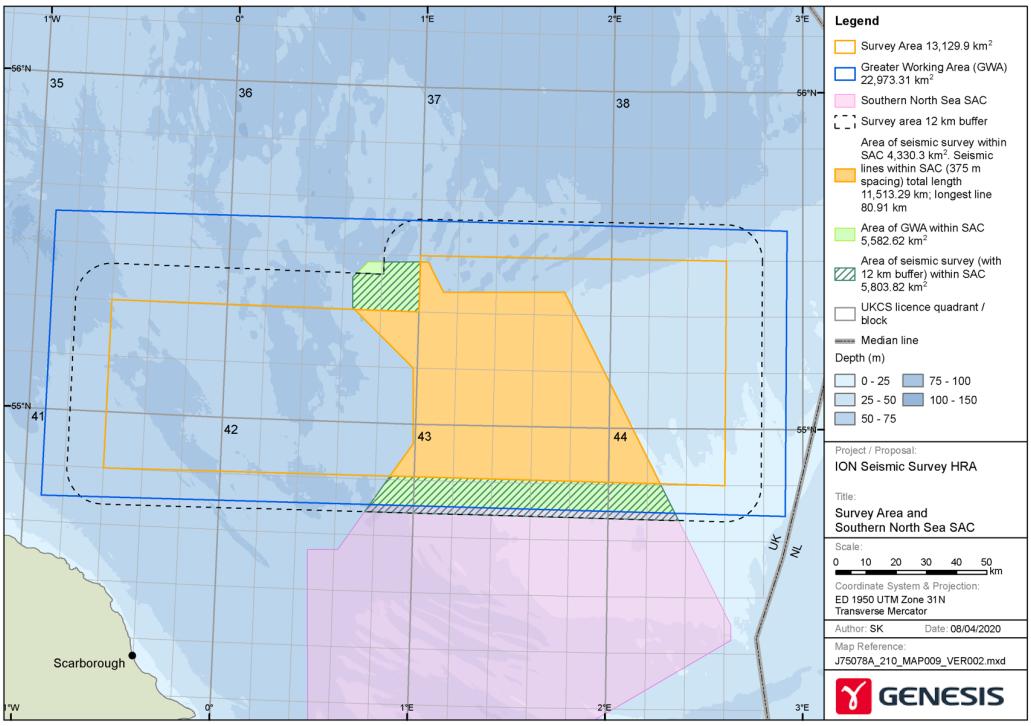


Figure 18: Area of seismic survey within the Southern North Sea SAC.

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.

A total of 5,583 km^2 of the Greater Working Area is within the Southern North Sea SAC[1] (ION 2020a) and therefore overlaps 15.1% of the SAC as a whole and 20.6% of the 'summer' area. However, airguns will only be operating within the Survey Area and, aside from the soft-starts, they will not be operating in the wider Greater Working Area. The area of seismic survey to be

[1] It is noted that the calculated Greater Working Area within the SAC presented within the application (ION 2020a) is larger than that calculated by BEIS for this assessment. The differences between the two calculations make no difference to any conclusions made in this assessment.

undertaken within the Survey Area and within the SAC is therefore 4,330 km^2 (Figure 18). This overlaps with 11.7% of the SAC as a whole and 16.0% of the 'summer' area.

10.18 Noise arising from the proposed seismic survey will be transient as the vessel moves along the pre-determined survey lines. The extent of displacement (deterrence) 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 2020a).

10.19 When undertaking the seismic survey, the vessel will be travelling at 5 knots (9.26 km/h). Consequently, the maximum length of line that could, in theory, be surveyed over the course of a single day is 222 km. Assuming a 12 km EDR, the total area impacted over the course of 24 hrs would be 5,780 km^2 (Figure 19). This presumes that airguns are operating continuously throughout a 24 hr period. This is an unrealistic scenario as there will be breaks of 3.5 hrs in airgun operations at the end of each line as the vessel turns before starting the next line (ION 2020c); consequently, airguns will not be operating throughout a 24 hr period. Furthermore, approximately 75% of the Greater Working Area and 67% 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.

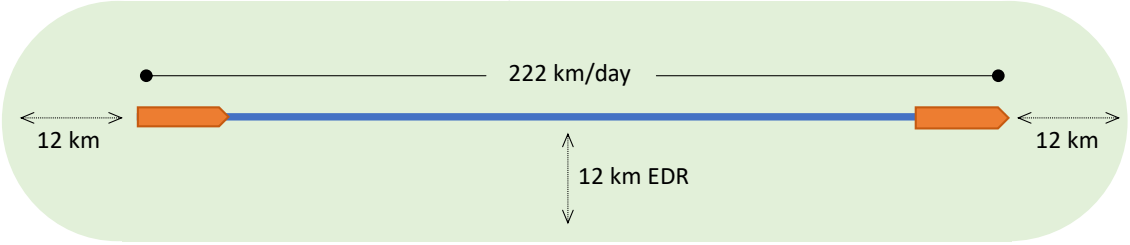


Figure 19: Worst-case theoretical area of impact from a seismic survey travelling at 5 knots using 12 km EDR.

10.20 Based on the configuration of the planned survey route (Figure 18), the maximum length of a single survey line within the Survey Area is 205 km, of which 89 km is the maximum length of line within the SAC. The average length of survey line within the SAC is estimated to be 75 km[1].

10.21 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 3.5 hrs to undertake each line turn (ION 2020c). Consequently, as the vessel will undertake at least one line turn each day the airguns will be operating for no more than 20.5 hrs per day. If

[1] The total length of line within SAC is 11,513 km to be undertaken over a period of 165 days. Consequently, the average length of line per day within the SAC is 75 km, covering an area of 1,805 km per day.

the vessel travels at 5 knots and the airguns operate continuously for 20.5 hrs, the maximum length of survey line undertaken during any single day could be 190 km, of which 89 km could be within the SAC (Figure 20).

10.22 The maximum realistic area within the SAC that will be impacted per day is estimated to be 2,136 km^2. This is equivalent to impacting 5.8% of the SAC as a whole and 7.9% 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 a period of 20.5 hrs during any single day with airguns switched off for a period of no less than 3.5 hrs at the end of each line. It also assumes that the vessel will travel no faster than 5 knots when undertaking the survey and successive lines are no more than 9.4 km apart. It is therefore considered to be realistic worst-case scenario based on the information presented within the application.

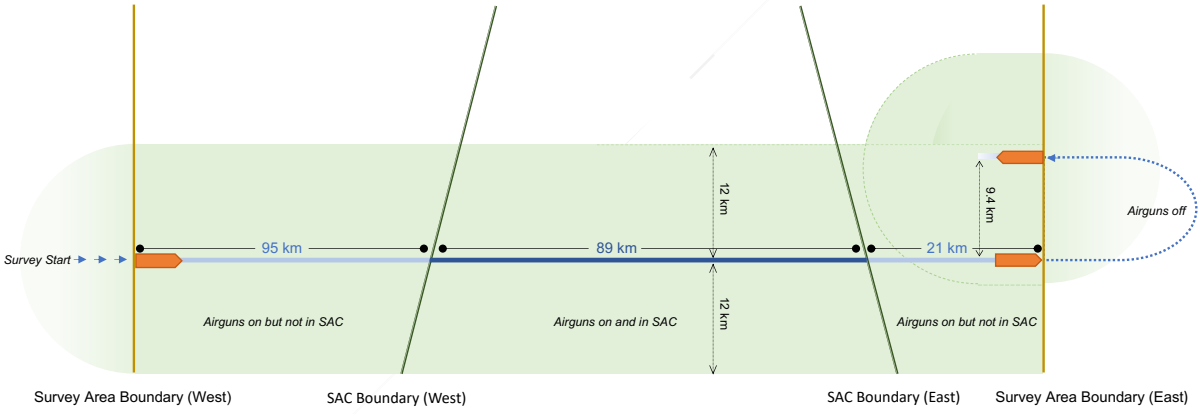


Figure 20: Maximum area of impact over 24 hrs from proposed ION seismic survey within the Southern North Sea SAC.

Seasonal Threshold

10.24 The survey is planned to be undertaken over a period of 165 days. Originally it was intended to commence on 1 April 2020 with completion no later than 22 October 2020.; the start of the survey has now been delayed to no earlier than 1 June 2020.

10.25 In order to assess the seasonal spatial overlap it is presumed that the survey will start on 1 June 2020 and therefore, of the 165 days of possible seismic survey to be undertaken, 122 days could 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 122 days during the summer period.

10.26 The maximum realistic daily area impacted within the SAC of 2,136 km^2, will only arise on one day during the course of the season, on all other days the extent of the daily impact within the SAC will be lower. It is therefore unrealistic and inappropriate to calculate the extent of the seasonal impact based on the maximum area of daily effect which will only occur on one out of 122 days. The seasonal threshold has therefore been based on the average length of line surveyed each day within the SAC across the course of a season, i.e. 75.2 km; an area of 1,805 km^2, over 122 days.

10.27 Based on the daily average impact the seasonal threshold would be 4.5% of the SAC (Table 12).

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

Table 12: Estimated extent of seasonal disturbance on harbour porpoise from proposed ION seismic survey within the SAC.

SAC area	Area impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
Worst-case (Maximum daily impact - 122 days in summer period)				
'summer'	2,136	7.9	122	5.3
Realistic worst-case (Mean daily impact 122 days in summer period)				
'summer'	1,805	6.7	122	4.5

Conclusion

10.29 Results from noise modelling indicate that no more than one harbour porpoise is at risk of physical injury from noise arising from the airguns. With proposed mitigation discussed in Section 13 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 1,356 harbour porpoise may be disturbed at any one time; this is 0.4% 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, any changes in behaviour due to disturbance will cease quickly after the vessel has moved away and any porpoises that may have been displaced are predicted to return to the area within 24 hrs.

10.31 The results from the threshold approach indicate that up to 7.9% of the 'summer' area may be impacted each day and up to 4.5% 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 draft threshold approach, BEIS is satisfied that the proposed survey alone will not have an adverse effect upon the integrity of the Southern North Sea SAC with respect to harbour porpoise.

Berwickshire and North Northumberland Coast SAC and 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 Berwickshire and North Northumberland Coast SAC and the 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 over the Dogger Bank.

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 33 m of the sound source (Table 6). Additional modelling undertaken for previous assessments indicates that this could extend to 99 m (although this is based on modelling results 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 at 5 knots (9.26 km/h). Noise capable of causing disturbance is predicted to occur out to no more than either 13.3 km or 17 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 no more than two hours based on the maximum area of 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 Berwickshire and North Northumberland Coast SAC lies 53 km from the Survey Area and the Humber Estuary SAC lies 130 km away. Approximately 91% of the Survey Area has densities of below 0.2 ind./km^2, although it is recognised that higher densities over the Dogger Bank will

be impacted by noise. On an average estimated density of 0.25 ind/km^2 (See Forewind 2013 and Figure 7) being disturbed across the proposed Survey Area an estimated 139 grey seals could be disturbed.

10.40 The estimated grey seal population for the Berwickshire and North Northumberland Coast SAC is 16,491 individuals, consequently, if all the grey seals impacted are from this SAC 0.84% of the SAC population may be disturbed at any one time.

10.41 The estimated grey seal population for the Humber Estuary SAC is 6,526 individuals, consequently, if all the grey seals impacted are from this SAC 2.1% of the SAC may be disturbed at any one time.

10.42 Note that it is extremely unlikely that all grey seals disturbed are from the one SAC and that it is highly probable that grey seals that are disturbed originate from a number of sites located along the east coast.

10.43 There is potential for repeated levels of noise capable of causing both 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.

10.44 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.

10.45 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 two hours of the cessation of piling the distribution of seals returns to pre-piling scenarios (Russell *et al.* 2016).

10.46 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).

10.47 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

10.48 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 Berwickshire and North Northumberland Coast SAC and the Humber Estuary SAC 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 two 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.

10.49 The duration and effect of any impact on grey seals is predicted to be temporary and although the proposed survey 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.

10.50 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.

10.51 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 Berwickshire and North Northumberland Coast SAC or 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 Projects identified as having potential to cause an in-combination impact are:

- Hornsea Project Two offshore wind farm - UXO clearance,
- Viking Link Inter Connector – UXO clearance,
- Hornsea Project Two offshore wind farm – Pile-driving,
- Triton Knoll offshore wind farm – Pile-driving,
- Tolmount – Pile-driving,
- Spirit Energy – Pegasus W development surveys,
- Spirit Energy – Ossian rig site survey,
- Spirit Energy - Bonnie Brae rig site survey.

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 10).

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

11.5 In order to reduce the potential in-combination effect associated with UXO clearance Ørsted have proposed the following limitations when considering concurrent activities (Ørsted 2020a):

11.6 During the summer 2020 season (April to September, inclusive):

- A maximum of five detonations all within 5 km of each other will occur in any 24-hour period within the SNS or a 26 km buffer surrounding the SAC (during the same 24-hour period); and

- UXO detonations (within the SNS SAC or a 26 km buffer surrounding the SAC) will not occur during the same 24-hour period as piling at the substations (during the same 24-hour period).

11.7 These measures reduce the potential extent of impacts across the SAC during any one day.

Hornsea Two UXO clearance

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

11.9 Noise modelling undertaken 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).

11.10 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.

11.11 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.

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

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

11.14 The worst-case scenario of five detonations to be undertaken within a 5 km radius will impact a maximum area of 2,303 km^2 within the SAC, equivalent to 8.53% of the 'summer' area (Ørsted 2020a).

11.15 In the event that up to 60 UXO detonations are undertaken during the 'summer' period with five detonations per day, the seasonal average is 0.65%. In the event that only one detonation per day occurs (the 'worst-case' seasonal scenario) the seasonal average is 2.5% (Table 13).

Table 13: Seasonal spatial overlap for Hornsea Two UXO detonations without bubble curtains.

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of detonations	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Single UXO detonation per day					
'summer'	2,009	7.4	60	62	2.5
Five UXO detonations per day					
'summer'	2,303	8.5	60	14	0.6

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

11.16 The potential impact from UXO detonations using the threshold approach is unrealistically worst-case:

- It assumes that there will be 60 detonations all of which will be undertaken during the summer period; this figure is speculative and considered to be a maximum.
- The assessment presumes that all 60 detonations have the same maximum area of effect within the SAC. It is highly unlikely that five items of UXO are positioned such that they could cause the maximum area of impact.
- The maximum area of impact can only occur on one day. It is therefore unrealistic and self-evidently not possible to have the same level of impact over the course of a season.
- This assessment is based on the presumption that bubble curtains are not being used to reduce the risk of injury and extent of disturbance (See Section 13, Mitigation). During 2019 Ørsted cleared 26 items of UXO within the project area and used bubble curtains for 23 of them; therefore on 88% of occasions bubble curtains have been used. This significantly reduces the potential area of displacement or disturbance.

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

11.18 The reduction in the EDR to 15 km reduces the daily threshold to between 2.6% and 4.6% depending on the number of detonations per day and the seasonal threshold to between 0.35% and 0.88% (Table 14).

Table 14: Seasonal threshold for Hornsea Two UXO detonations with bubble curtains.

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of detonations	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Single UXO detonation per day					
'summer'	707	2.6	60	62	0.88
Five UXO detonations per day					
'summer'	1,257 [2]	4.6	60	14	0.35

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

2 – Estimated based on all five detonations being within a 5 km radius of each other.

12 Hornsea Project Two Pile-driving

12.1 Between July and October 2020 Ørsted are planning to undertake pile-driving at two substations associated with the Hornsea Two wind farm: A Reactive Compensation Station (RCS) and an Offshore Substation (OSS). BEIS are aware that pile-driving is unlikely to commence before September 2020.

12.2 The Reactive Compensation Station will have four pin-piles installed over a period of between one and three days, the Offshore Substation has eight pin-piles and will take between two and five days to be installed. In total there will be between three and eight days of piling noise undertaken during the summer period.

12.3 For the purposes of this assessment noise modelling undertaken by BEIS for the Review of Consents for the installation of 3.5 m diameter piles using a 2,300 kJ hammer at Hornsea Two wind farm has been used.

12.4 The results from the modelling indicate that the onset of PTS could occur out to 585 m and encompass an area of 1.1 km^2. Levels of noise predicted to cause disturbance could occur out to 26.8 km and cover an area of 2,251 km^2.

12.5 Based on the results from noise modelling and a peak density of 2.22 ind./km^2 an estimated two harbour porpoise are at risk of PTS from the pile-driving and 1,683 harbour porpoise may be disturbed or displaced.

12.6 Noise modelling undertaken for Hornsea Two and presented in the application indicates that the onset of PTS in grey seals would occur within 500 m of pile-driving and displacement would occur no further than 2 km and extend over an area of 12.57 km^2. The estimated number of grey seal predicted to be displaced by pile-driving is no more than 25 individuals (SMart Wind 2015).

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

12.8 The results of the assessment based on a 15 km EDR for pin-pile driving at the Reactive Compensation Station indicate that up to 38 km^2 of the SAC may be impacted. Pile-driving at the Offshore Substation could impact 530 km^2 of the SAC. A maximum daily area of the SAC impacted is 2.0% and the average is 1%. The seasonal average has been calculated based on the average area of the SAC impacted over the course of the season by pile-driving and for activities to last the maximum number of eight days (Ørsted 2020a). The seasonal average arising from pile-driving is 0.05%.

Table 15: Estimated extent of seasonal disturbance on harbour porpoise from proposed pile-driving at Hornsea 2 offshore wind farm within the SAC.

SAC area	Mean area of SAC impacted per day (km^2)	Mean Daily Threshold (%)	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Pin-pile driving Hornsea 2 substations				
'summer'	284	1.0	10	0.05

1 – This accounts for two days 'recovery time' following cessation of pile-driving.

12.9 Ørsted have committed to not undertake UXO clearance and pile-driving during the same 24 hr period. Therefore, the impacts of the two activities are not additive on a daily basis but are for the seasonal threshold (Ørsted 2020a).

Viking Link Interconnector

12.10 The Viking Link Interconnector is a HVDC cable between Denmark and the UK. The total cable length in the marine environment is 620 km, of which 64 km is within the Southern North Sea SAC (NGVL 2018a). Prior to installing the cable a UXO clearance campaign is planned to be undertaken no sooner than 31 May 2020 and end in September 2020 (NGVL 2019a, MMO 2020).

12.11 The Marine Licence application is for the clearance of no more than 25 items of UXO across the entire length of cable. The exact number of UXO items to be cleared nor their locations are unknown. However, BEIS have been made aware that one item of UXO has been identified within the SAC and a further three items have been identified within 26 km of the SAC boundary. Licence conditions state that no more than one item of UXO can be cleared in any 24 hr period (MMO 2017c, 2018).

12.12 Results from noise modelling presented in the application indicate that the onset of PTS could occur out 8.5 km and cover an area of 226.98 km^2 for a UXO with a 260 kg charge weight and estimated up to 200 harbour porpoises to be at risk of PTS, this is equivalent to 0.06% of the North Sea Management Unit population (NGVL 2018a, MMO 2017c). However, this is without mitigation, which includes the use of Acoustic Deterrent Devices (ADD) and where appropriate the use of bubble curtains that will reduce the risk of harbour porpoise being within the area when

UXO are detonated (NGVL 2019b). The estimated number of individuals potentially displaced or disturbed from UXO clearance based on the outputs from noise modelling is not available.

12.13 NGVL have estimated the number of harbour porpoise displaced based on the 26 km EDR and estimate up to 1,886 harbour porpoise may be disturbed from clearance of UXO, this is equivalent to 0.56% of the North Sea Management Unit population (NGVL 2018a)

12.14 NGVL have undertaken an assessment using the draft SNCB threshold approach. The assessment is based on the detonation of UXO having an EDR of 26 km and all 25 items of UXO being wholly within the SAC (NGVL 2019a). The worst-case scenario for a single detonation within the SAC is that it will impact an area of 2,124 km^2 during any 24 hr period and consequently affect 7.8% of the 'summer' area and over the course of the season affect 1.2% of the seasonal threshold (Table 16).

12.15 In the event that bubble curtains are used the daily threshold is reduced to 2.6% and the seasonal threshold to 0.38%.

Table 16: Worst-case scenario seasonal threshold for Viking Link Interconnector UXO detonations with and without bubble curtains.

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of detonations	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Single UXO detonation per day without bubble curtains					
'summer'	2,124	7.8	25	27	1.15
Single UXO detonation per day with bubble curtains					
'summer'	707	2.6	25	27	0.38

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

12.16 The maximum number of detonations permitted under the Marine Licence is 25 and was approved prior to the completion of the UXO clearance surveys. Consequently, the exact number and locations of UXO that may need to be cleared were unknown. Subsequent to the Marine Licence being issued NGVL have undertaken surveys and identified one item of UXO within the SAC and a further three within 26 km of the boundary. Consequently the worst-case scenario will not occur. A revised assessment based on known UXO clearance is presented in Table 17. The results show that based on known survey results the seasonal threshold does not exceed 0.25%. In the event that bubble curation are used for all four detonations the seasonal threshold is reduced to 0.38%.

Table 17: Likely seasonal threshold for Viking Link Interconnector UXO detonations with and without bubble curtains

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of detonations	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Single UXO detonation per day without bubble curtains					
'summer'	2,124	7.8	4	6	0.25
Single UXO detonation per day with bubble curtains					
'summer'	707	2.6	4	6	0.08

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

12.17 This assessment is precautionary in that it is based on the maximum area of impact within the SAC for all four detonations and it is known that for three items of UXO this cannot be the case as they lie outwith the SAC and for the one item of UXO within the SAC to have the maximum impact it must occur along a length of no more than 6.9 km of cable route (Figure 21).

12.18 NGVL have committed to using bubble curtains when conditions are suitable for their use (NGVL 2019b). Based on the 88% usage of bubble curtains by Ørsted during 2019 in the region it is likely that NGVL will also use bubble curtains during UXO clearance along the cable route. In the event that this occurs the daily threshold is reduced to 2.6% and the seasonal threshold to 0.08% (Table 17).

12.19 BEIS have been made aware that Ørsted and NGVL will be using the same vessel when operating bubble curtains; both projects cannot operate bubble curtains at the same time. A realistic worst-case scenario is for only one project to undertake UXO clearance during any one day.

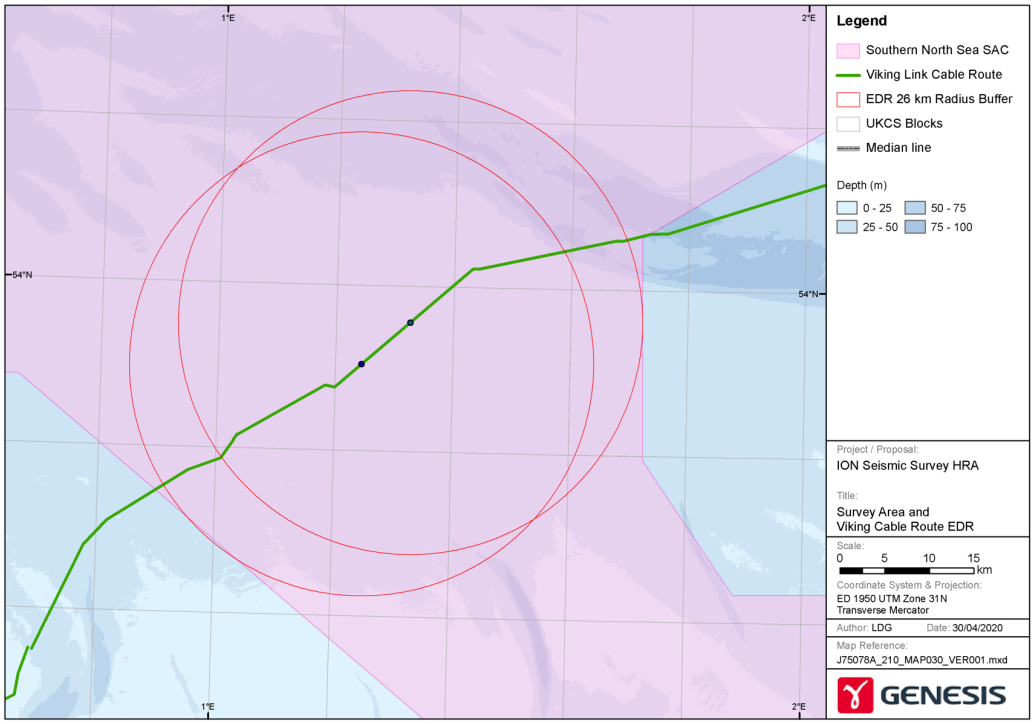


Figure 21: Locations where maximum area of impact within the SAC could occur from Viking Link Interconnector UXO clearance.

12.20 NGVL estimate that impacts from UXO clearance could cause the onset of PTS in up to ten grey seals and, based on a 26 km radius of disturbance up to 637 could be displaced (NGVL 2018c).

Triton Knoll

12.21 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 2011). The project lies wholly outwith the SAC but partially within 26 km of the SAC boundary.

12.22 Offshore construction requiring pile-driving is anticipated to last no more than 23 days and be completed by 13 June 2020.

12.23 Results from the noise modelling undertaken for BEIS indicate that there is potential for sound levels arising from pile-driving to cause the onset of PTS from between 1.56 km and 2.54 km depending on the hammer energy used to install the pile and the location of the pile-driving within the wind farm area. Noise capable of causing the onset of PTS may extend over an area of between 7.8 km^2 and 20.5 km^2 (BEIS 2018).

12.24 The harbour porpoise density across the Triton Knoll wind farm area is estimated to be 0.11 ind./km^2 (TKOWL 2011). Based on this site specific density, between one and two harbour

porpoise are predicted to be at risk of PTS at the start of pile-driving activity; this is equivalent to no more than 0.0005% of the North Sea Management Unit population.

12.25 Displacement of harbour porpoise may extend from between 16.1 km and 16.9 km and cover an area of between 689.9 km^2 and 934.5 km^2 depending on the pile-driving location and the hammer energy used to install the pile. Based on results using a dose response curve and a zonal specific mean density of 0.11 ind./km^2, the estimated number of harbour porpoise predicted to be displaced is between 27 and 39 individuals; 0.008% and 0.01% of the North Sea Management Unit population. Within the SAC it is estimated that no harbour porpoise will be displaced by pile-driving during construction of the wind farm (BEIS 2018).

12.26 Based on the draft threshold approach the maximum area of the Southern North Sea SAC that could be impacted based on a 26 km EDR is 0.18% and the seasonal threshold is 0.02% (Table 18).

Table 18: Daily and seasonal spatial overlap for Triton Knoll pile-driving.

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of days pile-driving	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Pile-driving					
'summer'	47.86	0.18	23	25	0.02

1 – This accounts for two days 'recovery time' following cessation of pile-driving.

12.27 Surveys undertaken at the Triton Knoll offshore wind farm recorded grey seals in relatively low densities of 0.285 ind./km^2 and noise modelling undertaken to support the application estimated the noise from pile-driving could cause the onset of PTS for up to 64 grey seals and cause disturbance to between 89 and 221 individuals (TKOWL 2011, 2018). The HRA undertaken for the project concluded that there would be no adverse effect on the integrity of Humber Estuary SAC from the project alone or in-combination (DECC 2013).

Oil and gas industry activities

12.28 The currently planned or consented oil and gas related activities that could have the potential to cause an in-combination are presented in Table 11.

12.29 BEIS have identified two projects that could cause an in-combination impact within the SAC. They are:

- Pile-driving at the Tolmount field,
- Geophysical survey at the Pegasus West field.

Tolmount Pile-driving

12.30 Premier Oil have submitted a Consent to Locate application to install the Tolmount normally unmanned installation (NUI) at the Tolmount field, located approximately 3 km from the perimeter of the Southern North Sea SAC boundary. Part of the works require pile-driving eight 2.59 m diameter piles to anchor the jacket legs into the seabed. Installation of the NUI is planned to be undertaken in May (or possibly June) 2020 (Premier Oil 2020).

12.31 Noise modelling undertaken to support the application indicate that the onset of PTS could occur in harbour porpoise within 234 m of the pile-driving and strong behavioural disturbance out to 3.1 km (Premier Oil 2020). Site specific data on the density of harbour porpoise in the area is not readily available. However, at Triton Knoll (the closest wind farm to the proposed pile-driving) densities of harbour porpoise were reported as being 0.11 km^2 (TKOWFL 2011). Similar densities of harbour porpoise are predicted to occur at Tolmount. Based on these densities less than one harbour porpoise is predicted to be at risk of PTS and three may be displaced.

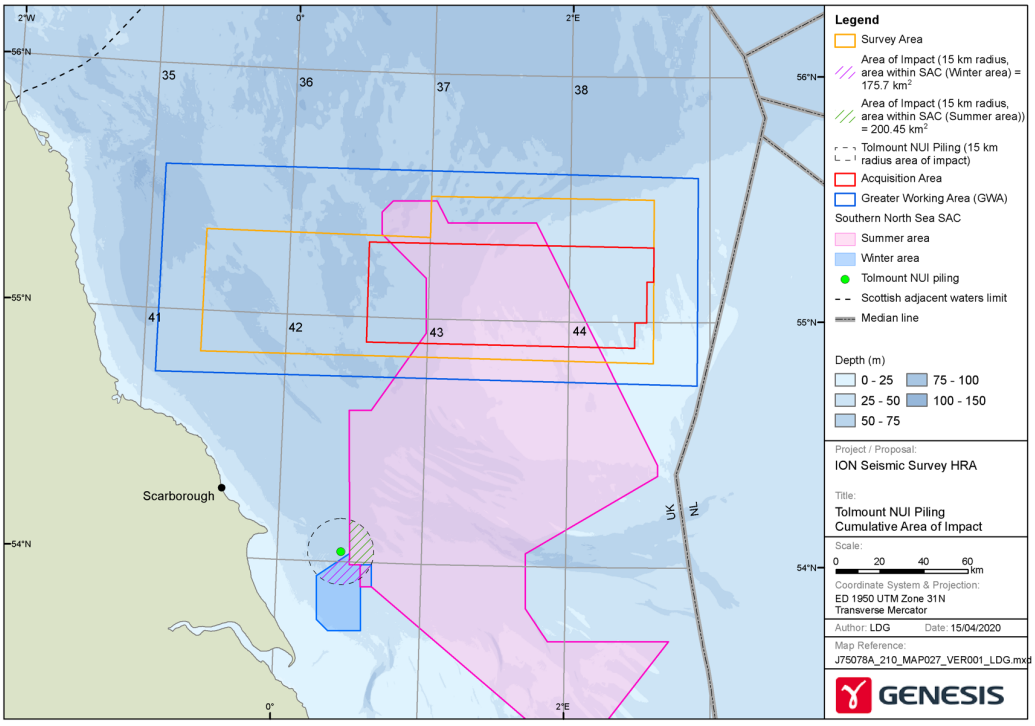


Figure 22: Tolmount NUI and 15 km EDR.

12.32 Based on the draft thresholds and a 15 km EDR it is estimated that sound from pin pile-driving could affect 200 km^2 of the 'summer' area of the SAC (Figure 22). Pile-driving is expected to last over a period of five days (Premier 2020). Consequently noise from pile-driving could affect 0.5% of the SAC as a whole and 0.8% of the 'summer' area. The seasonal threshold is 0.03% (Table 19).

Table 19: Daily and seasonal spatial overlap for Tolmount pile-driving.

SAC area	Maximum area of SAC impacted (km^2)	Daily Threshold (%)	No. of days pile-driving	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Pile-driving					
'summer'	200	0.8	5	7	0.03

1 – This accounts for two days 'recovery time' following cessation of pile-driving.

12.33 Results from noise modelling indicate that the onset of PTS to grey seals will occur within 16 m of the piling and disturbance could occur out to 3.1 km. There is a very low risk of any seals being within the range that PTS is predicted to occur and, based on a density of 0.32 ind./km^2, it is estimated that no more than 10 grey seals may be disturbed by the proposed activities (Premier Oil 2020).

Pegasus West geophysical surveys

12.34 Spirit Energy have submitted an application to undertake a pipeline route survey and a platform site survey at the Pegasus West field. The surveys will be undertaken in Blocks 43/12, 43/13, 43/18, 43/19 and 43/24 and are located within the Southern North Sea SAC (Figure 23). The surveys will be undertaken during May (or potentially June) 2020 and last no more than 28 days in total (Spirit Energy 2020a).

12.35 The surveys entail the use of a sub-bottom profiler (pinger, sparker and boomer), magnetometer, multi-beam survey, echo-sounder survey and side-scan sonar survey.

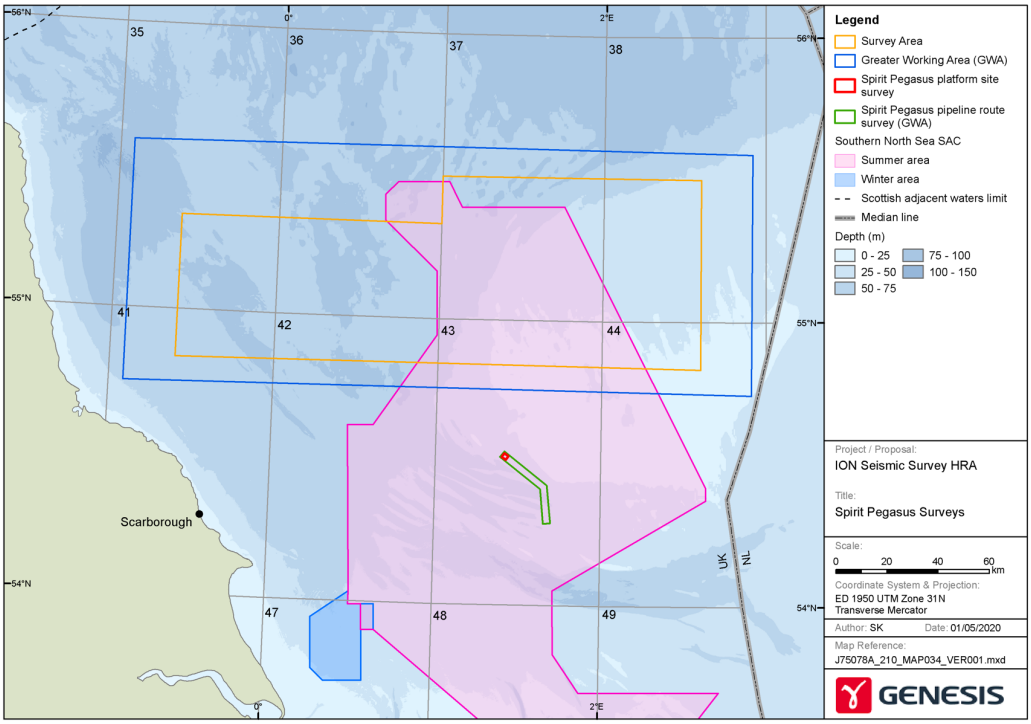


Figure 23: Spirit Energy Pegasus West pipeline route and rig site survey locations.

12.36 Noise modelling undertaken by the Applicant indicates that the noise source with the highest SPL is the sub-bottom profiler pinger with a source level of 223 dB re: 1 µPa @ 1m $_{(0\text{-}p)}$. The noise modelling indicates that the onset of PTS in harbour porpoise could occur out to 11 m from the source and for pinnipeds within 3 m (based on SPL metric). Consequently, there is a very low risk of any harbour porpoise or seals receiving noise at levels capable of causing the onset of PTS.

12.37 Within the application noise modelling has not been used to assess the potential extent of displacement or disturbance and therefore it is not possible to undertake an assessment of disturbance based on outputs from noise modelling.

12.38 The SNCB threshold approach has not been used in the application. For the purposes of this in-combination assessment BEIS have undertaken an assessment based on the threshold approach.

12.39 The total length of the pipeline route survey is 32 km and the Greater Working Area is 98 km^2 and the Survey Area is 61 km^2. The rig site survey covers an area of 3.6 km^2 (Spirit Energy 2020a). The survey vessel will travel at 4 knots (7.4 km/h) with each line being 30 m apart. There will be 65 line turns with each line turn taking approximately 30 minutes (Spirit Energy 2020b). It is not known if the airguns will be switched off between each line, nor is it known how far apart each successive line will be. For the purposes of this assessment it is presumed that the airguns

will not be switched off between lines and that each successive line will be 250 m apart (half the pipeline survey corridor). Furthermore it is presumed that the airguns will be operating throughout the whole of the 28 days of survey. In the absence of any further information this provides a precautionary worst-case scenario.

12.40 Following SNCB guidance an EDR of 5 km has been used for this assessment (JNCC, NE and DAERA 2020).

12.41 Based on the above information it is estimated that the maximum length of survey that could be undertaken in a single day is 177.6 km. Consequently, it is possible that 5.5 survey lines could be undertaken along the 32 km pipeline corridor per day. The maximum total area of SAC impacted per day by the proposed Pegasus survey is estimated to be 431 km^2. This is equivalent to 1.6% of the daily threshold. The seasonal threshold based on 28 days of survey is 0.26% (Table 20).

Table 20: Estimated extent of seasonal disturbance on harbour porpoise from proposed Pegasus West geophysical site survey within the SAC.

SAC area	Area impacted per day (km^2)	Daily Threshold (%)	No. of days survey	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Worst-case (Maximum daily impact - 28 days in summer period)					
'summer'	431	1.6	28	30	0.26

1 – This accounts for two days 'recovery time' following cessation of geophysical survey.

Other oil and gas applications

12.42 Other oil and gas applications for activities planned to be undertaken between April and September 2020 are summarised below.

12.43 An application to undertake a rig site survey at the Ossian prospect within UKCS Blocks 36/28, 42/2a and 42/3a has been made by Spirit Energy (Spirit Energy 2020c). The survey entails the use of a two-dimensional High Resolution Seismic (2D-HR) and a two-dimensional Ultra High Resolution Seismic (mini-gun) (2D-UHR) plus a sub-bottom profiler and side-scan sonar. The work is planned to be undertaken between 12 April 2020 and 1 April 2021 and last over a period of six days. Note BEIS have recently been advised that the planned activities may not now start until September/October 2020.

12.44 The survey lies 22.6 km from the closest boundary of the Southern North Sea SAC and therefore will not impact on harbour porpoise within the SAC (Figure 24).

12.45 Noise modelling undertaken by the applicant based on a PTS threshold of 187 dB re 1 μPa^2s (as opposed to 186 dB re 1 μPa^2s) indicates that the risk of PTS to seals from the 2D seismic survey

could occur out to 169 m. Consequently, the risk of PTS occurring in any seal is very low (Spirit Energy 2020c).

12.46 No assessment has been made within the application on the impacts of disturbance to grey seals. However, the proposed survey is in an area of very low usage by grey seals (See Figure 7) and any disturbance is predicted to be relatively localised and therefore the number of grey seals predicted to be disturbed is relatively low.

12.47 An application to undertake a rig site survey at the Bonnie Brae prospect located within UKCS Blocks 42/3 and 42/8 has been made by Spirit Energy. The survey covers an area of 42 square kilometres (inner working area) and 144 square kilometres (greater working area which also includes Block 42/7) across UK waters (Spirit Energy 2020d). The survey entails the use of a two-dimensional High Resolution Seismic (2D-HR) and a two-dimensional Ultra High Resolution Seismic (mini-gun) (2D-UHR) plus a sub-bottom profiler and side-scan sonar. The work is planned to be undertaken between 12 April 2020 and 1 April 2021 and last over a period of six days. Note BEIS have recently been advised that the planned activities may not now start until September/October 2020.

12.48 The Greater Working Area lies 10.3 km from the closest boundary of the Southern North Sea SAC and the Inner Working Area lies 14.3 km from the boundary (Figure 24). Consequently, the area where airguns will be operating lies beyond the distance at which impacts on harbour porpoise within the SAC are predicted to occur.

12.49 As with the Ossian rig site survey the same noise modelling results have been used using the same incorrect noise thresholds and no assessment has been made on the impacts from the proposed seismic survey on grey seals (Spirit Energy 2020d). The number of grey seals within the Bonnie Brae rig site survey area is predicted to be very low and the impacts from the 2D seismic survey will be relatively localised. The risk of any grey seals being within the range at which the onset of PTS is predicted to arise is low and due to the location of the survey relatively low numbers of grey seal are likely to be disturbed.

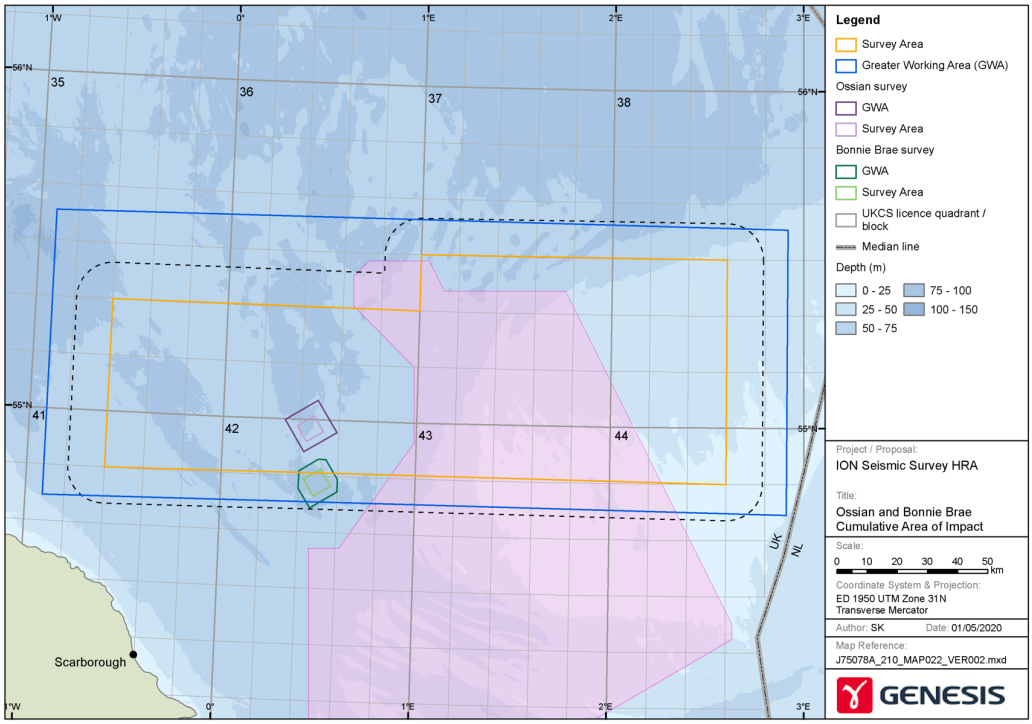


Figure 24: Ossian and Bonnie Brae rig site surveys.

12.50 Chrysaor Production (U.K.) Limited have applied for a Marine Licence to remove the Viking GD jacket and associated piles and risers (ML/384/4). The work will be undertaken between 1 May 2018 and 30 June 2020 and require the use of heavy-lift vessels. In addition there is contingency to undertake dredging activities. Noise from both the vessels used during decommissioning and dredging (if undertaken) could cause localised displacement of harbour porpoise. The effects are predicted to be limited to within 600 m of the proposed activities and temporary. The small scale and temporary nature of the disturbance is not predicted to cause an in-combination impact.

12.51 Spirit Energy have applied for two Marine Licences to undertake decommissioning activities at the Audrey B installation, located within the Southern North Sea SAC (ML/411/2 and ML/431/1). The work is to be undertaken between 23 November 2018 and 31 October 2020 and entails the removal and temporary deposit of risers on to the seabed. Noise arising from this activity will be primarily from the vessel(s) undertaking the work. Vessel noise will be localised and temporary and will not contribute in any significant way to the current levels of shipping and noise within the SAC.

12.52 Chrysaor Production (U.K.) Limited have applied for a Marine Licence to remove mattresses and move rock within the SAC as part of their ongoing decommissioning activities at the LOGGS complex. (ML/570/0). Work will be undertaken between 1 May and 31 October 2020. The work will require the use of vessels and a small electric dredger to reposition the rock. The predominant noise source will be vessel noise which could cause a localised area of disturbance

and not contribute in any significant way to the current levels of shipping occurring within the SAC.

12.53 Premier Oil have submitted an application to prepare seabed prior to installing two pipelines (a 20" production pipeline and 3" methanol pipeline) from the Tolmount field to Easington terminal (ML/551/0). The proposed activities will be undertaken between 1 March and 30 September 2020. Activities include pre-cut trenching operations, dredging and post-lay trenching operations. Noise from dredging operations is predicted to impact on a localised area and cause localised level of displacement out to no more than 600 m (See Para. 8.14). The impacts from disturbance will be temporary with any harbour porpoise returning to the area once the activities have been completed. The small scale and temporary nature of the disturbance is not predicted to cause an in-combination impact.

12.54 An application to deposit two mattresses and a telecommunications branching unit has been made by Tampnet AS (Licence Ref. No. ML-495). The proposed activities occur within the Southern North Sea SAC and are to be undertaken between 18 July 2019 and 30 June 2020. The only sound arising is from the vessel(s) that will be used to undertake the work. Vessel noise does have the potential to cause a localised area of disturbance for harbour porpoise within the SAC. The additional vessel(s) 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.

Shipping

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

12.56 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.

12.57 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

12.58 The in-combination assessment has been undertaken using outputs from both noise modelling and the threshold approach. Due to the number of current and planned activities being undertaken within or adjacent to 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.

12.59 The timelines for each of the activities identified as having the potential to cause an in-combination impact are presented in Figure 25. There is potential for the greatest daily impact to occur in June, when UXO clearance at Hornsea Two and Viking Link Interconnector could coincide with the proposed ION seismic survey. The proposed Tolmount pile-driving is planned to be undertaken in May, but there is potential for it to be delayed and pile-driving to also be undertaken in June.

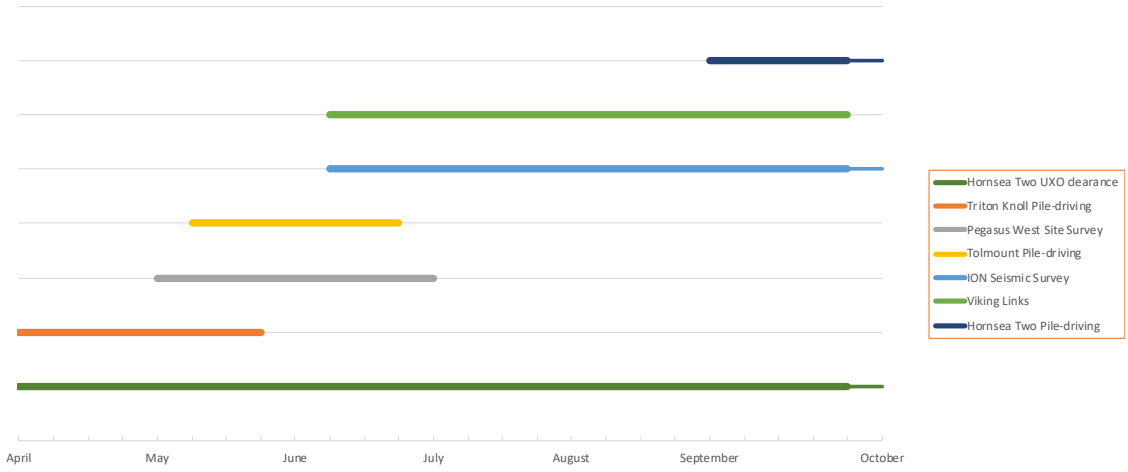


Figure 25: Timeline of activities within the Southern North Sea SAC that may have an in-combination impact.

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

Noise modelling

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

Physical Injury

12.61 Based on the results from the noise modelling a total of 631 harbour porpoise could be at risk of PTS from proposed activities affecting the Southern North Sea SAC (Table 21). Consequently, it is estimated that up to 0.19% of the North Sea Management Unit could, in theory, be impacted.

Table 21: Estimated number of harbour porpoise at risk of PTS from proposed activities in Southern North Sea SAC without mitigation.

Activity	PTS
Pegasus West Site Survey	0
ION Seismic Survey	1
Tolmount Pile-driving	<1
Triton Knoll Pile-driving	2
Hornsea Pile-driving	2
Viking Link Interconnector UXO clearance	200
Hornsea UXO clearance	425
Total	**631**

12.62 For UXO clearance at Hornsea Two and Viking Link Interconnector, both Ørsted and NGVL have committed to incorporating mitigation measures in order to reduce the risk of injury (Ørsted 2018d 2020a, NGVL 2019a, b). Mitigation that may reduce the risk of injury include the use of MMO and the use of ADDs. Under certain conditions both developers may also use 'scare charges' and bubble curtains to help reduce the extent of injurious noise. Although the use of mitigation may reduce the risk of auditory injury it is recognised that it is not possible to totally prevent it and both developers have applied for European Protected Species (EPS) licences for both disturbance and injury.

Disturbance

12.63 The number of harbour porpoise predicted to be disturbed by the proposed ION seismic survey is 1,356 individuals. Although, the mobile nature of the seismic survey will cause a wider area to be disturbed and consequently increase the number of harbour porpoise potentially affected.

12.64 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 and this has been calculated for Viking Link based on a 26 km radius of disturbance (NGVL 2018a) but not been undertaken for clearance of UXO at Hornsea Two.

12.65 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 within 24 hrs of the noise ceasing.

In-combination threshold approach

12.66 There are a number of potential scenarios that could be used for assessing the in-combination impacts using the threshold approach:

- 'Theoretical worst-case'. This scenario presumes that bubble curtains are not used for any UXO clearance and that both Ørsted and NGVL clear six items of UXO in a single day. This scenario is theoretically possible under the licence conditions. However, BEIS believe this is highly unlikely to arise on the basis that both developers have committed to using bubble curtains whenever possible and recent experience in the area indicates a very high usage of bubble curtains during UXO clearance. BEIS does not believe that this theoretical worst-case scenario will arise and therefore has not considered it further in this assessment.
- 'Realistic worst-case'. This scenario is based on the maximum daily length of line within the SAC from the proposed ION seismic survey. It presumes that only one developer is clearing UXO during any one day and that the UXO is cleared on that day without the use of a bubble curtain. This scenario is a realistic worst-case in that it is known that a small proportion of UXO cleared in the area during 2019 did not use bubble curtains and therefore it is likely that during at least one day in the summer period of 2020 this could occur. However, it is thought unlikely that both projects will clear UXO on the same day, in particular as only four items of UXO that could impact on the SAC have been identified by Viking Link project. BEIS is of the opinion that the realistic worst-case is the most appropriate scenario for assessing the daily threshold based on the currently available information.
- 'Realistic-case'. This scenario is based on the estimated average length of line surveyed within the SAC by the proposed ION seismic survey. It assumes that bubble curtains will be used by both developers when undertaking UXO clearance and that only one developer will clear UXO during any one day. Therefore there is no in-combination impact from UXO clearance in any one day. BEIS is of the opinion that this is the most likely and realistic scenario for assessing the seasonal threshold based on the currently available information.

12.67 Based on the realistic worst-case scenario the daily threshold will not be exceeded in any month during the summer period in 2020 (Table 22).

12.68 Based on the likely worst-case scenario the daily thresholds are not exceeded with the highest threshold occurring in June when up to 13.9% of the 'summer' area of the SAC could be affected (Table 23).

Table 22: Realistic worst-case in-combination daily threshold (%).

Activity	Apr	May	Jun	Jul	Aug	Sept
ION Seismic Survey	0	0	7.9	7.9	7.9	7.9
Tolmount Pile-driving	0	0.8	0.8	0	0	0
Hornsea Two UXO detonation (5/day)	8.5	8.5	8.5	8.5	8.5	8.5
Triton Knoll Pile-driving	0.18	0.18	0.18	0	0	0
Pegasus West Site Surveys	0	1.6	1.6	0	0	0
Total %	**8.7**	**11.1**	**19.0**	**16.4**	**16.4**	**16.4**

The realistic worst-case scenario presumes no use of bubble curtains and that only one developer will clear UXO during any single day and therefore there is daily no in-combination UXO impact between Hornsea Two and Viking Link. Hornsea Two has the larger of the predicted daily impacts and is therefore used.

Pile-driving and UXO clearance at Hornsea Two will not occur on the same day and therefore is not additive.

Table 23: Likely worst-case in-combination daily threshold %

Activity	Apr	May	Jun	Jul	Aug	Sept
Tolmount Pile-driving	0	0.8	0.8	0	0	0
ION Seismic Survey [1]	0	0	6.7	6.7	6.7	6.7
Hornsea Two UXO detonation (5/day) [2]	4.6	4.6	4.6	4.6	4.6	4.6
Triton Knoll Pile-driving	0.18	0.18	0.18	0	0	0
Pegasus West Site Surveys	0	1.6	1.6	0	0	0
Total %	**4.8**	**7.2**	**13.9**	**11.3**	**11.3**	**11.3**

1 – Based on an estimated average daily length of survey line within SAC of 75.2 km.

2 – Based on maximum area of potential impact with the use of bubble curtains and a presumed EDR of 15 km.

Only one developer will clear UXO during any single day and therefore there is no daily in-combination UXO impact between Hornsea Two and Viking Link. Hornsea Two has the larger of the predicted daily impacts and is therefore used.

Pile-driving and UXO clearance at Hornsea Two will not occur on the same day and therefore is not additive.

12.69 Under both the realistic and likely worst-case in-combination scenarios the seasonal threshold is not exceeded (Table 24). In the event that activities are delayed the in-combination seasonal threshold during 2020 may be further reduced.

Table 24: In-combination seasonal thresholds %

Activity	Summer seasonal threshold (%)	
	Realistic worst-case	Likely worst-case
Tolmount Pile-driving	0.03	0.03
ION Seismic Survey [1]	5.3	4.5
Hornsea Two UXO detonation (1/day) [2]	2.5	0.88
Hornsea Two Pile-driving	0.05	0.05
Viking Link UXO detonation (1/day) [2]	0.25	0.08
Triton Knoll Pile-driving	0.02	0.02
Pegasus West Site Surveys	0.26	0.26
Total	**8.4**	**5.8**

1 - Based on an estimated average daily length of survey line within SAC of 75.2 km

2 - Realistic worst-case is based on no use of bubble curtains, likely worst-case presumes use of bubble curtains.

12.70 There are varying levels of confidence in the extent and duration of impacts from each of the activities that could occur within the Southern North Sea SAC which affect the results of this assessment; a summary is presented in Table 25. Any changes in any of the Projects' schedules or scopes of work could affect the threshold based assessment.

Table 25: Confidence in extent and duration of potential impacts from planned activities within or adjacent to the Southern North Sea SAC between April and September 2020.

Project	Confidence	Comment
ION Seismic Survey	High	High to Moderate certainty activities will be undertaken during 'summer' 2020. Moderate to Low certainty on when activities will commence. Very High level of certainty that the survey will be undertaken along known pre-determined survey lines. High level of certainty from published evidence on the extent and duration of impacts.
Hornsea Two UXO Clearance	Moderate	Very High certainty activities will be undertaken during 'summer' 2020. Very High confidence of regular usage of bubble curtains to mitigate noise impacts. Low certainty on the location and number of UXO required to be detonated. Low certainty on the number of UXO to be cleared per day, ranging anywhere from between one and five. Daily and Seasonal thresholds are based on two opposing scenarios. Both cannot happen. Very limited evidence on the extent of displacement from UXO clearance. No evidence supporting a 26 km EDR.
Hornsea Two pile-driving	Very High	Very High certainty activities will be undertaken during 'summer' 2020. High level of certainty in the area of SAC that could be impacted. High level of certainty from published evidence on the extent and duration of impacts.
Viking Link UXO clearance	High	Very High certainty activities will be undertaken during 'summer' 2020. Very High certainty in the location and number of UXO required to be detonated. Very limited evidence on the extent of displacement from UXO clearance. No evidence supporting a 26 km EDR.
Triton Knoll pile-driving	Very High	Very High certainty activities will be undertaken during 'summer' 2020. High level of certainty in the area of SAC that could be impacted. High level of certainty from published evidence on the extent and duration of impacts.
Tolmount pile-driving	Very High	Very High certainty activities will be undertaken during 'summer' 2020. High level of certainty in the area of SAC that could be impacted. High level of certainty from published evidence on the extent and duration of impacts.
Pegasus West Site Survey	High	High certainty activities will be undertaken during 'summer' 2020. High level of certainty in the area of SAC that could be impacted. Moderate level of certainty from published evidence on the extent and duration of impacts.

In-combination assessment Southern North Sea SAC conclusions

12.71 Results from noise modelling indicate that up to 631 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 0.19% of the Management Unit population and therefore below the level of 1.7% at which a population level effect is predicted to occur. Mitigation measures that are licence conditions significantly reduce the risk of any harbour porpoise receiving sound levels capable of causing the onset of PTS.

12.72 The results from the threshold approach indicate that the daily threshold will not be exceeded under either the realistic or likely worst-case scenarios.

12.73 The seasonal threshold will not be exceeded under any scenario.

12.74 Based on the best available information and supported by results from noise modelling and the draft threshold approach, BEIS is satisfied that the proposed ION seismic survey in-combination with other plans will not have an adverse effect upon the integrity of the Southern North Sea SAC with respect to harbour porpoise.

In-combination assessment on Humber Estuary SAC and Berwickshire and North Northumberland Coast SAC: Grey seals

12.75 There is potential for an in-combination impact on grey seals from the proposed ION seismic survey and pile-driving being undertaken at Tolmount, Triton Knoll and Hornsea Two offshore wind farm along with UXO clearance being undertaken along the Viking Link Interconnector and at Hornsea Two offshore wind farm.

12.76 The assessment for the proposed ION seismic 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 6 and Para. 10.37). Consequently, there will be no in-combination impact on grey seals with respect to physical injury.

12.77 There is potential for in-combination impacts arising from displacement or disturbance. It is estimated that up to 139 grey seal could be impacted by the proposed ION survey (Para. 10.39). It is estimated that >1,032 grey seals may be disturbed or displaced by other proposed projects (Table 26).

Table 26: Estimated number of grey seals at risk of PTS and disturbance from proposed activities.

Activity	Disturbance
ION Seismic Survey	139
Ossian Rig site survey	Unknown but low numbers predicted
Bonnie Brae rig site survey	Unknown but low numbers predicted
Tolmount Pile-driving	10
Triton Knoll Pile-driving	89 - 221
Hornsea Pile-driving	<25
Viking Link Interconnector UXO clearance	637
Hornsea UXO clearance	Unknown
Total	**>1,032**

12.78 The activities capable of causing disturbance will not all occur at the same time and therefore the number of grey seals disturbed at any one time will be lower.

12.79 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 but where very low numbers of UXO are cleared per day, i.e. one per day, it is predicted that although the level of noise may incite a startle response to individuals within the area the risk of displacement is relatively low.

12.80 It is estimated that at least 1,032 grey seals could be displaced or disturbed by the proposed activities which is 4.5% of the combined SAC grey seal populations.

12.81 Although the number of grey seals that could be impacted by the proposed survey in-combination with other activities is relatively high compared with both SAC populations, 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 Berwickshire and North Northumberland Coast SAC and Humber Estuary SAC conclusions

12.82 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 ION seismic survey and therefore there is no in-combination impact with other plans or programmes.

12.83 There is potential for an in-combination impact from the proposed seismic survey and other activities to cause displacement or disturbance.

12.84 It is estimated that at least 4.5% of the grey seal SAC population could be disturbed by planned activities. However, any displacement or disturbance impacts will be temporary with seals capable of relocating away from an area without causing a population level effect.

12.85 Based on the best available information and supported by results from noise modelling, BEIS is satisfied that the proposed ION survey in-combination with other plans or projects will not have an adverse effect upon the integrity of the Berwickshire and North Northumberland Coast SAC nor the Humber Estuary SAC with respect to grey seal.

13 MITIGATION

13.1 The following section presents a summary of the planned mitigation submitted by the Applicant that will reduce the risk of an adverse effect occurring.

13.2 ION have committed to following the JNCC guidelines for *minimising the risk of injury to marine mammals from geophysical surveys* (JNCC 2017a, ION 2020). 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.
- Airguns will 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.

14 CONCLUSIONS

14.1 The Secretary of State has carefully considered all of the information available in order to undertake a Habitats Regulations Assessment. He considers the proposed ION 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, Berwickshire and North Northumberland Coast SAC and Humber Estuary SAC.

14.2 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.

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

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

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