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 2021

Issued April 2021
Rev 3.0

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1 INTRODUCTION

1.1 This is a record of the Habitats Regulations Assessment (HRA) undertaken by the Department for Business Energy and Industrial Strategy (BEIS) in respect of a planned seismic survey to be undertaken by GX Technology EAME Ltd / GX Technology Corporation (hereafter referred to as 'ION'.

1.2 This HRA covers a planned 3D seismic survey in Quadrants 34 - 38 and 40 - 44 off the east coast of England. The planned activities are presented in the application to carry out a marine survey GS/1163/0 (Version 1) and associated environmental assessment submitted to BEIS on 11 December 2020 (ION 2020a,b).

1.3 BEIS is the competent authority for applications submitted under the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (S.I. 2001/1754) (As Amended) (referred to as the Offshore Habitats Regulations).

1.4 BEIS recognises that there is potential for activities to impact on sites designated under the European Habitats 92/43/EC and Birds Directives 209/147 EC. Consequently, as the competent authority, BEIS has undertaken an assessment to determine whether the potential impacts from the proposed seismic survey as identified in the application may cause likely significant or adverse effects to the qualifying features of designated sites and thereby affect the integrity of the sites.

1.5 As part of the assessment, potential in-combination impacts from future plans or projects within the designated sites have been assessed to determine whether there is potential for likely significant or adverse effects on the integrity of the sites. The in-combination assessment may include potential future activities that are not the subject of any currently submitted projects or plans. By doing so it does not pre-empt the requirement to undertake HRA when future licence applications are submitted. It does not pre-determine any decision regarding future programmes or projects. However, where possible, it does provide a strategic overview of potential in-combination impacts from forecast activities.

1.6 This document presents the finding of the assessment undertaken by BEIS.

Habitats Regulations Assessment

1.7 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.

1.8 The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended) transposed the Directives into UK law for activities consented under the Petroleum Act 1998.

The Offshore Petroleum Activities (Conservation of Habitats) (Amendment) Regulations 2007 extended certain provisions of the 2001 regulations.

1.9 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*.

1.10 The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 make changes to three statutory instruments including the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (the Offshore Habitats Regulations), which is relevant to this assessment. The 2019 regulations ensure that the protection provided under the existing regulations, including the 2001 regulations remain as they were prior to the UK's exit of the EU. This includes the continued protection of designated sites along with their qualifying features and the requirement for a competent authority to undertake an assessment of any plans or projects that could impact on the sites or their features.

1.11 The Conservation of Habitats and Species Regulations 2017 (as amended) and The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) provide for the designation of sites for the protection of habitats and species of national importance; these sites are called Special Areas of Conservation (SACs). For the protection of birds, these sites are called Special Protection Areas (SPAs). Collectively, all existing and future SACs and SPAs form a national site network[1].

1.12 Possible SACs (pSACs), candidate SACs (cSACs) and potential SPAs (pSPAs) are afforded the same levels of protection by the UK Government as sites that have already been designated. Sites designated under the Ramsar Convention are also afforded the same level of protection as a designated site.

1.13 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/National Site unless there are imperative reasons of overriding public interest for carrying out the plan or project.

[1] Prior to 1 January 2021 national sites were referred to as European sites.

2 SURVEY DESCRIPTION

2.1 The following is a summary of the proposed ION 3D 2021 seismic survey, further details may be found within the application (ION 2020a,b).

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 the east coast of England. The planned survey is located within UKCS Blocks 35/21 - 35/25, 35/27 - 35/30, 36/ 16 – 36/30, 37/16 – 37/30, 38/16, 38/17, 38/18, 38/21,38/22, 38/23, 38/26, 38/27, 38/28, 41/1 – 41/10, 42/1 - 42/8, 43/1 – 43/7 and 44/1. The Greater Working Area covers approximately 21,344 km^2, with the Survey Area covering 12,627 km^2 (Figure 1).

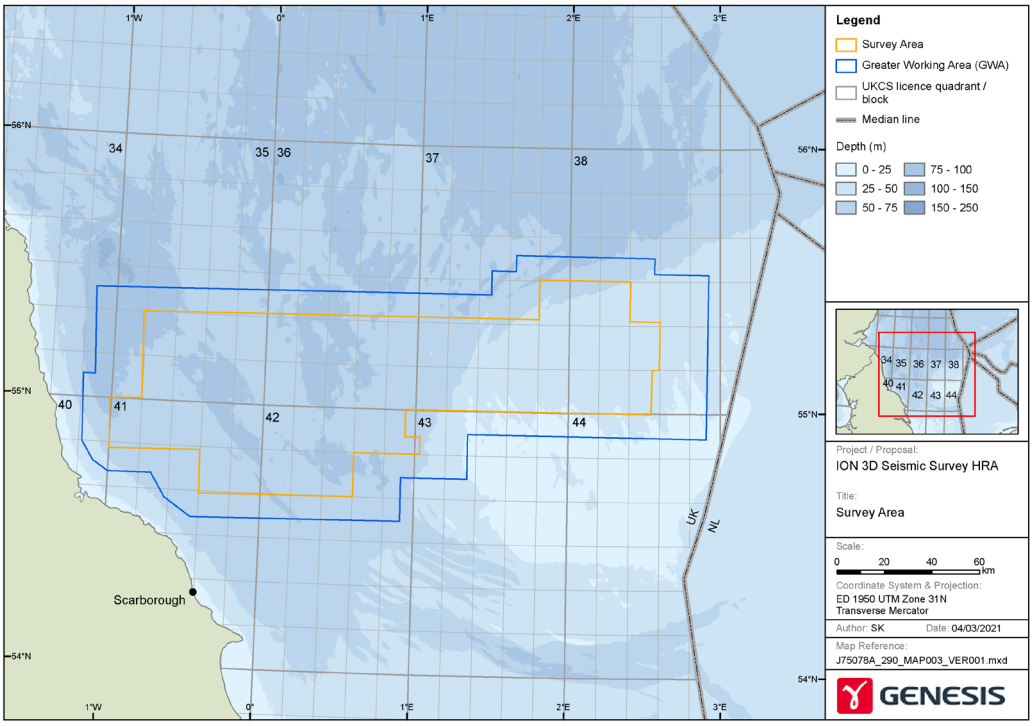

Figure 1: Location of the proposed ION 2021 3D seismic showing survey and greater working areas.

2.3 The survey was scheduled to take place between 1 April and 31 October 2021 and expected to last up to 165 days (ION 2020b). The proposed survey will now start in mid-April.

2.4 The proposed survey will be undertaken by a seismic survey vessel (*Amazon* Warrior) towing eight or ten 9,500 m streamers at a speed of between 4.5 knots (8.3 km/h) and 5 knots (9.3 km/h). The width of each towed survey array will be approximately 1,125 m and each surveyed line will be 563 m apart (ION 2020a,b). The total volume of airguns operated will be 3,390 cu. in. and be fired at intervals of every 5.4 or 7.2 seconds depending on the option chosen.

2.5 The total Greater Working Area is 21,344 km^2, although the Survey Area (the area within which airguns will be operating) is 12,627 km^2 (ION 2020a). 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 4,816 km, with a maximum length of any single line within the SAC of 73.3 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 April – 31 October 2021
Total duration of survey (days)	165
Greater Working Area (km^2)	21,344
Survey Area (km^2) [1]	12,627
No. of survey turns	145
Line spacing (m)	563
Consecutive line gap (km)	9.4 (18 km worse-case)
Line Direction	270^o – 90^o
Longest survey line (km)	227.5
Greater Working Area in SAC (km^2)	4,822
Survey Area in SAC (km^2)	2,718
Length of line in SAC (km)	4,816
Longest single survey line in SAC (km)	73.3

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 3,390 cu. in. airgun array is 255 dB re 1 µPa $_{(0\text{-}P)}$ at 1 m and for the 8,000 cu in. airgun it is 243 dB re 1 µPa $_{(0\text{-}P)}$ at 1 m.

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

Array Parameter	Array Option		
Arrays x sub-arrays	3 x 2	2 x 3	2 x 1
Total volume (cu. In).	3,390	3,390	8,000
Sound pressure - dB re 1 µPa (0-p)	254	255	243
Sound exposure level - dB re 1 µPa^{2}s	233	233	223
Pulse rate (Seconds)	5.4	5.4	7.2
Towed depth (m)	6	8	8
Vessel speed (knots)	4.5 - 5	4.5 - 5	4.5 - 5

3 DESIGNATED SITES

3.1 The proposed seismic survey is being undertaken in waters within or adjacent to several 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 out with 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).

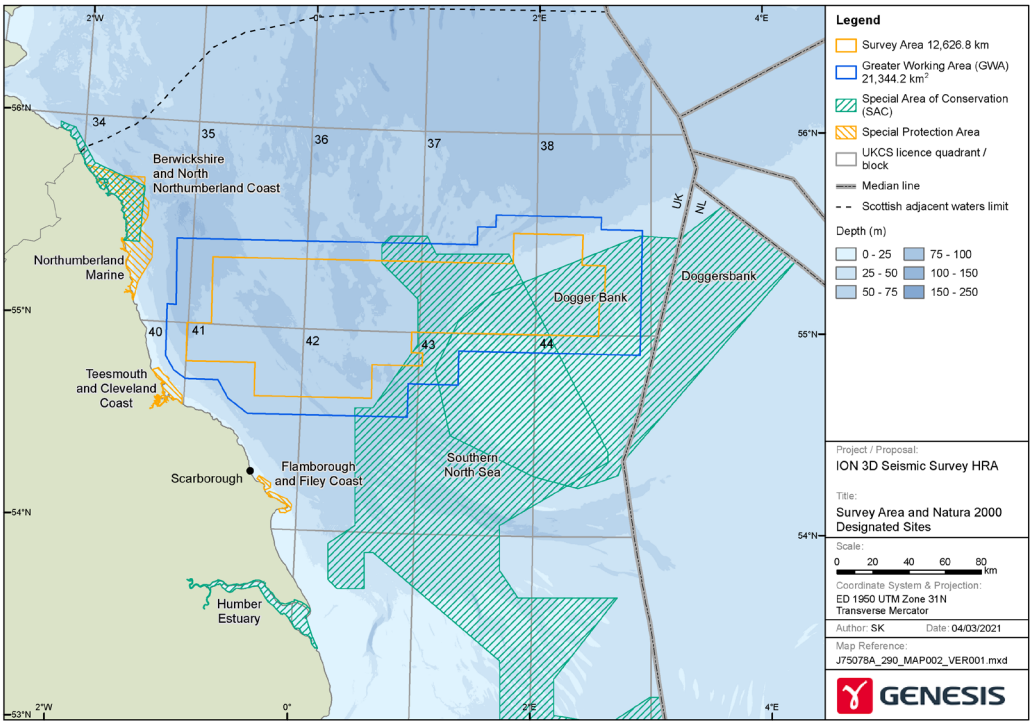

Figure 2: Location of proposed ION survey and relevant designated sites.

3.3 The qualifying sites and species relevant to this HRA:

- 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 – Dutch sector (Harbour porpoise, Grey seal, Common seal),
- Dogger Bank SAC – German sector (Harbour porpoise, 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 Sites identified as having qualifying features that could be impacted by the proposed survey and their distance from both the Greater Working and Survey areas are presented in Table 3.

Table 3: Designated sites identified as having qualifying features that could be impacted by the proposed survey.

Designated site	Distance from		Qualifying features
	Greater Working Area (km)	Working Area (km)	
Southern North Sea SAC	0	0	Harbour porpoise
Humber Estuary SAC	92	130	Grey seal, Sea lamprey, River lamprey
Berwickshire and North Northumberland Coast SAC	20	41.5	Grey seal
Doggersbank SAC (Dutch sector)	7	31.5	Harbour porpoise, Grey seal, Harbour seal
Dogger Bank SAC (German sector)	47	73.3	Harbour porpoise, Harbour seal
Flamborough and Filey Coast SPA	34	*c*.44	Gannet, Kittiwake, Herring gull, Puffin, Razorbill and Guillemot, plus seabird assemblage
Teesmouth and Cleveland Coast SPA	8	*c*.18	Little tern, Sandwich tern
Northumberland Marine SPA	13	*c*.23	Arctic tern, Common tern, Little tern, Roseate tern, Sandwich tern, Guillemot, Puffin, plus seabird assemblage

3.5 The proposed Greater Working Area overlaps 4,822 km^2 of the Southern North Sea SAC, equivalent to 12.8% 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 from the other designated sites listed above could occur within the Greater Working and Survey Areas.

3.6 The Greater Working Area overlaps a total of 4,741 km^{2}of the Dogger Bank SAC (UK sector). However, the site is designated for habitat features that will not be impacted by the proposed seismic survey.

Qualifying features

3.7 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

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

- Southern North Sea SAC,
- Doggersbank SAC.
- Dogger Bank (German sector) SAC.

3.9 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. 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).

3.10 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).

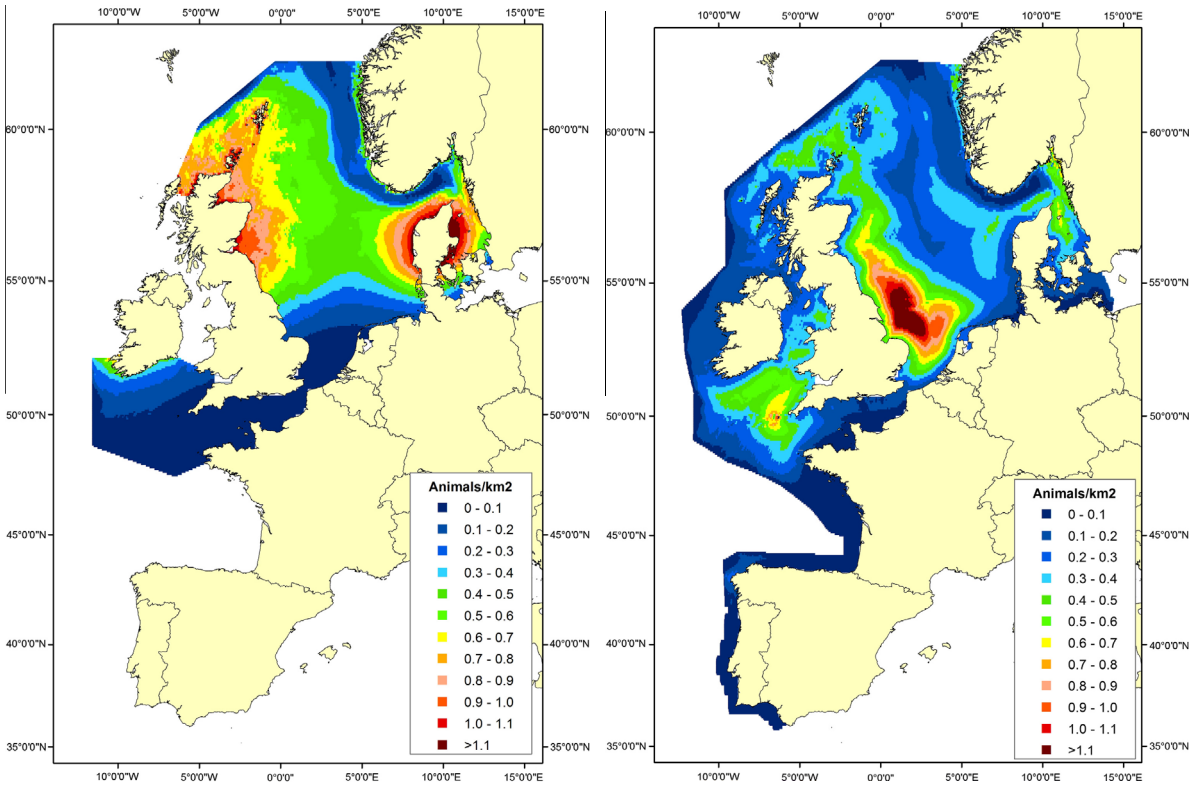

Figure a. Figure b.

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).

3.11 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).

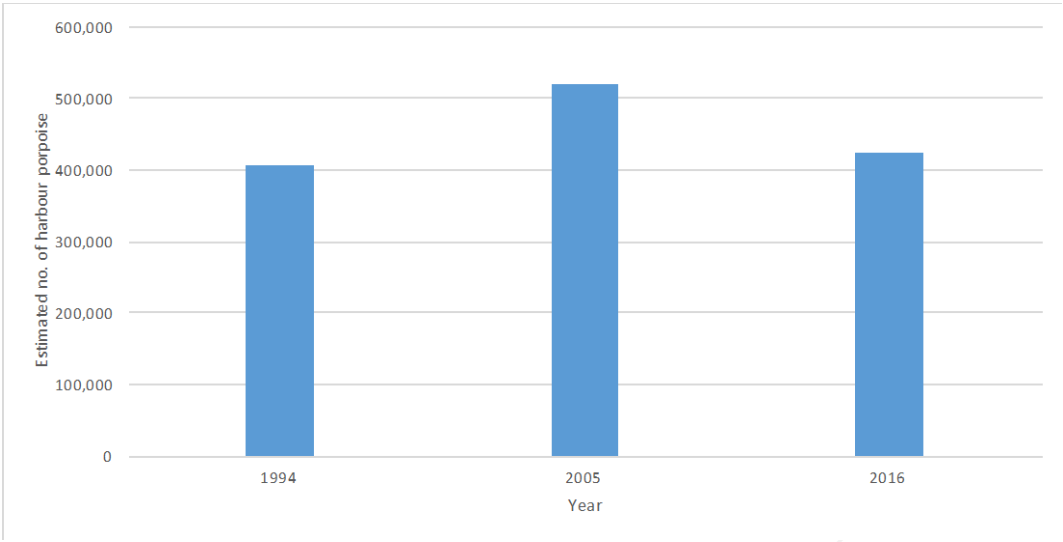

Figure 4: Estimated number of harbour porpoise within the SCANS survey area recorded during SCANS I, II and III surveys (Hammond *et al.* 2017).

3.12 There are three Management Units identified for harbour porpoise in the north-east Atlantic, of which, the Southern North Sea SAC, the Doggersbank SAC and the German Dogger Bank SAC lie within the North Sea Management Unit. The harbour porpoise population within the North Sea Management Unit was originally estimated to be 227,298 (176,360 – 292,948) 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).

3.13 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.

3.14 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.

3.15 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).

3.16 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 5a). 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 5b) (Heinänen and Skov 2015). A winter survey undertaken across the Central North Sea in November 2011 reported an average density across the whole surveyed area of 0.63 ind./km^2 (Cucknell *et al*. 2016).

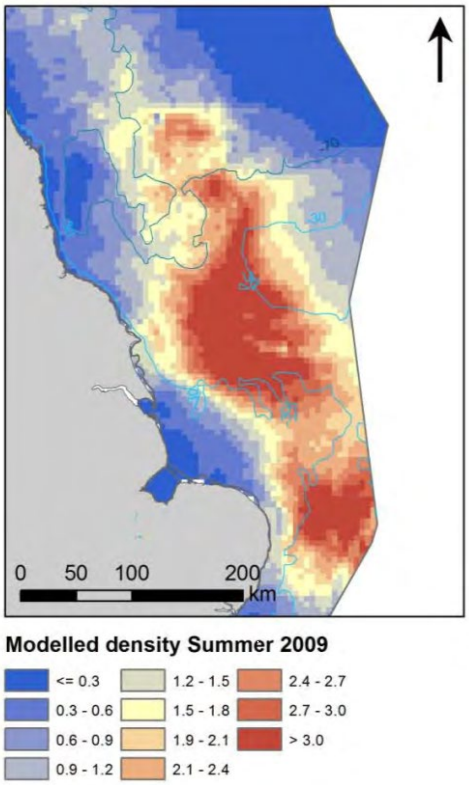

Figure a.

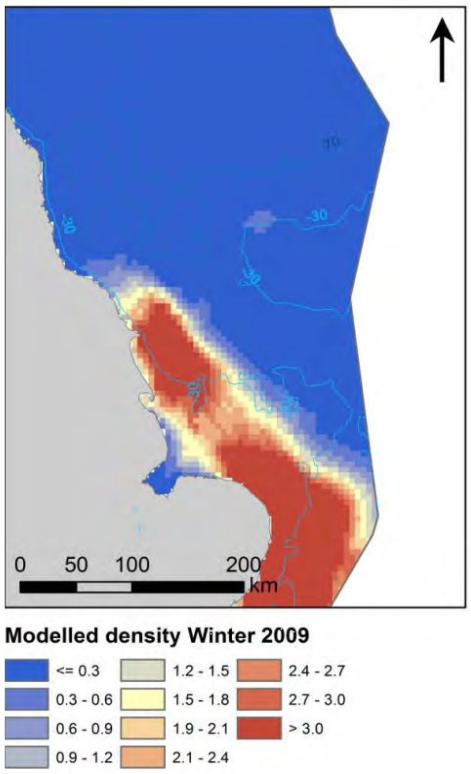

Figure b.

Figure 5: 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).

3.17 Surveys undertaken across the southern North Sea, including areas within and encompassing the SAC, have reported lower densities of harbour porpoise than modelled estimates. 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).

3.18 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. Individuals tagged in Danish waters were recorded off the east coasts of England and Scotland (Sveegaard 2011).

3.19 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).

3.20 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).

3.21 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.

3.22 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).

3.23 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).

3.24 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.

3.25 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).

3.26 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.

3.27 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

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

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

3.29 Grey seals occur widely around the waters off eastern England with most 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 6,288 grey seals, giving an estimated population of 15,028[2] (SCOS 2019).

[2] 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).

The latest count for the Berwickshire and North Northumberland Coast SAC is 6,427 individuals (SCOS 2019) and therefore an estimated population of 15,360 individuals.

3.30 Their distribution offshore comprises predominantly of short-range return trips from haul-out sites to local foraging areas (Figure 6). 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).

3.31 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 6). 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).

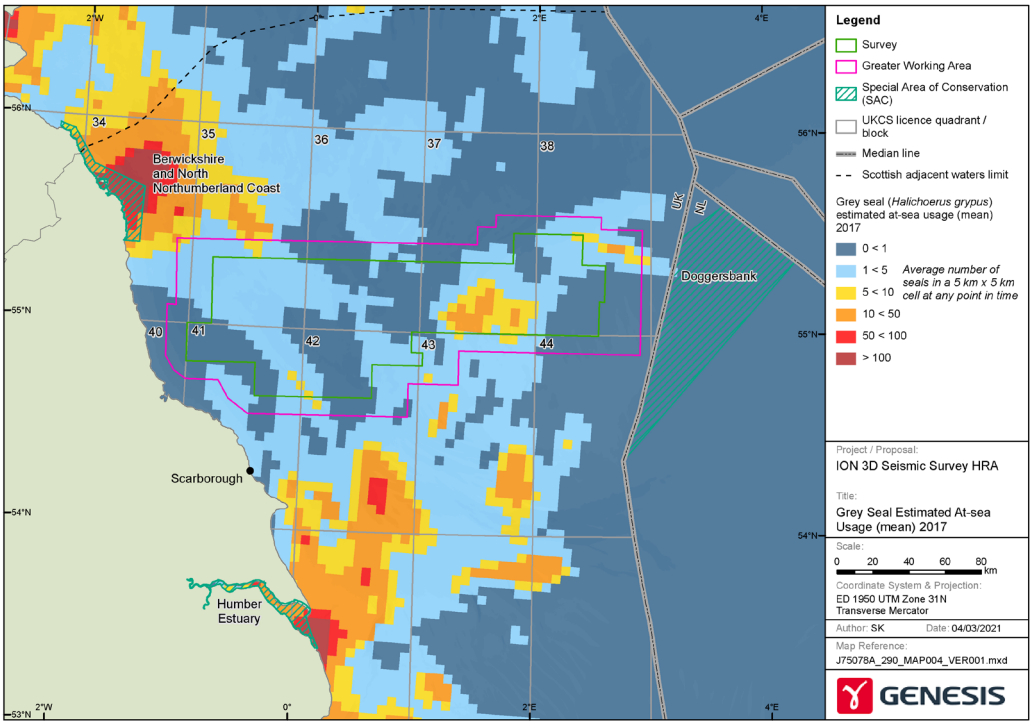

Figure 6: Distribution of grey seals in waters off Eastern England.

3.32 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). 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,
- Dogger Bank SAC (German sector).

3.35 Harbour seals occur widely around the waters off eastern England and in Dutch waters with most activity in the nearshore waters (Figure 7 and Figure 8). 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.

3.36 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 7. 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 8). Longer movements offshore occurred primarily between December and March (Aarts *et al*. 2016). Similarly, in Danish waters, between May and August nearly all harbour seals are close to their breeding sites with adults in particular remaining in the proximity of their breeding sites throughout the year. Non-adult harbour seals have been shown to range more widely, particularly between December and April (Dietz *et al*. 2013).

3.37 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 cephalopods (SCOS 2015).

3.38 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.

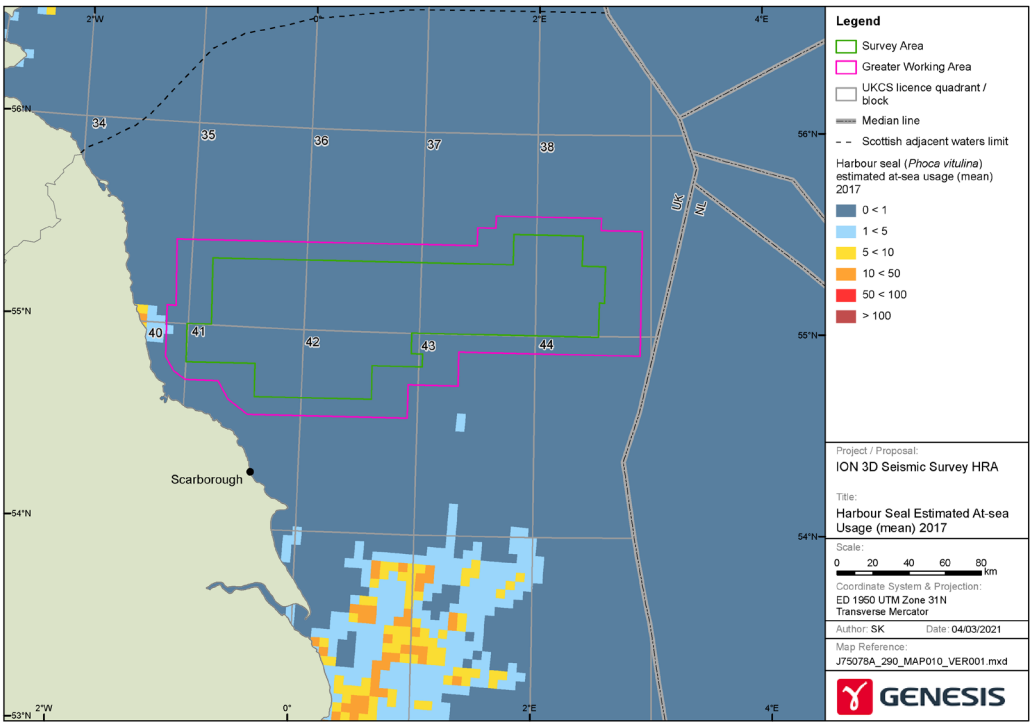

Figure 7: Distribution of harbour seals in waters off Eastern England.

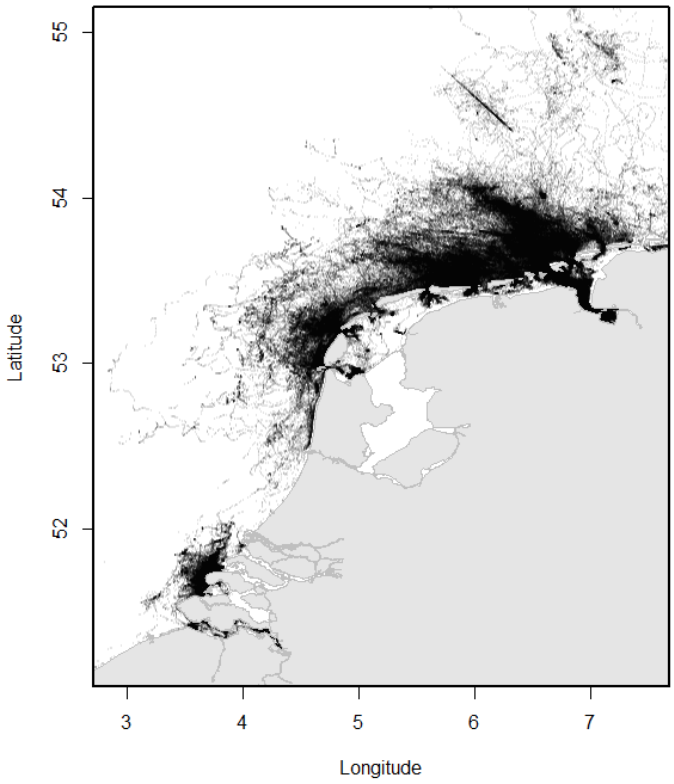

Figure 8: Distribution of tagged harbour seals in Dutch waters (Source: Aarts *et al*. 2016).

Seabirds

3.39 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 4 (Woodward 2019).

3.40 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:

- 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).

3.41 It is also recognised that seabirds from other SPA colonies may also occur in the proposed Survey Area, particularly those with extensive foraging ranges, e.g. gannet, or 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.

3.42 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 4: 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

3.43 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 (Garthe *et al.* 2000, Ropert-Coudert. 2009, Cox *et al*. 2016). Surface feeders spend relatively longer periods of time below the sea surface. In shallow waters guillemots have been reported to 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 5 for reported dive durations for a range of relevant species.

Table 5: Reported seabird dive durations.

Species	Average dive duration (seconds)
Tern Spp.	1 to 2 [1]
Gannet	4.6 to 6 [2, 6, 8]
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, 8 - Garthe *et al.* 2000.

3.44 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).

3.45 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)

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

3.47 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.

3.48 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).

3.49 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.

3.50 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

3.51 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 2019).

3.52 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).

3.53 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).

3.54 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).

3.55 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).

3.56 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).

3.57 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.

3.58 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).

3.59 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).

3.60 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

3.61 This HRA draws on several information sources relating to the proposed project and the site designation which should be read in conjunction with this report including,

- ION (2020a). ION UKCS Southern North Sea 3D Seismic Survey. ION Geophysical Corporation. 9 December 2020.
- ION (2020b). Application to carry out a Marine Survey. Application GS/1163/0 (Version 1). GX Technology EAME Ltd. 11 December 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 (2020a).
- 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).

3.62 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), OSPAR (2009) and Erbe *et al*. (2018).

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: 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, based on the SEL metric, there is no risk of PTS to harbour porpoise from the use of the 8,000 cu in airgun array. If either of the 3,390 cu in airgun arrays are used without a soft-start, the onset of PTS could arise to within 24 m and 25 m depending on the option selected. This is reduced to below levels at which the onset of PTS is predicted to occur when a soft-start is undertaken (ION 2020a).

5.4 The onset of PTS in pinnipeds only arises within 32 m and 33 m of the airgun when a 3,390 cu. in. airgun arrays are operated without a soft-start. This is reduced to 10 m when a soft-start is undertaken. For all other airgun options PTS is not predicted to occur (ION 2020a).

5.5 The results from the modelling indicate that there is a risk of behavioural effects, e.g. displacement and disturbance to a harbour porpoise from within an area of between 1.2 km and 2.4 km, based on the use of a 8,000 cu. in. airgun (ION 2020a)[3].

5.6 Injury to fish is expected to arise between 8 m and 145 m depending on species group and behavioural impacts out to 603 m depending on the airgun array (ION 2020a).

5.7 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.

5.8 Noise modelling has been undertaken for BEIS to assess the potential impacts to harbour porpoise from a seismic survey within the Southern North Sea SAC (BEIS *in prep.,* 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 and but a higher maximum SPL of 261 compared with 255 dB *re* 1 μPa^2s $_{(0\text{-peak})}$ from the 3,390 cu. in. airgun option in the ION application. The results from both sets of noise modelling for harbour porpoise are presented in Table 7.

[3] The applicant defines disturbance as 'strong' disturbance where there will physical displacement at 165 dB re 1 µPa (SPLpk-pk) and 'mild' disturbance at levels of 145 dB re 1 µPa2s (SEL single pulse).

Table 6: Harbour porpoise estimated areas of physical injury and disturbance.

Harbour porpoise	ION (3,390 cu. in. airgun)		BEIS (3,220 cu. in. airgun)	
	Distance (m)	Maximum area (km^2)	Distance (m)	Maximum area (km^2)
PTS (no soft-start)	25	0.002	-	-
PTS (with soft-start)	0	0	320	0.32
Disturbance	2,400	18.09	7,800	301

PTS SEL Threshold weighted 155 re 1 μPa^2s.
'mild' disturbance - 145 dB re 1 $\mu Pa_{(rms)}$.

5.9 Noise modelling to assess potential impacts to grey seals from seismic surveys has not previously been undertaken by BEIS in the proposed survey area. 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 $\mu Pa^2s_{(0\text{-peak})}$ compared to 255 dB *re* 1 $\mu Pa^2s_{(0\text{-peak})}$. Consequently, a larger area of potential impact might be predicted by the modelling previously undertaken for BEIS.

5.10 The results from the two sets of noise modelling undertaken for grey seal are presented Table 7.

Table 7: Grey and harbour seal estimated areas of physical injury and disturbance.

Pinneped	ION (3,390 cu. in. airgun)		BEIS (5,000 cu. in. airgun)	
	Distance (m)	Maximum area (km^2)	Distance (m)	Maximum area (km^2)
PTS (no soft-start)	33	0.003	-	-
PTS (with soft-start)	10	0.0003	99	0.031
Disturbance	2,000	12.566	17,000	383

PTS SEL Threshold weighted 185 re 1 μPa^2s.
'mild' disturbance - 160 dB re 1 $\mu Pa_{(rms)}$.

Potential impacts on harbour porpoise

5.11 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 0 and 320 m from the airguns (Table 6).

5.12 There is potential for levels of noise at which disturbance could occur to extend from between 2.4 km and 7.8 km from the airguns and encompass an area of between 18.9 km^2 and 383 km^2 (Table 6).

Potential area of impact on grey and harbour seals

5.13 The results from the modelling indicate that noise levels that have the potential to cause the onset of auditory injury (PTS) to seals will occur between 10 m and 99 m from the airguns (Table 7).

5.14 There is potential for levels of noise at which disturbance could occur to extend between 2.0 km and 17.0 km from the airguns and encompass an area of between 12.56 km^2 and 383 km^2 (Table 7).

Potential impacts on fish

5.15 Results from the noise modelling undertaken by ION for the application and previously by BEIS are presented in Table 8. Noise levels that have the potential to cause mortality to fish species with swim bladders could occur from between 46 m and 302 m. For fish without swim bladders, e.g. Lampreys, mortality could occur from between 31 m and 140 m from the seismic survey (OGA 2016, ION 2020a).

Table 8: Maximum distances at which mortality and disturbance 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** All species	**Disturbance** All species
ION	46	31	46	603
BEIS	302	140	302	-

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

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

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 Southern North Sea SAC (JNCC 2017d,e; JNCC 2020a). 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 9 (JNCC 2020a). Relevant to this assessment is the EDR for seismic surveys which is 12 km. This is based on recent evidence indicating that harbour porpoise can be displaced up to 12 km from seismic survey (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 9: Precautionary Effective Deterrent Ranges (EDR) (Source: JNCC 2020a).

Activity	Effective Deterrent Range (km)
Monopile	26
Unexploded Ordnance	26
Pin-pile [1]	15
Monopile with noise abatement	15
Conductor piling	15
Seismic survey	12
High Resolution Geophysical Surveys	5

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

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 and NE 2019).

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 SAC 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 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 can 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 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*' (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 2020a). 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 2020a).

7.15 The potential extent of noise causing disturbance that would meet these proposed thresholds and therefore impact on the integrity of the site is presented in Table 10. 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 10: 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 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 fully adopted by all 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 2018).

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).

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

7.22 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).

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

Doggersbank SAC

7.24 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).

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

Dogger Bank (German sector) SAC

7.25 The Dogger Bank (German sector) SAC lies within German waters encompassing an area of 1,698 km^2. The site became a SAC in 2010. Qualifying species for the site include harbour porpoise and harbour seal (BfN 2010).

Dogger Bank (German sector) SAC Conservation Objectives

• Maintain and restore the site's specific ecological functions, biodiversity and natural hydrodynamics and morphodynamics.

• Maintain at and restore to favourable conservation status habitat type 1110 (sandbanks which are slightly covered by sea water all the time) together with its typical and endangered species and ecological communities.

• Maintain at and restore to favourable conservation status the following Habitats Directive species and their natural habitats: harbour porpoise and common seal.

Source: BfN. 2010

Flamborough and Filey Coast SPA

7.26 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

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

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

Northumberland Marine SPA

7.29 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.

7.30 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 20 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 2020a). (Table 11 and Figure 9). Two wind farms (Triton Knoll and Hornsea Two) are currently undertaking offshore construction. 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 Belgium, the SeaMade wind farms: Mermaid and Seastar are under construction. However, all the monopile foundations have been installed.

Table 11: Offshore wind farms located within 26 km of the Southern North Sea SAC.

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

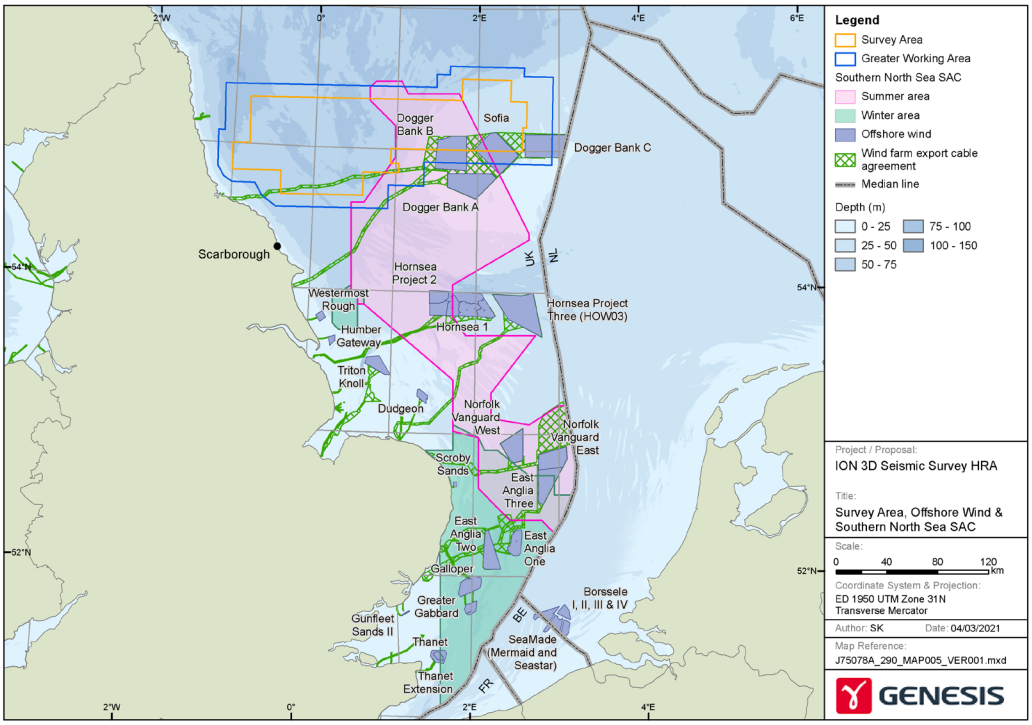

Figure 9: Offshore wind farms located within 26 km of the Southern North Sea SAC.

8.6 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. Of the offshore wind farms that are relevant to the in-combination assessment the Hornsea Two offshore wind farm could be pile-driving during the period of the proposed seismic survey in 2021 (Ørsted 2020). The Triton Knoll offshore wind farm has completed installing the foundations and therefore no further pile-driving is anticipated.

8.7 Other offshore wind farm activities that could cause an impact on qualifying features include the clearance of UXO and geophysical surveys. An application has been submitted to the Marine Management Organisation to undertake the clearance of up to 25 items of UXO at the Dogger A and Dogger B wind farms, including export cable routes, between May and December 2021 (DBWF 2021, MMO 2021).

8.8 No consent is required by the offshore wind farm industry for undertaking geophysical surveys. Consequently, there is no information available regarding potential geophysical surveys that could cause an in-combination impact. However, the Supporting Environmental Information submitted by Dogger Bank Wind Farm in support of the proposed UXO clearance being undertaken at Dogger A and Dogger B wind farms, reports up to six geophysical surveys to be undertaken at Dogger A, B and C, Sofia and at Hornsea Three and Hornsea Four during 2021.

There is little or no published information on when, where or how the six proposed geophysical surveys will be undertaken.

Cable laying activity

8.9 The Viking Link project is a high voltage direct current (HVDC) electrical interconnector between Denmark and the UK. The 762 km long cable will be laid between Jutland in Denmark and Bicker Fen in Lincolnshire and crosses the Southern North Sea SAC (NGVL 2018a). Four items of unexploded ordnance were identified along the cable route within 26 km of the Southern North Sea SAC boundary, of which one was in the SAC; these were to be cleared in 2020. No other UXO clearance activities are associated with this project are known of (NGVL 2018b, NGVL 2019, MMO 2020).

Aggregate and dredging activity

8.10 Existing localised aggregate dredging occurs primarily in the southern half of the SAC, along the east coast (Figure 10). 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.

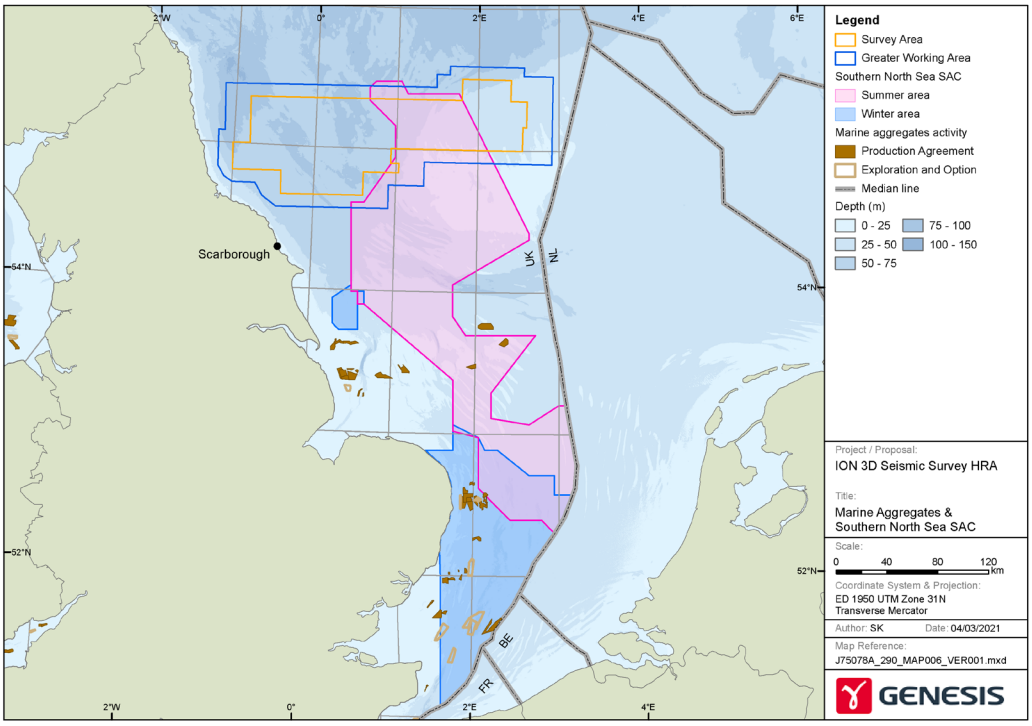

Figure 10: Existing marine aggregate activities in the Southern North Sea SAC.

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

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

Oil and gas activity

8.13 There is 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 in the 'summer' area of the site (Figure 11) (OGA NDR 2020).

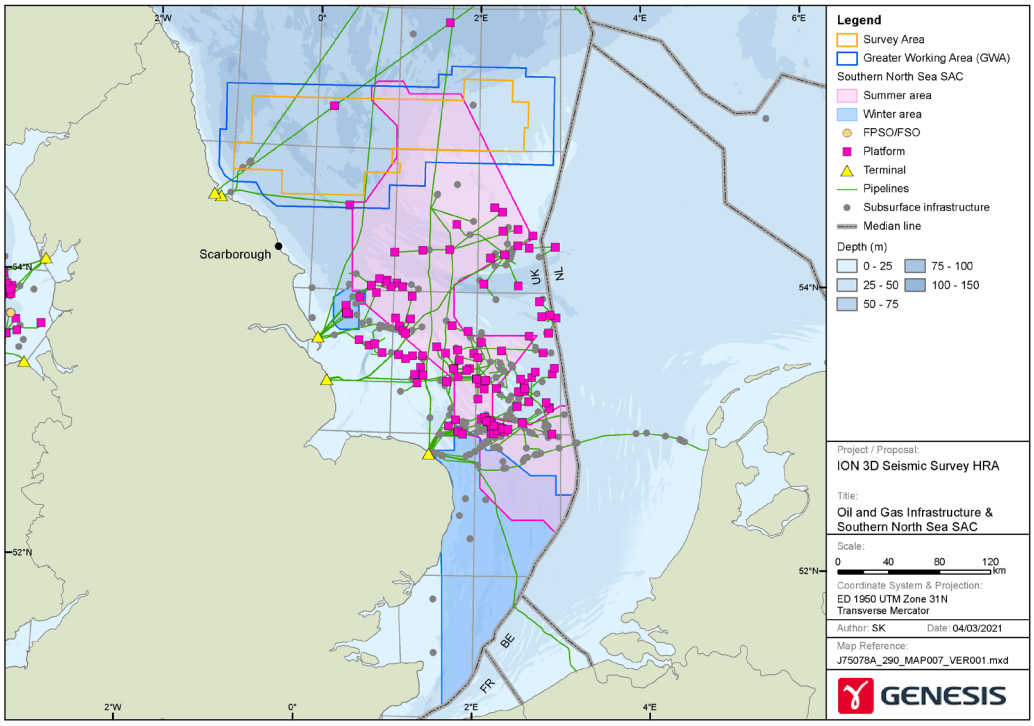

Figure 11: Existing oil and gas infrastructure within the Southern North Sea SAC.

8.14 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.

8.15 BEIS are aware of a number of planned oil and gas related activities within the area during the period the proposed survey will be undertaken that could cause an in-combination effect including a geophysical survey in Blocks 42/3, 32/38 and 43/13 (Table 12).

8.16 The proposed operations include drilling activities. Noise from drilling activities is largely dependent on the type of drilling platform being used. Jack-up rigs are the most frequently used drilling platform in the Southern North Sea and produce the lowest levels of sound. Studies in Danish waters reported sound source levels of 148 re 1µPa-m $_{(rms)}$ from drilling activities undertaken from a fixed platform (Bach *et al.* 2010). The level of sound arising from drilling is relatively low and occurs predominantly at a low frequency and is a continuous sound source (Greene 1987; McCauley 1998; Nedwell and Edwards 2004). Sound arising from drilling is outwith the main hearing frequencies for harbour porpoise.

8.17 Studies using Passive Acoustic Monitoring (PAM) at platforms located on the Dogger Bank did not record any decrease in harbour porpoise activity at the platforms when drilling was being undertaken and indicated that harbour porpoises appeared to use oil and gas platforms as

feeding refuges (Todd *et al.* 2007, Todd *et al*. 2009). Similar results have been reported from studies undertaken at two platforms in Danish waters (Bach *et al.* 2010).

8.18 The placement of oil and gas infrastructure will be undertaken using vessels and is not predicted to cause any significant increase in the level of vessel activity within the SAC above which currently occurs within the site.

Table 12: 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
Shell	DR/2081/0	48/20	15 April 2021 (application)	Drilling at Galleon field.
Chrysaor	CL/1150/0	49/17	26 February 2021 – 30 September 2021	Location of mobile drilling unit.
IOG	CL/1168/0	49/21	13 April 2021 (application)	Location of permanent installation.
Perenco	CL/1157/0	49/27	21 February 2021 – (application)	Location of permanent installation.
ENI	ML/668/0	48/30	1 April 2021 (application)	Marine licence
Chrysaor	GS/1187/1	49/12	3 March 2021 – 30 April 2021	Marine Survey (SSS and MBES)
Geoex	GS/1199/0	multiple	10 June – 30 Sept 2021	Marine Survey (2D)

MBES = Multi-beam Echosounder, SSS = Side-scan Sonar.

8.19 There is one application (GS/1190/0) to undertake a geophysical survey across a wider area of the central and northern North Sea (EPI 2021). Two lines of the survey will cross the Southern North Sea SAC. The survey was originally planned to start in April 2021 but has been delayed and will start on 10 June 2021 and be completed by 30 September 2021. An HRA for the proposed survey has still to be undertaken and a consent decision has yet to be determined. However, there is potential for an in-combination impact with the proposed ION survey.

Shipping

8.20 Impacts from shipping on harbour porpoise within the SAC have been identified as arising from shipping noise and collision impacts. Shipping noise is the predominant anthropogenic source of noise within the marine environment and is reported to have a negative effect on harbour porpoise within the SAC when vessel traffic exceeds 80 vessels per day (Heinänen and Skov 2015). Shipping has been on-going in the southern North Sea for many hundreds of years and the area is important for shipping, with relatively high numbers of vessels occurring within it. Based on vessel track lines, in 2015 a total of 269,018 vessels track lines were recorded transiting across the SAC; an average of 737 vessels per day (MMO 2017a).

8.21 The level of vessel activity across the 'summer' and 'winter' areas of the SAC differs (Figure 12). There is relatively widespread vessel activity in low densities across the 'summer' area, with 76% of the quadrants having less than seven vessels per week and 17% having less than one vessel per week. Compared with the 'winter' area of the SAC where 14% of the quadrants had, on average, less than seven vessels per week and only 1% had less than one vessel per week. In contrast 11% of the 'winter' area had more than 70 vessels per week compared with none in the 'summer' area. The areas with relatively higher levels of shipping (>24 vessels per day), occur over 4% of the 'winter' area. Therefore, the 'winter' area has relatively localised, higher density, areas of vessel traffic compared with the 'summer' area that has widespread but low-density vessel traffic.

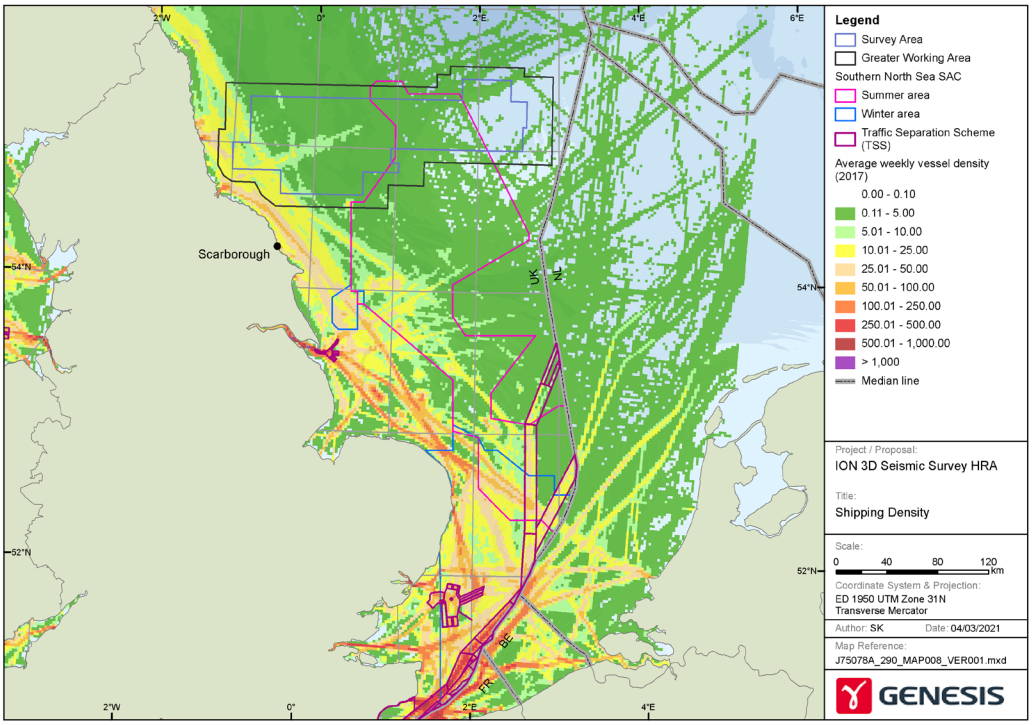

Figure 12: Shipping density within the SAC during 2017.

Fishing activity

8.22 Fishing occurs widely across the southern North Sea and has also been on-going in the area for many hundreds of years. Most 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 13) (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.

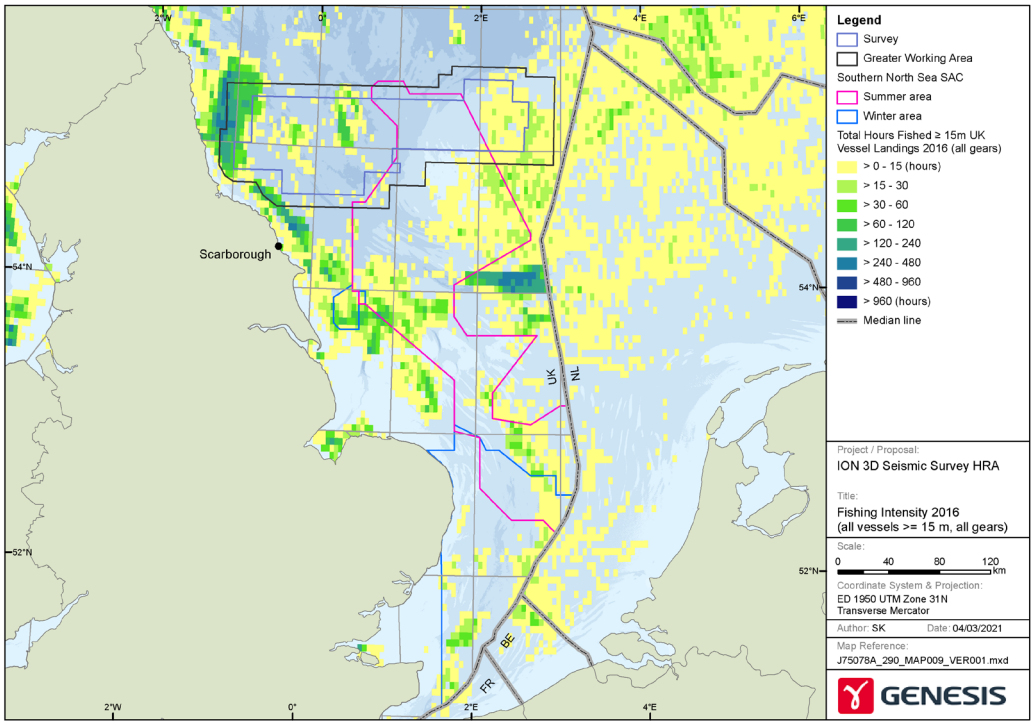

Figure 13: Fishing intensity across the SAC during 2016 by UK registered vessels

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

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

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:

- Construction pile-driving at Hornsea Two offshore wind farm,
- UXO clearance at Dogger A and Dogger B offshore wind farms,
- Geoex Seismic Geophysical Survey,
- Geophysical Survey at Dogger A offshore wind farm,
- Geophysical Survey at Dogger B offshore wind farm,
- Geophysical Survey at Dogger C offshore wind farm,
- Geophysical Survey at Sofia offshore wind farm,
- Geophysical Survey at Hornsea Three offshore wind farm,
- Geophysical Survey at Hornsea Four offshore wind farm.

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 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 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 and the Dogger Bank SAC (German Sector).

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 7.8 km from the airguns and extend over an area of 301 km^2 (Table 6).

9.6 The Doggersbank SAC is 7 km from the Greater Working area and 31.5 km from the proposed 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 The Dogger Bank (German sector) SAC lies 47 km from the closest boundary of the proposed surveys Greater Working Area and 73.3 km form the Survey Area. This is beyond the range at which disturbance from the seismic survey is predicted to impact on harbour porpoise and

therefore harbour porpoise within the SAC will not be impacted and the proposed seismic survey will not cause a likely significant effect.

9.8 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

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

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

9.11 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 7).

9.12 Based on the results from noise modelling, the known offshore distribution of grey seals (Figure 6) 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.

9.13 The Doggersbank SAC is 31.5 km from the Survey Area and therefore beyond the range noise from the seismic survey is predicted to cause disturbance within the site (Table 7). Consequently, the proposed seismic survey will not cause a likely significant effect on grey seals in the Doggersbank SAC.

Harbour Seal

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

9.15 Harbour seals are a qualifying species for the Doggersbank SAC and the Dogger Bank(German sector) SAC.

9.16 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 383 km^2 (based on combined worst-case modelling outputs) (Table 7).

9.17 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.

9.18 The Doggersbank SAC is 31.5 km from the Survey Area and the Dogger Bank (German sector) SAC lies 73.3 km from the survey area. Consequently, noise from the proposed seismic survey is not predicted to cause disturbance to harbour seals within the SACs for which they are a qualifying feature.

9.19 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 or the Dogger Bank (German sector) SAC.

Sea Lamprey and River Lamprey

9.20 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.

9.21 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 can 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).

9.22 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 8). 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 s greater. Modelling undertaken by the applicant indicates disturbance to fish will occur out to 603 m (ION 2020a).

9.23 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 and disturbance out to 603 m. 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

9.24 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 4). Out with 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.

9.25 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.

9.26 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).

9.27 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.

9.28 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.

9.29 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.

9.30 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.

9.31 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

9.32 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

9.33 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.

9.34 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 2018).

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 two sets of 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. The extent and duration of the survey is then measured against 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 6).

10.7 The peak harbour porpoise density across the SAC is estimated to be >3 per km^2 (Figure 5) (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 7.8 km from the airguns, covering an area of 301 km^2 (Table 6). If disturbance occurs entirely within the SAC, then approximately 0.8% of the SAC as a whole and 1.1% 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 903 harbour porpoise could be disturbed by a seismic survey. This is equivalent to 0.3% 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 between 4.5 and 5 knots (8.4 - 9.26 km/h) (ION 2020a,b). As the vessel undertakes a survey, disturbance in any area will last no more than two hours in any one location (Figure 14). 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 will be temporary, with porpoises predicted to return to the area impacted within 24 hrs.

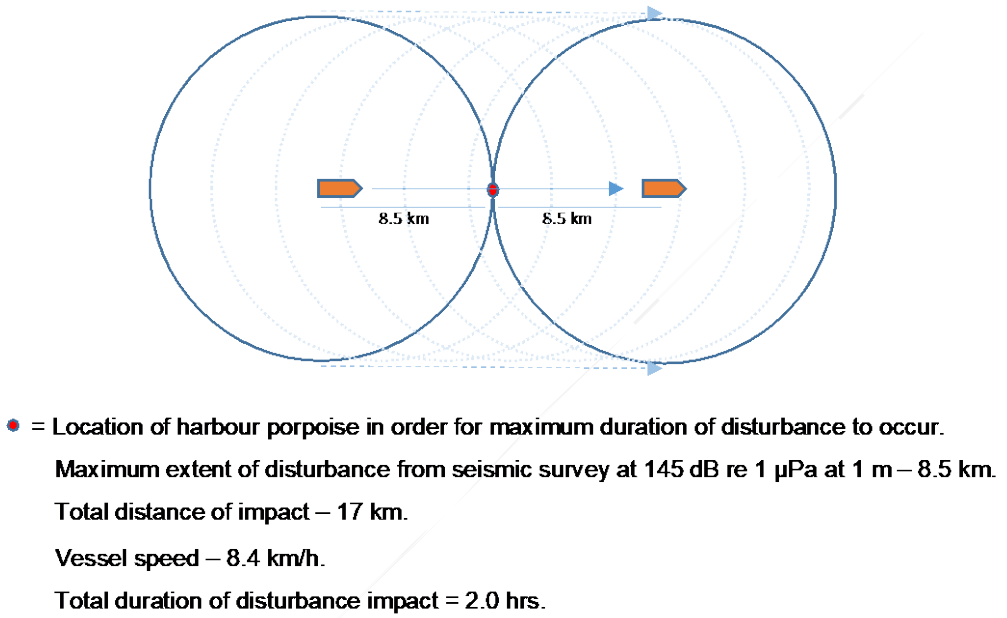

Figure 14: Diagram showing potential maximum duration of disturbance to harbour porpoise from seismic survey.

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 (the extent of the EDR). 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 15).

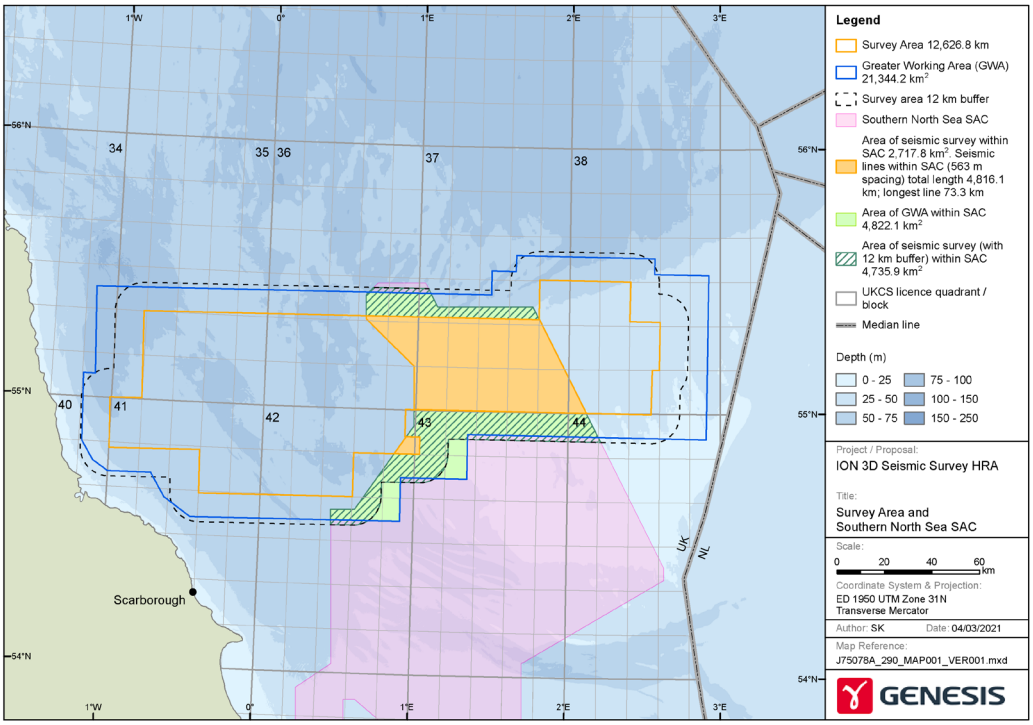

Figure 15: Area of seismic survey within the Southern North Sea SAC.

Daily Threshold

10.17 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 4,822 km^2 of the Greater Working Area is within the Southern North Sea SAC[4] and therefore overlaps 13.0% of the SAC as a whole and 17.8% of the 'summer' area. However, airguns will only be operating within the Survey Area and, aside from the period when soft-start is undertaken, the airguns will not be operating in the wider Greater Working Area. The area of seismic survey to be undertaken within the Survey Area and within the SAC is 2,718 km^2 (Figure 15). The Survey Area overlaps with 7.3% of the SAC as a whole and 10.1% of the 'summer' area.

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

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.

10.19 When undertaking the seismic survey, the vessel will be travelling at a maximum speed of 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 16). This presumes that airguns are operating continuously throughout a 24 hr period. This is an unrealistic scenario as there will be breaks of approximately 3.5 hrs in airgun operations at the end of each line as the vessel turns before commencing the next line (ION 2021); consequently, airguns will not be operating throughout a 24 hr period. Furthermore, approximately 77% of the Greater Working Area and 79% 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.

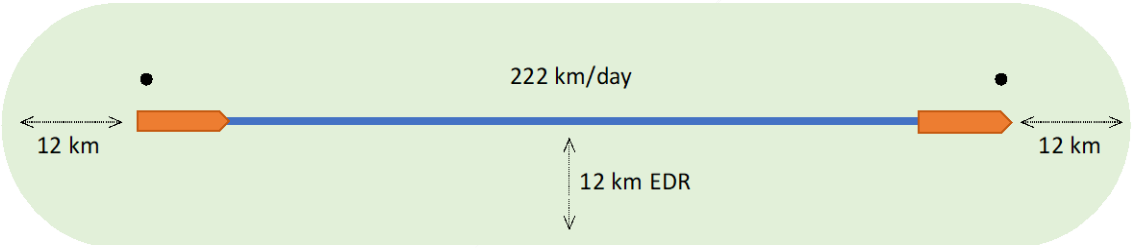

Figure 16: Worst-case theoretical area of impact from a seismic survey travelling at 5 knots, using 12 km EDR.

10.20 Based on the configuration of the planned survey route (Figure 15), the length of the longest survey line is 227 km. However, the survey line with the greatest extent within the SAC is slightly shorter with a total length of 217 km; of which 73.3 km is within the SAC. It is therefore highly likely that the survey will traverse the SAC only once during any one 24 hr period (Figure 17). The average length of line surveyed each day within the SAC is estimated to be 29 km[5].

10.21 The maximum area within the SAC that will be impacted per day is estimated to be 1,759 km^2. This is equivalent to impacting 4.7% of the SAC as a whole and 6.5% of the 'summer' area per day. Consequently, the daily threshold will not be exceeded by the proposed seismic survey on its own.

10.22 This scenario assumes that the airguns are operating over a period of 24 hrs during any single day with airguns not switched off and no line turns being undertaken. It also assumes that the

[5] The total length of line within SAC is estimated to be 4,816 km to be undertaken over a period of 165 days. Consequently, the average length of line per day within the SAC is 29 km, covering an area of 696 km^2 per day.

vessel will travel no faster than 5 knots when undertaking the survey. It is therefore considered to be realistic worst-case scenario based on the information presented within the application.

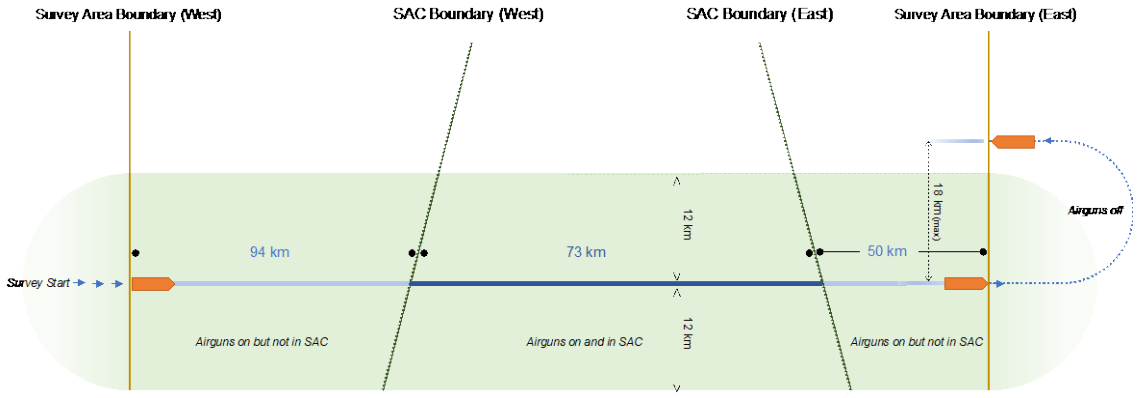

Figure 17: Maximum area of impact over 24 hrs from proposed ION seismic survey within the Southern North Sea SAC.

Seasonal Threshold

10.23 The survey is planned to commence on 1 May 2021 and be completed by 1 October 2021 and be undertaken over a period of 165 days. Consequently, the survey will occur throughout the 153 days of the summer period between 1 May and 30 September.

10.24 In order to assess the seasonal spatial overlap, it is presumed that the survey will start no earlier than 1 May 2021 and last for the whole of 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 summer period.

10.25 The maximum realistic daily area impacted within the SAC of 1,759 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 165 survey 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. 29 km: an area of 696 km^2, over 153 days.

10.26 Based on the daily average impact the seasonal threshold would be 2.1% of the SAC and therefore the seasonal threshold is not exceeded by the proposed survey (Table 13).

Table 13: 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 - 156 days in summer period)				
'summer'	1,759	6.5	153	5.4
Realistic worst-case (Mean daily impact 156 days in summer period)				
'summer'	700	2.6	153	2.2

Conclusion

10.27 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.

10.28 There is a risk of harbour porpoise being displaced or disturbed by the proposed seismic survey. Noise modelling indicates that up to 903 harbour porpoise may be disturbed at any one time; this is 0.3% 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 approximately 24 hrs.

10.29 The results from the threshold approach indicate that up to 6.5% of the 'summer' area may be impacted each day and 2.2% of the seasonal threshold. The daily and seasonal thresholds are not exceeded.

10.30 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.

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

Berwickshire and North Northumberland Coast SAC and Humber Estuary SAC

Grey seal

10.32 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.

10.33 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 6)[6]. Over the majority of the Survey Area densities of grey seals are relatively low with higher areas of usage over the UK sector of the Dogger Bank.

Physical Injury

10.34 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 7). 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).

10.35 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

10.36 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 2 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.

10.37 The Berwickshire and North Northumberland Coast SAC lies 53 km from the Survey Area and the Humber Estuary SAC lies 130 km away. Approximately 98% 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

[6] Note: the applicant has assessed based on a peak density of grey seals within the Greater Working Area of 1.36 ind./km^2 (ION 2020a). Consequently, the number of grey seals estimated to be within the Greater Working Area is 28,600 individuals which is larger than the grey seal populations at either of the two SACs. Based on the known SAC populations and the results from the tracking studies (Figure 6), the estimates derived from this density is unrealistically high and densities from other sources (e.g. Forewind 2013) have been used for the purposes of this assessment.

and Figure 6) being disturbed across the proposed Survey Area an estimated 139 grey seals could be disturbed.

10.38 The estimated grey seal population for the Berwickshire and North Northumberland Coast SAC is 15,360 individuals, consequently, if all the grey seals impacted are from this SAC 0.90% of the SAC population may be disturbed at any one time.

10.39 The estimated grey seal population for the Humber Estuary SAC is 15,028 individuals, consequently, if all the grey seals impacted are from this SAC 0.92% of the SAC may be disturbed at any one time.

10.40 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 within the Survey Area originate from a number of sites located along the east coast and therefore all the predicted impacts will not be impacting upon a single site.

10.41 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.

10.42 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.

10.43 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).

10.44 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).

10.45 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

10.46 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.

10.47 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.

10.48 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.

10.49 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 ION seismic survey.

11.2 Projects identified as having potential to cause an in-combination impact are:

- Hornsea Project Two offshore wind farm – Pile-driving,
- Geoex Geophysical Seismic Survey – Airgun noise.

Hornsea Project Two Pile driving

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 9). At its closest point pile-driving at Hornsea two could occur no closer than 91.3 km from the Survey Area (Figure 18).

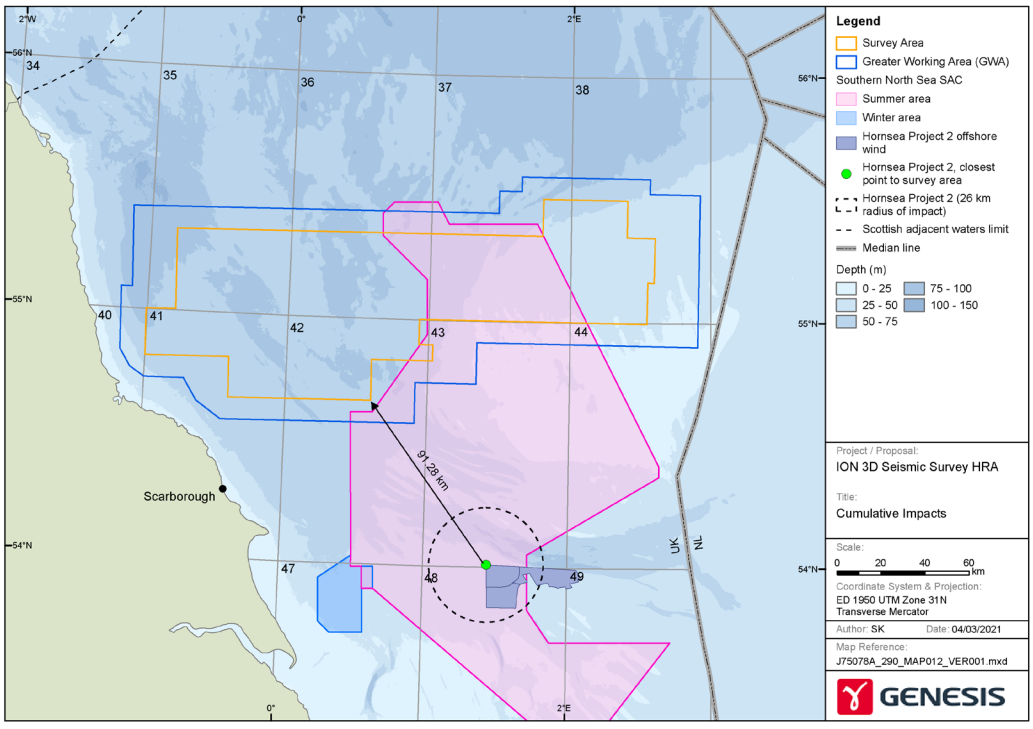

Figure 18: Location of planned pile-driving at Hornsea Two and the proposed ION seismic survey.

11.4 Ørsted will be installing turbine foundations throughout 2021, although the exact timing of the activities are unknown. A total 165 turbines are to be installed.

11.5 For the purposes of this assessment noise modelling undertaken by BEIS for the Review of Consents within the Southern North Sea SAC has been used. The modelling results are based on the use of a 3,000 kJ hammer at Hornsea Two wind farm.

11.6 The results from the modelling (based on a weighted SEL) indicate that the onset of PTS could occur out to 1,534 m and encompass an area of 7.38 km^2. Levels of noise predicted to cause disturbance (based on unweighted SEL) could occur out to 29.5 km and cover an area of 2,794 km^2.

11.7 Based on the results from noise modelling and a peak density of 2.22 ind./km^2 an estimated 16 harbour porpoise are at risk of PTS from the pile-driving and 2,119 harbour porpoise may be disturbed or displaced, of which 1,982 may be within the SAC (BEIS 2020).

11.8 However, the use of an acoustic deterrent device will be operated during all pile-driving activities and this will significantly reduce the risk of any harbour porpoise occurring within the range at which the onset of PTS is predicted to arise.

11.9 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).

11.10 The results of the assessment based on a 26 km EDR for pile-driving turbine foundations indicate that up to 1,976 km^2 of the 'summer' area of SAC may be impacted. Turbines installed outwith the SAC or nearer the SAC boundary will have a smaller EDR overlapping the SAC. Consequently, an assessment based on all turbines impacting a maximum area within the SAC is an unrealistic worst-case.

11.11 As a worst-case, noise from pile-driving at Hornsea Two could cause displacement of harbour porpoise over 5.3% of the SAC as a whole and 7.3% of the 'summer' area. There will be no impacts on the 'winter' area. Based on the worst-case scenario, the seasonal average is estimated to be 6.7% of the 'summer' area (BEIS 2020).

11.12 A realistic worst-case scenario for assessing the seasonal impact is based on the average area impacted by pile-driving each of the 165 turbine foundations over the course of a single season. Based on a realistic worst-case scenario the seasonal threshold is 4.7% (Ørsted 2020).

Table 14: Estimated extent of seasonal disturbance on harbour porpoise from proposed pile-driving at Hornsea 2 offshore wind farm within the SAC.

SAC area	Maximum area of SAC impacted per day (km²)	Mean Daily Threshold (%)	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Turbine foundation installation – Unrealistic worst-case				
'summer'	1,976	7.3	167	6.7
Turbine foundation installation – Realistic worst-case				
'summer'	1,401	5.2	167	4.7

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

Dogger A and Dogger B offshore wind farm UXO clearance

11.13 The Dogger A and Dogger B offshore wind farms (formerly known as Creyke Beck A and Creyke Beck B) are located in Round 3 Offshore Wind Farm Zone; Zone 3: Dogger Bank. The Zone is located between 125 km and 290 km off the coast of Yorkshire. The Dogger A offshore wind farm is located, at its closest point, 131 km from shore and covers an area of 515 km² and the Dogger B is located, at its closest point, 131 km from shore and covers an area of 599 km². Both wind farms lie within the boundaries of the Southern North Sea SAC (Figure 19).

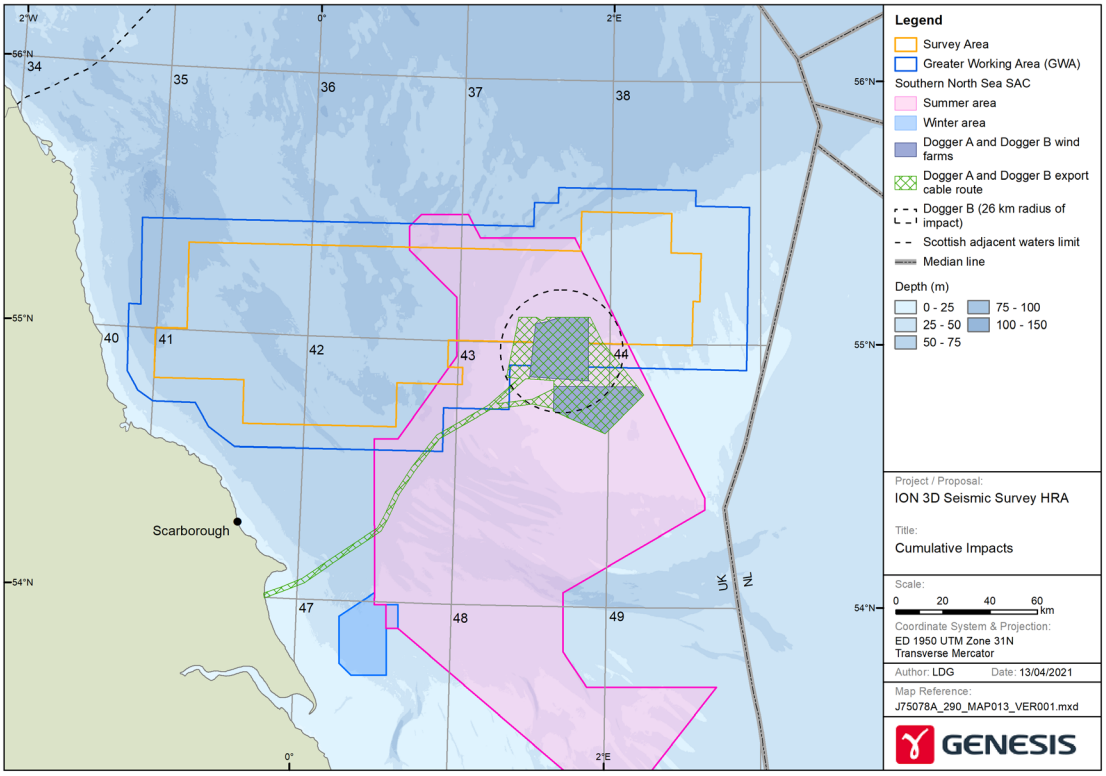

Figure 19: Proposed UXO clearance at Dogger A and B and location of proposed ION 2021 seismic survey.

11.14 Clearance of unexploded ordnance within both Dogger A and Dogger B and along the export cable route is planned to be undertaken over a six week period between May and December 2021. A geophysical survey is to be undertaken to determine the presence of UXO within the survey area. The exact number of UXO items to be cleared is unknown but it is predicted that up to 25 items of UXO with a maximum charge weight of 700 kg NEQ may need to be cleared (DBWF 2021).

11.15 Mitigation to reduce the potential impacts of UXO detonation on marine mammals, fish and other marine wildlife includes the use of low-order clearance. Low-order clearance entails the use of a small charge to burn out the explosive material from a UXO, without the need of detonating the UXO. Consequently, there is a significant reduction in the level of noise arising from its use.

11.16 In the event that, following an investigation, the use of low-order clearance is deemed unsuitable, bubble-curtains will be deployed under certain environmental conditions. However, it is possible that neither the use of low-order clearance or the use of bubble curtains is possible. If this occurs then the UXO will be cleared without the use of noise limiting mitigation.

11.17 Noise modelling undertaken by the applicant indicates that the onset of PTS could occur in harbour porpoise over an area of 670 $km^{2.}$ Based on an average Southern North Sea SAC density and the Dogger Bank Zonal density both of 0.71 ind./km^2 an estimated 476 harbour porpoise are at risk of PTS from the detonation of UXO (DBWF 2021, Forewind 2014, BEIS 2020) [7]. In the event that a bubble curtain is used the area impacted is reduced to 85 km^2 and could therefore impact on 60 harbour porpoise.

11.18 An acoustic deterrent device (ADD) will be operated during all UXO clearance. The length of time the ADD is operating will depend on whether other noise mitigation measures are being undertaken. If low-order clearance is used the ADD will be operational for 15 minutes, if bubble curtains are used the ADD will be operated for 50 minutes and if no noise limiting mitigation is being undertaken the ADD will be operated for 155 minutes. The use of the ADD will reduce the risk of any harbour porpoise from occurring within the range at which the onset of PTS is predicted to occur.

11.19 In order to estimate the number of harbour porpoise disturbed from UXO clearance the EDR of 26 km has been used, equating to an area of 2,124 km^2. Based on a site specific density of 0.71 ind./km^2, the estimated number of harbour porpoise that could be disturbed is 1,508 individuals.

[7] Note the assessment undertaken in support of the application suggests that 595 harbour porpoise could be at risk of the onset of PTS and up to 2,003 may be disturbed (DBWF 2021). These estimates are based on the SCANS III harbour porpoise density of 0.888 ind./km^2. The use of site specific density data obtained from at least 24 months of survey data, as used for this assessment, is considered to be more robust than a density estimated from a single survey collected during a single month of survey. Consequently, the estimated number of harbour porpoise impacted in this assessment is different from that estimated within the DBWF (2021) assessment.

11.20 The applicant has undertaken an assessment of the potential disturbance to harbour porpoise within the Southern North Sea SAC using the threshold approach. A number of potential worst-case scenarios have been assessed depending on the location of the UXO in relation to the SAC and a presumption that no noise limiting mitigation measures are in use, i.e. neither low-order detonation nor bubble curtains are used. The results from all three scenarios indicate that UXO cleared within either the Dogger A or B wind farm areas could impact on 7.9% of the 'summer' area. However, the average potential area of overlap ranges from between 4% of the 'summer' area along the export cable route and 7.8% of the summer area in area to be cleared within Dogger B (DBWF 2021) (Table 15).

11.21 In the event that noise reducing mitigation is used during the clearance of UXO, the realistic worst-case scenario is for the clearance to impact across an area of 707 km^2 contributing 2.6% of the daily threshold (Table 15)[8]

11.22 The seasonal impact ranges from between 0.55% and 1.07% of the seasonal threshold based on a realistic worst-case scenario (Table 15).

11.23 Although it is conceivable that an item of UXO could be detonated without any form of noise limiting mitigation, the probability of this occurring is relatively low. However, as a realistic worst-case scenario it is possible for it to occur on one day and therefore contribute to the daily threshold. However, it is not realistic to presume that this would occur for all possible 25 detonations over the course of a season. Consequently, calculating a seasonal threshold based on their being no noise limiting mitigation is an unrealistic worst-case scenario.

[8] There is no published EDR for the use of bubble curtains when undertaking UXO clearance. For the purposes of this assessment it is presumed to be 15 km radius, based on the EDR for pile-driving with noise abatement.

Table 15: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed Dogger A and Dogger B offshore wind farm UXO clearance within the SAC.

SAC area	Maximum area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
UXO clearance at Dogger A – Unrealistic worst-case (no mitigation)				
'summer'	2,124	7.9	25	1.07
UXO clearance at Dogger B – Unrealistic worst-case (no mitigation)				
'summer'	2,124	7.9	25	1.07
UXO clearance export cable route – Unrealistic worst-case (no mitigation)				
'summer'	2,124	7.9	25	1.07
UXO clearance at Dogger A – Realistic worst-case (no mitigation)				
'summer'	1,695	6.3	25	0.86
UXO clearance at Dogger B – Realistic worst-case (no mitigation)				
'summer'	2,121	7.8	25	1.07
UXO clearance export cable route – Realistic worst-case (no mitigation)				
'summer'	1,062	4.0	25	0.55
UXO clearance at Dogger A – Worst-case (with bubble curtain mitigation)				
'summer'	707	2.6	25	0.35
UXO clearance at Dogger B – Worst-case (with bubble curtain mitigation)				
'summer'	707	2.6	25	0.35
UXO clearance export cable route – Worst-case (with bubble curtain mitigation)				
'summer'	707	2.6	25	0.35

The *Unrealistic worst-case (no mitigation)* is based on the maximum area of impact occurring at all UXO clearance locations.

The *Realistic worst-case (no mitigation)* is based on the average area impacted within the SAC.

The *Worst-case (with bubble curtain mitigation)* is based on the maximum area of impact occurring at all UXO clearance locations.

11.24 The applicant has undertaken an assessment on the potential impacts on grey seals from the proposed UXO clearance. Based on noise modelling undertaken it is estimated that a total of six grey seals could be impacted by PTS if no noise limiting mitigation is undertaken and less than one could be impacted if bubble curtains are used. The number of grey seals estimated to be disturbed by UXO clearance is 341 individuals without any mitigation, this is reduced to 14.5 individuals if bubble curtains are used (DBWF 2021).

Wind farm geophysical surveys

11.25 Geophysical surveys for the offshore wind farm industry are not regulated and require a voluntary notification of the proposed activities to be submitted to the MMO. Consequently, there is no information available regarding the potential five geophysical surveys that may be undertaken within the Southern North Sea SAC during 2021.

11.26 Within the DBWF (2021) environmental information supporting the application for the proposed UXO clearance the applicant has considered the potential impacts from three of the geophysical surveys that they propose to be undertaking during 2021, namely those at Dogger A, B and C offshore wind farms and included an assessment for the proposed geophysical survey at Sofia offshore wind farm. No information on the proposed geophysical surveys at Hornsea Three or Hornsea Four are available and therefore no assessment can be undertaken for these two potential activities.

11.27 The estimated number of harbour porpoise is based on a 5 km radius of impact, as per the recommended EDR. With a site specific density of 0.71 ind./km^2 an estimated 56 harbour porpoise may be disturbed at any given time for each of the four proposed geophysical surveys for which there is some information.

11.28 The applicant has calculated the daily area of potential disturbance within the SAC for all four surveys to be 256 km^2. Consequently, each could impact on the 0.9% of the daily threshold and between 0.5% and <0.01% of the seasonal threshold. (Table 16).

Table 16: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed geophysical surveys at Dogger and Sofia offshore wind farms within the SAC.

SAC area	Area of SAC impacted per day (km^2)	Mean Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
Dogger A geophysical survey				
'summer'	256	0.9	111	0.5
Dogger B geophysical survey				
'summer'	256	0.9	111	0.5
Dogger C geophysical survey (export cable only)				
'summer'	256	0.9	1	<0.01
Sofia geophysical survey (export cable only)				
'summer'	256	0.9	1	<0.01

11.29 The estimated number of grey seal to be impacted by each of the geophysical surveys is estimated to be 16 individuals (DBWF 2021).

Oil and gas industry activities

11.30 There is one planned oil and gas related activity that could have the potential to cause an in-combination impact.

Multi-client Geophysical Survey

11.31 On 17 March 2021 Filial AV Geoex submitted an application to undertake a 2D multi-client Geophysical Survey in the North Sea and Norwegian Sea between June and September 2021. The survey is expected to last no longer than 120 days, with 62 in UK waters. The seismic survey uses a single 6,270 cu. in. airgun towed at an average depth of 17 m below the sea surface (EPI 2021).

11.32 Within the UK the survey covers an area of 237,501 km^2 and comprises 6,235 km of survey line. Two survey lines lie within the Southern North Sea SAC and the applicant has calculated a total of 71 km of line that could, in theory, be undertaken in a single day.

11.33 Results from noise modelling presented within the Geoex application indicate that PTS could occur out to 1,000 m based on an SPL of 202 dB *re* 1 µPa $_{(0\text{-peak})}$ and 100 m based on a cumulative SEL of 155 dB *re* 1 μPa^2s. From these modelled outputs it is estimated that three harbour porpoise could receive levels of noise capable of causing the onset of PTS.

11.34 Disturbance is predicted to occur out to 6,000 m based on an SPL of 160 dB *re* 1 µPa $_{(rms)}$. The number of harbour porpoise, grey seal or harbour seal predicted to be disturbed based on noise modelling results has not been presented within the application.

11.35 Disturbance to harbour porpoise is predicted to occur out to 6,000 m and therefore over an area up to 113 km^2.[9] On this basis, an estimated 339 harbour porpoise are predicted to be disturbed within the SAC at any one time.

11.36 The results of the assessment based on a 12 km EDR for seismic survey noise indicate that up to 1,704 km^2 of the SAC could be impacted. Should this occur up to 6.3% of the 'summer' area could be impacted by the proposed Geoex survey. The seasonal impact is not included within the assessment but is, based on other information provided, estimated to be 0.1% (Table 17).

[9] This is considered a precautionary estimate as sound from airguns does not propagate in a circle and typically the area impacted is smaller than if using a circular area of impact as has had to be done here.

Table 17: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed Geoex seismic survey within the SAC.

SAC area	Area impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days) [1]	Seasonal Threshold (%)
Worst-case (Maximum daily impact - 2 days in summer period)				
'summer'	1,704	6.3	4	0.1

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

11.37 Disturbance to grey seal is predicted to occur out to 6,000 m and therefore over an area up to 113 km^2. On this basis, an estimated 29 grey seal are predicted to be disturbed at any one time[10].

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

Noise modelling

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

Physical Injury

11.39 Based on the results from the noise modelling between 4 and 496 harbour porpoise could be at risk of PTS from proposed activities affecting the Southern North Sea SAC (Table 18). With the proposed mitigation in place for pile-driving at Hornsea two and at the Dogger A and B UXO clearance it is predicted that no harbour porpoise will be impacted by PTS. The level of noise arising from sub-bottom profilers used during geophysical surveys is below the thresholds at which the onset of PTS is predicted to arise. Consequently, it is predicted that no more than four harbour porpoise are at risk of the onset of PTS from proposed activities within the Southern North Sea SAC. It is estimated that up to 0.001% of the North Sea Management Unit harbour porpoise population could, in be impacted.

[10] Calculation based on an average density of grey seals of 0.25 ind./km^2 (Forewind 2013).

Table 18: Estimated number of harbour porpoise at risk of the onset of PTS from proposed activities in the Southern North Sea SAC.

Activity	Harbour porpoise PTS
ION Seismic Survey	1
Hornsea Two Pile-driving	0 – 16
Dogger A and B UXO clearance	0 – 476
Geoex Seismic Survey	3
Dogger A, B, C and Sofia Geophysical Surveys	0
Total	**4 - 496**

Disturbance

11.40 The number of harbour porpoise predicted to be disturbed by planned activities within the Southern North Sea SAC is between 3,641 and 5,093 individuals depending on the use of noise limiting mitigation at Dogger A and B (Table 19). It is recognised that multiple UXO detonations undertaken over a wider area and the mobile nature of both the seismic and geophysical surveys will cause wider areas of disturbance and consequently increase the number of harbour porpoise potentially affected. However, the clearance of UXO is undertaken no more than once per day and the very short duration of each detonation is unlikely to elicit disturbance behaviour, in that harbour porpoise will likely exhibit a startle response but are not predicted to avoid the area following a single detonation.

11.41 The estimated number of harbour porpoise that may be disturbed is equivalent to 1.1% and 1.5% of the North Sea Management Unit population. This is within the levels at which a population level of effect is predicted not to arise based on the ASCOBANS thresholds (See Para. 10.4).

12 **Table 19: Estimated number of harbour porpoise at risk of disturbance from proposed activities in the Southern North Sea SAC.**

Activity	Harbour porpoise PTS
ION Seismic Survey	903
Hornsea Two Pile-driving	2,119
Dogger A and B UXO clearance	56 – 1,508
Geoex Seismic Survey	339
Dogger A Geophysical survey	56
Dogger B Geophysical survey	56
Dogger C Geophysical survey	56
Sofia Geophysical survey	56
Total	**3,585 – 5,037**

In-combination threshold approach

12.1 Based on the worst-case scenario without any mitigation, the daily threshold could be exceeded, between May and the end of September with up to 28.9% of the 'summer' area of the SAC potentially impacted (Table 20). This is above the maximum daily threshold, recommended by the Nature Conservation Bodies, that could cause an adverse effect on the integrity of the site.

12.2 The probability of having the maximum theoretical area of impact arising from all activities on the same day is so extremely small (approximately 1 in 6,500,000), that it is beyond reason that it will occur. It is therefore safe to conclude that the daily threshold based on the unrealistic worst-case maximum area of impact from all eight projects will not arise.

12.3 An assessment based on the average area of SAC impacted each day and the use of noise limiting mitigation provides a more probable daily threshold. Table 21 presents the daily threshold based on the average area of SAC impacted each day from the proposed ION seismic survey and pile-driving at Hornsea Two along with bubble curtains being used for UXO clearance and maximum impacts arising from the proposed Geoex survey and each of the four wind farm related geophysical surveys . Under this more probable scenario the daily threshold could be marginally exceeded between June and September. However, for this to arise all four geophysical surveys must be undertaken at the same time and the maximum are of daily impact from the Geoex survey must occur on the same day as UXO clearance is being undertaken.

12.4 Based on a realistic worst-case scenario (with mitigation) the in-combination impacts across the season will be 8.4% of the 'summer' area (Table 22). Consequently, the seasonal threshold is not exceeded.

Table 20: Unrealistic Worst-case (no mitigation) in-combination daily threshold (%).

Activity	Apr	May	Jun	Jul	Aug	Sept
ION Seismic Survey	0	6.5	6.5	6.5	6.5	6.5
Hornsea Two Pile-driving	7.3	7.3	7.3	7.3	7.3	7.3
Dogger A and B UXO clearance	0	7.9	7.9	7.9	7.9	7.9
Geoex Seismic Survey	0	0	6.3	6.3	6.3	6.3
Dogger A Geophysical survey	0	0	0	0	0	0
Dogger B Geophysical survey	0	0	0	0	0	0
Dogger C Geophysical survey	0	0	0	0	0	0
Sofia Geophysical survey	0.9	0.9	0.9	0.9	0.9	0.9
Total %	**8.2**	**22.6**	**28.9**	**28.9**	**28.9**	**28.9**

Note DBWF have committed to not undertake geophysical surveys at Dogger A, B or C in the same 24 hr period as UXO clearance is being undertaken without noise mitigation measures in place. Consequently there is no in-combination impact under the unrealistic worst-case scenario.

Table 21: Worst-case (with mitigation) in-combination daily threshold (%).

Activity	Apr	May	Jun	Jul	Aug	Sept
ION Seismic Survey	0	2.6	2.6	2.6	2.6	2.6
Hornsea Two Pile-driving	5.2	5.2	5.2	5.2	5.2	5.2
Dogger A and B UXO clearance	0	2.6	2.6	2.6	2.6	2.6
Geoex Seismic Survey	0	0	6.3	6.3	6.3	6.3
Dogger A Geophysical survey	0.9	0.9	0.9	0.9	0.9	0.9
Dogger B Geophysical survey	0.9	0.9	0.9	0.9	0.9	0.9
Dogger C Geophysical survey	0.9	0.9	0.9	0.9	0.9	0.9
Sofia Geophysical survey	0.9	0.9	0.9	0.9	0.9	0.9
Total %	**8.8**	**14.0**	**20.3**	**20.3**	**20.3**	**20.3**

Based on:

- mean daily impacts from ION seismic survey and Hornsea Two pile-driving.
- Bubble curtains used for UXO clearance.
- Maximum area of impact from Geoex seismic survey.
- Maximum area of impact from all wind farm geophysical surveys.

Table 22: Seasonal thresholds in-combination

Activity	Worst-case Seasonal threshold (no mitigation)	Realistic-worst-case (with mitigation)
ION Seismic Survey	5.4	2.2
Hornsea Two Pile-driving	6.7	4.7
Dogger A and B UXO clearance	1.1	0.35
Geoex Seismic Survey	0.1	0.1
Dogger A Geophysical survey	0.5	0.5
Dogger B Geophysical survey	0.5	0.5
Dogger C Geophysical survey	0.01	0.01
Sofia Geophysical survey	0.01	0.01
Total %	**14.3**	**8.4**

12.5 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 (Table 23)[11]. Any changes in any of the Projects' schedules or scopes of work could affect the threshold based assessment.

[11] Note Table 16 presents the confidence that activities will be undertaken on the basis that they have or will be consented. For those Projects that have not been consented this is a presumption made for the purposes of this HRA only, required in order to address potential in-combination impacts. It does not in any way fetter any future HRA conclusions or consent decisions.

Table 23: Confidence in extent and duration of potential impacts from planned activities within or adjacent to the Southern North Sea SAC between April and September 2021.

Project	Confidence	Comment
ION Seismic Survey	High	Very High to High certainty activities will be undertaken during summer 2021. Moderate to Low certainty on when activities will be undertaken within the SAC. 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 pile-driving	Very High	Very High certainty activities will be undertaken during summer 2021. Very High certainty on when activities will be undertaken within the SAC. 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.
UXO clearance at Dogger A and B	High	Very High certainty activities will be undertaken during summer 2021. High certainty on when activities will be undertaken within the SAC. Very High confidence of regular usage of either low ordnance detonation or bubble curtains to mitigate noise impacts. Very high certainty on the number of UXO to be cleared per day. Low certainty on the number of UXO to be cleared or the number of days detonations will take place. Very limited evidence on the extent of displacement from UXO clearance. No evidence supporting an EDR.
Geoex Seismic Survey	Moderate	High to Moderate certainty activities will be undertaken during summer 2021. Very Low certainty on when activities will be undertaken within the SAC. 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.
Dogger A, B, C and Sofia geophysical surveys	Low	Very High certainty activities will be undertaken during summer 2021. Very Low certainty on what activities will be undertaken within the SAC. Very Low certainty on when activities will be undertaken within the SAC. Low level of certainty from published evidence on the extent and duration of impacts.

In-combination assessment Southern North Sea SAC conclusions

12.6 Results from noise modelling indicate that up to four harbour porpoise could be at risk of physical injury in the form of PTS from known planned activities within or adjacent to the SAC. This is 0.001% of the Management Unit population and therefore below the level of 1.7% at which a population level effect is predicted to occur. The estimated number of harbour porpoise that could be disturbed is between 3,641 and 5,093 individuals, depending on the use of noise limiting mitigation during UXO clearance. This is below the 1.7% at which population level effects are predicted to occur.

12.7 The results from the threshold approach indicate that if there all activities impact over the maximum possible area on the same the daily threshold will be exceeded. However, the probability of this occurring is exceedingly small. Furthermore, noise limiting mitigation to be in place for planned UXO clearance activities significantly reduces the extent of any impact. Under this, more probable, scenario the daily threshold could be marginally exceeded. Although, the daily threshold could be exceeded under the more realistic scenario, the exceedance by 0.3% is considered to be marginal. The aim of the noise management is to keep below the thresholds as much as possible and even under the more probable scenario there is a level of precaution that with the assumption that all four geophysical surveys along with the Geoex seismic survey, will be impacting the maximum possible area on the same day. If it does occur it is likely to arise on only the one day. Consequently, it is predicted that the daily thresholds could be exceeded on a very limited basis.

12.8 Based on the best available information and supported by results from noise modelling and the 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

12.9 There is potential for an in-combination impact on grey seals from the proposed ION seismic survey, pile-driving being undertaken at Hornsea Two offshore wind farm, UXO clearance at Dogger A and B, the proposed Geoex survey and wind farm related geophysical surveys at Dogger A, B, C and Sofia.

12.10 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 7 and Para. 10.35). Consequently, there will be no in-combination impact on grey seals with respect to physical injury.

12.11 There is potential for in-combination impacts arising from displacement or disturbance. It is estimated that between 272 and 598 grey seals could be disturbed or displaced from in-combination impacts depending on the use of bubble curtains during UXO clearance (Table 24). A potential disturbance of up to 598 grey seals is equivalent to 3.89% of the Berwickshire and North Northumberland Coast SAC and 3.97% of the Humber Estuary SAC grey seal population. If low order clearance or bubble curtains are used during the UXO clearance the proportion of the populations impacted are reduced to 1.77% and 1.81% at Berwickshire and North Northumberland Coast SAC and Humber Estuary SAC respectively.

12.12 It is not realistic to presume that all the grey seals impacted by the proposed activities are all derived from a single SAC population and the proportion of the grey seal population from both SACs potentially disturbed is estimated to be between 0.89% and 1.97% depending on the use of noise limiting mitigation. 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.

Table 24: Estimated number of grey seals at risk of disturbance from proposed activities.

Activity	Disturbance
ION Seismic Survey	139
Hornsea Pile-driving	<25
Dogger A and B UXO clearance	15 - 341
Geoex Survey	<29
Dogger A Geophysical survey	16
Dogger B Geophysical survey	16
Dogger C Geophysical survey	16
Sofia Geophysical survey	16
Total	**272 - 598**

In-combination assessment Berwickshire and North Northumberland Coast SAC and Humber Estuary SAC conclusions

12.13 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.

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

12.15 It is estimated that between 0.89% and 1.97% of the grey seal combined SAC populations 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.

12.16 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 2020a). This will include:

- A minimum of 20 minutes soft-start undertaken every time the air-guns are switched on.
- The use of three 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.
- Air-guns 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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