Offshore Petroleum Regulator
for Environment & Decommissioning

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

Lodestone Seismic Survey

Issued May 2023
Rev 1.0

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1 INTRODUCTION

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

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

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

1.4 Since the departure of the UK from the EU the requirements under the Habitats Regulations remain largely unchanged with any amendments made under the Conservation of Habitats and Species Amendment (EU Exit) Regulations 2019. European sites, formerly Natura 2000 network, are now part of the UK's National Site Network.

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

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

1.7 An application to undertake a Marine Survey by CGG Services (UK) Limited (hereafter CGG) was submitted to the Department of Energy Strategy and Net Zero (DESNZ) in February 2023 (CGG 2023a).

1.8 This is a record of the Appropriate Assessment in the form of a Habitats Regulations Assessment (HRA), undertaken by the Secretary of State for Department of Energy Strategy and Net Zero in

respect of a proposed Lodestone Seismic Survey that may cause a significant effect on the qualifying features of the Southern North Sea SAC and Humber Estuary SAC

1.9 The proposed seismic survey relevant to this assessment is not directly connected with, or necessary to, the management of any National sites but it may affect them. The purpose of this HRA is to determine whether the proposed seismic survey will adversely affect the integrity of any National Site Network designated site.

2 SURVEY DESCRIPTION

2.1 The following is a brief summary of the proposed CGG 3D seismic survey, further details may be found within the application (CGG 2023a,b).

2.2 The proposed regional survey will be undertaken across the Southern North Sea in quadrants 42, 43 and 44 off of the east coast of England. The planned survey is located within UKCS Blocks: 42/6, 43/6, 44/6, 44/11, 44/16, 44/21 and 44/26. The Permit area (Greater Working Area) covers approximately 9,890 km^2, with the Survey Area covering 7,508 km^2 (Figure 1).

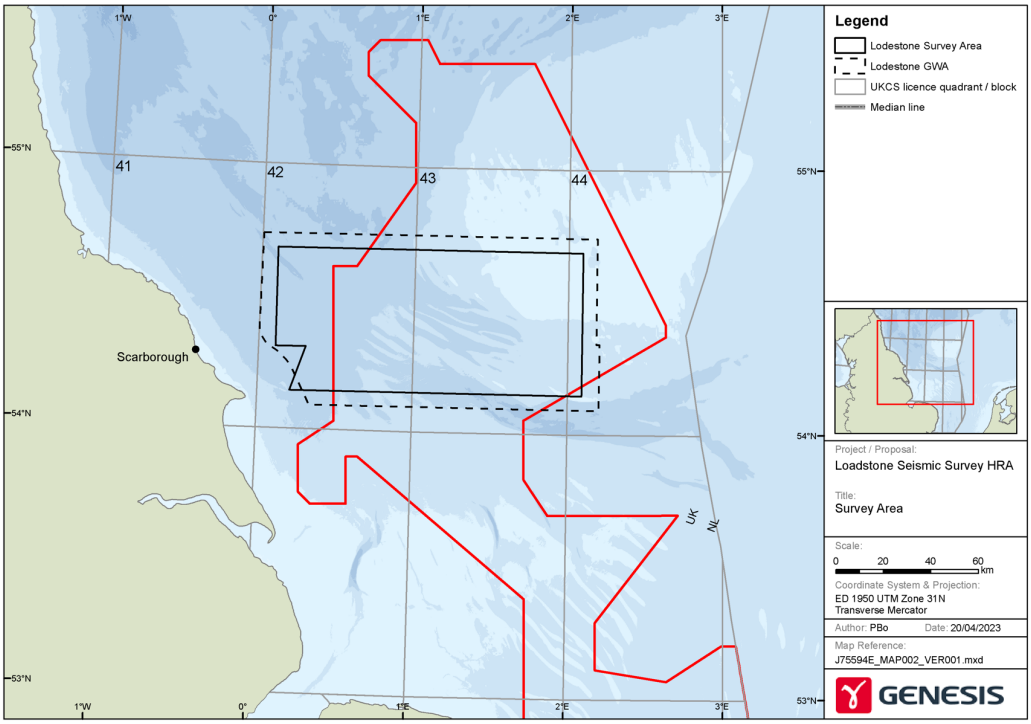

Figure 1: Location of the proposed Lodestone 3D seismic showing survey and greater working areas.

2.3 The survey is scheduled to take place between 1 June and 31 December 2023 and expected to last up to 114 days, with airguns operating for 71 days (CGG 2023a).

2.4 The proposed survey will tow up to 14, 8,450 m streamers at a speed of approximately 5 knots (9.3 km/h). The width of each towed survey array will be approximately 700 m and each surveyed line will be approximately 475 m apart (CGG 2023a). The maximum combined airgun volume will be 3,390 cu. in. The airguns will be firing at intervals of every five seconds. A summary of the proposed survey specifications is presented in Table 1.

2.5 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). The duration of each line turn is approximately 186 minutes (CGG 2023a).

Table 1: Survey parameters.

Survey Parameter	Application
Start date and End date	1 June – 31 December 2023
Total duration of survey (days)	114
Greater Working Area (km^2)	9,890
Survey Area (km^2) [1]	7,508
Total length of survey line (km)	
No. of survey lines (km)	114
Line spacing (m)	475
Consecutive line gap (km)	
Line Direction	272° – 90°

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

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

Table 2: Proposed seismic array parameters (Source: CGG 2023a).

Array Parameter	Array Option
Total volume (cu. In).	3,390
Sound pressure - dB re 1 µPa (0-p)	254
Sound exposure level - dB re 1 μPa^2s	233
Pulse rate (Seconds)	5
Towed depth (m)	5
Vessel speed (knots)	5

3 DESIGNATED SITES

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

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

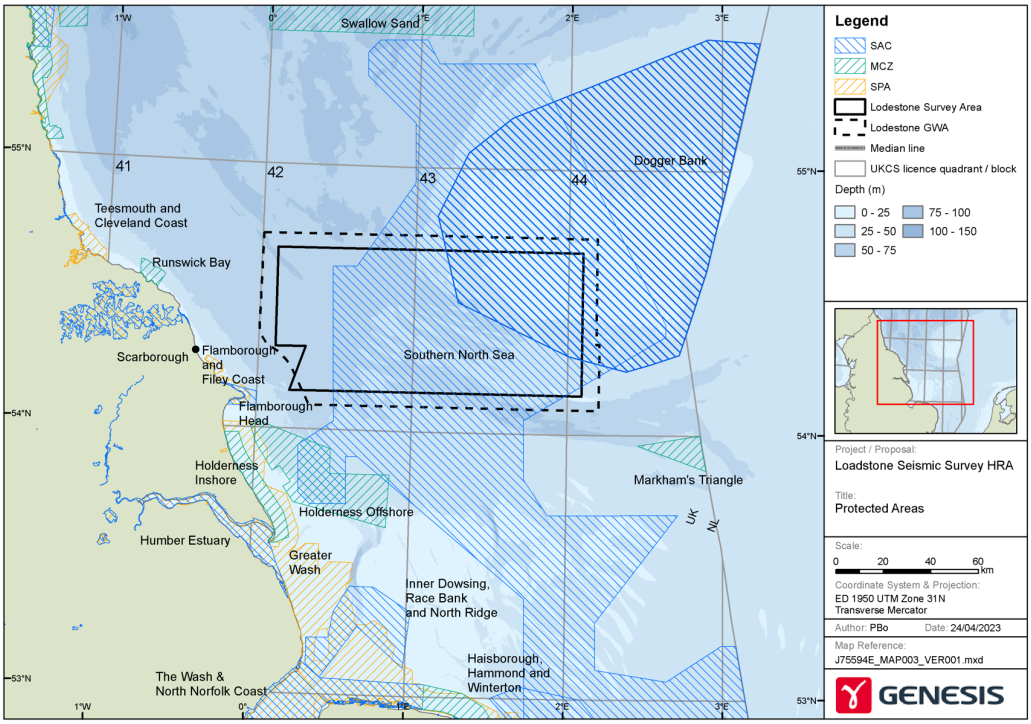

Figure 2: Location of proposed CGG 3D seismic survey and relevant designated sites.

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

- Southern North Sea SAC (Harbour porpoise),
- Humber Estuary SAC (Grey seal, Sea lamprey, River lamprey),
- 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),

3.4 The proposed Greater Working Area overlaps 6,208 km^2 of the Southern North Sea SAC, equivalent to 16.8% 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 the other designated sites listed above could occur within the Greater Working and Survey Areas.

3.5 The Survey and Greater Working Areas overlap the Dogger Bank SAC. However, the site is designated for habitat features that will not be impacted by the proposed seismic survey.

Qualifying features

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

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

Harbour porpoise

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

- Southern North Sea SAC.

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

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

3.10 Following the completion of the most recent SCANS survey (SCANS III), the latest estimated harbour porpoise populations within the whole of the SCANS survey area is 424,245 (CV 313,151 – 596,827). Since 1994 the population of harbour porpoises within the SCANS surveyed area has remained relatively stable (Hammond *et al*. 1995, Hammond 2006, Hammond *et al.* 2017, Hammond *et al*. 2021).

3.11 There are three Management Units identified for harbour porpoise in the north-east Atlantic, of which, the Southern North Sea SAC lies within the North Sea Management Unit. The harbour porpoise population within the North Sea Management Unit was originally estimated to be 227,298 (176,360 – 292,948) (IAMMWG 2015). This estimated population of harbour porpoise is recognised to have been derived from data collected in 2005 and 2016 during a single month and that the harbour porpoise population within the SAC will vary across seasons and years. The population estimated from the Joint Cetacean Protocol (JCP), where abundance and distribution data from multiple sources collected over a period of time have been integrated was 333,808 individuals (JNCC 2017a). The most recent population estimate for the North Sea Management Unit is 346,601 individuals and this figure has been used for this assessment (IAMMWG 2022).

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

3.13 Harbour porpoise densities vary seasonally and across the Southern North Sea SAC (Evans and Teilmann 2009). Site-specific surveys undertaken by wind farm developers have shown considerable variation in the spatial and temporal distribution of harbour porpoises across years (e.g. Forewind 2013, SMart Wind 2017). Typically, peak abundance has been reported to occur between May and July at sites across the Dogger Bank area and between September and April at sites further south (e.g. Forewind 2014, SMart Wind 2015, EAOWL 2015). Lowest reported abundance across nearly all wind farm surveyed areas occurs between November and February, although the poorer survey conditions that occur predominantly during the winter months may be a contributing factor in the lower number of harbour porpoise recorded during this period.

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

3.15 Surveys undertaken across the southern North Sea, including areas within and encompassing the SAC, have reported lower densities of harbour porpoise than that estimated from JCP data. Densities reported from SCANS III surveys are from between 0.888 ind./km^2 in SCANS block O and 0.607 ind./km^2 in SCANS block L (Hammond *et al.* 2017, 2021). Similarly, data obtained

across the Dogger Bank area including the Southern North Sea SAC, in 2011 recorded a density of 1.88 ind./km^2 (Gilles *et al.* 2012). Data obtained from surveys undertaken at 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).

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

3.17 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).

3.18 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).

3.19 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.

3.20 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).

3.21 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).

3.22 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.

3.23 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).

3.24 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.

3.25 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

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

- Humber Estuary SAC,

3.27 Grey seals occur widely around the waters off eastern England with the majority of activity in the nearshore waters to the south of the Humber Estuary, at Donna Nook, where a grey seal colony is located within the Humber Estuary SAC (Russell *et al*. 2017). The latest counts within the Humber Estuary SAC; at Donna Nook give a maximum estimated population of 20,867 (SCOS 2021).

3.28 Their distribution offshore comprises predominantly of short-range return trips from haul-out sites to local foraging areas (Figure 3). 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).

3.29 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 3).

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

3.31 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).

3.32 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.

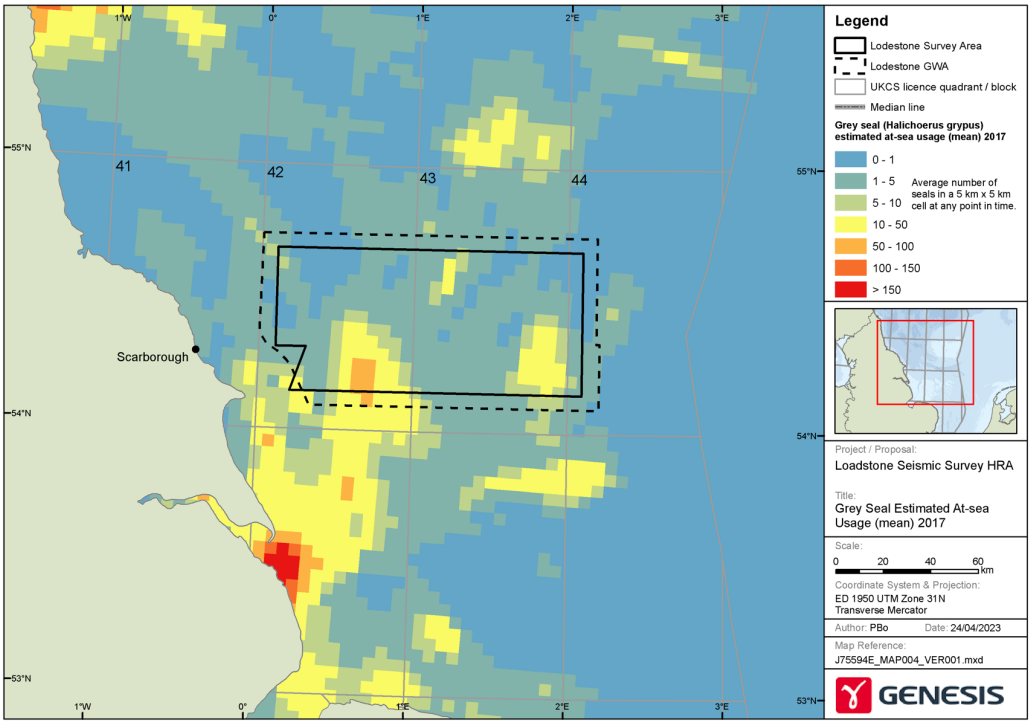

Figure 3: Distribution of grey seals in waters off Eastern England.

Seabirds

3.33 The survey is planned to occur in offshore waters during the seabird breeding season, during which time birds within the area of the proposed survey may originate from SPAs designated for breeding seabirds. The mean maximum foraging ranges of seabirds that could be impacted by the proposed survey are presented in Table 3 (Woodward 2019).

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

Species	Mean maximum Foraging Range (km)	SPA
Gannet	315.2 ±194.2 3	Flamborough and Filey Coast
Kittiwake	156.1 ±144.5	Flamborough and Filey Coast
Herring gull	61.1 ± 44	Flamborough and Filey Coast
Puffin	137.1 ± 128.3	Flamborough and Filey Coast
Razorbill	88.7 ± 75.9	Flamborough and Filey Coast
Guillemot	73.2 ± 80.5	Flamborough and Filey Coast

3.34 Based on the mean maximum foraging ranges, seabirds from one SPA are identified as being at risk from the proposed survey during the breeding period. The SPA is:

- Flamborough and Filey Coast SPA (Gannet, Kittiwake, Herring gull, Puffin, Razorbill and Guillemot, plus seabird assemblage).

3.35 It is also recognised that seabirds from other SPA colonies may also occur in the proposed Survey Area, particularly outwith the breeding period. However, it is not possible to determine which designated sites these birds may originate from and consequently the sites cannot be considered within this assessment.

3.36 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 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.

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3.38 At sea, seabirds forage either predominantly by surface feeding, e.g. Gulls and Petrels; surface diving, e.g. Auks or plunge diving, e.g. Terns and Gannets. Surface feeders and plunge diving species are largely aerial and spend relatively short periods of time, if any, below the sea surface, e.g. plunge diving gannets spend on average 4.7 (±2.8) seconds below the sea surface, although individual dives may last longer with occasional dives recorded lasting up to 39 seconds (Ropert-Coudert. 2009, Cox *et al*. 2016). Surface feeders spend relatively longer periods of time below the sea surface. In shallow waters guillemots spend on average 46.4 (±27.4) seconds below the sea surface and shags 61 seconds (Thaxter *et al.* 2009, Wanless *et al.* 1993). Consequently, surface diving seabirds (e.g. guillemot, razorbill, puffin) are at more risk of impacts from underwater noise than other species of seabird predicted to be present in the proposed Survey Area. See Table 4 for reported dive durations for a range of relevant species.

Table 4: Reported seabird dive durations.

Species	Average dive duration (seconds)
Gannet	4.7 to 6 [1, 4]
Razorbill	19 to 40 [3,4]
Puffin	40 [2, 4]
Guillemot	35 to 119 [4,5]

1 - Ropert-Coudert 2009, 2 - Wanless *et al.* 1988, 3 - Thaxter *et al*. 2009, 4 – MeyGen 2011, 5 - Thaxter *et al*. 2009.

3.39 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).

3.40 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)

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

3.42 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.

3.43 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).

3.44 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.

3.45 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

3.46 Fish are not qualifying species for the Southern North Sea SAC nor, aside from lampreys, are they qualifying features of the other designated sites subject to this assessment. However, potential impacts on fish that are prey for harbour porpoise and seabirds could affect the integrity of the sites by reducing their prey base (JNCC and NE 2016).

3.47 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).

3.48 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).

3.49 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).

3.50 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).

3.51 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).

3.52 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.

3.53 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).

3.54 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).

3.55 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

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

- CGG (2023a) Application to Carry Out a Marine Survey. Application GS/1520/0 (Version 1). 23 February 2023.
- CGG (2023b). *Environmental Assessment Justification and EPS Risk Assessment for Lodestone Seismic Survey*.
- 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 (2020).
- Harbour Porpoise (*Phocoena phocoena*) possible Special Area of Conservation: Southern North Sea. Draft Conservation Objectives and Advice on Activities. JNCC and NE (2019).
- A potential approach to assessing the significance of disturbance against conservation objectives of the harbour porpoise cSACs. Version 3.0. Discussion document JNCC (2017d).
- Noise assessment and management in harbour porpoise SACs. Briefing note: Use of thresholds to assess and manage the effects of noise on site integrity. JNCC. (2017e).

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

4 POTENTIAL IMPACTS

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

4.2 The airguns used in the seismic surveys are pneumatically-driven impulsive transducers that generate high intensity, low frequency, short duration sound pulses at regular intervals of typically between every 10 to 15 seconds. The seismic source geometry is designed to focus the output from the array vertically downwards minimising any horizontally propagating sounds (OGP/IAGC 2004). The level of sound generated by an airgun array depends on various factors including gun volume, array design, the number of airguns, spacing and air pressure. Field measurements of the sound emitted by airgun arrays used by the oil and gas industry show that levels of source intensity expressed as peak SPL range from 235 to 259 dB re 1µPa- m (Richardson *et al*. 1995, OSPAR 2009). The frequency range of emitted energy is typically in the 5 Hz to 500 Hz range and strongest from 10 to 120 Hz, but with some energy in the 500 Hz to 1 kHz range (Richardson *et al*. 1995, Hermannsen *et al.* 2015).

Marine Mammals

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

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

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

4.5 The range at which marine mammals may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Pinnipeds (seals) are potentially more sensitive to low frequency sounds than cetaceans and harbour porpoise may be more sensitive to relatively high frequencies. Other factors which may affect the potential impact of sound on marine mammals includes ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as

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

Fatal effects

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

Physical injury

4.7 Underwater sound has the potential to cause hearing damage in marine mammals, either permanently or temporarily. The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, the duty cycle of the sound source and duration of the exposure (Southall *et al*. 2019, OSPAR 2009).

Behavioural Change

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

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

Seabirds

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

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

4.3 There is limited information on the ability of seabirds to hear underwater. Reviews undertaken indicate that birds may have relatively poor hearing ability below the sea surface with peak hearing sensitivity below 2 kHz (Dooling and Therrien 2012). However, studies undertaken on

two captive guillemots reported behavioural responses to play-back broadband noise above 120 dB re. 1 µPa and up to 137 dB re. 1 µPa (the maximum used for the study) (Hansen *et al*. 2020).

4.4 Studies on great cormorant indicate that at 2 kHz they have relatively good hearing ability (Hansen *et al*. 2016). Studies on two species of diving sea-duck: the long-tailed duck and surf scoter, indicated hearing ability underwater of between 0.5 and 2.86 kHz for long-tailed duck and a peak sensitivity at 1 kHz for surf scoter (Therrien 2014, James *et al*. 2018).

4.5 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

4.6 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

4.7 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 (CGG 2023b).

Harbour porpoise

5.2 The modelling indicates that there is no risk of PTS to harbour porpoise beyond 500 m of the airgun array options based on either the SPL or SEL metric. The modelling does not provide the distance at which the onset of PTS is predicted to occur and therefore, for the purposes of this assessment it is presumed that the onset of PTS could occur out to 500 m from the airgun sound source.

5.3 No noise modelling has been undertaken to assess potential disturbance effects, instead the applicant has referred to the 12 km EDR.

Grey seal

5.4 The modelling indicates that there is no risk of PTS to grey seal beyond 500 m of the airgun array options based on either the SPL or SEL metric. The modelling does not provide the distance at which the onset of PTS is predicted to occur and therefore, for the purposes of this assessment it is presumed that the onset of PTS could occur out to 500 m from the airgun sound source.

5.5 No noise modelling has been undertaken to assess potential disturbance effects on grey seal, instead the applicant has referred to the 12 km range, equivalent to the EDR used for assessing impact on harbour porpoise.

Fish (prey species)

5.6 No noise modelling has been undertaken to assess the potential impacts on fish from the proposed survey (CGG 2023b).

5.7 Noise modelling carried out for previous seismic surveys undertaken in the same area using similar air gun array indicate that injury to fish might be expected to arise no greater than 200 m from the airgun source (BEIS 2021). For fish without swim bladder impacts might be predicted to smaller with injury unlikely to occur beyond 150 m from the sound source (OGA 2016).

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

6 EFFECTIVE DETERRENT RADIUS / RANGE

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

6.2 The published precautionary EDR are presented in Table 5 (JNCC 2020). Relevant to this assessment is the EDR for seismic surveys which is published as being 12 km.

6.3 The use of a 26 km EDR has been used for pile-driving and 5 km for the geophysical surveys when considered in the in-combination assessment.

Table 5: Precautionary Effective Deterrent Ranges (EDR) (Source: JNCC 2020).

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

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

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

7 CONSERVATION OBJECTIVES

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

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

Southern North Sea SAC

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

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

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

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

Southern North Sea SCI Conservation Objectives

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

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

Source: JNCC and NE 2019

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

7.7 The '*integrity of the site*' is not defined in the Conservation Objectives. However, 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 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 2020). The proposed approach is not based on a population level impact but is instead based on a temporal and spatial level where a proportion of the area within the SAC may be affected over a period of time.

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

7.15 The potential extent of noise causing disturbance that would meet these proposed thresholds and therefore impact on the integrity of the site are presented in Table 6. 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 6: Estimated extent sound levels capable of causing displacement disturbance occur in order to impact on site integrity.

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

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

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

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

7.19 In order to undertake any meaningful assessment using the threshold approach accurate information on the timing, duration and extent of activities being undertaken is required. Where this information is lacking or where speculative 'worst-case' scenarios are used there is little or no confidence that the results will bear any resemblance to the true extent of impact within the SAC on any single day or across the course of a season.

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).

7.22 The Humber Estuary SAC Conservation Objectives are:

Humber Estuary SAC Conservation Objectives

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

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

Source: Natural England 2018a

Flamborough and Filey Coast SPA

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

Flamborough and Filey Coast SPA Conservation Objectives

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

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

Source: Natural England 2019

8 IN-COMBINATION IMPACTS

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

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 24 UK offshore wind farms that are either operating or applications have been submitted and that lie wholly within the Southern North Sea SAC or are within 26 km of the boundary (Figure 4). (This 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 2020)). A further six wind farms are currently in pre-application phase. (Table 7).

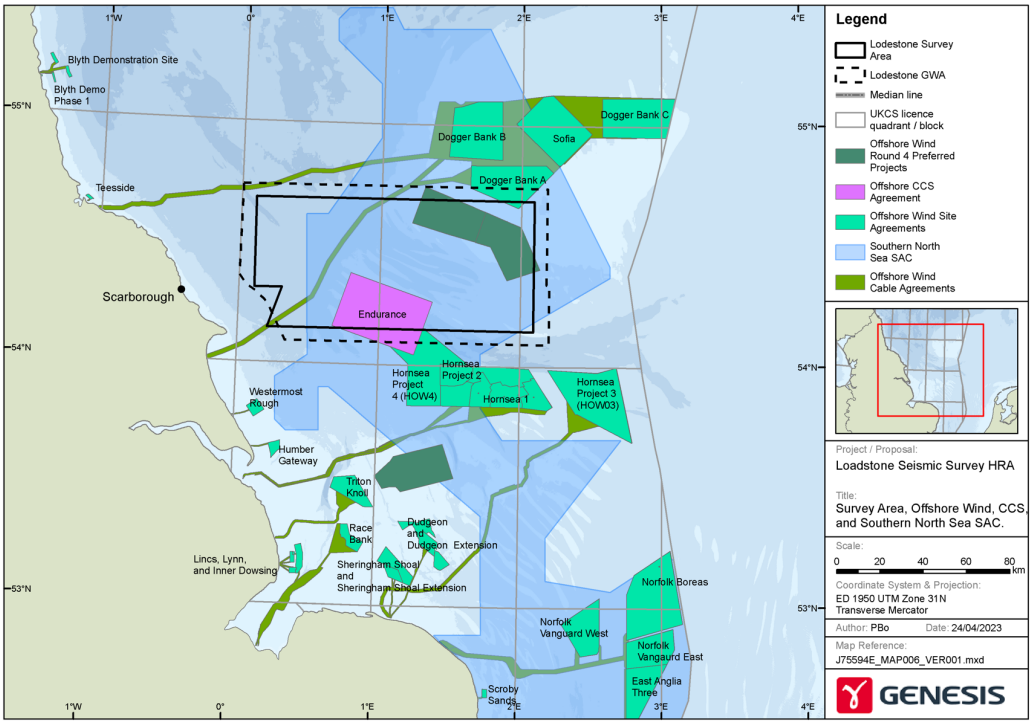


Figure 4: Offshore wind farms in Southern North Sea and location of proposed Lodestone seismic survey location.

8.5 During the period of the proposed survey the following wind farm related activities could be undertaken that could cause an in-combination impact:

- Dogger Bank A offshore wind farm could be installing turbine foundations and therefore carrying out pile-driving.
- Dogger Bank B could commence pile-driving in August 2023 (Gov 2023). This is after the completion of the proposed Hewett survey and therefore not cause a daily in-combination impact but could cause an in-combination impact based on a seasonal threshold assessment.

8.6 All other wind farms are either operating, consented but not started offshore construction or have submitted applications and are awaiting determination and no other activities have been identified as having potential for causing an in-combination impact.

Table 7: 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	Operating
Westermost Rough	Operating
Round 3	
Dogger Bank A	Offshore construction started
Dogger Bank B	Onshore construction started
Dogger Bank C	Onshore construction started
Sofia	Consented
East Anglia One	Operating
East Anglia One North	Consented
East Anglia Two	Consented
East Anglia Three	Consented
Hornsea Project One	Operating
Hornsea Project Two	Offshore construction started
Hornsea Project Three	Consented
Hornsea Project Four	Application submitted
Norfolk Vanguard	Consented
Norfolk Boreas	Consented
'Round 3+'	
Dogger Bank D	Pre-application
Extension Projects	
Dudgeon and Sheringham Shoal Extensions	Application submitted
Five Estuaries	Pre-application
North Falls	Pre-application
Round 4	
Dogger Bank South: West	Pre-application
Dogger Bank South: East	Pre-application
Outer Dowsing	Pre-application

Cable laying activity

8.7 The NeuConnect Project includes the installation, operation and maintenance of a 1400 MW electricity interconnector between the electricity networks of Great Britain (GB) and Germany. Two High-Voltage Direct Current submarine cables will be installed in a single cable bundle, which will also contain a fibre optic control and communication cable.

8.8 The proposed works include the use of a sub-bottom profiler and has therefore been identified in the Southern North Sea Noise Register (Gov 2023). The information to inform the HRA does not include any reference to noise impacts within the SAC from a sub-bottom profiler (NeuConnect 2021). Furthermore, the HRA undertaken requires within it a licence condition that the sub bottom profiler survey work will not be carried out in the Southern North Sea SAC during the wintering period between the months of 1 October to 31 March inclusive (MMO 2021). No such condition has been included for impacts in the summer period between April and September. There is no evidence within the HRA documentation that there will be any use of a sub-bottom profiler within the summer area of the Southern North Sea SAC during the summer period. Consequently, it is concluded that there will be no in-combination impact resulting from activities associated with the NeuConnect Project.

Aggregate extraction and dredging activity

8.9 Existing localised aggregate dredging occurs primarily in the southern half of the SAC, along the east coast. 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.

8.10 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)).

8.11 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

8.12 There is a long history of oil and gas activities within the boundaries of the Southern North Sea SAC. Since 1965, when the first well was spudded (first drilled), there has been extensive oil and gas development with a total of 117 installations installed within the SAC. The vast majority (94%) of all the installations within the boundary of SAC are located in the 'summer' area of the site (Figure 5) (OGA NDR 2020).

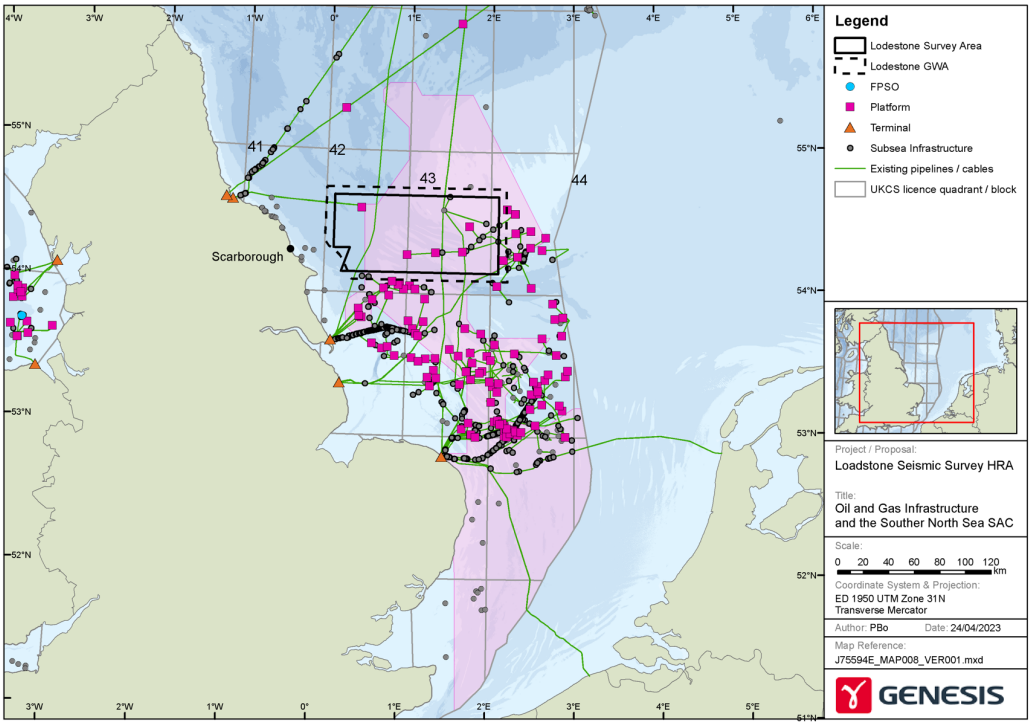


Figure 5: Existing oil and gas infrastructure within the Southern North Sea SAC.

8.13 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 over a ten year period up to 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.

8.14 OPRED are aware of planned oil and gas related activities within the SAC during the period the proposed survey will be undertaken. These include:

- Crosgan drilling appraisal well,
- Endurance Field Bunter Outcrop survey,
- Somerville and Anning Marine Survey
- Murdoch KM and NW Bell ZX Survey,
- Johnston site survey,
- Hewett Field seismic survey.

Crosgan appraisal well

8.15 One-Dyas submitted an application (GS/1499/0) to carry out a marine survey on 26 January 2023. The application is for the drilling of an appraisal well with the earliest start date of 1 February 2023 and latest end date 31 December 2023 (ONE-Dyas 2023a).

8.16 The Crosgan well is an appraisal well which will be drilled over a period of 75 days. The well is planned to be drilled in a maximum of five sections after the 30" conductor has been installed. Once the 30" section is drilled a 30" conductor will be pilled in place to a depth of run at ±70 m (230 ft) measured depth and cemented in place. Piling of the conductor will be undertaken using a hammer and is expected to last up to eight hours (ONE-Dyas 2023b).

8.17 In addition to the above drilling activity, a Vertical Seismic Profile (VSP) survey will be undertaken to acquire data on the well, which will involve the use of a seismic array from the jack-up rig into the wellbore. The VSP operation is expected to take no more than 24 hours to complete and will involve a four-gun array. The total time of the VSP operations, including deployment of equipment, is one day. (ONE-Dyas 2023b).

8.18 An HRA has been undertaken for this application (OPRED 2023a)

Endurance Field Bunter Outcrop Survey

8.19 BP have submitted an application to undertake seismic survey at the Endurance reservoir site (Licence application number GS/1500) (BP 2023a,b). The purpose of the survey is to acquire 3D imaging of the Endurance structure in support of the Northern Endurance Partnership carbon capture, utilisation and storage project. The survey will acquire data that could not be acquired during a previous seismic survey of the area (GS/1332) undertaken in 2022.

8.20 The proposed survey area will cover an area of approximately 10 km^2 and will intersect with UKCS blocks 43/27 and 43/28. The survey area lies wholly within the Southern North Sea SAC The survey greater working area is approximately 233 km^2 in area and intersects with UKCS blocks 43/22, 43/23, 43/27 and 43/28.

8.21 The proposed activities are to be undertaken over a period of 20 days from 23 March 2023. However, licence allows for activities to be undertaken up to 31 May 2023. Consequently, there is potential for seasonal in-combination impacts.

8.22 An HRA has been undertaken for this application (OPRED 2023b).

Sommerville and Anning Marine Survey

8.23 Hartshead Resources Limited have applied to undertake a marine survey to check for potential obstructions and debris at proposed jack-up rig locations within the Somerville and Anning fields. At each field, the survey will be undertaken over an area of 1 km^2, with an option to infill along the tie-in line between the two locations. The survey is located in UKCS Block 49/17, with the greater working area extending into Blocks 49/11, 49/12, 49/16 and 49/17; an area of 13.5 km by 8 km (HRL 2023b)

8.24 The survey entails the use of a 2D High Resolution (2DHR) seismic airgun and a sub bottom profiler. Along with a multi beam echo-sounder, sidescan sonar.

8.25 The operations are scheduled to commence on 10th April 2023, at the earliest, and will last for up to 10 days. To account for potential scheduling, operational and weather delays, the marine survey consent has been requested until 31st May 2023 (HRL 2023a).

8.26 In addition to undertaking seismic geophysical survey a total of 27 grab samples may be obtained within the North Norfolk Sandbanks and Saturn Reef SAC.

8.27 An HRA has been undertaken for this application (OPRED 2023c).

NW Bell ZX and Murdoch KM Survey

8.28 Harbour Energy propose to conduct a geophysical site survey at NW Bell ZX and Murdoch KM in Blocks 49/22 and 49/23 (NW Bell) and Blocks 44/22 and 44/23 (Murdoch KM) (Harbour Energy 2023a). The NW Bell ZX lies within the Southern North Sea SAC and the Murdoch KM lies 5.9 km outwith the SAC. Consequently, only activities associated with the NW Bell ZX could impact on the Southern North Sea SAC.

8.29 The proposed survey activities will comprise of Sub-bottom Profiling, Multibeam Echosounder, Side Scan Sonar, Echo-sounder Survey and passive magnetometer. The purpose of the planned geophysical survey is to gather data on the seabed bathymetry and conduct debris clearance at NW Bell ZX and Murdoch KM (Harbour Energy 2023a).

8.30 The proposed activities were to be undertaken over a period of two days from 9 March 2023. However, licence allows for activities to be undertaken up to 31 May 2023. Consequently, there is potential for both daily and seasonal in-combination impacts from activities at NW Bell ZX.

Johnston Survey

8.31 Harbour Energy propose to conduct a site survey at the Johnston field located in Block 43/27 (Harbour Energy 2023b). The survey will be across two locations, Johnston E&A well area and Johnston J4 and J5 wells area, within Block 43/27.

8.32 The survey activities will comprise of a 2D Ultra High Resolution Seismic Survey, Sub-bottom Profiling, Multibeam Echo Sounder, Side Scan Sonar and Echo Sounder Survey. The purpose of the planned geophysical survey is to gather data on the seabed and environmental conditions of the Johnston field, and the mapping of shallow hazards (Harbour Energy 2023b).

8.33 The proposed activities were to be undertaken over a period of two days from 15 March 2023. However, licence allows for activities to be undertaken up to 31 May 2023. Consequently, there is potential for both daily and seasonal in-combination impacts.

Hewett Field Bathymetric and Seismic Survey

8.34 ENI have submitted an application to undertake a bathymetric and 3D seismic survey at the Hewett gas field between May and October 2023 (ENI 2023). The bathymetric survey will require the use of a Innomar Medium-USV sub-bottom profiler and the 3D seismic survey will use a 585 cu. in. airgun source and cover a survey area of 670 km^2.

8.35 The combined surveys will be undertaken over a period of 130 days between 1 May and 8 September, with a contingency for up to end of October (ENI 2023). Consequently, there is potential for both daily and seasonal in-combination impacts.

Shipping

8.36 Impacts from shipping on harbour porpoise within the SAC have been identified as arising from shipping noise and collision impacts. Shipping noise is the predominant anthropogenic source of noise within the marine environment and is reported to have a negative effect on harbour porpoise within the SAC when vessel traffic exceeds 80 vessels per day (JNCC and NE 2016). Shipping has been on-going in the southern North Sea for many hundreds of years and the area is important for shipping, with relatively high numbers of vessels occurring within it. Based on vessel track lines, in 2015 a total of 269,018 vessels track lines were recorded transiting across the SAC; an average of 737 vessels per day (MMO 2017a).

8.37 The level of vessel activity across the 'summer' and 'winter' areas of the SAC differs (Figure 6). 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.

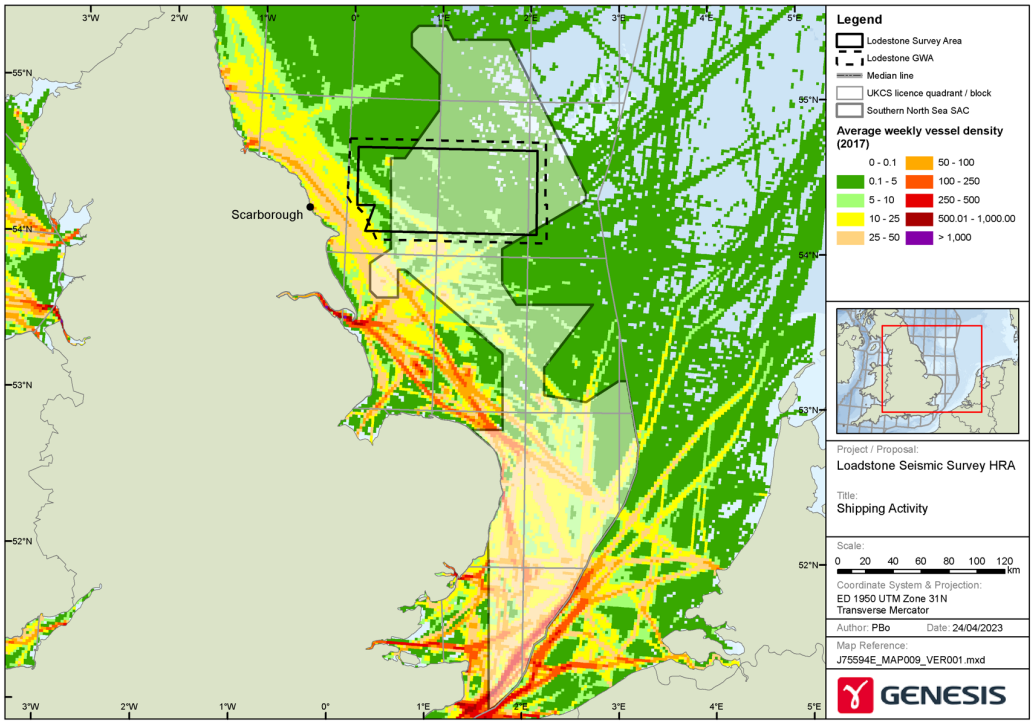


Figure 6: Shipping density within the SAC during 2015.

Fishing activity

8.38 Fishing occurs widely across the southern North Sea and has also been on-going in the area for many hundreds of years. The majority of current fish landings are obtained from areas adjacent to the SAC but there is widespread fishing activity in the southern half and north-eastern edge of the SAC and relatively moderate to high levels of fishing activity along the western edge of the central part of the SAC (Figure 7) (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.

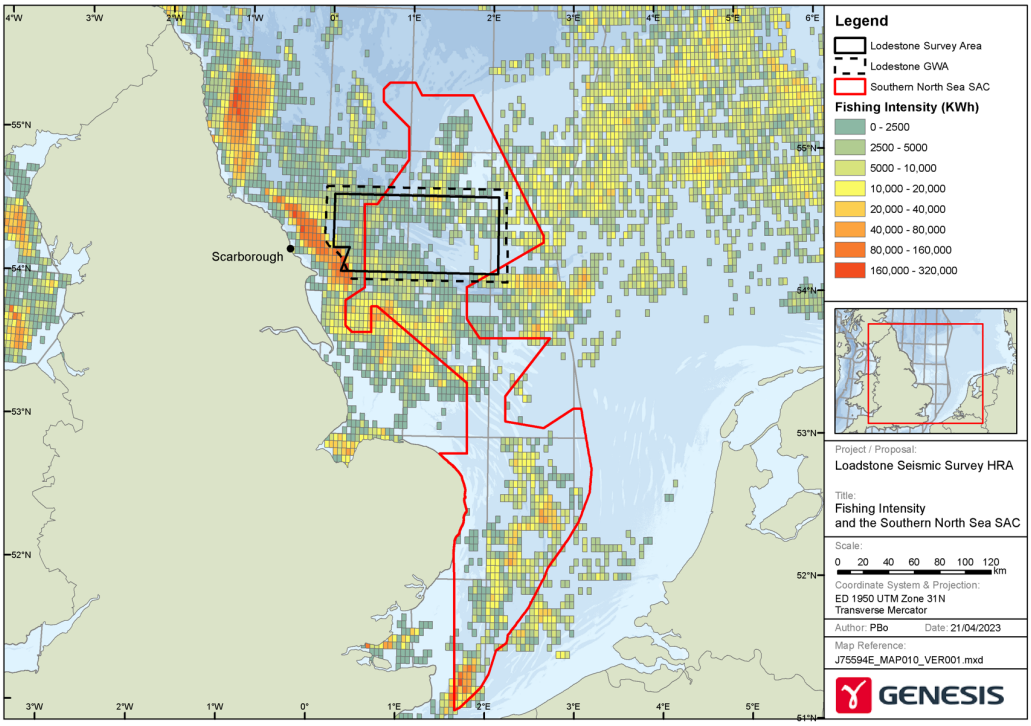


Figure 7: Fishing intensity across the SAC during 2016 by UK registered vessels.

8.39 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).

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

8.41 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

8.42 Following consideration of all known developments that could cause a likely significant effect, OPRED 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 Dogger Bank A offshore wind farm,

- Construction pile-driving at Dogger Bank B offshore wind farm,
- Crosgan Appraisal Well,
- Endurance Field Bunter Outcrop survey,
- Somerville and Anning Marine Survey
- Johnston site geophysical survey,
- NW Bell ZX and Murdoch KM geophysical survey,
- Hewett Field seismic survey.

8.43 On-going routine activities such as shipping, that could contribute to impacts on qualifying species, will also be being undertaken for the duration of the proposed surveys.

9 LIKELY SIGNIFICANT EFFECTS TEST

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

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

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

Harbour porpoise

9.4 Harbour porpoise are a qualifying species for the Southern North Sea SAC.

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 500 m of the sound source and disturbance or displacement effects to occur 12 km from the airguns and extend over an area of 452 km^2.

9.6 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

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

9.8 Grey seals are a qualifying species at the Humber Estuary SAC.

9.9 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 500 m of the sound source.

9.10 Based on the results from noise modelling, the known offshore distribution of grey seals (Figure 3) and their behaviour, it is concluded that there is potential for a likely significant effect on grey seals from the Humber Estuary SAC. The potential impacts on grey seal are therefore considered further in the Appropriate Assessment.

Fish

9.11 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.

9.12 Fish hearing is based on detecting particle motion directly stimulating the inner ear. However, those with swim bladders are also able to detect pressure waves and can detect a wider range of frequencies and sounds of lower intensity than fishes without swim bladders (Popper 2003). Fish with swim bladders include prey species for harbour porpoise and seals, such as herring, are recognised to be hearing specialists. Those without, e.g. sandeels, are considered to have a relatively low sensitivity to noise. Most fish with swim bladders are able to detect sound within the 100 Hz to 2 kHz range, those without swim bladders are unlikely to detect sound above 400 Hz (Popper *et al*. 2014).

9.13 Results from existing noise modelling indicate that noise levels capable of causing lethal effects on fish with swim bladders could occur out to 500 m from the airgun and for fish without swim bladders impacts could occur to 150 m. The area of impact within which physical injury could occur is therefore relatively very small. However, the area within which disturbance could occur may be substantially greater. Modelling undertaken for piling operations at the Hornsea Two offshore wind farm within the SAC indicate a general behavioural response may occur out 25 km for 'hearing specialists' (DONG 2015). Although the sound profile from piling is different from that of a seismic survey it does indicate the potential extent of disturbance to fish beyond the area of physical injury.

9.14 Results from existing noise modelling indicate that the there is potential for an impact on sea lamprey and river lamprey to within 150 m of the seismic survey. Based on the distance of the seismic surveys from the SAC and the low risk of any Lamprey occurring in the Survey Area it is concluded that there will not be a likely significant effect on sea lamprey or river lamprey from the proposed survey.

Seabirds

9.15 During the breeding season seabird distribution is constrained by the requirement to return to breeding colonies. However, their foraging ranges can be extensive and breeding birds from a number of SPAs could occur across the proposed Survey Area (Table 3). Outwith the breeding season seabirds are widely dispersed away from their colonies and it is not possible to determine from which SPA, if any, those present in the area may be from.

9.16 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.

9.17 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).

9.18 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.

9.19 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.

9.20 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.

9.21 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.

9.22 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

9.23 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

9.24 Based on the information presented within the application relating to the proposed activities and the advice received during consultation it is concluded that it is not possible to exclude a likely significant effect on the following designated sites and qualifying species:

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

9.25 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 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 designated sites identified as having qualifying species for which no likely significant effect could not be ruled out from the project alone and in-combination.

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

10.4 The assessment of the potential impacts from the seismic survey is based on the results from noise modelling undertaken by the applicant. 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. 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 500 m of the sound source (See Section 5).

10.7 The peak harbour porpoise density across the SAC is estimated to be >3 per km^2 (Heinänen and Skov 2015). Based on this peak density and the worst-case scenario of PTS occurring out to 500 m of the survey, an estimated three harbour porpoise could be affected at the start of the seismic survey.

10.8 The North Sea Management Unit harbour porpoise population is 346,601 individuals and therefore the worst-case scenario of less than three harbour porpoise being impacted is <0.0009% of the Management Unit population.

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

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

Disturbance

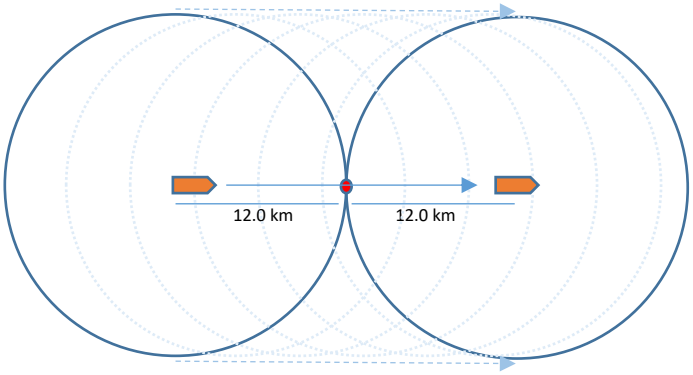
10.11 The largest distance any noise likely to cause disturbance is estimated to propagate out to is 12 km from the airguns, covering an area of 452 km^2 (Section 5). Assuming that disturbance occurs entirely within the SAC, then approximately 1.2% of the SAC as a whole and 3.7% of the 'summer' area could be affected by the proposed seismic survey at any one time.

10.12 Based on a peak site density of 3.0 ind./km^2 an estimated 1,356 harbour porpoise could be disturbed by a seismic survey. This is equivalent to 0.39% of the North Sea Management Unit harbour porpoise population being disturbed.

10.13 A seismic vessel will transit across an area and over the duration of a survey the total number of harbour porpoises disturbed will be greater. The application states that the seismic survey will be travelling at 5 knots (9.26 km/h) (CGG 2023a). As the vessel undertakes a survey, disturbance in any area will last less than three hours in any one location (Figure 8). Once the vessel has left the area, sound levels will reduce to background levels. The disturbance effects are therefore transient and once the vessel has moved away from an area there is, in effect, no disturbance on those porpoises previously impacted.

10.14 Studies undertaken in the Danish sector of the Central North Sea reported disturbance out to 12 km from a 3,570 cu. in. airgun, although the duration of the disturbance is not reported (Sarnocińska *et al*. 2020). Similar studies undertaken in the Moray Firth using a 470 cu in airgun with source levels estimated to be 242–253 dB re 1 µPa @ 1 m (peak to peak), reported a decrease in the relative densities of harbour porpoises within 10 km of the airgun and an increase in densities at greater distances. However, porpoises continued to occur at sites within the impacted area during the seismic survey and there was a decline in the level of displacement over the ten day period that surveys were undertaken, indicating an increasing level of acclimation during the

surveys. Once the surveys had ceased the number of detections returned to baseline levels within a day (Thompson *et al.* 2013, Pirotta *et al.* 2014). Therefore, any displacement effects caused by seismic surveys are predicted to be temporary, with porpoises returning to the area impacted within 24 hrs.



= Location of harbour porpoise in order for maximum duration of disturbance to occur.
Maximum extent of disturbance from seismic survey at 145 dB re 1 µPa – 33.2 km.
Total distance – 24.0 km.
Vessel speed – 9.26 km/h.
Maximum duration of disturbance impact = 2hrs 40 mins.

Figure 8: 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). No assessment has been undertaken within the application using the threshold approach.

10.16 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 OPRED based on information presented within the application.

10.17 OPRED have estimated the area of the survey within the SAC and within the SAC plus a 12 km buffer. Furthermore, by using GIS, OPRED have estimated the maximum length a single survey line may be within the SAC (Figure 9).

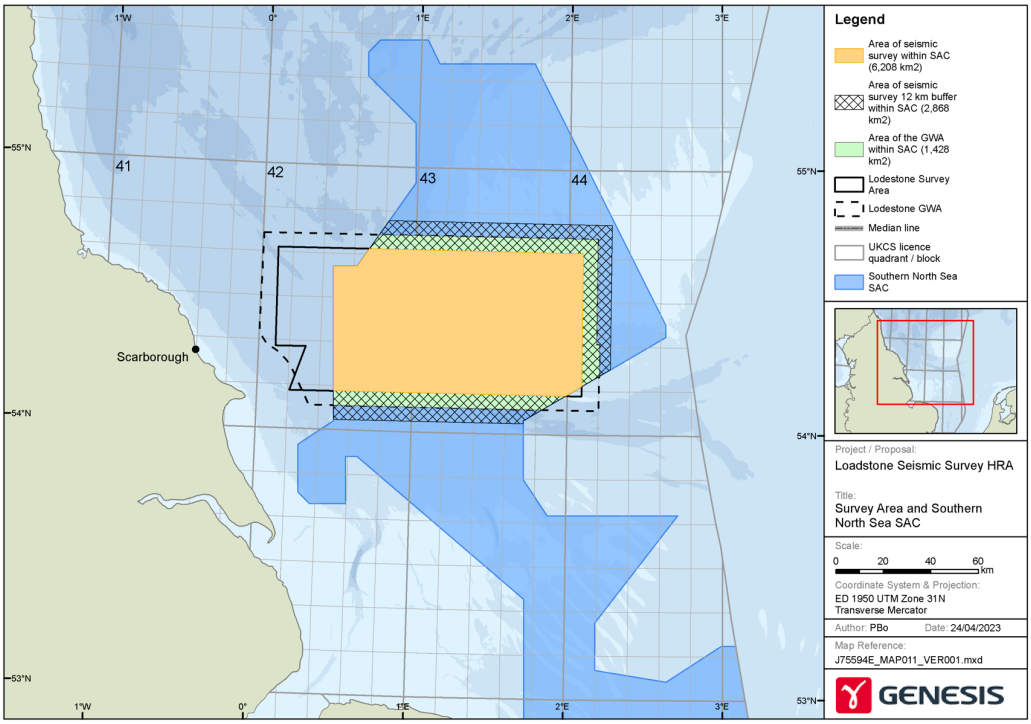


Figure 9: Area of seismic survey within the Southern North Sea SAC.

Daily Threshold

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

A total of 7,636 km^2 of the Greater Working Area is within the Southern North Sea SAC and therefore overlaps 20.7% of the SAC as a whole and 28.2% of the 'summer' area. However, airguns will only be operating within the Survey Area and, aside from the soft-starts, they will not be operating in the wider Greater Working Area. The area of seismic survey to be undertaken within the Survey Area and within the SAC is therefore 4,330 km^2 (Figure 9). This overlaps with 16.8% of the SAC as a whole and 23.0% of the 'summer' area.

10.19 Noise arising from the proposed seismic survey will be transient as the vessel moves along the pre-determined survey lines. The extent of displacement (deterrence) over the period of one day will therefore be greater than if the survey was stationary.

10.20 When undertaking the seismic survey, the vessel will be travelling at 5 knots (9.26 km/h). Consequently, the maximum length of line that could, in theory, be surveyed over the course of a single day is 222 km. Assuming a 12 km EDR, the total area impacted over the course of 24 hrs would be 5,780 km^2 (Figure 10). This presumes that airguns are operating continuously throughout a 24 hr period. This is an unrealistic scenario as there will be breaks of 3.0 hrs in

airgun operations at the end of each line as the vessel turns before starting the next line (CGG 2023a); consequently, airguns will not be operating throughout a 24 hr period. Furthermore, approximately 23% of the Greater Working Area and 17% 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.

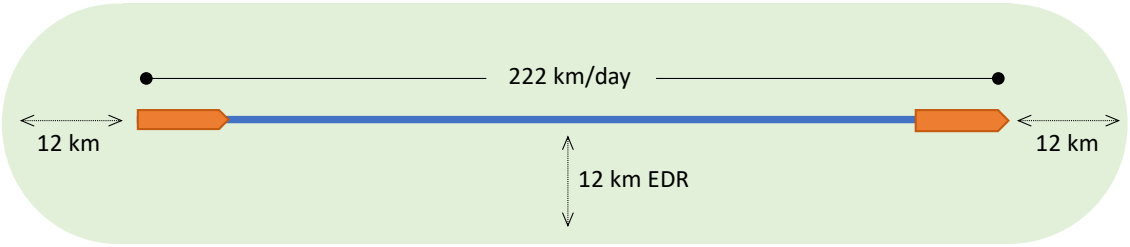


Figure 10: Worst-case theoretical area of impact from a seismic survey travelling at 5 knots using 12 km EDR.

10.21 Based on the configuration of the planned survey route (Figure 9), the maximum length of a single survey line within the Survey Area is 128 km, of which 105 km is the maximum length of line within the SAC. There will be 113 survey lines with an average length of 110 km (CGG 2023b).

10.22 The airguns will be switched off at the end of each line, during which time the vessel will turn, before commencing a soft-start at the start of each preceding line. It is estimated that it will take 3.0 hrs to undertake each line turn (CGG 2023a,b). Consequently, as the vessel will undertake at least one line turn each day the airguns will be operating for no more than 21 hrs per day. If the vessel travels at 5 knots and the airguns operate continuously for 21 hrs, the maximum length of survey line undertaken during any single day could be 194 km, of which 171 km could be within the SAC (Figure 11).

10.23 The maximum realistic area within the SAC that could be impacted per day is estimated to be 3,725 km^2. This is equivalent to impacting approximately 10.1% of the SAC as a whole and 13.8% of the 'summer' area per day. Consequently, the daily thresholds will not be exceeded by the proposed seismic survey on its own.

10.24 This scenario assumes that the airguns are operating over a period of 21 hrs during any single day with airguns switched off for a period of no less than 3.0 hrs at the end of each line. It also assumes that the vessel will travel no faster than 5 knots when undertaking the survey and successive lines are no more than 9.7 km apart. It is therefore considered to be realistic worst-case scenario based on the information presented within the application.

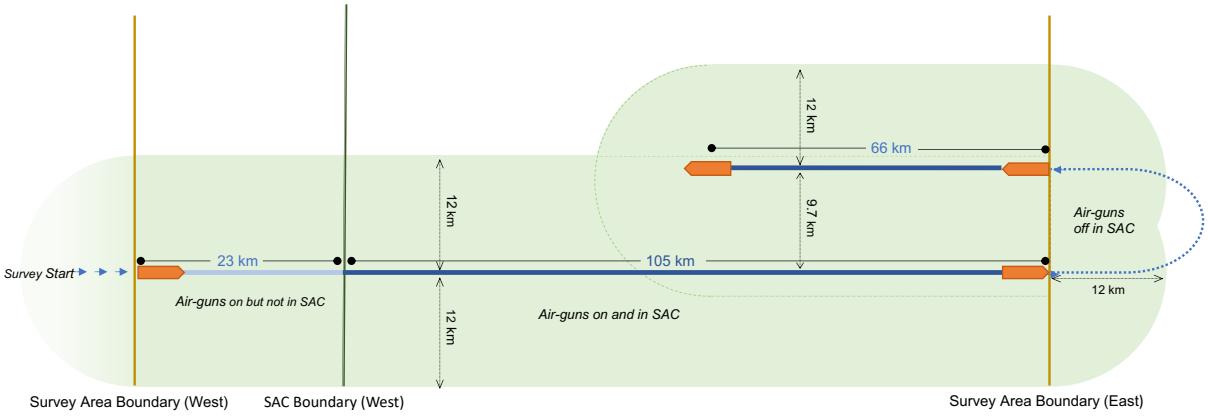


Figure 11: Maximum area of impact over 24 hrs from proposed Lodestone seismic survey within the Southern North Sea SAC.

Seasonal Threshold

10.25 The survey is planned to be undertaken over a period of 114 days between June 2023 with completion no later than December 2023. The airguns will be operating for 71 days (CGG 2023b)

10.26 In order to assess the seasonal spatial overlap it is presumed that the survey will start on 1 June 2020 and therefore, in theory, the whole survey could occur during the summer period.

10.27 In the event that the survey is undertaken each day over the maximum daily area of 3,725 km^2 over the whole survey duration of 114 days, the seasonal average is 8.6% (Table 8). In the event that survey activity only occurs on 71 of the 114 days the seasonal impact is reduced to 5.3%.

10.28 The maximum realistic daily area impacted within the SAC of 3,698 km^2 will not arise during each day the survey is being undertaken. The applicant states that there will be 113 survey lines with the average line length being 110 km (CGG 2023b). On this basis, it is estimated that the total length of line to be surveyed is *c.*12,430 km. This will be undertaken over a period of 71 days, out of a total of 114 days that the survey vessel will be operating. Consequently, an estimated daily average length of line surveyed could be 175 km, of which 152 km could be within the SAC[1]. This reduces the average daily area of impact to an estimated 3,541 km^2 and the seasonal impact to 5.0% (Table 8).

10.29 In the event the survey is undertaken over the entire 114 days, the average length of line surveyed each day is reduced to 109 km and the average area impacted within the SAC each day would be no greater than 2,842 km^2 [(2)]. However, the duration of the noise produced during the survey would be at its greatest and therefore the seasonal impact is 6.5% (Table 8).

[1] This assumes that of the 175 km that could on average be surveyed 23 km occurs outwith the SAC (see Figure 11).
[2] Calculation based on a single surveyed line of 109 km per day wholly within SAC with noise extending 12 km either side (i.e. a 24 km corridor), plus noise extending beyond end of survey line a further 12 km (see Figure 11).

10.30 Under both the worst-case and realistic worst-case scenarios the seasonal threshold is not exceeded by the proposed survey.

Table 8: Estimated extent of seasonal disturbance on harbour porpoise from proposed Lodestone 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 - 114 days in summer period)				
'summer'	3,725	13.8	114	8.6
Worst-case (Maximum daily impact - 71 days in summer period)				
'summer'	3,725	13.8	71	5.3
Realistic worst-case (Mean daily impact 114 days in summer period)				
'summer'	2,842	10.5	114	6.5
Realistic worst-case (Mean daily impact 71 days in summer period)				
'summer'	3,541	13.1	71	5.0

Conclusion

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

10.32 There is a risk of harbour porpoise being displaced or disturbed by the proposed seismic survey. Noise modelling indicates that up to 1,356 harbour porpoise may be disturbed at any one time; this is 0.4% of the North Sea Management Unit population and therefore below the predicted level of disturbance that could cause a population level effect. The disturbance will be of short duration as the vessel transits through the Survey Area. Once the vessel has passed, any changes in behaviour due to disturbance will cease quickly after the vessel has moved away and any porpoises that may have been displaced are predicted to return to the area within 24 hrs.

10.33 The results from the threshold approach indicate that up to 13.8% of the 'summer' area may be impacted each day and between either 5.0% and 8.6% of the average seasonal threshold. The daily and seasonal thresholds are not exceeded.

10.34 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.

10.35 Based on the best available information and supported by results from noise modelling and the draft threshold approach, OPRED 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.

Humber Estuary SAC

Grey seal

10.36 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 the Humber Estuary SAC are at risk of being impacted by noise arising from the proposed survey.

10.37 Densities of grey seal across the proposed seismic survey working area range from <1 individual per 5 km^2 and <100 individuals per 5 km^2, i.e. between <0.04 and 4.0 individuals per km^2 (Figure 3). Over the majority of the Survey Area densities of grey seals are relatively low.

Physical Injury

10.38 Results from noise modelling presented within the application indicate that there is a risk of physical injury in the form of PTS within 500 m of the sound source (Section 5).

10.39 The potential area within which the onset of PTS is predicted to occur is very localised and covers an area of no more than 0.78 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

10.40 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 12 km from the survey vessel (CGG 2023b). 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.

10.41 The Humber Estuary SAC lies 60 km from the Survey Area. On an average estimated density of 0.25 ind/km^2 (See Forewind 2013 and Figure 3) being disturbed across the proposed Survey Area, an estimated total of up to 113 grey seals could be disturbed at any one time by the proposed survey.

10.42 The estimated grey seal population for the Humber Estuary SAC is 20,867 individuals (See Section 3.27). Consequently, if all the grey seals impacted are from this SAC an estimated 0.5% of the SAC population could be disturbed at any one time.

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

10.44 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.

10.45 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.

10.46 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).

10.47 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).

10.48 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

10.49 It is predicted that there is a very low risk of any physical injuries to grey seals arising from the proposed seismic survey. However, grey seals from the Humber Estuary SAC 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.

10.50 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.

10.51 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.

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

11 IN-COMBINATION ASSESSMENT

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

11.2 Projects identified as having potential to cause an in-combination impact are listed below. It is anticipated that the work will be undertaken from June through to end of December 2023. Projects listed in italics have completed their activities and therefore do not contribute to the daily impact but do contribute to the seasonal impact.

- Dogger Bank A offshore wind farm: pile-driving,
- Dogger Bank B offshore wind farm: pile-driving,
- *Crosgan Appraisal Well,*
- *NW Bell ZX and Murdoch KM geophysical site survey,*
- *Endurance Field Bunter Outcrop survey,*
- *Johnston geophysical site survey,*
- *Somerville and Anning Marine Survey,*
- Hewett Field seismic survey.

Construction pile-driving at Dogger Bank A and Dogger Bank offshore wind farms

11.3 Offshore construction at the Dogger Bank A Offshore wind farm commenced in 2022 and offshore construction at Dogger Bank B will commence in August 2023. Pile-driving could occur at both offshore wind farms during 2023. However, there will be no concurrent pile-driving of monopiles across each of the wind farms (DBWF 2022). Figure 12 presents the location of Dogger Bank A and Dogger Bank B offshore wind farms in relation to the proposed Lodestone seismic survey.

11.4 For the purposes of this assessment noise modelling undertaken by Dogger Bank Wind Farm for the Dogger Bank A and B offshore wind farms has been used. The modelling is based on the installation of 95 wind turbines at each of the wind farms. Each turbine will have 10 m diameter monopile driven into the seabed using a 4,000 kJ hammer (DBWF 2021).

11.5 The results from the modelling indicate that the onset of PTS could occur out to 1,400 m and encompass an area of 4 km^2. Levels of noise predicted to cause disturbance could occur out to 19 km and cover an area of 890 km^2 (DBWF 2021).

11.6 Based on the results from noise modelling and a peak density of 0.71 ind./km^2 recorded across the Dogger Bank Zone (Forewind 2014), an estimated three harbour porpoise are at risk of PTS from the pile-driving and 632 harbour porpoise may be disturbed or displaced by activities at either Dogger Bank A or Dogger Bank B.

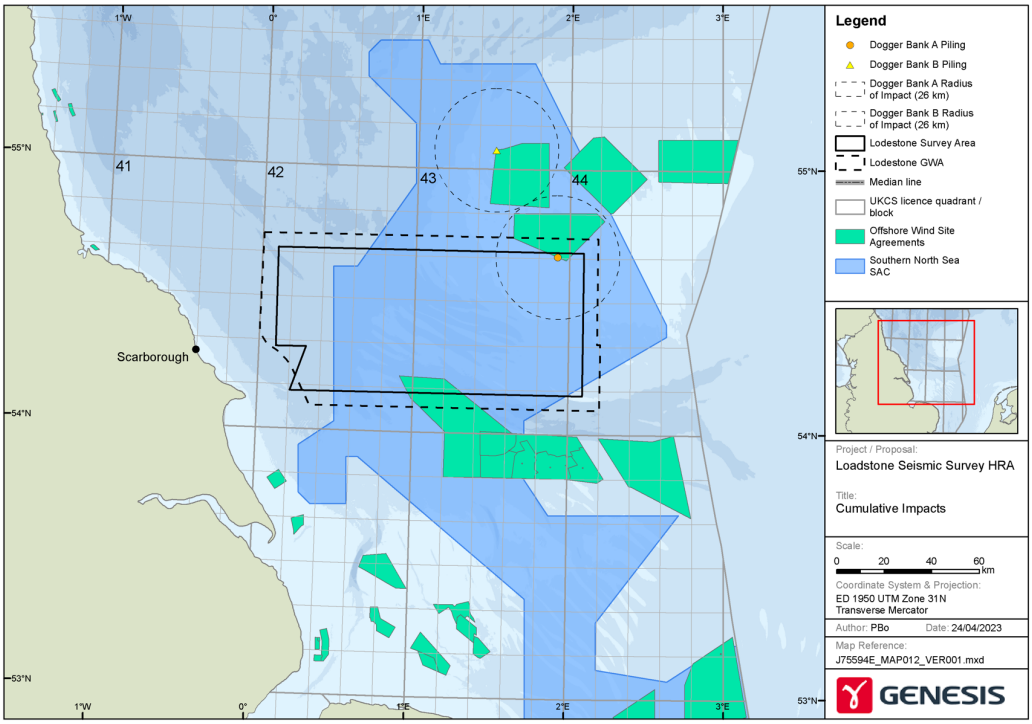


Figure 12: Location of proposed Lodestone seismic survey and potential impacts from pile-driving at Dogger Bank A and Dogger Bank B offshore wind farms.

11.7 Based on the threshold approach with an EDR of 26 km the results of the assessment indicate a maximum area of impact within the SAC from a single pile-driving event of 2,124 km^2, impacting 7.9% of the 'summer' area of the SAC. However, the worst-case scenario could theoretically be three monopiles being installed per day, each 5 km apart and pin-piling offshore platform foundations at either Dogger Bank A or Dogger Bank B (DBWF 2022). In this, unlikely scenario the maximum area impacted each day could be 10.47% of the SAC (Table 9).

11.8 Similarly the seasonal average ranges from between 0.20 and 6.49% depending on the scenario (Table 9).

11.9 For Dogger Bank B the scenarios are similar, although the daily and seasonal impacts are larger, with between 7.09% and 12.0% of the SAC summer area impacted daily and average across the season of between 5.25% and 7.03% (Table 10).

11.10 The installation of the pin-piles for the offshore platforms at both Dogger Bank A and Dogger Bank B was undertaken in February 2023 (DBWF 2023a, b). Consequently, the worst case scenarios where concurrent monopile and pin-pile activity could be undertaken will not occur over the summer period.

11.11 Note that Dogger Bank B is not due to commence pile-driving for foundations until approximately 10 August 2023 and following completion of foundation installations at Dogger Bank A. Consequently, the worst-case scenario for Dogger Bank B (where pile-driving is predicted to occur over a period of 152 days), is not technically possible and has not been considered further in this assessment.

11.12 The worst-case scenario used for this assessment is based on Dogger Bank A installing three monopiles per day. However, it is noted that to date of the 25 turbine foundations so far installed at Dogger Bank A, no more than one has been installed over any 24 hr period (DBWF 2023c). Based on actual activities undertaken to date a realistic worst case scenario is for there to be no more than one turbine installed per day at either Dogger Bank A or Dogger Bank B.

Table 9: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed pile-driving at Dogger Bank A offshore wind farm within the SAC (source DBWF 2022).

SAC area	Area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
Pile driving Dogger Bank A: Single monopile/day				
'summer'	2,124	7.9	152	5.25 [1]
Pile driving Dogger Bank A: Three monopiles/day				
'summer'	2,539	9.40	152	6.43 [1]
Pile driving Dogger Bank A: Single piling of monopile and piling of offshore platform pin-piles				
'summer'	2,830	10.47	4	0.20
Pile driving Dogger Bank A: Three monopiles/day and piling of offshore platform pin-piles				
'summer'	3,246	10.47	152	6.49

1 = Average area of impact over 152 days.

Table 10: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed pile-driving at Dogger Bank B offshore wind farm within the SAC (DBWF 2022).

SAC area	Area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
-Pile driving Dogger Bank B: Single monopile/day				
'summer'	2,124	7.9	152	5.25 [1]
-Pile driving Dogger Bank B: Three monopiles/day				
'summer'	2,539	9.4	152	6.98 [1]
Pile driving Dogger Bank B: Single piling of monopile and piling of offshore platform pin-piles				
'summer'	2,830	10.47	4	0.21
Pile driving Dogger Bank B: Three monopiles/day and piling of offshore platform pin-piles				
'summer'	3,246	12.01	152	7.03 [1]

1 = Average area of impact over 152 days.

Crosgan Appraisal Well

11.13 An application to undertake drilling at the proposed Crosgan Appraisal Well stated that activities could commence in March or April 2023. Noise arising from conductor pile-driving and the use of Vertical Seismic Profiler (VSP) could cause disturbance (ONE-Dyas 2023a).

11.14 One-Dyas have confirmed that the works were completed before the end of March 2023 and therefore did not contribute to any of the daily or seasonal thresholds during the summer period.

NW Bell ZX and Murdoch KM Survey

11.15 Harbour Energy propose to conduct a geophysical site survey, including the use of a sub-bottom profiler at NW Bell ZX and Murdoch KM (Harbour Energy 2023a).

11.16 The proposed activities are to be undertaken over a period of two days between 9 March and 31 May 2023.

11.17 The results from the noise modelling undertaken by the applicant indicate that the onset of PTS could within 15 m from the sound source and encompass an area of 0.0007 km^2. Levels of noise predicted to cause disturbance could occur out to 590 m (based on a disturbance threshold of 160 dB) and cover an area of 1.1 km^2 (Harbour Energy 2023a).

11.18 Based on the results from noise modelling and a peak density of 3.0 ind./km^2, less than one harbour porpoise is estimated to be at risk of PTS from the geophysical survey and three harbour porpoise may be disturbed or displaced.

11.19 The applicant has not undertaken an assessment based on the SNCB threshold approach.

11.20 Using the recommended 5 km EDR for the use of geophysical surveys it is estimated that the maximum daily area impacted would be 80.3 km^2 [1]. This would impact on 0.3% of the 'summer' area of the SAC. The total duration of activities within the SAC will be one day. Consequently the proposed geophysical survey will contribute 0.002% of the seasonal threshold (Table 11).

Table 11: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed NW Bell ZX geophysical site survey within the SAC.

SAC area	Area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
'summer'	80.3	0.3	1	0.002

Bunter Outcrop seismic survey

11.21 An application to undertake the Bunter Outcrop seismic survey advised that it could commence on 23 March 2023 and be completed no later than 31 May 2023 (BP 2023).

11.22 The results from the noise modelling undertaken by the applicant indicate that the onset of PTS could occur out to 150 m and encompass an area of 0.07 km^2. Levels of noise predicted to cause disturbance could occur out to 6.7 km and cover an area of 188 km^2 (BP 2023).

11.23 Based on the results from noise modelling and a peak density of 3.0 ind./km^2 less than one harbour porpoise is estimated to be at risk of PTS from the seismic survey and 564 harbour porpoise may be disturbed or displaced.

11.24 Based on the SNCB threshold approach with an EDR of 12 km the results of the assessment indicate a maximum area of impact within the SAC over the course of a single day being 651 km^2, impacting 2.4% of the 'summer' area of the SAC. The total duration of activities will be seven days. Consequently the proposed seismic survey will contribute 0.09% of the seasonal threshold (Table 12).

11.25 The survey was completed in April 2023.

Table 12: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed Bunter Outcrop seismic survey within the SAC.

SAC area	Area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
'summer'	651	2.4	7	0.09

[1] Calculated based on a 5 km EDR and the total area to be surveyed at NW Bell being 1.8 km^2.

Johnston Geophysical Survey

11.26 Harbour Energy propose to conduct a site survey using geophysical equipment including a sub-bottom profiler at the Johnston field.

11.27 The proposed activities are to be undertaken over a period of two days between 15 March and 31 May 2023.

11.28 The results from the noise modelling undertaken by the applicant indicate that the onset of PTS could occur out to 73 m from the sound source and encompass an area of 0.017 km^2. Levels of noise predicted to cause disturbance could occur out to 470 m (based on a disturbance threshold of 160 dB) and cover an area of 0.7 km^2 (Harbour Energy 2023b).

11.29 Based on the results from noise modelling and a peak density of 3.0 ind./km^2, less than one harbour porpoise is estimated to be at risk of PTS from the geophysical survey and two harbour porpoise may be disturbed or displaced.

11.30 The applicant has not undertaken an assessment based on the SNCB threshold approach.

11.31 Using the recommended 5 km EDR for the use of geophysical surveys and the largest of the two survey areas is 0.9 km long. It is estimated that the maximum daily area impacted would be 118.8 km^2 [1]. Consequently the proposed survey could impact on 0.4% of the SAC summer area over the course of one day. The total duration of activities will be two days. Consequently, the proposed geophysical survey will contribute 0.004% of the seasonal threshold (Table 13).

Table 13: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed Johnston geophysical survey within the SAC.

SAC area	Area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
'summer'	119	0.4	2	0.004

Hewett Field bathymetric and seismic survey.

11.32 The proposed survey will be undertaken between 20 June and 31 October 2023. The survey is expected to take up to 130 days to complete (Gov. 2023).

11.33 Noise modelling indicates that the level of noise arising from the seismic survey at which the onset of PTS is predicted to occur will not be exceeded beyond 104 m (ENI 2023). Consequently, there is little or no risk of any auditory injury to harbour porpoise from the proposed seismic survey.

11.34 The modelling indicates that there is potential for a strong behavioural response within 1.5 km of the seismic survey and a mild behavioural reaction within 31 km (ENI 2023). The area impacted by the survey is not presented in the application. Based on a strong behavioural response

[1] Calculated based on a square area of impact of 10.9 km (5km + 5km + 0.9km).

occurring within 1.5 km radius of the airguns it is estimated that the area of disturbance could occur over an area of 7.0 km^2. Based on a maximum density of 3 ind./km^2, an estimated 21 harbour porpoise could be disturbed by the seismic survey.

11.35 Based on the SNCB threshold approach with an EDR of 12 km, the applicant estimated that 1,237 km^2 could be impacted per day (ENI 2023), equating to 4.6% of the daily threshold. Based on the impact occurring over a period of 102 days the seasonal impact is estimated to be 2.6% (Table 14).

Table 14: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed pile-driving at Dogger Bank B offshore wind farm within the SAC.

SAC area	Area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
-Pile driving Dogger Bank B monopiles				
'summer'	1,237	4.6	102	2.6

Sommerville and Anning Marine Survey

11.36 Hartshead Resources Limited have applied to undertake a marine survey within the Somerville and Anning fields.

11.37 The survey entails the use of a 2D High Resolution (2DHR) seismic airgun and a sub bottom profiler. Along with a multi beam echo-sounder, sidescan sonar.

11.38 The operations are to be undertaken over a period of ten days between 10 April and 31 May 2023 (HRL 2023a).

11.39 The results from the noise modelling undertaken by the applicant indicate that the onset of PTS could occur out to 2,100 m from the sub-bottom profiler and encompass an area of 13.18 km^2. Consequently, up to 42 harbour porpoise could be at risk of physical injury from noise arising from the proposed use of sub-bottom profiler based on a peak density of 3.0 ind./km^2.

11.40 No noise modelling to assess the potential impacts of disturbance has been undertaken by the applicant. A fixed 12 km radius of noise was used, equivalent to the EDR for seismic airguns. Based on a peak density of 3.0 ind./km^2, 1,356 harbour porpoise could be at risk of disturbance from the geophysical survey.

11.41 The applicant has not undertaken an assessment based on the SNCB threshold approach.

11.42 The results from the threshold approach undertaken by OPRED indicate that up to 3.2% of the 'summer' area may be impacted for a period of ten days and the survey could contribute up to 0.17% of the seasonal threshold (Table 15).

11.43 There will be no impact on the winter area of the SAC.

Table 15: Estimated extent of daily and seasonal disturbance on harbour porpoise from proposed Sommerville and Anning Marine Survey within the SAC.

SAC area	Area of SAC impacted per day (km^2)	Daily Threshold (%)	Estimated duration of impact (days)	Seasonal Threshold (%)
'summer'	880	3.2	10	0.17

11.44 The survey will have been completed before the start of the Lodestone seismic survey.

In-combination scenarios

11.45 The in-combination assessment has been undertaken using outputs from both noise modelling and the threshold approach where available. Due to the number of current and planned activities being undertaken within or adjacent to the SAC and the level of uncertainty surrounding them, there are a number of potential in-combination scenarios. This section assesses the potential levels of in-combination impact that could arise.

11.46 The timelines for each of the activities identified as having the potential to cause an in-combination impact are presented in Figure 13.

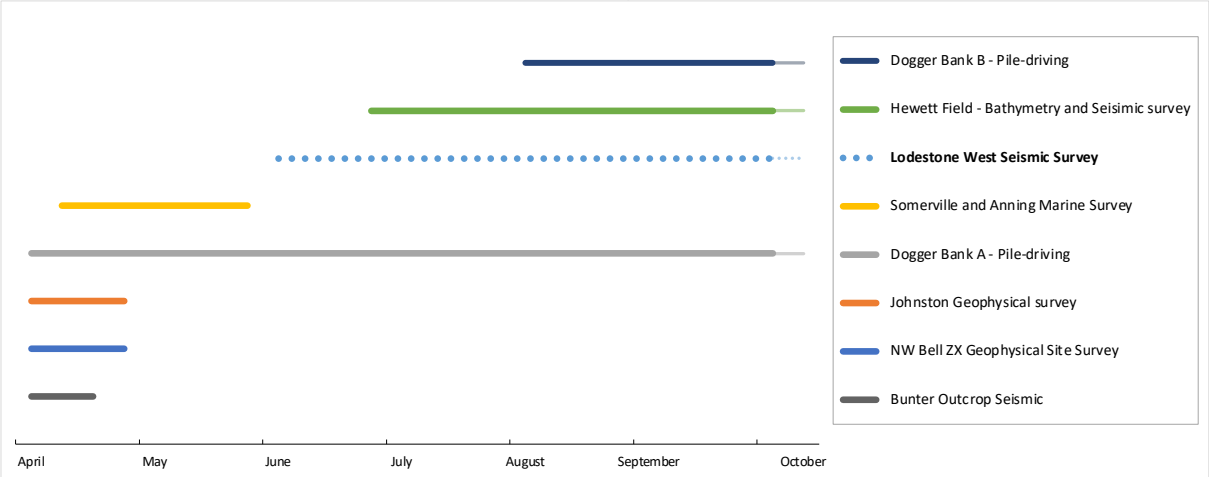


Figure 13: Timeline of known activities within the 'summer' area of Southern North Sea SAC that could have an in-combination impact in summer 2023.

Note Dogger Bank A and Dogger Bank B monopile pile-driving will not occur concurrently.

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

Noise modelling

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

Physical Injury

11.48 The results from noise modelling indicate that less than three harbour porpoise could be at risk from the onset of PTS arising from the proposed seismic survey.

11.49 An estimated 42 harbour porpoise could be impacted from the proposed use of a sub-bottom profiler at the Somerville and Anning fields. All other uses of either sub-bottom profiler or seismic airguns to be undertaken in summer 2023 indicate less that one harbour porpoise to be at risk of PTS. Although. these are effectively zero as the physical presence of the vessels is predicted to ensure that no harbour porpoise are within the range at which the onset of PTS is predicted to arise from these activities aside from the Somerville and Anning surveys.

11.50 In-combination impacts could arise from pile-driving at Dogger Bank A and Dogger Bank B where an estimated three harbour porpoise could be impacted at both wind farms.

11.51 The potential in-combination impact of approximately 51 harbour porpoise is equivalent to 0.015% of the North Sea Management Unit population.

Disturbance

11.52 The total number of harbour porpoise estimated to be disturbed by the proposed survey is 1,356 individuals.

11.53 The only activities being undertaken at the same time as the proposed survey are pile-driving at either Dogger Bank A or Dogger Bank B offshore wind farms and the proposed Hewett field seismic survey. All other activities will have been completed prior to the start of the Lodestone survey and therefore do not contribute to the disturbance totals.

11.54 At Dogger Bank A and Dogger Bank B an estimated 632 harbour could be disturbed or displaced by each project due to pile-driving. Although pile-driving at each of the wind farms will not be undertaken concurrently and therefore disturbance will only arise at one of the wind farms on any single occasion. Consequently, a maximum estimated 632 harbour porpoise could be disturbed at any one time. The Hewett Field survey could also disturb up to 21 harbour porpoise.

11.55 During the period the proposed Lodestone seismic survey will be undertaken from June onwards, an estimated 2,009 harbour porpoise could be disturbed at any one time within the Southern North Sea SAC, equivalent to 0.58% of the North Sea Management Unit Population. If displaced, harbour porpoise will be able to relocate elsewhere and evidence from studies indicate that they will return to the area within 24 hrs of the noise ceasing. Consequently, any impacts are predicted to be temporary and impact on a relatively small proportion of the relevant population.

In-combination threshold approach

11.56 There is always a level of uncertainty over the timing of activities that could impact on harbour porpoise within the Southern North Sea SAC. This uncertainty over the timings can cause overly

precautionary assessments as activities that are unlikely to occur or have been completed, included in the assessment, conflating the daily and seasonal totals.

11.57 For the purposes of this in-combination assessment all potential activities are predicted to occur, potentially on the one day. This gives to rise a highly precautionary and unrealistic in-combination total. However, there is a relatively high degree of certainty that the proposed survey could occur on the same days as construction pile-driving is being undertaken at Dogger Bank A. There is less certainty that proposed activities at Dogger Bank B will commence in August, as planned. There is a high degree of certainty that activities relating to the Hewett field surveys wil be undertaken over the same period. There is however, low confidence on the extent of any impact within any single day from the Hewett survey. Delays in the commencement of any of these activities reduce the risk of daily and seasonal thresholds being exceeded. Other activities that contribute to the seasonal threshold have a high level certainty, in that they have either completed activities or have commenced them.

'Potential worst-case (June - September)'. This scenario is based on:

- The maximum area of impact predicted from the proposed Lodestone survey during the course of one day.
- The maximum area of impact from pile-driving at the Dogger Bank A offshore wind farm installing three foundations in one 24 hr period.
- The maximum area of impact estimated from the Hewett field seismic survey.

11.58 These scenarios are the potential worst-case in that, for them to arise, the maximum area of potential impact from all the projects must occur on the same day. The probability of this occurring is considered to be small.

11.59 Based on the potential worst-case (June - September) scenario the daily threshold is exceeded between June and September (Table 16).

11.60 Under the potential worst-case in-combination scenarios the seasonal threshold is exceeded (Table 17). In the event that activities are delayed, the in-combination seasonal threshold during the summer period of 2023 may be reduced.

Table 16: Potential worst-case in-combination daily threshold (%).

Activity	April	May	June	July	Aug	Sept
Bunter Outcrop survey	2.4	2.4	-	-	-	-
NW Bell ZX geophysical survey	0.3	0.3	-	-	-	-
Johnstone geophysical survey	0.4	0.4	-	-	-	-
Somerville and Anning Survey	3.2	3.2				
Dogger Bank A - Pile-driving	7.9 [1]	9.4	9.4	9.4	9.4	9.4
Hewett bathymetric and seismic	-	-	4.6	4.6	4.6	4.6
Lodestone seismic	**-**	**-**	**13.8**	**13.8**	**13.8**	**13.8**
Dogger Bank B – Pile-driving	-	-	-	-	9.4	9.4
Total %	**15.2**	**15.7**	**27.8**	**27.8**	**27.8**	**27.8**

1 – no more than one foundation was installed during any 24 hr period during April 2023 (DBWF 2023c)
2 – Pile-driving at Dogger Bank B wind farm will not occur on the same day as pile-driving at Dogger Bank A. There is no in-combination daily threshold affect.

Table 17: Potential worst-case In-combination seasonal thresholds (%).

Activity	Summer seasonal threshold (%)
	Potential worst-case
Bunter Outcrop survey	0.09
Somerville and Anning surveys	0.17
Dogger Bank A - Pile-driving	6.4
Johnstone geophysical survey	0.004
NW Bell ZX geophysical survey	0.002
Hewett Field bathymetric and seismic	2.56
Lodestone seismic	**8.6**
Dogger Bank B - Pile-driving	Included in Dogger Bank A
Total %	**17.8**

'Realistic worst-case (June - September)'. This scenario is based on:

- The maximum area of impact predicted from the proposed Lodestone survey during the course of one day.
- The maximum of one pile-driving activity occurring at either the Dogger Bank A or Dogger Bank B offshore wind farms. (this is based on their not having been more than one foundation pile-driven per day at Dogger Bank A wind farm to date).
- The maximum area of impact estimated from the Hewett field seismic survey.

11.61 These scenarios are the realistic worst-case based on known activities to date and the probability of them occurring.

11.62 Based on the realistic worst-case (June - September) scenario the daily threshold is exceeded between June and September (Table 18).

11.63 Under the realistic worst-case in-combination scenarios the seasonal threshold is exceeded (Table 19). In the event that activities are delayed, the in-combination seasonal threshold during the summer period of 2023 may be reduced.

Table 18: Potential worst-case in-combination daily threshold (%).

Activity	April	May	June	July	Aug	Sept
Bunter Outcrop survey	2.4	2.4	-	-	-	-
NW Bell ZX geophysical survey	0.3	0.3	-	-	-	-
Johnstone geophysical survey	0.4	0.4	-	-	-	-
Somerville and Anning Survey	3.2	3.2				
Dogger Bank A - Pile-driving	7.9 [1]	7.9	7.9	7.9	9.4	9.4
Hewett bathymetric and seismic	-	-	4.6	4.6	4.6	4.6
Lodestone seismic	**-**	**-**	**13.8**	**13.8**	**13.8**	**13.8**
Dogger Bank B – Pile-driving	-	-	-	-	7.9	7.9
Total %	**15.2**	**15.2**	**26.3**	**26.3**	**26.3**	**26.3**

1 – no more than one foundation was installed during any 24 hr period during April 2023 (DBWF 2023c)
2 – Pile-driving at Dogger Bank B wind farm will not occur on the same day as pile-driving at Dogger Bank A. There is no in-combination daily threshold affect.

Table 19: Realistic worst-case in-combination seasonal thresholds (%).

Activity	Summer seasonal threshold (%)
	Potential worst-case
Bunter Outcrop survey	0.09
Somerville and Anning surveys	0.17
Dogger Bank A - Pile-driving	5.25
Johnstone geophysical survey	0.004
NW Bell ZX geophysical survey	0.002
Hewett Field bathymetric and seismic	2.56
Lodestone seismic	**6.5**
Dogger Bank B - Pile-driving	Included in Dogger Bank A
Total %	**14.6**

Based on:
an estimated average daily impact from the lodestone survey over the duration of 114 days.
no more than one piled foundation installed per day at either Dogger Bank a or Dogger Bank B

11.64 There are varying levels of confidence in the extent and duration of impacts from each of the activities that could occur within the Southern North Sea SAC which affect the results of this assessment; a summary is presented in Table 20. Any changes in any of the Projects' schedules or scopes of work could affect the threshold based assessment.

Table 20: Confidence in extent and duration of potential impacts from planned activities within or adjacent to the Southern North Sea SAC between April and September 2020.

Project	Confidence	Comment
Dogger Bank A pile-driving	Very High	Very High certainty activities will be undertaken during 'summer' 2023. Very High certainty on when activities will commence. They have commenced. 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.
Dogger Bank B	High	High certainty activities will be undertaken during 'summer' 2023. 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.
NW Bell ZX and Murdoch KM geophysical site survey	High	Very High certainty activities will be undertaken during 'summer' 2023. 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.
Endurance Field Bunter Outcrop survey	High	Very High certainty activities will be undertaken during 'summer' 2023. 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.
Johnston geophysical site survey	High	Very High certainty activities will be undertaken during 'summer' 2020. High level of certainty in the area of SAC that could be impacted. High level of certainty from published evidence on the extent and duration of impacts.
Somerville and Anning Marine Survey	High	Very High certainty activities will be undertaken during 'summer' 2020. High level of certainty in the area of SAC that could be impacted. High level of certainty from published evidence on the extent and duration of impacts.
Hewett Field seismic survey	Moderate	High certainty activities will be undertaken during 'summer' 2020. Moderate to low 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.

In-combination assessment Southern North Sea SAC conclusions

11.65 Results from noise modelling indicate that up to three harbour porpoise could, in theory, be at risk of physical injury in the form of PTS from all planned activities within or adjacent to the SAC. This is <0.001% of the Management Unit population and therefore below the level of 1.7% at which a population level effect is predicted to occur. Mitigation measures that are licence conditions

significantly reduce the risk of any harbour porpoise receiving sound levels capable of causing the onset of PTS.

11.66 The estimated number of harbour porpoise at risk of disturbance is estimated to be 1,356 individuals. This is equivalent to 0.39% of the North Sea Management Unit population being disturbed at any one time. This is below the 1.7% at which population level impacts are predicted to arise.

11.67 Noise modelling results estimate that 2,009 harbour porpoise could be disturbed in-combination with other plans or projects. This is below the 1.7% at which population level impacts are predicted to arise.

11.68 The results from the threshold approach indicate that neither the daily nor seasonal thresholds are exceeded under the potential worst-case scenario by the project alone.

11.69 The results from the threshold approach indicate that both the daily and seasonal thresholds will be exceeded under both worst-case scenarios.

11.70 Based on the best available information and supported by results from noise modelling and the threshold approach, it is concluded that there is potential for an adverse effect upon the integrity of the Southern North Sea SAC with respect to harbour porpoise from the proposed Lodestone seismic survey in-combination with other known plans or projects.

In-combination assessment on Humber Estuary SAC: Grey seals

11.71 There is potential for an in-combination impact on grey seals from the proposed Lodestone seismic survey and pile-driving being undertaken at Dogger Bank A, Dogger Bank B. .

11.72 The assessment for the proposed Lodestone 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 (Para. 10.39). Consequently, there will be no in-combination impact on grey seals with respect to physical injury.

11.73 There is potential for in-combination impacts arising from displacement or disturbance. It is estimated that up to 113 grey seal could be impacted by the proposed Lodestone survey (Para. 10.41). The estimated number of grey seals to be disturbed at either Dogger Bank A or Dogger Bank B is estimated to be 16 individuals based on a TTS threshold, i.e. a significant disturbance. It is estimated that 129 grey seals may be disturbed or displaced by other proposed projects (Table 21).

Table 21: Estimated number of grey seals at risk of PTS and disturbance from proposed activities.

Activity	Disturbance
Lodestone Seismic Survey	139
Dogger Bank A or Dogger Bank B pile-driving	16
Total	**129**

11.74 It is estimated that 129 grey seals could be displaced or disturbed by the in-combination impacts at any one time, which is 0.6% of the Humber Estuary SAC grey seal populations.

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

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

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

11.77 It is estimated that at least 0.6% of the grey seal SAC population could be disturbed by planned activities. However, any displacement or disturbance impacts will be temporary with seals capable of relocating away from an area without causing a population level effect.

11.78 Based on the best available information OPRED is satisfied that the proposed Lodestone survey in-combination with other plans or projects will not have an adverse effect upon the integrity of the Humber Estuary SAC with respect to grey seal.

12 MITIGATION

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

12.2 CGG have committed to following the JNCC guidelines for *minimising the risk of injury to marine mammals from geophysical surveys* (JNCC 2017a, CGG 2023b). This will include:

- A minimum of 20 minutes soft-start undertaken every time the airguns are switched on.
- The use of two dedicated Marine Mammal Observers.
- The use of Passive Acoustic Monitoring (PAM).
- Observations will be undertaken for at least 30 minutes prior to the soft-start and there will be a minimum of a 20 minute delay from the time of the last marine mammal detection within the 500 m mitigation zone and the commencement of the soft-start.
- Airguns will be switched off at the end of each line and in the event that the survey is suspended for more than 10 minutes, a 30 minute pre-shoot search and 20 minute soft-start must be undertaken.

13 CONCLUSIONS

13.1 The Secretary of State has carefully considered all of the information available in order to undertake a Habitats Regulations Assessment. He considers the proposed Lodestone 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 and Humber Estuary SAC.

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

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

13.4 Having considered all of the information available to him the Secretary of State has concluded that the proposed Lodestone seismic survey will have an adverse effect on the integrity of the Southern North Sea SAC in-combination with other plans or projects with respect to potential impacts on harbour porpoise.

13.5 The Secretary of State has concluded that the proposed Lodestone seismic survey will not have an adverse effect on the integrity of the Humber Estuary SAC in-combination with other plans or projects with respect to potential impacts on grey seal.

Prepared by: Philip Bloor
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