ScottishPower Renewables and Shell new Energies Joint Venture

MarramWind Offshore Wind Farm

Export Cable Corridor Geophysical, Geotechnical and Environmental Surveys
European Protected Species (EPS) and Basking Shark Risk Assessment

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SCOTTISHPOWER RENEWABLES

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Report for

ScottishPower Renewables (UK) Limited

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1 Introduction

1.1 Project Overview

1.1.1 ScottishPower Renewables (UK) Limited (SPR) and Shell New Energies Holding Limited (Shell), have formed MarramWind Limited, a Joint Venture to develop the MarramWind floating offshore wind farm (OWF).

1.1.2 Located 75 km off the north-east coast of Scotland, the proposed MarramWind OWF has a grid connection capacity of 3 GW of renewable energy. The MarramWind OWF array site is within the Marine Scotland Sectoral Marine Plan (SMP) development plan area NE7 (Error! Reference source not found.).

1.1.3 An export cable is required to connect the OWF array site to the east coast of Scotland. In order to select the most appropriate route for the export cable, an Export Cable Corridor (ECC) needs to be surveyed. This risk assessment relates to the ECC survey works only and not to the OWF array site.

1.1.4 MarramWind Limited is now commencing various workstreams to inform environmental statements and permitting requirements for the ECC, detailed engineering options and installation processes. A suite of surveys is required for the provision of data in order to inform these workstreams. In particular, data on the physical, chemical and biological nature of the seabed and water column are needed.

1.1.5 The following site investigation surveys are therefore required within the ECC:

- Geophysical survey that consists of a bathymetry survey using multi-beam echo sounding (MBES), hydro-acoustic positioning tracking ultra-short baseline (USBL) acoustic positioning system, magnetometer survey, seabed mapping using side scan sonar (SSS), sub-bottom profiling (SBP), and Single Channel seismic or Multi-Channel ultra-high resolution (UHR) seismic survey. The purpose of the geophysical survey is to identify the seabed and sub-seabed conditions of the ECC.
- Geotechnical survey that consists of a sampling and testing programme within the Search Area to evaluate the nature and mechanical properties, as well as the sediment chemistry, of the superficial seabed sediments. The survey programme includes vibro-coring and piezocone penetrometer testing (PCPT).
- Environmental survey that maps the distribution and extent of marine benthic habitats. This will comprise a benthic sampling programme to collect drop-down video (DDV) footage and grab samples for the analysis of benthic fauna, particle size distribution (PSD), and sediment chemistry.

1.2 Purpose of the Report

1.2.1 This report is a European Protected Species (EPS) and basking shark risk assessment in support of applications by MarramWind Limited (the applicant) to Marine Scotland, for an inshore EPS licence and offshore EPS licence to undertake a geophysical survey and a basking shark licence for the site investigation surveys.

1.2.2 The purpose of this report is to identify and assess the survey activities that have the potential to affect cetaceans (whales, dolphins, and porpoises) and marine turtles within the ECC Search Area, which are all EPS.

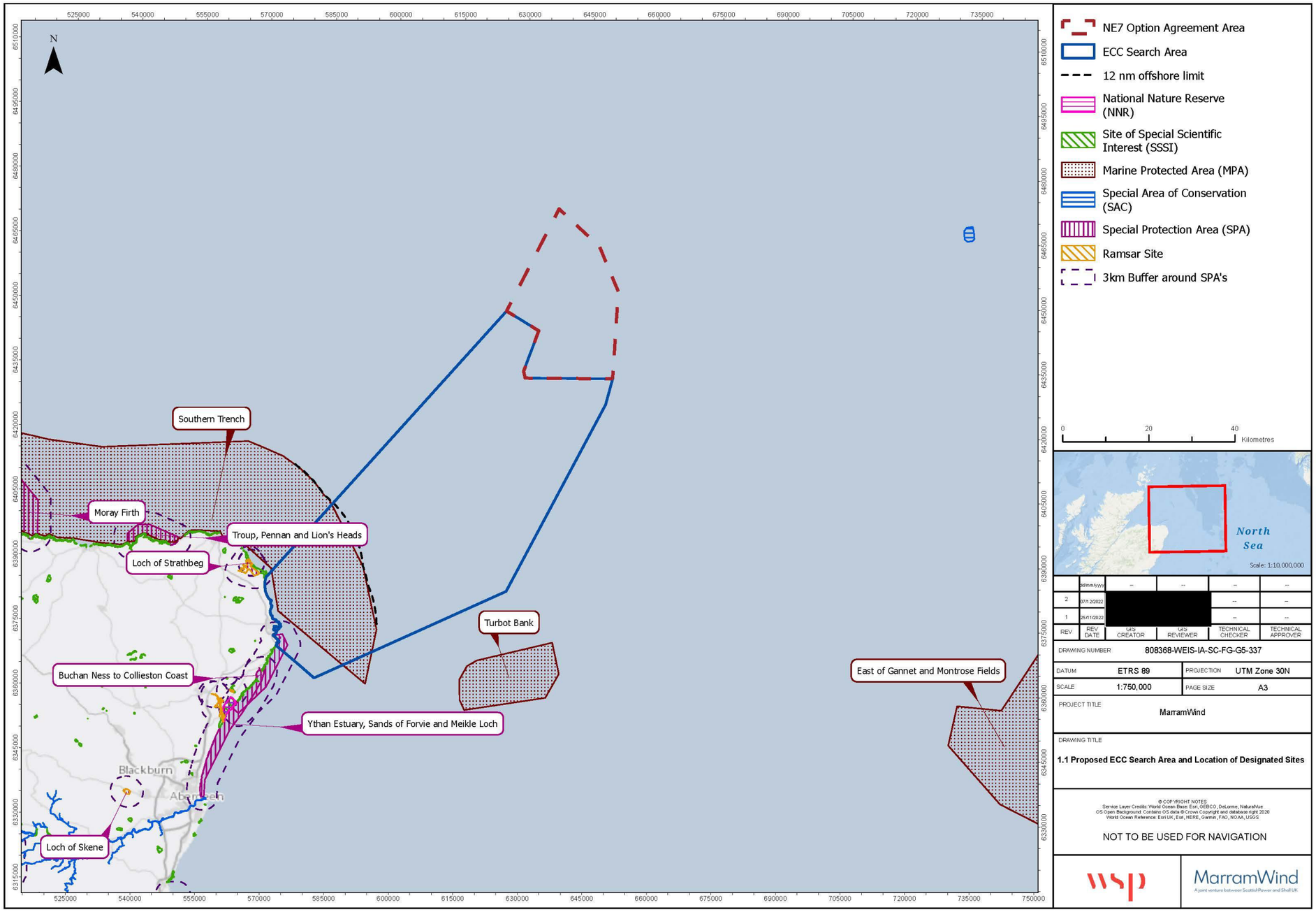
1.2.3 Whilst not EPS, seals and basking shark (*Cetorhinus maximus)* are a priority species and as such are also considered in this report where relevant. Basking sharks are also

considered in line with the requirement for MarramWind Limited to apply for a basking shark licence in relation to the proposed survey.

1.2.4 **Section 6: Designated Sites and Priority Marine Features (PMFs)** of this report is intended to inform both the EPS Licencing process and the Marine Licencing exemption requests to Marine Scotland, which is required for the geotechnical and environmental survey (removal of sediment samples). As such, all survey activities that have the potential to impact designated sites or PMFs have been assessed within this report (see **Section 2: Legislative Context**).

1.2.5 ECC optioneering is ongoing so the Project is considering a Search Area for the ECC route. The final ECC will be located within the Search Area and will cover a significantly smaller area than the Search Area. At this stage of Project design, there is one potential ECC Search Area being considered by MarramWind Limited (**Figure 1.1**). The ECC Search Area considered (**Figure 1.1**)**,** takes into account variation around the Project design and landfall options that are currently being considered for this Project.

Figure 1.1 Proposed Search Area and location of designated sites



2. Legislative Context

2.1 European Protected Species

2.1.1 All cetaceans and marine turtles are listed under Annex IV of the EU Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (known as the Habitats Directive) as EPS requiring strict protection.

2.1.2 The requirements of the Habitats Directive, which define the need to assess EPS, remain in force post the UK's exit from the EU[1] and are transposed by the following two articles of legislation in Scottish waters:

- The Conservation (Natural Habitats, &c.) Regulations 1994, known as the Habitats Regulations), which transpose the Habitats Directive into national law in Scotland. This legislation covers waters within the 12 nautical mile (nm) limit (known as territorial waters).
- Conservation of Offshore Marine Habitats and Species Regulations 2017 (known as the Offshore Regulations). These transpose the Habitats Directive into UK law for all offshore activities. This legislation covers UK waters beyond the 12 nm limit.

2.1.3 Both sets of legislation are relevant in this instance due to the ECC Search Area covering both inshore and offshore waters. These Regulations provide for the designation and protection of European sites (in this case Special Areas of Conservation, or SACs) and the protection of EPS. Both the Habitats Regulations 2017 (under regulation 39) and the Offshore Regulations 2017 (under regulation 45) state that it is an offence to:

- deliberately capture, injure or kill an EPS (including all cetaceans);
- deliberately disturb an EPS; or
- damage or destroy a breeding site or resting place of an EPS.

2.1.4 The legislation in force does not define disturbance in this context. Disturbance is defined here as an activity that impairs the ability of the EPS to survive, breed, rear/nurture their young, to migrate, or an activity which significantly affects the local distribution or abundance of the species.

2.1.5 If the risk of injury or significant disturbance cannot be mitigated to negligible levels, then an EPS licence is required. In Scotland, EPS licensing is conducted by Marine Scotland Licensing Operations Team (MS-LOT) who will seek guidance from the relevant Statutory Nature Conservation Bodies, which includes NatureScot. The Joint Nature Conservation Committee (JNCC) is the overarching statutory adviser on UK nature conservation. Licences are granted under the following circumstances:

2.1.6 The reason for the considering the need for an EPS licence in this case relates to one of the specified purposes listed in the Habitats Regulations, which includes:

- It is required for renewable energy purposes.

[1] Scottish Government, EU Exit: habitats regulations in Scotland. Available online: https://www.gov.scot/publications/eu-exit-habitats-regulations-scotland-2/pages/1/

- There is no alternative way to reduce injury or disturbance risk; and
- The action covered under the licence is not of detriment to the 'favourable conservation status' of the species.

2.1.7 Favourable conservation status is defined in the Habitats Directive as the following:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable element of its natural habitats.
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future.
- There is, and will probably continue to be, a sufficiently large habitat to maintain its population on a long-term basis.

2.2 Basking Shark

2.2.1 Basking sharks are protected under the Wildlife and Countryside Act 1981 (as amended), and as such it is an offence to disturb or injure this species. If an activity taking place in Scottish inshore waters (within the 12 nm boundary) is likely to cause to disturbance or injury to basking sharks, a licence is required to undertake the activity legally. Marine Scotland (on behalf of the Scottish Ministers) is the licensing authority for commercial activities under the Wildlife and Countryside Act 1981 (as amended).

3. Proposed Activities to be Licenced

3.1 Extent

3.1.1 The proposed site investigation survey described in **Section 1.1** will be undertaken in the ECC Search Area currently being considered as the subject of this risk assessment. A proportion of ECC Search Area falls in both inshore (within 12 nm) and offshore waters (outside 12 nm) (**Table 3.1**). The ECC Search Area incorporates the area required for vessel line turns (1.5 km buffer) and it is not expected that any survey work will take place outside of these areas.

Table 3.1 Proposed site investigation survey in the ECC Search Area

ECC Search Area	Total Area (km^2)	Area within 12 nm (km^2)	Area outside 12 nm (km^2)
ECC Search Area	3,230.23	690.19 (21.37%)	3224.04 (78.63%)

3.2 Timing and Duration

3.2.1 The proposed geotechnical, geophysical and environmental surveys for the selected ECC survey route (including a 1.5km buffer) are currently scheduled to commence in spring 2023. The survey period would occur on dates (yet to be confirmed) between 1stMarch and 30th September 2023. Within this period, noise-generating geophysical survey activity (i.e. any day during which any duration of geophysical survey occurs) is expected to occur for a maximum of 14.3 weeks (100 days). This is the maximum duration for the entire survey, including works in both inshore and offshore waters. Given that the majority of the ECC Search Area is outside the 12 nm limit, it is assumed that the majority of days subject to noise-generating survey activities will also be outside the 12 nm limit.

3.3 Proposed Vessels

3.3.1 Two vessels will be required for the survey works; one vessel will survey the sections of ECC in areas of >15 m water depth. The other vessel will survey the nearshore areas of 0m to 15m water depth (with overlap). The specific vessel provider and availability are yet to be confirmed. If needed, the survey vessels may interchange with other survey vessels of similar vessel specifications throughout the survey duration to allow for crew changes. The vessels are expected to mobilise from Aberdeen or Peterhead. Details of the survey vessels likely to be used are provided in **Table 3.2** below, noting that vessel availability and provider are yet to be confirmed.

Table 3.2 Details of proposed survey vessels

Vessel Type	Description
Offshore research vessel	Offshore survey vessel working 24/24 hr along the entire route in water depths of more than 15m. Vessel likely to be medium-sized, meaning 50-100m in length.
Small coastal survey vessel	One (or more) coastal survey vessel working 12/24 hr on the nearshore part of the route only, with overlap with the area surveyed by the offshore vessel. This vessel will be suitable for operations in water depths <20m and is likely to be a catamaran design (to be confirmed). Vessel likely to be small-sized, meaning <50m in length.

3.4 Geophysical/ Seismic Survey Activities

3.4.1 The geophysical survey includes the requirement for five activities that use acoustic methods. These activities are outlined in **Table 3.3**, along with indicative equipment specifications and makes/models of proposed equipment to be used. Note that the geotechnical and environmental survey specifications are not included here as it is considered these activities have very limited potential to affect EPS (cetaceans and turtles). See **Section 6: Designated Sites and Priority Marine Features** for further detail and consideration of geotechnical and environmental survey activities.

Table 3.3 Geophysical / seismic survey activities and the indicative equipment specifications

Survey activity	Equipment specification	Equipment makes and models
Multi-beam echo sounder (MBES)	A hull or pole mounted multi-beam echo sounder system.	Kongsberg EM2040 or Teledyne RESON SeaBat® 7125-SV
Side Scan Sonar (SSS)	Tri-frequency hydrographic sonar.	Edgetech 4205
Sub-bottom profiling (SBP)	Hull mounted or pole mounted chirp sub-bottom profiler, or a hull mounted interferometric sub-bottom profiler will be used. Each type needs testing before the most appropriate type of equipment for the Search Area can be selected. This risk assessment considers the worst-case scenario for sound-generating equipment in relation to EPS and priority species (**Table 3.4**).	Innomar SES-2000 Medium 100, Edgetech 3300 HM

Survey activity	Equipment specification	Equipment makes and models
Underwater acoustic positioning (Ultra Short Base Line - USBL)	Standard hull mounted USBL permanently fixed to the vessel.	Kongsberg HiPAP 502
Ultra-High Resolution (UHR) Seismic Sparker or Single Channel Seismic	Towed sparker source and multichannel streamer with an ultra-high-resolution source.	Applied Acoustic Engineering Dura-Spark 400 or 300 and GeoEel 48 channel hybrid streamer (Offshore) or Applied Acoustic Engineering Dura-Spark 400 and 8 element ministreamer (Nearshore).
Magnetometer		Geometrics G-882

3.5 Sound Source Levels

3.5.1 In order to calculate the level of sound propagation needed for the assessment of impacts to cetaceans, the maximum noise output, or source level for each survey activity is required. These values depend on the equipment being used, the power level at which it is being operated and the pulse length.

3.5.2 For the purpose of this assessment, the worst-case sound source levels have been identified for each survey activity based on the proposed systems given in **Table 3.3**. The source levels, which are presented in **Table 3.4** below, have been source from the specification sheets for previous similar surveys undertaken by the MarramWind JV geoscience team and subject matter expert experience on other comparable surveys. The source levels assume that the equipment is being operated at the highest power levels and the longest pulse lengths. This provides the most conservative source levels and ensures the assessment is representative of the worst-case.

3.5.3 For each survey activity/noise emitting item of equipment, both the worst-case operating frequency, and the worst-case relevant sound pressure level (SPL) metric has been provided. The worst-case operating frequency reflects the lowest operating frequency of each activity/noise emitting item of equipment. In the context of the underwater noise modelling methodology, as detailed in **Section 5.2**, the lower the frequency, the further the noise emissions propagate from the source. The worst-case SPLs reflect the maximum operating source level of each survey activity/noise emitting item of equipment. Consequently, it is considered that the use of the above SPL's and corresponding operating frequencies provides a robust and worst-case assessment.

3.5.4 The proposed operating frequency of the MBES is 300 kHz. The proposed SSS operating frequencies are 230 kHz and 540 kHz with maximum operating ranges of 0350 m and 150 m respectively. With reference to **Table 5.1**, the most sensitive cetacean to high-frequency sound is the harbour porpoise, which has an upper auditory limit of 160 kHz (Southall *et al.,* 2019). The operating frequencies of the MBES and SSS activity fall outside the auditory range of the harbour porpoise, and consequently all other pertinent cetaceans. Furthermore, sound produced at the proposed MBES and SSS operating frequencies (for a maximum water depth of 120 m) are likely to attenuate quicker than the lower operating frequency for MBES and SSS activity in deeper waters (>200 m) (JNCC, 2017). Consultation feedback from NatureScot on the recent risk assessment (Document ID: SCW-

DWF-ENV-RSA-JVA-000001) supporting the MarramWind EPS licence application for the geophysical survey of the OWF array site confirmed that NatureScot is in agreement that MBES and the SSS are not capable of affecting marine mammals, due to the frequencies and noise levels at which they operate[2].

3.5.5 On the basis above, sound propagation calculations for MBES and SSS activity have not been undertaken, and additional mitigation measures are not proposed for these activities.

3.5.6 Underwater acoustic positioning (e.g. USBL) is unlikely to be required on the small vessel operating in the nearshore (<15 m water depth) region of the ECC Search Area. Source levels are based on the medium sized offshore research vessels as the worst-case.

Table 3.4 Maximum source levels for proposed activities

Survey Activity/ Equipment	Worst-case Operating Frequency, kHz	Maximum Source Level, SPL_{pk} dB re 1 uPa @ 1m	Maximum Source Level, SPL_{rms} dB re 1 uPa @ 1m	Reference
Sub-bottom profiling (SBP)	85	247	-	
Underwater acoustic positioning (USBL)	21-31	207	-	Equipment specification sheets from similar surveys contracted previously by the MarramWind JV.
Ultra-High Resolution (UHR) Seismic Sparker	0.5	221*	-	
Medium-sized survey vessel operation[3]	<1	-	173	Prideaux (2016).

*This is a peak-peak value provided via direct communications with the relevant manufacturer, as a peak value is not available. Despite this, the peak-peak value has been used within the assessment as it is representative of a more conservative, and hence worst-case sound pressure level.

3.6 Actions Requiring Licencing

3.6.1 Under the Habitats Directive it is an offence to deliberately capture, injure or kill an EPS (including all cetaceans), deliberately disturb an EPS or damage or destroy a breeding site or resting place of an EPS (see **Section 2).** Therefore, this application and associated risk assessment are submitted in relation to the potential for geophysical survey activities, as described above, to disturb an EPS. The key pathways for impact include:

[2] Consultation letter sent from NatureScot to Marine Scotland dated 14th April 2022, subject matter '*EPS/BS-00009726 – MarramWind Limited – Geophysical surveys – Scotwind NE7 site – EPS Licence – Consultation – Response Required by 20 April 2022*'
[3] Sound source data for medium vessels from Prideaux G, (2016), 'Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessments for Marine Noise-generating Activities', Convention on Migratory Species of Wild Animals, Bonn.

- underwater sound disturbance to cetaceans from vessel movements and survey activities; and
- increased risk of collisions with cetaceans and marine turtles.

3.6.2 Note that the potential effects of underwater sound disturbance on marine turtles is scoped out of consideration, please see **Section 4.3** for further information on this.

3.6.3 Under the Wildlife and Countryside Act 1981 (as amended) it is an offence to cause to disturbance or injury to basking sharks. Therefore, this application and associated risk assessment are also submitted in relation to the potential for site investigation survey activities, as described above, to impact basking sharks. The key pathway for impact is risk of survey vessel collision with basking sharks.

3.7 Assessment of Satisfactory Alternatives

3.7.1 One of the drivers for offshore wind project development is the requirement for the UK to meet its Net Zero 2050 energy generation target. The selection of sites for OWF development was subject to an extensive site selection process led by the Crown Estate Scotland (CES) (in Scottish waters) in collaboration and consultation with relevant regulatory bodies and stakeholders. As a result of the strategic site selection process the NE7 OWF area was selected as a Plan Option for development by the CES, and the lease for its development was awarded to MarramWind Limited. As such, the MarramWind (NE7) OWF area is considered to represent one of the most suitable areas for offshore wind development in offshore Scottish waters, and there is no reasonable alternative location likely to have a lesser impact on EPS.

3.7.2 Export cables are critical components of any OWF, and without this infrastructure there would be no means through which to transmit generated electricity to the national grid. An ECC is therefore critical to the functioning of the MarramWind project and without it the Project will not be possible.

3.7.3 The geophysical survey is required in order to inspect and assess the seabed conditions within the ECC area, and as such the requirement for these surveys is inherently linked to the requirement for the Project itself.

3.7.4 The ECC Search Area proposed is currently deemed to be the most suitable, subject to the conclusions of MarramWind's ongoing optioneering processes. Alternative ECC Search Areas were previously considered by MarramWind Limited and have since been discounted due to the unsuitability of the landfall locations and further refinement to the cable route. The ECC Search Area proposed here has been defined taking into consideration the earlier ECC Search Areas and represents a smaller and more refined Search Area than those previously considered. This demonstrates the consideration of alternatives for the ECC Search Area.

Do Nothing

3.7.5 The proposed OWF Project would not be viable without a detailed inspection of the seabed prior to design and installation of the export cable and therefore a 'do nothing' scenario, whereby the surveys are not undertaken, is not an option if the Project is to reach the development phase.

Survey Location, Extent, Duration, and Timing

3.7.6 As described above, the location of the ECC Search Area and associated geophysical survey is directly linked to the location of the MarramWind OWF area.

3.7.7 The current ECC option represents a Search Area that will allow the most direct routes to landfall from the OWF area, and therefore represents the shortest export cable length and minimal ECC Search Area possible and it minimises the Project footprint and associated environmental impacts. Not completing geophysical surveys in the ECC area would result in not being able to develop the MarramWind OWF area, which is not considered an alternative option if the UK government is to reach its Net Zero 2050 energy generation targets.

3.7.8 In order to complete geophysical surveys across the ECC Search Area, the smallest number of survey lines will be undertaken within the ECC survey route area to provide a sufficient resolution of data to inform the engineering options and environmental baselines. It is considered that reducing the survey extent or duration by reducing the size of the survey route area, or number of survey lines, does not represent a viable alternative to the proposed methodology in this instance. As such, it is considered that the current proposed ECC Search Area represents the minimum survey extent and duration possible, and there is no reasonable alternative that would have a lesser impact on EPS.

3.7.9 As described in the baseline (**Section 4**) below, the key EPS likely to interact with the geophysical survey works are likely to occur within the ECC Search Area throughout the year, with little seasonal variation affecting the number of individuals of any EPS that could be affected. As a result of this, the timing of the survey is considered to have minimal impact on the potential for the works to affect EPS, and as such there is no alternative to the proposed current survey timings (**Section 3.2**) that would result in a lesser impact to EPS.

Survey Equipment/ Methodology

3.7.10 The type of equipment that is used for geophysical survey work is determined by the specific purpose of the survey being undertaken. In this instance the following survey equipment has potential to result in disturbance to EPS and is deemed essential for the Project:

- **USBL** is required to provide accurate positioning of 0.1% of the slant range[4] or better for the horizontal positioning of towed devices. This is an essential requirement for the use of towed devices and ensures the positional accuracy of data collected.
- **SBP and Single or Multi-Channel UHR** is used to identify geological structures below the seabed, including the delineation of shallow seabed geology to enable the creation of stratigraphic model and the detection sub-seabed geohazards such as buried boulders, peat layers close to the seabed and very shallow gas. An understanding of the sub-seabed is an essential requirement for determining the cable routing, successful burial to target depth and is also essential for identifying potential hazards in the area.

3.7.11 Both SBP and UHR are routinely used together to characterise sub-seabed geology and hazards across offshore sites. SBP data provides less penetration (typically 10-15 m below the seabed depending on the geology) but higher resolution (through higher frequencies). Single Channel UHR data provides more penetration (up to 60-80 m below seabed depending on geology) but reduced resolution (through lower frequencies). The two methods are complementary and both datasets are integrated into grounds models that summarise sub-seabed conditions. Together these methods provide the ability to detect and resolve a greater size range of geological or anthropogenic structures which could include archaeological features. Using SBP or UHR alone would not provide sufficiently

[4] The distance in a straight line between two points having different elevations.

detailed data on sub-seabed conditions. As such, the use of both equipment types combined is considered essential to the viability of the Project.

3.7.12 Other equipment types, such as seismic airguns were considered. However, this equipment has the potential to generate significantly greater sound source levels increasing the environmental footprint of this activity. These also produce sub-seabed penetration to unnecessarily deep depths and have therefore not been proposed for this survey. There are no other known types of geophysical survey equipment types/ models that produce lower sound source levels than those proposed for this survey, whilst also providing the correct type of data and level of data resolution. As a result of this, the use of the identified equipment is considered essential to the viability of the Project and there are not considered to be any reasonable alternative options to the use of the specified geophysical equipment.

3.7.13 It is proposed that the survey equipment identified will be deployed from a manned survey vessel, as described in **Section 3.3** above. The use of a manned survey vessel and deployment of towed and hull mounted geophysical equipment is considered essential for a variety of reasons. Firstly, in addition to geophysical surveys, seabed geotechnical surveys will also be completed in conjunction with the geophysical survey work. The geotechnical survey sampling locations will be selected in-situ based on the result of the geophysical survey data. Vessels with the capacity to complete both geophysical surveys and data analysis, as well as conduct geotechnical survey work for extended periods offshore, are therefore required.

3.7.14 Autonomous underwater vehicles (AUV) or unmanned surface vehicles (USVs) are not appropriate in this context as they cannot acquire geophysical data to the specifications equivalent to UHR. In addition, unmanned vessels do not have the ability to tow side scan sonar systems and are limited in the water depths that they can operate in.

3.7.15 A manned vessel would also still be required for the geotechnical survey work, so the use of an AUV would not eliminate the requirement for the medium-sized offshore research vessel while resulting in two sound sources. In addition to this, the implementation of any mitigation measures, such as pre-start observations, is more difficult if the AUV was in deep water or distant from the support vessel due to the absence of qualified observers near to the survey equipment. As such, it is not thought that the use of AUV's would reduce the potential for EPS disturbance or provide any benefits over the use of a manned survey vessel from which all activities could be completed.

3.7.16 Overall, it is considered that the equipment proposed, and the specific methodology for the completion of the works through the use of manned survey vessels, is the minimum requirement that will make the OWF development Project viable, and no better alternatives are available in this instance.

Conclusion

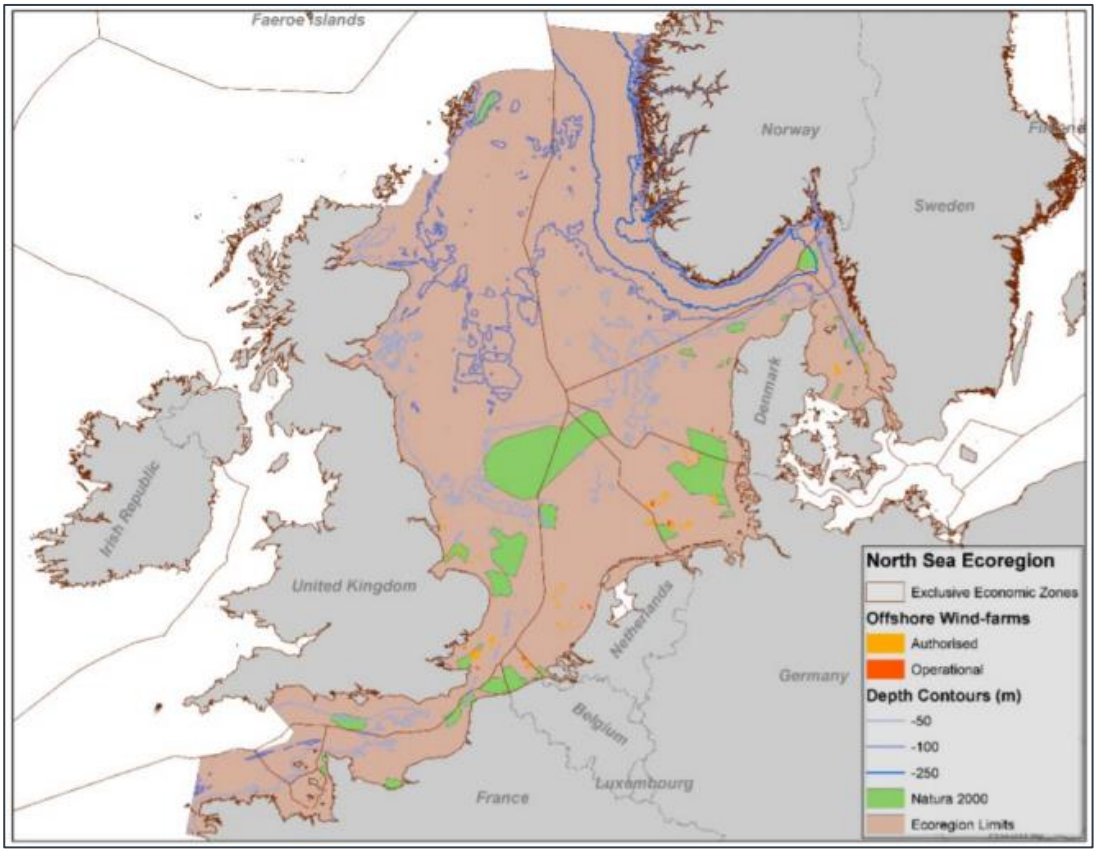
3.7.17 It is concluded that the proposed methodology for the survey works outlined in this document represents the most appropriate and viable way through which data required for the design, consenting and installation of the export cable for the OWF can be collected, and therefore the only viable means through which the Project can be developed. Thus, the applicant considers that the 'no satisfactory alternative test' has been met.

4. Marine Species Baseline

4.1 Study Area and Key Data Sources

4.1.1 The overall baseline study area is the Greater North Sea Ecoregion (**Figure 4.1**), (ICES, 2018), and the ICES North Sea Assessment Unit (Hammond *et al*., 2017). The large extent of this study area is considered appropriate in recognition of the fact that marine species are highly mobile and wide ranging. This extent takes into consideration (where available) species-specific Management Units published by the Inter Agency Marine Mammal Working Group (IAMMWG) (IAMMWG, 2015).

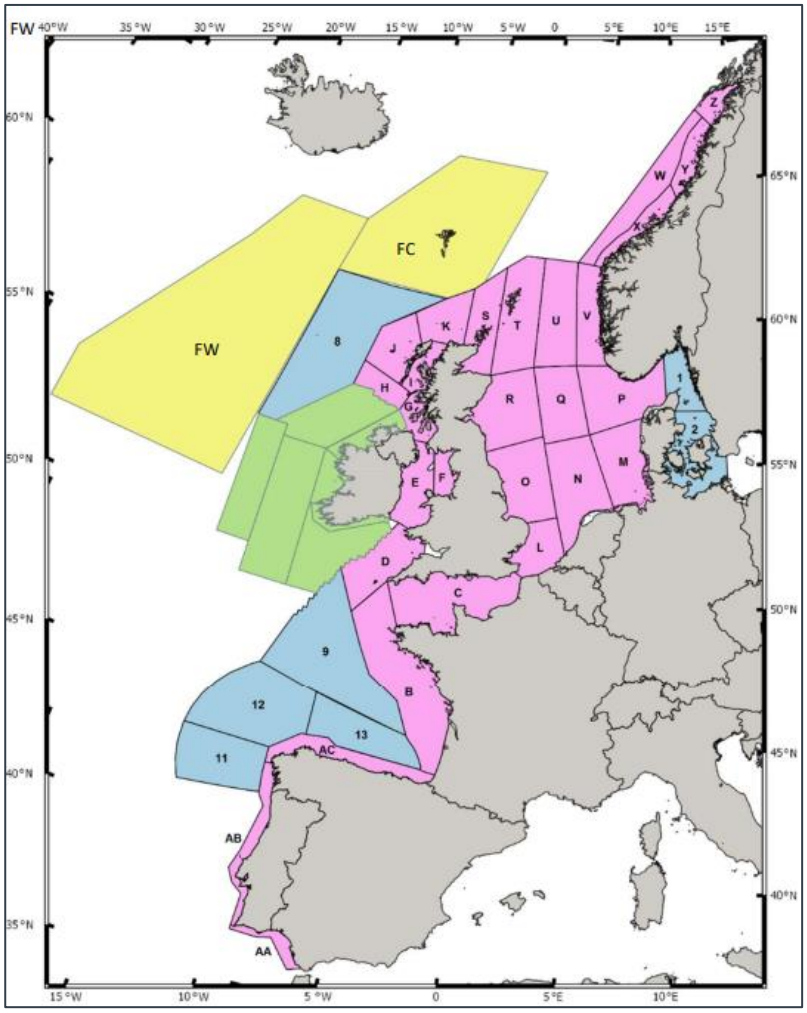
Figure 4.1 Indicative study area of the Greater North Sea Ecoregion (Source: ICES, 2018)



4.1.2 As part of the Small Cetaceans in European Atlantic waters and the North Sea (SCANS) Project, surveys were undertaken to estimate the abundance of small cetaceans across the North Sea. The first survey was undertaken in 1994, estimating the abundance of various cetacean species in the North Sea and Celtic Sea. The programme was repeated in 2005 (Hammond *et al*., 2013) (SCANS-II) and again in 2016 (SCANS-III) (Hammond *et al*., 2017). Within the context of the broader North Sea Ecoregion study area, data from SCANS III has been used to identify key areas of importance for relevant cetacean species in relation to the Search Area.

4.1.3 SCANS surveys were conducted in the summer and therefore data are representative of summer distributions only. However, it is understood that the densities of cetaceans around the British Isles are likely to be highest during this season (Hammond *et al*., 2017). The abundances presented are therefore considered to represent the worst-case of the maximum number of individuals potentially affected. A breakdown of the SCANS-III survey blocks is shown in **Figure 4.2**. The proposed survey Search Area is located within Blocks T and R.

Figure 4.2 Area covered by SCANS-III and adjacent surveys



4.1.4 In addition to the SCAN-III data the Inter-Agency Marine Mammal Working Group (IAMMWG) has calculated updated abundance estimates for cetacean Management Units (MU) within UK waters (IAMMWG, 2022). The estimated abundances are calculated using the most recent data available at the time including data from the ObSERVE Programme (Rogan et al., 2018) and SCANS-III (Hammond et al., 2021). MU boundaries take into account the biological populations and the ecological differences between them. They are also based on the management of human activities and political boundaries.

Figure 4.3 Map to show the Management Units for harbour porpoise (Source: IAMMWG, 2022)

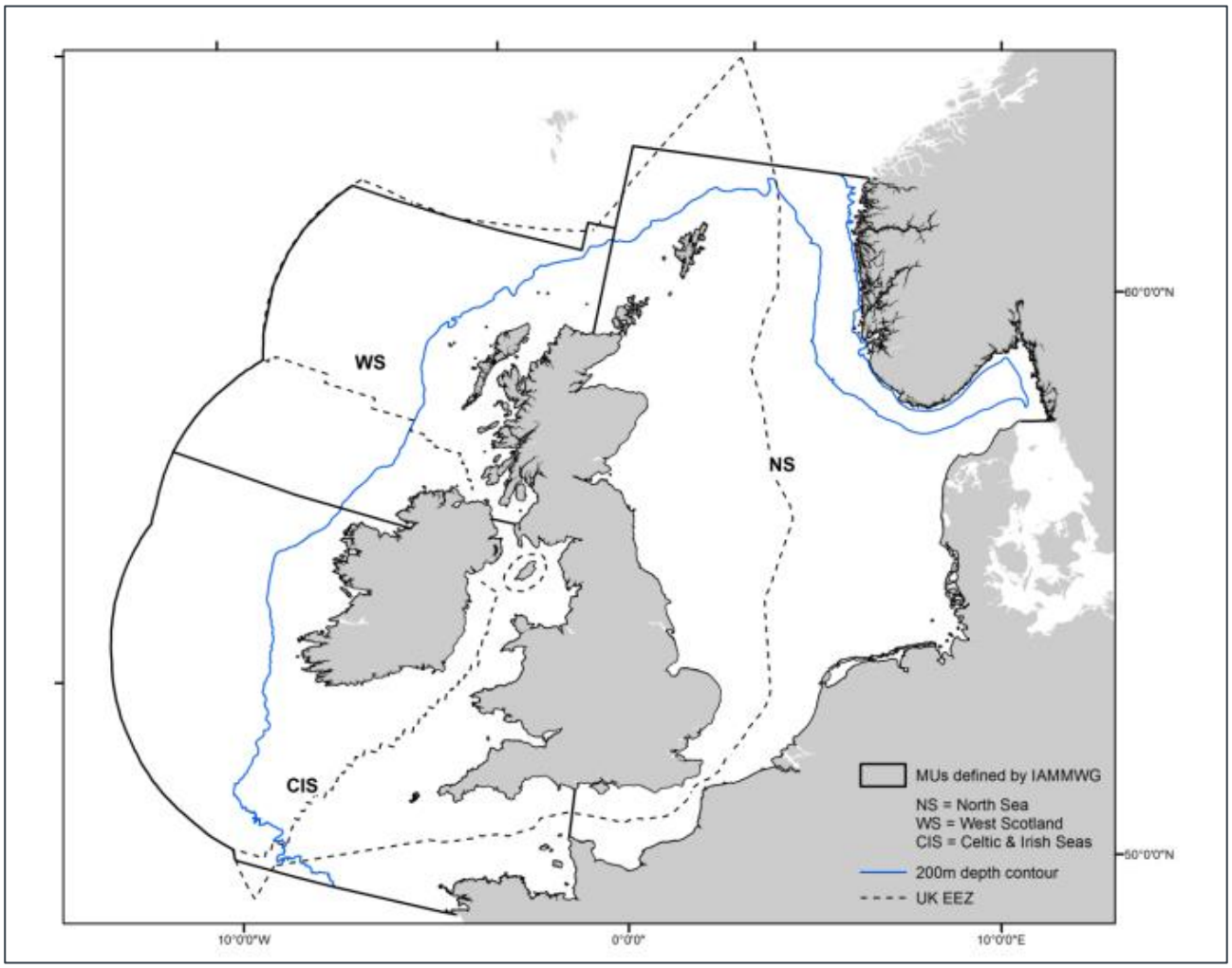
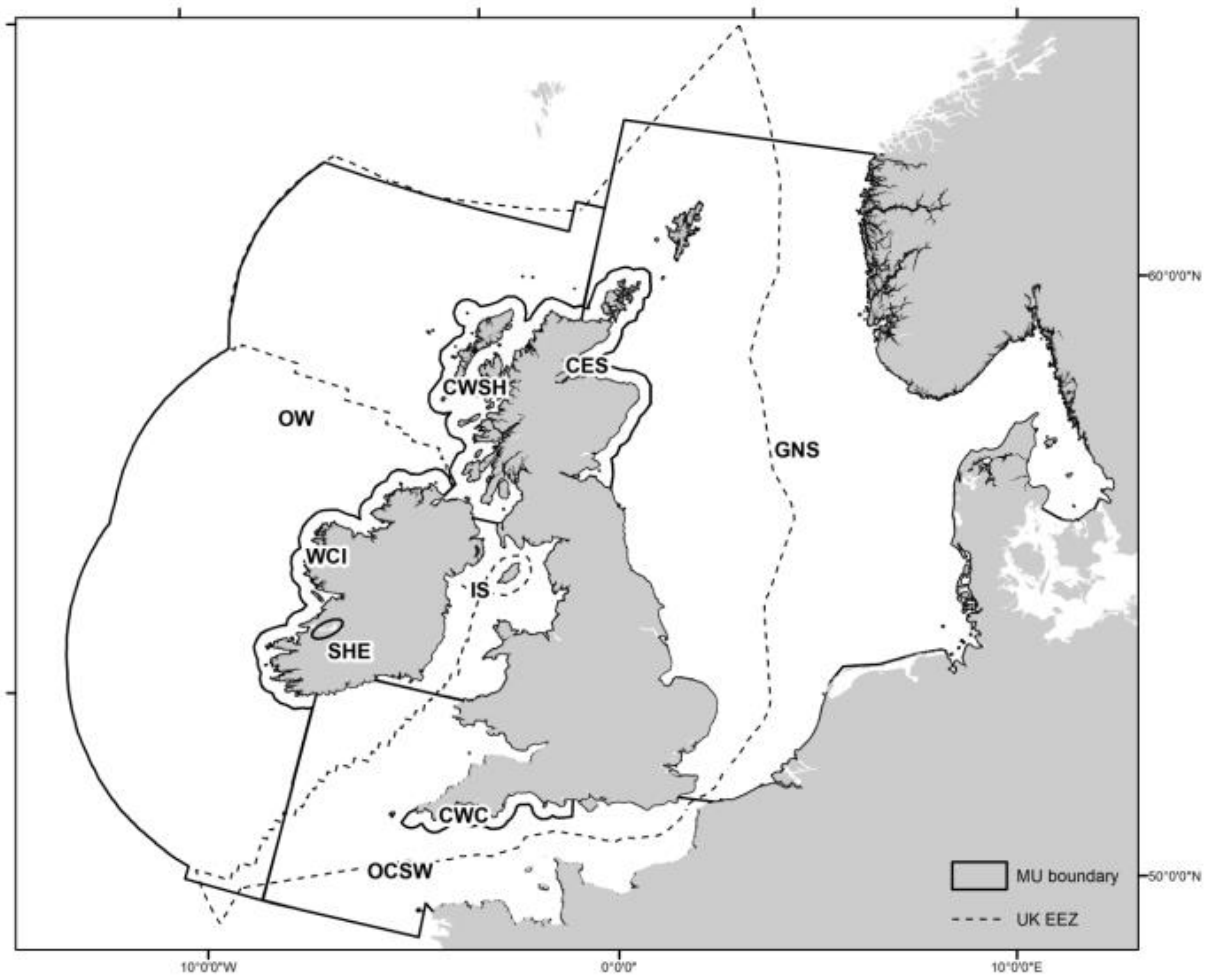
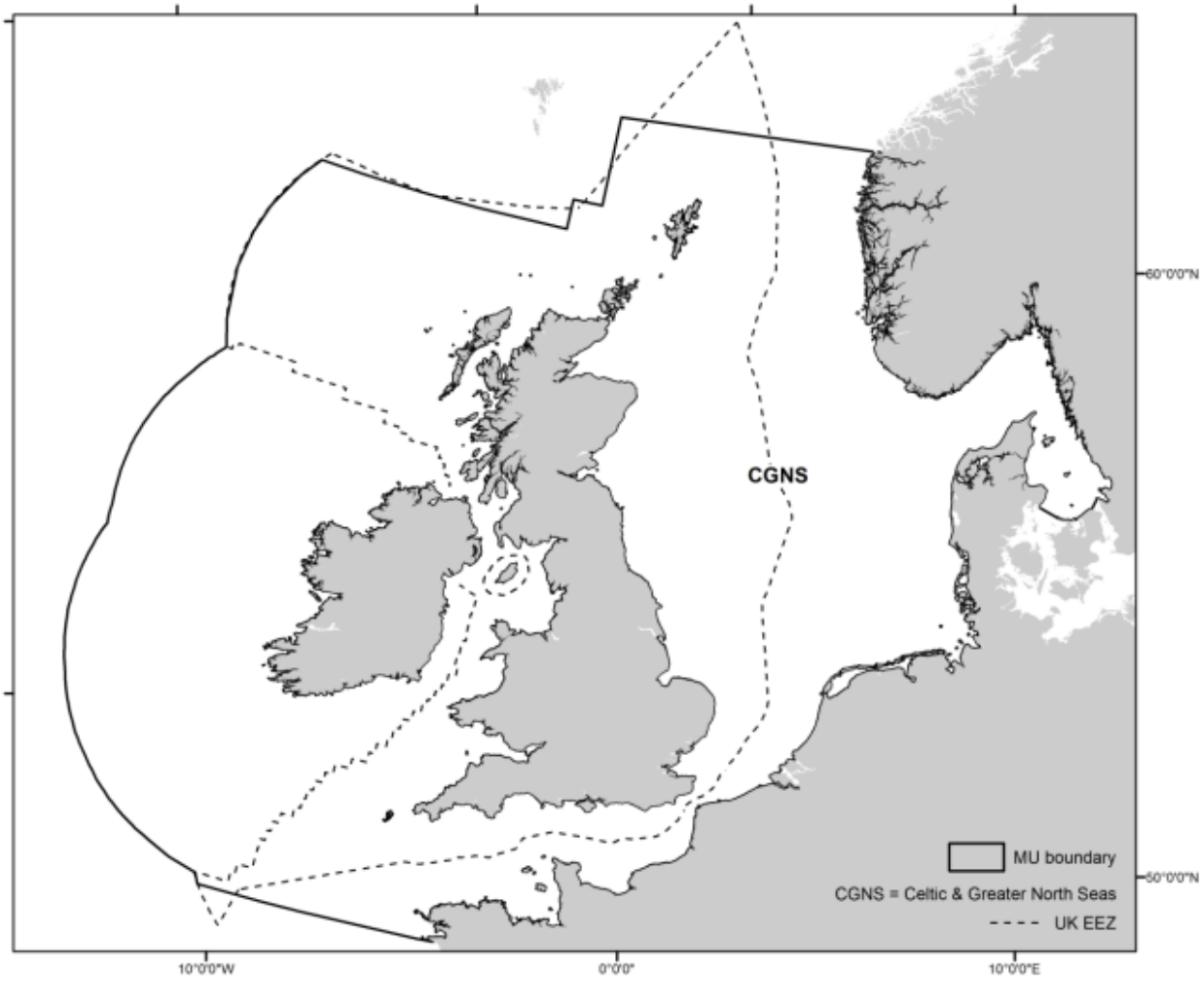


Figure 4.4 Map to show the Management Units for bottlenose dolphin (Source: IAMMWG, 2022)



GNS = Greater North Sea
CES = Coastal East Scotland
CWSH = Coastal West Scotland & Hebrides
IS = Irish Sea
CWC = Coastal West Channel
OCSW = Offshore Channel, Celtic Sea & South West England
WCI = West Coast of Ireland
SHE = Shannon Estuary
OW = Offshore Waters

Figure *4.5* Map to show the Management Units for white-beaked dolphin and minke whale (Source: IAMMWG, 2022)



4.1.5 Other data sources used to inform the baseline include:

- IAMMWG (2022). Updated abundance estimates for cetacean Management Units in UK waters. JNCC Report No. 680 (Revised March 2022), JNCC Peterborough, ISSN 0963-8091.
- Reid, J.B., Evans, P.G.H. and Northridge, S.P. (2003). Atlas of Cetacean Distribution in north-west European Waters. Joint Nature Conservation Committee, Peterborough.
- International Council for the Exploration of the Seas (ICES). (2018). Greater North Sea Ecoregion - Ecosystem Overview.
- Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M., Scheidat, M. and Teilmann, J., (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Wageningen Marine Research.
- Special Committee on Seals (SCOS) - SCOS provides scientific advice to the government annually on matters related the management of seal populations. This includes information related to the abundance, distribution.

- Inter-Agency Marine Mammal Working Group (IAMMWG). (2015). Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, Peterborough.
- Marine Scotland. (2020). Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters: Appendix 3 - SCANS surveys.

4.2 Cetaceans

4.2.1 There are four cetacean species, which are resident or commonly occur within the Greater North Sea Ecoregion (ICES, 2018). These species are:

- harbour porpoise (*Phocoena phocoena*);
- bottlenose dolphin (*Tursiops truncatus*);
- white-beaked dolphin (*Lagenorhynchus albirostris*); and
- minke whale (*Balaenoptera acutorostrata*).

4.2.2 Another five species are also known to be present but occur less regularly. These include the short-beaked common dolphin (*Delphinus delphis)*, Atlantic white-sided dolphin (*Lagenorhynchus acutus)*, long-finned pilot whale (*Globicephala melas)*, killer whale (*Orcinus orca)*, and Risso's dolphin (*Grampus griseus)*.

Harbour Porpoise

4.2.3 The harbour porpoise is one of the most common marine mammal species recorded in north-western European shelf waters (Reid *et al*., 2003) and in the North Sea (Hammond *et al.,* 2017). The species is known to be present in the North Sea throughout the year, with numbers peaking between July and October. Harbour porpoise rarely occur in waters deeper than 200 m, with the highest densities observed in waters <100 m deep. Higher densities have been recorded in areas of upwellings and strong tidal currents (Evans *et al.,* 2003).

4.2.4 The Search Area is located within the North Sea MU for harbour porpoise. The population of harbour porpoise within this MU is 346,601 with 46% (159,632) of those in the UK MU (IAMMWG, 2022).

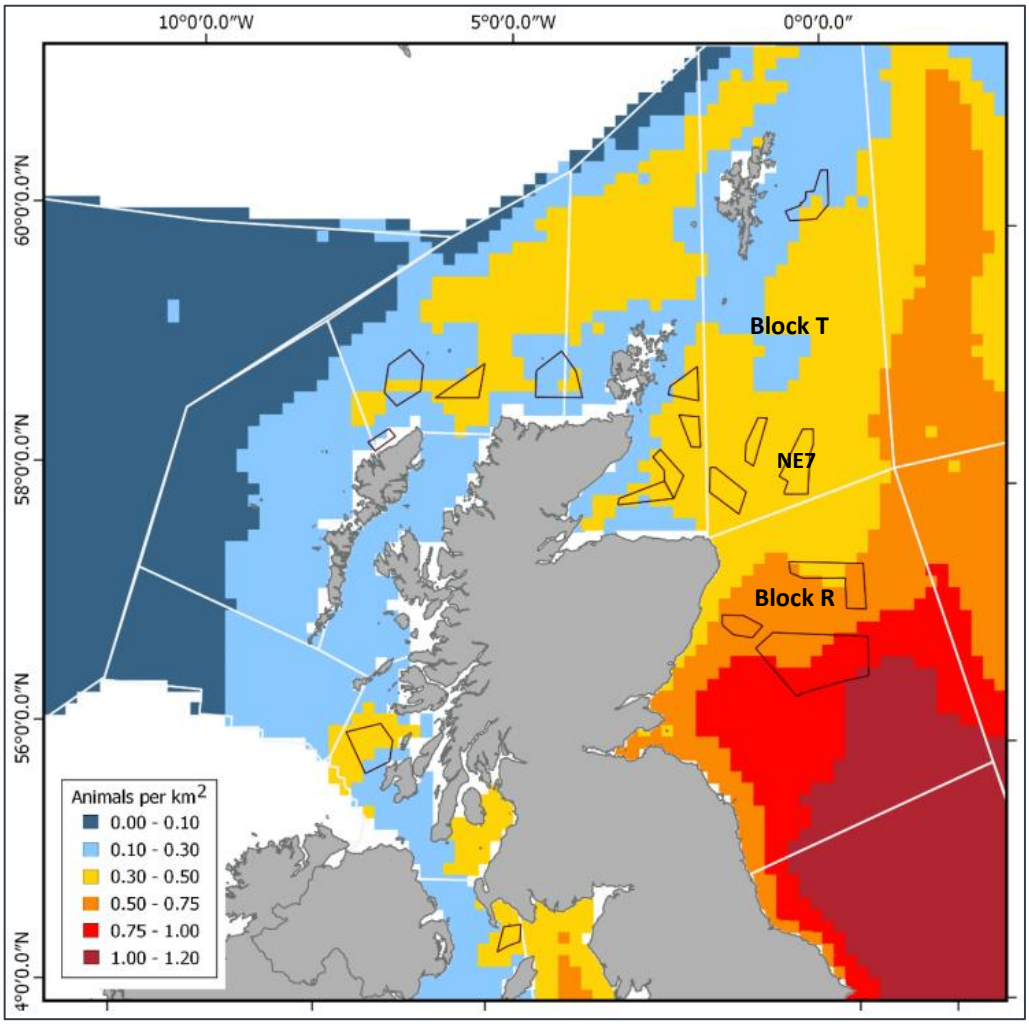
4.2.5 The Search Area is located fully inside Blocks T and R and density estimates for all Blocks are considered relevant. **Table 4.1** shows the SCANS-III data for blocks T and R. **Figure 4.6** presents the predicted density of harbour porpoise across Scottish waters.

Table 4.1 Harbour porpoise density and abundance estimates from the SCANS-III survey in blocks T and R.

Block	Density (groups/ km^2)	Mean group size	CV* (mean group size)	Density (animals/ km^2)	CV*	Abundance	CL low*	CL high*
T	0.303	1.33	0.046	0.402	0.295	26,309	14,219	45,280
R	0.434	1.38	0.053	0.599	0.287	38,646	20,584	66,524

*CV is the coefficient of variation of abundance and density of animals. CL low and CL high are the estimated lower and upper 95% confidence limits of abundance.

Figure 4.6 Predicted density for harbour porpoise based on SCANS III Survey data (2016)[5]



4.2.6 **Figure 4.6** indicates that Block T, the northern section of Block R, which are the location of the ECC Search Area, are all areas of low harbour porpoise density (0.30 – 0.50 animals/ km^2) in comparison to the central and southern North Sea where densities of 1.00-1.20 animals/ km^2 are observed. Harbour porpoises are generally observed in small groups of up to three individuals (ind.). The mean group size observed from the SCANS-III data was 1.33 ind. for Block T and1.38 ind. for Block R. The average for all blocks was 1.35 ind. (Hammond *et al*., 2017).

4.2.7 The biggest threat to harbour porpoise in the North Sea is considered to be bycatch (IAMMWG, 2015). Underwater sound is also a known threat to harbour porpoises as they are highly sensitive to sound. In the UK, the range and future prospects for the species is considered to be of a 'favourable' conservation status although the overall trend in the

[5] SCANS-III survey blocks are marked by white lines, and offshore wind strategic areas (as per 2020) are indicated by black lines (Marine Scotland, 2020).

conservation status of this species is unknown (JNCC, 2019). Globally this species is classified as 'Vulnerable' by the International Union of Conservation of Nature (IUCN, 2019).

4.2.8 Scotland's first SAC for the species was the Inner Hebrides and Minches SAC on the west of Scotland, which is now Europe's largest SAC for porpoises.[6] The closest site designated for this species is the Southern North Sea SAC, which is located over 200 km to the south of the Search Area.

Bottlenose Dolphin

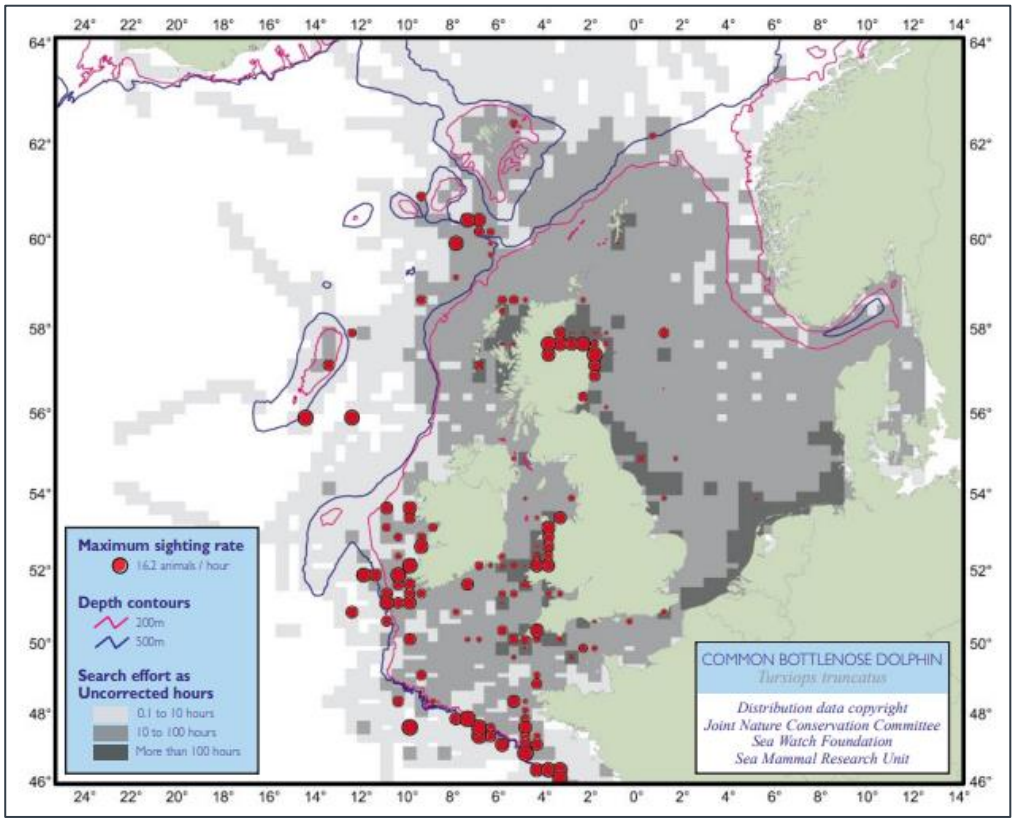
4.2.9 Bottlenose dolphins have two distinct ecotypes within UK waters; an inshore population and a wider-ranging offshore population (Louis et al, 2014). Bottlenose dolphins therefore form the two separate inshore and offshore populations in Scotland. Inshore, they are seen frequently on both the east and west coasts of Scotland. They generally occur in larger numbers between July and October. Some individuals/groups are resident year-round in some areas (Wilson *et al.,* 1997). **Table 4.2** shows the SCANS-III data for Blocks T and R and **Figure 4.7** presents UK sightings data of bottlenose dolphin (SCANS III predicted density maps are not available for this species due to the absence of SCANS III sightings data for Block T). The Search Area is located in both the Coastal East Scotland (CES) MU and the Greater North Sea (GNS) MU. The population of bottlenose dolphin in the UK proportion of the CESMU is 224. The population of bottlenose dolphins in the GNSMU is 2,022 with 93% (1,885) in the UK portion of the GESMU (IAMMWG,2022).

Table 4.2 Bottlenose dolphin density and abundance estimates from the SCANS-III survey in block R and T

Block	Density (groups/ km^2)	Mean group size	CV (mean group size)	Density (animals/ km^2)	CV	Abundance	CL low	CL high
T	No recordings of bottlenose dolphin within block T							
R	0.0057	5.25	0.584	0.0298	0.861	1,924	0	5,048

[6] https://sitelink.nature.scot/site/10508

Figure *4.7* Bottlenose dolphin sightings data (Reid et al., 2003)



4.2.10 During the SCANS-III survey in 2016, no bottlenose dolphins were recorded in Block T (Hammond *et al*., 2017). Within Block R a total of 1,924 animals (95% CL = 0 – 5,048) were observed. Sightings data (**Figure 4.7Error! Reference source not found.**) clearly indicate this species is found commonly within nearshore waters along the north-east coast of Scotland.

4.2.11 The bottlenose dolphins have declined steadily in Europe over the past century, which is believed to be due to seismic exploitation, dredging, pollution, an increase in shipping activity and direct and indirect fisheries (Sini *et al.,* 2005). Today, only low numbers of the species can be found along the coasts of continental Europe, the UK and Ireland. Despite these declines, the bottlenose dolphin is considered to be at 'favourable' conservation status in UK waters (JNCC, 2019) and is of 'Least Concern' globally (IUCN, 2019).

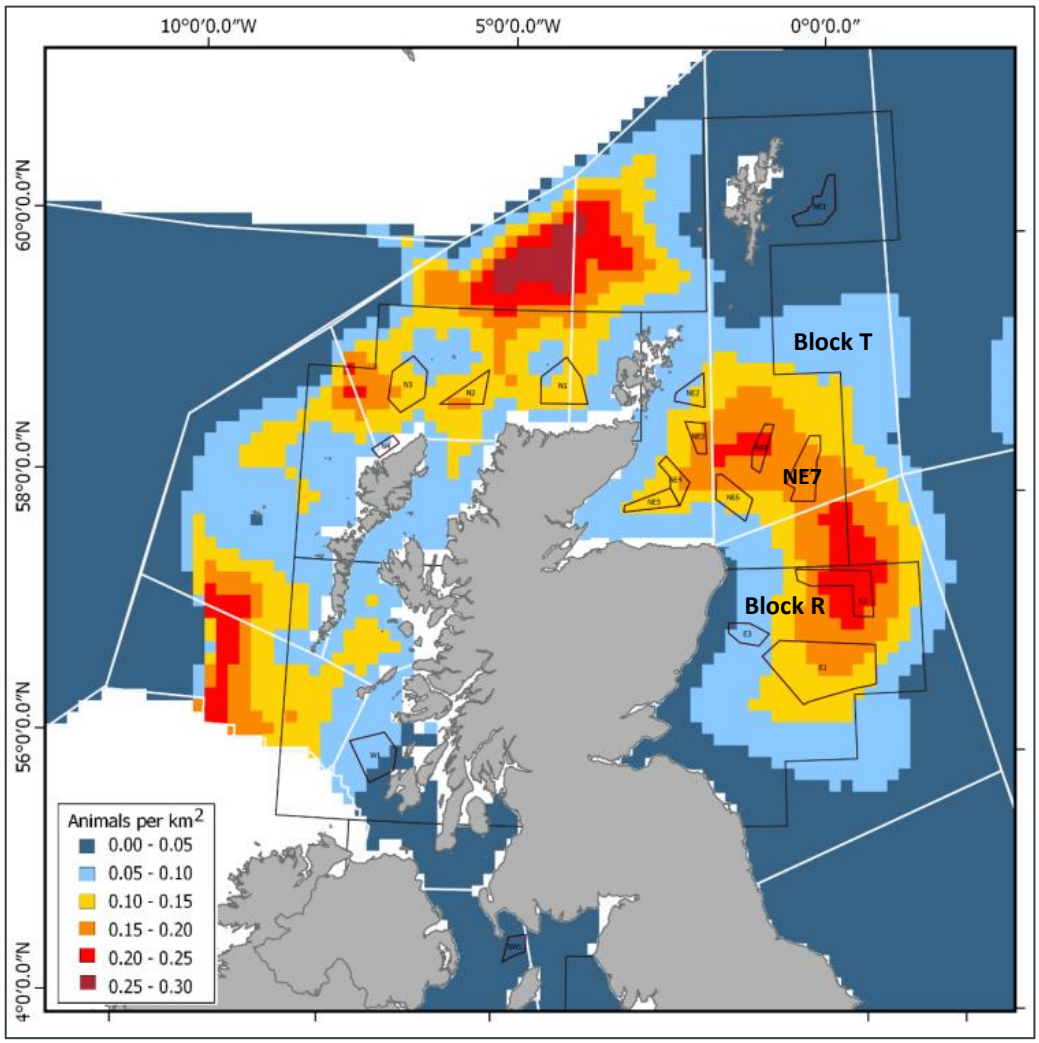
White-beaked Dolphin

4.2.12 The white-beaked dolphin is primarily distributed over northerly colder continental shelf waters and has a relatively restricted range. An estimated 80% of the European population occur in UK waters (Maddock, 2008), mostly in the waters around Scotland, including along the east coast. **Table 4.3** shows the SCANS-III white-beaked dolphin data for Blocks T and R. **Figure 4.8** presents the predicted density of this species across Scottish waters. The Search Area is located within the Celtic and greater North Sea MU for white-beaked dolphin. The abundance of white-beaked dolphin within this MU is 43,951 and the abundance in the UK portion is 34,025 (IAMMWG, 2022).

Table 4.3 White-beaked dolphin density and abundance estimates from the SCANS-III survey in blocks T and R.

Block	Density (groups/km^2)	Mean group size	CV (mean group size)	Density (animals/km^2)	CV	Abundance	CL low	CL high
T	0.011	3.43	0.261	0.037	0.463	2,417	593	5,091
R	0.066	3.70	0.131	0.243	0.484	15,694	3,022	33,340

Figure 4.8 Predicted density for white-beaked dolphin based on SCANS III Survey data (2016)[7]



4.2.13 During the SCANS-III survey, the highest estimated densities for the white-beaked dolphin were observed in inshore waters west of Scotland and in the northern North Sea (Hammond *et al*., 2017). The white-beaked dolphin also appears to occur in high densities in the western section of the northern North Sea (**Figure 4.8**) and is generally restricted to temperate and sub-Arctic seas. The species is present year-round in UK waters, but most frequently observed between June and October (Evans, 1992). In Block T, a total of 2,417 white-beaked dolphin were observed, in Block R a total of 15,694 were observed. Of all the SCANS III blocks surveyed, Block R exhibited the overall highest abundance and second highest density for this species.

4.2.14 A number of anthropogenic pressures impact the white-beaked dolphin, including underwater noise, incidental fishing (by-catch), unsustainable fishing, bio-contaminants,

[7] SCANS-III survey blocks are marked by white lines, and offshore wind strategic areas (as per 2020) are indicated by black lines (Marine Scotland, 2020).

and climate change (Tetley and Dolman, 2013). The species' distribution is known to be impacted by sea temperature, thus, one of the key threats is rising sea temperatures from climate change, which could result in the displacement of populations further north into potentially less suitable habitat (Tetley and Dolman, 2013). However, at present this species is considered to have a 'favourable' conservation status in UK waters (JNCC, 2019) and globally it is of 'Least Concern' (IUCN, 2019).

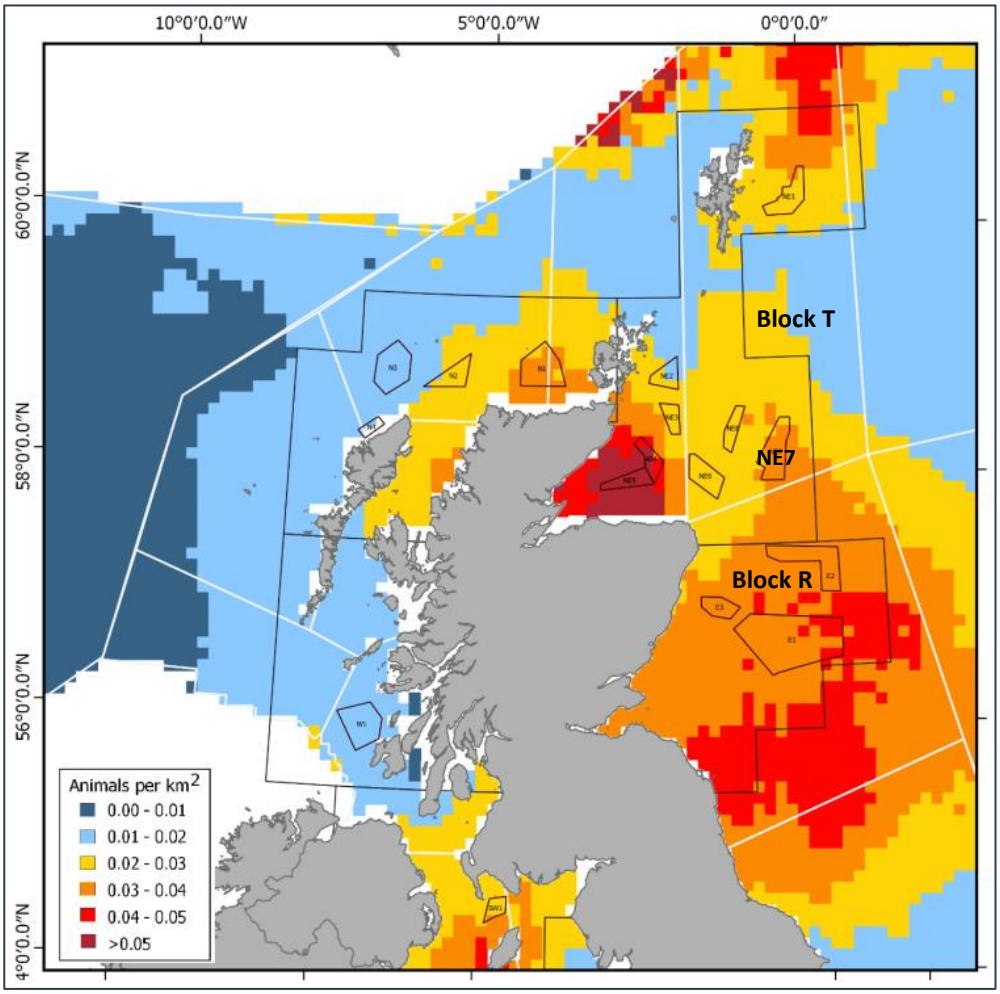
Minke Whale

4.2.15 The minke whale is widely distributed around Britain and Ireland, occurring throughout the north-western North Sea (Reid *et al*., 2003). This species can be found in UK waters year-round, although most sightings occur between May and September, with highest recorded numbers between July and September depending on the region (Evans *et al*., 2003). **Table 4.4** shows the SCANS-III minke whale data for Blocks T and R. **Figure 4.9** presents the predicted density of this species across Scottish waters. The Search Area is located within the Celtic and greater North Sea MU for minke whale. The population of minke whale within this MU is 20,118 with 51% (10,288) in the UK portion.

Table 4.4 Minke whale density and abundance estimates from the SCANS-III survey in blocks T and R.

Block	Density (groups/ km^2)	Mean group size	CV (mean group size)	Density (animals/ km^2)	CV	Abundance	CL low	CL high
T	0.0287	1.10	0.091	0.0316	0.805	2,068	290	6,960
R	0.0328	1.18	0.103	0.0387	0.614	2,498	604	6,791

Figure 4.9 Predicted density for minke whale based on SCANS III Survey data (2016)[8]



4.2.16 The SCANS-III survey recorded 2,068 minke whale (95% CL = 290 – 6,960) in Block T. Block R has a similar abundance to Block T, with a total of 2,498 whales recorded (95% CL = 604– 6,791). Block T and Block R contain the highest abundances of minke whale out of all the survey blocks. **Figure 4.9** clearly indicates the north-west North Sea is of importance to this species, with the highest predicted densities in the Moray Firth, to the west of the Search Area in Block S. The Southern Trench Marine Protected Area (MPA) is located off the Aberdeenshire coast, stretching from Buckie in the west to Peterhead in the east. Minke whale is a designated feature of this MPA, which highlights the importance of the area to this species.

4.2.17 Minke whales are considered to be sensitive to entanglement and incidental bycatch. Entanglement represents the single most frequently documented cause of mortality for minke whales in Scottish waters (Nature Scot, 2020). Minke whales are also known to be sensitive to underwater noise, although to what degree is not known. There is potential for

[8] SCANS-III survey blocks are marked by white lines, and offshore wind strategic areas (as per 2020) are indicated by black lines (Marine Scotland, 2020).

auditory injury, disturbance, and displacement from foraging areas as a result of activities which produce underwater noise at frequencies that overlap with the whales' hearing range. In 2019, minke whale were assessed to be in a favourable condition in UK waters (Nature Scot, 2020) and globally it is of 'Least Concern' (IUCN, 2019).

Other Cetacean Species

4.2.18 In addition to the four most common species, an additional five cetaceans may occur within the study area at times. These species include:

- Atlantic white-sided dolphin (*Lagenorhynchus acutus*);
- short-beaked common dolphin (*Delphinus delphis*);
- long-finned pilot whale (*Globicephala melas*);
- killer whale (*Orca orca*); and
- Risso's dolphin (*Grampus gripheus*).

4.2.19 In UK waters, the Atlantic white-sided dolphin is distributed around the west of Ireland and to the north and north-west of Britain. However, population estimates are difficult to obtain because of confusion with the white-beaked dolphin (Reid *et al*., 2003). This species inhabits deep waters around the north of Scotland throughout the year but is rare in the north-western North Sea (Reid *et al*., 2003). The most recent estimated population for Atlantic white-sided dolphins in the Celtic and Greater North Seas management unit (MU) is 18,128 animals (95% CI=6049-54323), with nearly 68% (12,293) occurring in the UK EEZ (IAMMWG, 2022) (CV=0.64; 95% CI=3891-38841).

4.2.20 The short-beaked common dolphin is often found in continental shelf waters, off the western coasts of Britain and Ireland, notably in the Celtic Sea and Western Approaches to the Channel, and off southern and western Ireland. In the North Sea, it has been observed occasionally, mainly in summer (June to September) (Reid *et al*., 2003). There are estimated to be a total of 56,556 (95% CI=33,014-96,920) individuals within the Celtic and Greater North Seas MU. Of these, 24% (13,607) (95% CI=8,720-21,234) are predicted to occur within the UK proportion of the MU (Hammond *et al*., 2013).

4.2.21 The long-finned pilot whale is common and widely distributed in deep Northern European waters, but seasonally enter coastal areas such as around the Faroe Islands, North Scotland, Western Ireland and the Channel Approaches west of England (Reid *et al*., 2003).

4.2.22 Killer whales are widely distributed in the deep North Atlantic and in coastal northern European waters, particularly around Iceland, the Faroe Islands and western Norway (Reid *et al*., 2003). In the UK, they occur primarily off the northern and western coasts of Scotland.

4.2.23 Risso's dolphins are primarily a warm water pelagic species, preferring continental slope waters (Reid *et al*., 2003). Most sightings in UK waters are in western Scotland, with the waters around the Outer Hebrides being a hotspot. There are few records of this species within the central and southern North Sea (Reid *et al*., 2003).

Summary of Cetacean Abundance and Density Estimates

4.2.24 Approximate abundances and densities for the four key cetacean species known to be present within the vicinity of the Search Area are provided in **Table 4.5** below. This data is based on the most recent abundance estimates from IAMMWG (2022). The four species are representative of all the functional hearing groups for cetaceans.

4.2.25 Assessments have therefore not been undertaken for cetacean species that are considered to be rare or infrequent in the area. The potential for these cetacean species to be impacted is considered unlikely due to them not occurring regularly within the area and the temporary nature of the works.

4.2.26 Furthermore, if individuals of other cetacean EPS were present in the area, then the proposed mitigation measures will be suitable for these species as the assessments have been carried out on all the representative functional hearing groups for porpoise, dolphin and whale species.

Table 4.5 Summary of abundance estimates for the four key cetacean species by IAMMWG (2022) Management Unit (MU)

Management Unit	Species	Abundance Estimate (individuals/MU)	95% Confidence Interval for MU	Estimated Abundance in UK portion of MU	95% Confidence Interval for UK portion of MU
North Sea	Harbour porpoise	346,601	289,498 – 419,967	159,632	127,442 - 199,954
Coastal East Scotland (inshore)	Bottlenose dolphin	-		224	214-234
Greater North Sea (offshore)	Bottlenose dolphin	2,022	548 – 7,453	1,885	476-7,461
Celtic and Greater North Seas	White-beaked dolphin	43,951	28,439 – 67,924	12,293	20,026 – 57,807
Celtic and Greater North Seas	Minke whale	20,118	14,061 – 28,786	10,288	6,210 – 17,042

4.3 Other Marine Species

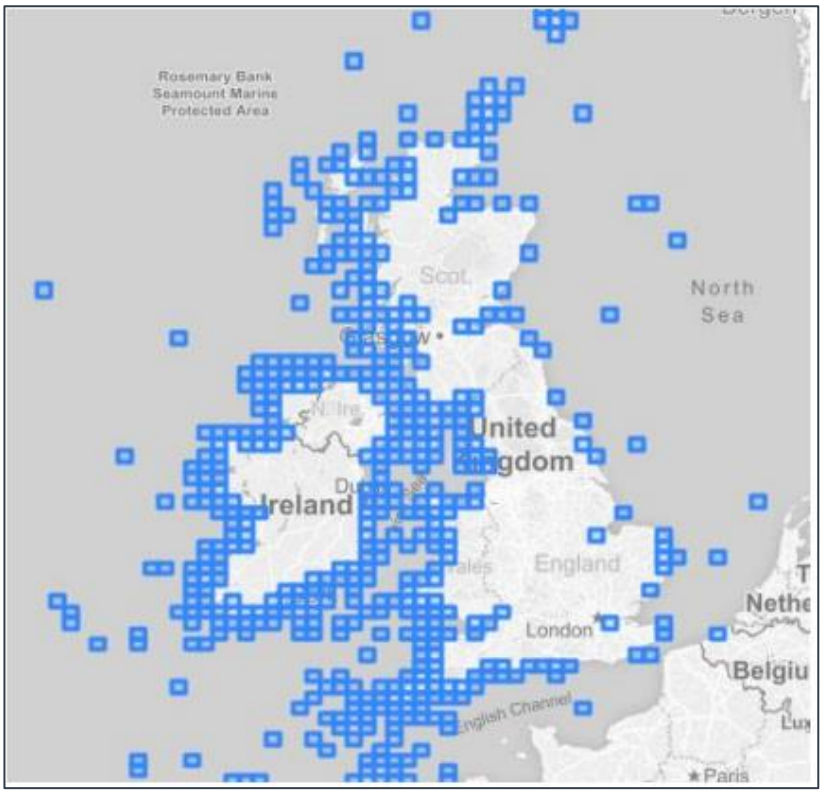
Marine Turtles

4.3.1 The leatherback turtle (*Dermochelys coriacea)* is the largest species of marine turtle, and it migrates to UK waters every summer, where it feeds on jellyfish. This species is primarily found on the western coast although occasional sightings are recorded on the east coast of Scotland – see **Figure 4.10** below (Reeds, 2004). The leatherback turtle is considered to be 'Vulnerable', with many populations listed by IUCN as 'Critically Endangered' and at risk of extinction (IUCN, 2013). In the UK, they are a Priority Species under the UK Post-2010 Biodiversity Framework (JNCC, 2012).

4.3.2 Other species of marine turtle that have been very occasionally observed in the UK include the loggerhead turtle (*Caretta caretta)*, green turtle (*Chelonia mydas)*, hawksbill turtle (*Eretmochelys imbricate)* and Kemp's Ridley turtle (*Lepidochelys kempii).*

4.3.3 Marine turtles have been scoped out of the assessment with regard to underwater sound, as the frequencies of most geophysical sound sources are outside of their low hearing range frequencies (with highest sensitivity between 100 and 400 Hz) (Popper *et al*., 2014), with the potential exception of UHR. However, sightings data indicates the species is highly unlikely to occur within the Search Area, and as such there is considered be extremely limited potential for this receptor group to interact with survey activities.

Figure *4.10* Sightings of leatherback turtle around the UK and Ireland (Reeds, 2004)



Basking Shark

4.3.4 Basking sharks can be found around the full extent of the UK coastline but are most frequently observed around the west coast of Scotland, the south-west of England, Wales, and the Isle of Man (Witt *et al*., 2012). The Sea of the Hebrides on the west coast of Scotland provides conditions that attract large numbers of sharks each summer. Numbers of basking shark within the ECC Search Area are unknown but likely to be very low, in the order of a few individuals, if any, as they are considered uncommon in the North Sea, though this may reflect observation effort (Witt *et al*., 2012).

4.3.5 Basking sharks lack gas-filled cavities such as swim bladders and are regarded as having low sensitivity to underwater sound (Popper *et al.,* 2014). Therefore, the species has been scoped out of the underwater sound assessment, as the potential impact to basking shark from underwater sound disturbance is not considered to be a concern. Potential impacts associated with collision risk have however been considered in the below assessments where relevant.

Seals

4.3.6 Two species of seal are known to inhabit Scottish waters where they have been recorded in internationally important numbers. These are the harbour seal (*Phoca vitulina)* and grey seal (*Halichoerus grypus).*

4.3.7 Approximately 36% of the world's grey seals breed in the UK, 80% of which breed at colonies in Scotland, with the main concentrations in the Outer Hebrides and in Orkney (SMRU, 2020). In the UK, grey seals typically breed on remote, uninhabited islands or coasts and in small numbers in caves. Preferred breeding locations allow females with young pups to move inland away from busy beaches and storm surges. In the north and west of Scotland pupping occurs mainly between September and late November. In the UK, grey seals are classified as an Annex II species of the EU Habitats Directive, and a total of 13 SACs have been designated in the UK for the protection of the species. None of these SACs are within proximity to the Search Area (i.e. <50 km away).

4.3.8 The UK grey seal population is considered to be stable and increasing, particularly within the eastern England colonies (SCOS, 2020). Overall, this species is at 'favourable' conservation status in the UK (JNCC, 2019). Globally, populations are also considered to be increasing and therefore the conservation status of this species is of 'Least Concern' (IUCN, 2019).

4.3.9 Approximately 32% of the European harbour seal population is found within the UK. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast of Scotland their distribution is more restricted to the Moray Firth. Scotland holds approximately 85% of the UK harbour seal population (SMRU, 2020). Harbour seals give birth on shore to a single pup in June or early July, although the timing of the pupping season may vary between locations.

4.3.10 Harbour seals are also classified as an Annex II species of the EU Habitats Directive, and a total of 16 SACs have been designated in the UK for the protection of the species. None of these SACs are within 50 km of the Search Area. The spatial range of the species is considered to be at a 'favourable' conservation status, while its overall status is considered to be 'unfavourable – inadequate.' However, this is an improvement from the 'unfavourable – bad' status reported in 2013 and is due to an overall increase in the population of harbour seals in the UK (JNCC, 2019). The global conservations status of harbour seal is of 'Least Concern' (IUCN, 2019).

4.3.11 There is a known haul-out location for both species of seal located around the mouth of the Ythan Estuary in Forvie National Nature Reserve (NNR)[9]. Seal haul-outs are locations on land where seals come ashore to rest, moult, or breed, and they are designated under section 117 of Marine (Scotland) Act 2010. No other haul-out locations or other areas of key habitat are known to occur within the ECC Search Area, although Moray Firth seal conservation area is located approximately 20 km to the north-west of the Search Area[10].

[9] NatureScot NNR Citation. Available from: https://sitelink.nature.scot/site/5027
[10] Online data source available from: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=446

5. Risk Assessment

5.1 Underwater Sound and Marine Mammals

5.1.1 Ambient underwater sound is the background sound level made up of a broad range of individual sound sources present in the ocean of both natural and anthropogenic origin (Hildebrand, 2004). Anthropogenic underwater sound sources arise from activities in and near the sea such as dredging, construction, hydrocarbon exploration and production, geophysical surveys, and sonars, among others (Richardson *et al*., 1995). Vessel movements also have the potential to produce a significant amount of underwater sound.

5.1.2 Many marine organisms, including marine mammals use sound for communication, to locate mates, to search for prey, to avoid predators and hazards, and in the case of cetaceans, for short- and long-range navigation (OSPAR, 2009).

5.1.3 The proposed survey works will generate two main types of underwater sound that could affect marine fauna – the acoustic signal of the geophysical survey equipment and the sound from the survey vessels.

5.1.4 There is also a risk of collisions between survey vessels and marine fauna. Each of these impacts have been considered in the below assessments.

Cetacean Hearing Sensitivity and Anthropogenic Sound

5.1.5 Man-made sound sources have the potential to affect cetaceans, where the frequency of the sound generated is within a species' auditory range. To reflect the different hearing sensitivities of cetacean species, Southall *et al*. (2019) classified marine mammals into functional hearing groups. These groups are shown in **Table 5.1**, together with the species in each category potentially present in the Search Area.

Table 5.1 Hearing sensitivity of key cetaceans in Search Area

Cetacean Hearing Group	Relevant Key Species	Estimated Auditory Bandwidth
Low frequency	Minke whale	7 Hz to 35 kHz
High frequency	Bottlenose dolphin and white-beaked dolphin	150 Hz to 160 kHz
Very high frequency	Harbour porpoise	275 Hz to 160 kHz

5.1.6 Exposure to anthropogenic sound can induce a range of adverse effects on marine life. Generally, the effects of noise on marine organisms can be categorised as follows (Southall *et al*., 2007):

- lethal effect and physical injury;
- auditory injury;
- behavioural responses; and

- masking.

Lethal Effect and Physical Injury

5.1.7 Evidence of direct lethal effects and physical injury in marine mammals, as a result of anthropogenic sound sources, is limited to animals in very close proximity to impulsive sound sources of very high intensity such as explosions and military sonar (Southall *et al.,* 2007). Indirect death in stranded marine mammals, particularly involving beaked whales, has been attributed to military sonar (Simonis *et al*., 2020) but the direct links between the two have been difficult to establish.

5.1.8 There is no evidence to indicate lethal effects and physical injury in cetaceans would result from the sound sources produced by vessel movements. There is also very limited evidence in scientific literature of lethal effects caused by geophysical or seismic activities although a mass stranding event of melon-headed whales (*Peponocephala electra*) in Madagascar was linked to operation of a deep-water high-power (12 kHz) MBES system (Southall *et al.,* 2013). This type of system will not be used as part of the proposed surveys (i.e. a lower power shallow-water system will be deployed). There is no evidence that low power echo sounders cause injury to cetaceans and therefore lethal effects to cetaceans from this activity, even indirectly, are not predicted to occur.

Permanent Auditory Injury

5.1.9 Underwater sound has the potential to cause injury to the auditory system of cetaceans from either brief exposure to extremely high sound levels or following more prolonged exposure to lower levels of continuous sound (Richardson *et al*., 1995).

5.1.10 This injury is a change in hearing sensitivity and is known as a permanent threshold shift (PTS). PTS is an irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. Available data from humans and other terrestrial mammals indicate that a 40 dB threshold shift approximates PTS onset. PTS is considered to be auditory injury.

5.1.11 Southall *et al.* (2007), and more recently the US National Marine Fisheries Service (NMFS, 2018) and Southall *et al.* (2019), provide indicative thresholds for sound levels that have the potential to cause PTS in marine mammals. The thresholds for PTS are based on dual criteria of unweighted, instantaneous peak sound pressure levels (SPLs) and M-weighted Sound Exposure Levels (SEL) where:

- SPL: Sound pressure level (SPL) is a means of characterizing the amplitude of a sound.
- SEL: An expression of total energy of a sound wave which incorporates both the SPL and duration; and
- M-weighted function: Frequency weighting applied to the SEL allowing functional hearing bandwidths of different marine mammal groups (see **Table 5.1**) and taking a relevant or derived species audiogram into account in the sound propagation.

5.1.12 The updated NMFS guidance (NMFS, 2018) adopts more stringent threshold criteria than Southall *et al*. (2007) based on more recent research. Recent evidence indicates that some species, high frequency cetaceans such as harbour porpoise in particular, are more susceptible to auditory injury than previously thought.

Temporary Auditory Injury and Behavioural Responses

5.1.13 Where underwater sound has the potential to cause temporary auditory injury and/or behavioural responses, this is generally referred to as a temporary threshold shift (TTS). Temporary threshold shifts are temporary, reversible increases in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. Based on data from cetacean TTS studies (Southall *et al*., 2007), a TTS of 6 dB is considered the minimum threshold shift clearly larger than any natural variation in an animal's normal hearing.

5.1.14 As with PTS, Southall *et al.* (2007), the US NMFS (NMFS, 2018) and Southall *et al.* (2019) provide indicative thresholds for sound levels that have the potential to cause TTS in marine mammals. The thresholds for TTS are based on the same criteria described above for PTS.

5.1.15 Behavioural reactions to underwater sound in marine mammals, and other marine receptors, are highly variable, context-dependent, and significantly less predictable than determining the effects of noise exposure on hearing or physiology (Erbe *et al.,* 2019). Assessing the severity of behavioural disturbance must consequently rely more on empirical studies, with carefully controlled acoustic, contextual, and response variables, than on extrapolations based on shared phylogeny or morphology.

5.1.16 Behavioural responses can involve a cessation of normal activities as well as avoidance or "startle" behaviour as a result of the detection of underwater noise. For example, animals detecting one kind of signal may simply orient to hear it, whereas they might panic and flee upon hearing a different sound, potentially even one that is quieter, if it is perceived to represent a threat. Other factors, such as continued exposure often results in habituation to the sound, followed by a recommencement of normal behaviour. Thus, such diverse responses (avoidance, no response, and attraction) highlight the importance of context in assessments of underwater noise for individuals and populations.

5.1.17 The latest threshold guidance documents (NMFS, 2018 and Southall *et al.,* 2019) do not include threshold criteria for behavioural responses, reflecting both a lack of empirical evidence and a high level of variability in behavioural responses. In this instance, thresholds for TTS are considered to represent thresholds for which behavioural responses would definitely occur. Outside of these thresholds it is difficult to accurately define a behavioural response, as described above. However, it is recognised that behavioural disturbance could still occur outside of the TTS thresholds, and as such TTS thresholds should not be used as a direct proxy for behavioural disturbance. This is taken into context-specific consideration in the assessments below where relevant.

5.1.18 Consultation feedback from NatureScot on the recent risk assessment (Document ID: SCW-DWF-ENV-RSA-JVA-000001) supporting the MarramWind EPS licence application for the geophysical survey of the OWF array site confirmed that NatureScot is in agreement that behavioural responses are context specific and that there is not an agreed disturbance threshold.

Masking

5.1.19 Underwater sounds, from natural or anthropogenic sources, may partially or entirely reduce the audibility of signals, a process known as auditory masking. In marine mammals masking could result in the temporary cessation of sound production or muffling and masking sounds of interest including communication and echolocation signals and predator and prey detection. At levels below this, animals may detect sound above background levels but no masking or changes in behaviour take place.

Impact Threshold Criteria

5.1.20 Updated thresholds based on current research on the effects of underwater sound on marine mammals have recently been published by the NMFS, commonly referred to as the NOAA criteria (NMFS, 2018). These updated thresholds are included in Southall *et al.* (2019), The values set out in Southall *et al*. (2019) are the same as the NMFS (2018) values, but some marine mammal species have been moved to different hearing groups. These hearing group shifts do not include any of the cetacean species included in this assessment.

5.1.21 The acoustic thresholds for the type of underwater sound that will be generated by the proposed geophysical survey are based on dual metrics of peak sound pressure level for a single pulse (SPL_R) and the cumulative sound exposure level (SEL_{CUM}) over a 24-hour time period.

5.1.22 The geophysical survey equipment operates within a very wide range of values of sound intensity, pulse length and pulse frequency (number of pulses or chirps per second). The noise emission specifications for the UHR and USBL systems provide values for these variables where the ranges are so broad as to make the calculation of cumulative sound exposure levels (SELs) very uncertain. Consequently, for the assessment of the UHR and USBL systems, both impulsive noise sources, the distances at which the SPL_R thresholds are exceeded have been calculated. However, more granular detail on the operation and subsequent noise propagation characteristics of the SBP system are available. Therefore, the distances at which the SEL_{CUM} thresholds are exceeded have been calculated for the SBP. Further information on the use of the dual metrics within the assessment is provided in **Section 5.2**.

5.1.23 The SPL_R sound pressure level thresholds are based on the unweighted threshold values for impulsive sounds, which are fixed for each hearing group. However, the SEL_{CUM} thresholds are frequency dependent and therefore should be weighted correctly. Despite this, as described in **Section 5.2**, the proposed SBP system produces a sound field covering a wide range of frequencies that overlap with the audible spectrum of all marine mammal groups. Consequently, no weighting adjustments have been used in the assessment of the SBP noise emissions to ensure the most conservative assessment method.

5.1.24 **Table 5.2** below provides the acoustic PTS thresholds for peak sound pressure level measured at distance R (SPL_R) and the cumulative sound exposure level (SEL_{CUM}), for a recommended accumulation period of 24-hours.

Table 5.2 PTS and TTS thresholds for marine mammals

Cetacean hearing group	Impulsive sound sources				Continuous sound sources			
	PTS		TTS		PTS		TTS	
	SPL_R	SEL_{CUM}	SPL_R	SEL_{CUM}	SPL_R	SEL_{CUM}	SPL_R	SEL_{CUM}
Low frequency	219	183	213	168	-	199	-	179
High frequency	230	185	224	170	-	198	-	178
Very high frequency	202	155	196	140	-	173	-	153

5.2 Underwater Sound Propagation Calculations

5.2.1 For the purposes of this assessment, underwater sound propagation has been calculated using a widely accepted spreading law (Urick, 1983; Xavier, 2002) expressed below. This method provides an approximation of transmission loss due to geometric spreading and seawater absorption loss, as per:

$$TL = N \log (r) + \alpha r + C$$

5.2.2 where:

TL is the transmission loss at a distance *r* from the source

N is the wave mode coefficient; for spherical propagation N=20, and cylindrical propagation N=10

r *r* is the straight-line distance between the source and receiver in metres

α is an attenuation coefficient that is dependent on frequency, temperature, water depth, salinity and acidity, where *α* is in dB/km

C is a fixed attenuation due to acoustic screening; in open water this is assumed 0

5.2.3 Several assumptions have been made in order to undertake the modelling on the basis of the above methodology. These are provided in full below.

Assumptions

Wave mode coefficient

5.2.4 The nature of sound transmission in 'shallow' water is highly variable, site specific and strongly dependent on the acoustic properties of the sea surface and sea floor. In a worst-case configuration, the transmitted sound field can be composed of many propagation paths by successive reflections on the sea surface and sea floor. In this configuration, the acoustic energy remains 'trapped' between the two boundaries of the sea surface and sea floor, and the sound propagation can be representative of cylindrical spreading (N=10). In 'deep' water, it is typical for spherical spreading to take place (N=20). Richardson et al. (1995) suggest that depths 200 m is commonly regarded as the boundary between 'shallow' and 'deep' regardless of source wavelength. It is understood that the deepest water in the proposed Search Area is 120 m, and hence considered 'shallow'.

5.2.5 Richardson *et al.* (1995) suggest using N=15 for underwater transmission in shallow water conditions where the depth is greater than five times the wavelength. In this case, five times the worst-case[11] wavelength is significantly less than the shallowest region of the Search Area. However, a wave mode coefficient of N=10 has been used within the modelling to represent a worst-case scenario due to unknown acoustic properties of the site area and has been applied at all depths from 120 m to the shore. This approach is conservative, and likely to overestimate the received sound level at an increasing distance from the source (Farcas *et al*., 2016).

[11] The worst-case wavelength is the wavelength of the lowest operating frequency of the corresponding survey activity/noise emitting equipment. As described in **Section 3.5**, in the context of the underwater noise modelling methodology, the lower the frequency, the further the noise emissions propagate from the source.

Attenuation coefficient

5.2.6 The absorption loss term within the transmission loss calculation considers attenuation of sound due source operating frequency, water depth, and a number of seawater physical properties. There are a number of empirical methods proposed that calculate this coefficient, of which four have been considered within the modelling (Francois and Garrison, 1982; Fisher and Simmons, 1977; Ainslie and McColm 1998; Thorp 1967). The Fisher and Simmons (1977) method provides the most conservative estimates of attenuation coefficient and has hence been used to represent a worst-case scenario.

Acoustic source noise levels and operating frequencies:

5.2.7 Where acoustic source noise levels and operating frequencies have not been provided by the client, conservative assumptions have been made of levels and frequencies. Where different modes of the equipment have a range of operating frequencies and/or sound levels, the lower frequency range (which will propagate further due to decreased attenuation of low frequency of sound in water), and the higher sound levels have been considered.

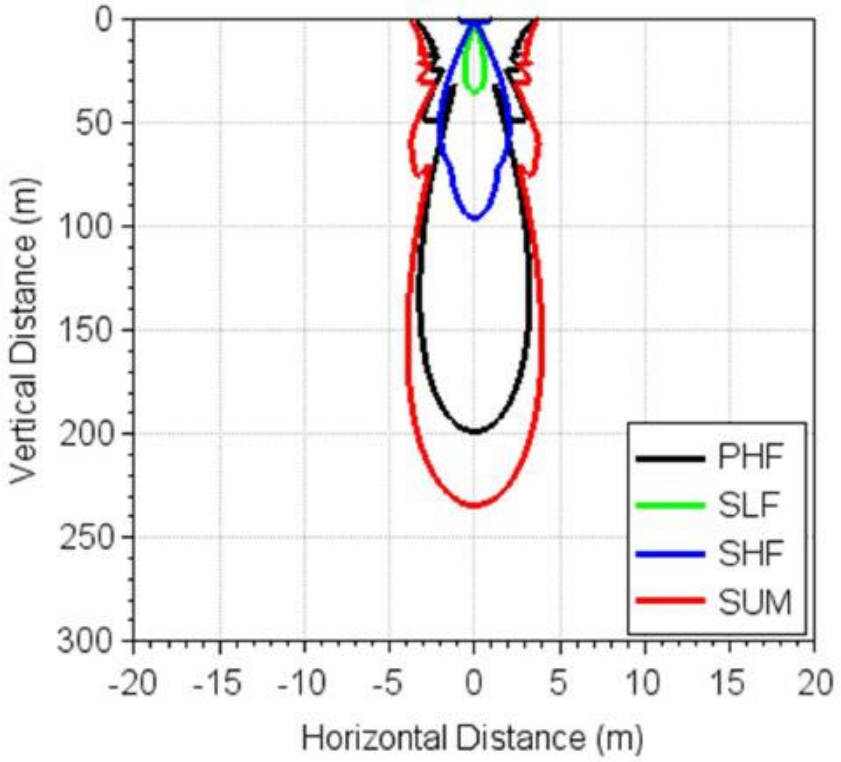
Acoustic source directionality

5.2.8 The sub-bottom profiler (SBP) source identified for assessment is the Innomar SES-2000 medium-100 Parametric Sub-bottom profiler. This system is strongly directional, with the vast majority of the signal being emitted vertically downward towards the seafloor.

5.2.9 **Figure 5.1** below illustrates the modelled isopleths for the different frequency components of the emitted signal (primary high frequency (PHF), secondary high frequency (SHF), and secondary low frequency (SLF)[12]), as well as the three components combined (SUM). This is a clear illustration of the large asymmetry between the vertical and horizontal components of the emitted signal.

[12] A parametric SBP makes use of a physical effect which generates low-frequency sound waves by emitting two different high frequencies (around 100kHz) at high sound pressures simultaneously. The transmitted PHF sound waves interact in the water and new frequencies are generated (i.e. SHF and SLF). The SHF component comprises the sum of the primary frequencies and harmonics (integer multiples of the original frequencies) and is at lead 6 dB below the PHF source level. The SHF components will attenuate over very short distances however, due to the high absorption coefficient of high frequency underwater sound in seawater (Fugro, 2021).

Figure 5.1 Modelled isopleth example of the SES-2000 medium-100 Parametric SBP (Wunderlich, 2021)



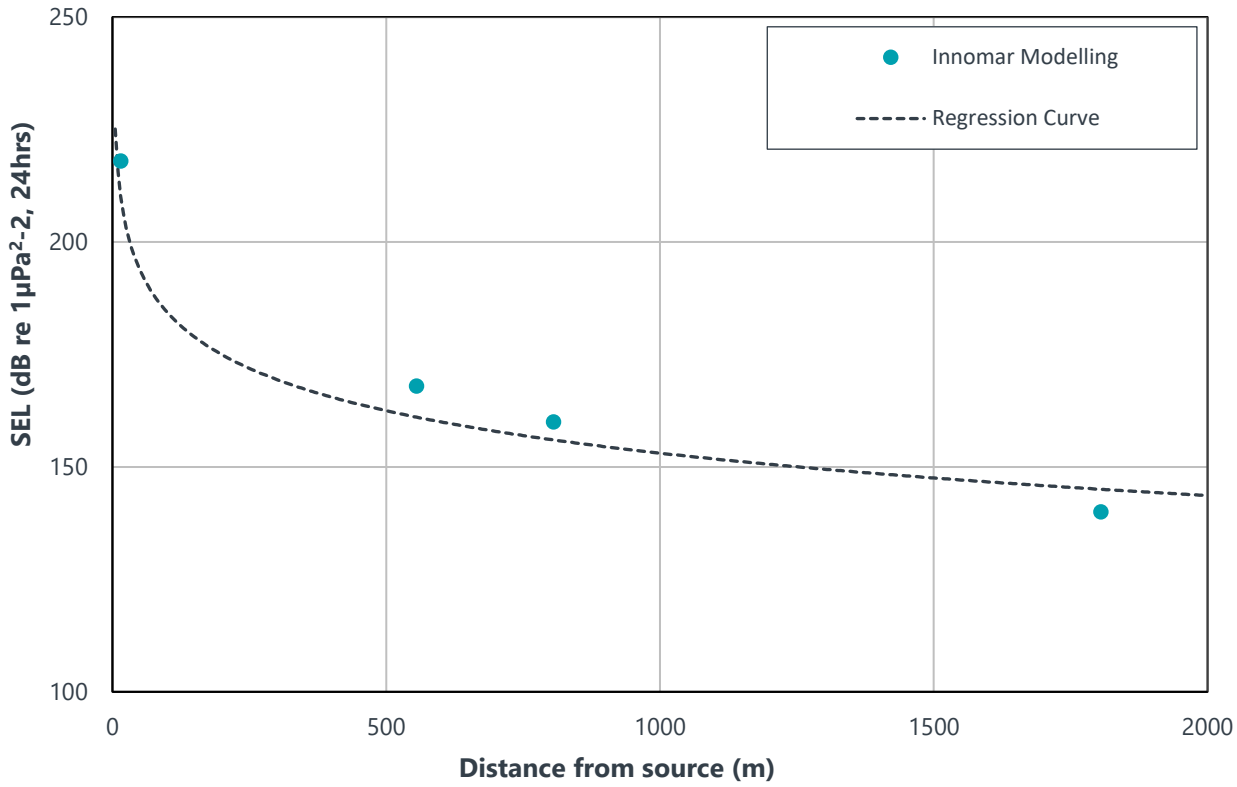
5.2.10 **Table 5.3** below provides modelled results by Innomar at several vertical and horizontal distances for a number of set cumulative SEL values over a 24-hour period (Wunderlich, 2021).

Table 5.3 Modelled vertical and horizontal distances at set SEL values due to sound emissions from the Innomar SES-2000 medium-100 SBP (Wunderlich, 2021)

	SEL <218 dB re 1µPa²-s (24hrs)	**SEL <168 dB re 1µPa²-s (24hrs)**	**SEL <160 dB re 1µPa²-s (24hrs)**	**SEL <140 dB re 1µPa²-s (24hrs)**	**SPL <196 dB re 1 µPa**
Vertical Distance	300 m	3,350 m	6,500 m	20,000 m	240 m
Horizontal Distance	10 m	550 m	800 m	1,800 m	5 m

5.2.11 **Figure 5.2** below provides a graphical representation of the horizontal distances at the set cumulative SEL values as shown in **Table 5.3**.

Figure 5.2 Innomar SES-2000 medium-100 SBP horizontal sound attenuation



5.2.12 On the above basis, the regression curve illustrated in **Figure 5.2** has been used to calculate the horizontal distances from the source at which the relevant thresholds are exceeded (*regression coefficient = 13.6*).

Hearing threshold criteria

5.2.13 The geophysical survey equipment operates within a very wide range of values of sound intensity, pulse length and pulse frequency (number of pulses or chirps per second). This flexibility allows the acoustic signal to be tailored in real time to meet the requirements for an analysis of a highly heterogenous seabed environment. Whilst the equipment specifications provide values for these variables the ranges are so broad as to make the calculation of cumulative SELs very uncertain and for this reason these calculations are excluded. Thus, for impulsive sounds, whilst the dual threshold criteria are included in the report, the distances at which the SEL_{CUM} thresholds are met have not been calculated with the exception of the SBP system, as explained in **Section 5.1**. It will be the responsibility of the survey contractor to use equipment at the lowest sound intensity possible to achieve the desired results. Thus, distances relate to the SPL of a single pulse but do nevertheless give some indication of the scale of the potential impact ranges. Furthermore, it is worth noting that a more complex modelling methodology would be required to assess more granular detail of the sound intensity, pulse length and pule frequency characteristics.

Modelling uncertainty

5.2.14 For the purposes of undertaking an assessment of the effects of underwater sound sources and the recommendations for exclusion zones, the adoption of simple geometric calculations, rather than full modelling, does have a number of limitations (Farcas *et al*., 2016). The spreading law underestimates noise levels close to the source, which is the region where noise levels are highest (and risk of injury and disturbance is greatest), and overestimates noise levels further from the source. Thus, these factors are considered when viewing the calculated distances and the effect of any mitigation measures on impacts, particularly as these are generally applied in close proximity to the sound source.

5.3 Impact Assessment – Geophysical Survey

Sound Propagation & Species Thresholds

5.3.1 A number of activities will be undertaken as part of the geophysical survey works that will produce an acoustic sound source and have the potential to result in impacts to cetaceans. These are:

- SBP;
- UHR; seismic acquisition and
- USBL.

5.3.2 As discussed in Section 3.5, the sound produced by MBES and SSS is of very high frequency and outside the hearing range of cetaceans, as shown in **Table 5.1**, and therefore not considered in the assessment below.

5.3.3 The underwater sound propagation calculations indicate that permanent and temporary auditory injury from a single pulse is generally restricted to an area in very close proximity to the sound source (**Table 5.4**).

Table 5.4 Estimated distances (m) at which impact thresholds may be exceeded by corresponding acoustic sound source associated with the geophysical survey

Survey activity	Cetacean hearing group	SPL_R		SEL_{CUM}	
		PTS (m)	***TTS (m)***	***PTS (m)***	***TTS (m)***
SBP*	Low frequency	Not reached	Not reached	125	350
	High frequency	Not reached	Not reached	100	300
	Very high frequency	Not reached	5	950	1800
UHR	Low frequency	2	6	-	-
	High frequency	Not reached	Not reached	-	-

Survey activity	Cetacean hearing group	SPL_R		SEL_{CUM}	
		PTS (m)	***TTS (m)***	***PTS (m)***	***TTS (m)***
	Very high frequency	79	316	-	-
USBL	Low frequency	Not reached	Not reached	-	-
	High frequency	Not reached	Not reached	-	-
	Very high frequency	3	12	-	-

*Approximate distances on the basis of the Innomar modelling data points in conjunction with the best-fit regression curve.

PTS/ TTS Zones

5.3.4 The lowest TTS onset SPL_R is 196 dB re 1µPa for 'very high frequency' cetaceans, as provided in **Table 5.2**. The modelled results by Innomar, and as provided in **Table 5.3**, show that this threshold would be exceeded at 240 m directly below the SBP. However, in any horizontal direction this threshold is exceeded at only 5 m from the SBP for the very high frequency group of cetaceans (i.e. porpoises). Consequently, it is highly unlikely that any cetaceans would be adversely affected by any single pulse as the SPL_R criteria for either PTS or TTS exposure would not be exceeded.

5.3.5 The modelling results summarised in **Table 5.3,** and graphically presented in **Figure 5.2**, provide distances from the SBP at which certain SEL_{CUM} levels are met over a 24-hour period. The horizontal distance at which the PTS threshold for the most sensitive species group (i.e. the Harbour Porpoise) is exceeded is approximately 900 m, whereas the horizontal distance of the TTS threshold extends to approximately 1,800 m.

5.3.6 It is important to note, that this method assumes that any affected animal would remain in close proximity to the survey vessel for a period of 24-hours in order to exceed these thresholds. This is highly unlikely as animals experiencing any discomfort caused by high sound levels would move away from the sound source.

5.3.7 The worst-case distance at which the lowest TTS onset SPL_R is exceeded for the most sensitive species group (i.e. very high frequency cetaceans) for the UHR is 316 m, and for the USBL is 12 m. The worst-case distance at which the lowest PTS onset SPL_R is exceeded for the most sensitive species group for the UHR is 79 m, and for the USBL is 3 m. Consequently, it is considered unlikely that the SPL_R criteria for either PTS or TTS exposure would be exceeded.

5.3.8 As described above, it is unlikely that the proposed survey operations would cause any injury to cetaceans. However, a certain level of behavioural response may be expected from individual cetaceans reacting to underwater noise. This assessment, with particular reference to **Table 5.5**, will focus on whether any of these behavioural responses are likely to significantly affect the local distribution or abundance of any of the cetacean species present in the wider Search Area.

MMO Mitigation Zone

5.3.9 Before the geophysical activity starts up, there will be a period of observation by a Marine Mammal Observer (MMO), or a passive acoustic monitoring (PAM) system operator, in the case of operations during the hours of darkness. Based on the maximum distance of 316 m for the onset of TTS as indicated in **Table 5.4**Table 5.4 Estimated distances (m) at which impact thresholds may be exceeded by corresponding acoustic sound source associated with the geophysical survey, it is proposed that this observation area covers a distance of 500 m, in-line with the JNCC guidelines (JNCC, 2017). The likelihood that any animals occur within 500 m of the source, and are therefore at risk of PTS, is very low. Following the observation period survey activities commence with a soft-start (where the facility is available), with sound intensity building to full power gradually over time, increasing the time available for any cetaceans in auditory range to move away. Further information regarding these mitigation measures can be found in **Section 7**.

5.3.10 The 500 m zone outlined above covers the area within which PTS could occur, the maximum distance of which is 79 m for very high frequency cetaceans (i.e. porpoises) only. In addition to this, the sound propagation methodology comprises conservative inputs due to unknown acoustic properties of the site area, and hence the modelled figures are considered to represent a worst-case scenario (**Section 5.2**). Thus, the risk of injury to cetaceans from any of the geophysical survey activities is considered highly unlikely.

5.3.11 It is important to reiterate, the exceedances of the SEL_{CUM} thresholds associated with the SBP, assumes that animals remain close to the survey vessel for a period of 24-hours in order to exceed these thresholds. In reality, avoidance behaviour means that animals experiencing discomfort will move away, thereby reducing their exposure. Consequently the likelihood of PTS or TTS is highly unlikely.

5.3.12 On the basis of the above, the distances at which TTS and PTS might occur are within the 500 m MMO mitigation zone and can therefore be excluded from additional assessment below.

Species Density and Sensitivity

5.3.13 The species most likely to be present in the ECC Search Area is the harbour porpoise, occurring at an estimated density of 0.599 individuals/ km^2 in Block R, which has the highest density out of the relevant blocks and is therefore considered worst-case (**Table 5.56**). This species is known to have very sensitive hearing and has been seen to react to some underwater sounds. For example, harbour porpoises have been observed to respond to sound produced by impact piling at significant distances from the sound source.

5.3.14 Work by Lucke *et al*. (2009) showed that aversive behavioural reactions of a captive harbour porpoise corresponded to a distance of >10 km and up to 25 km around a pile driving site (also see Dahne, 2013). However, the sounds from impact piling are of a much lower frequency (e.g., 20Hz to 20kHz) than geophysical sources (Prideaux, 2017). The generally higher frequency sounds from activities associated with the proposed survey do not propagate as far and so the distance at which behavioural responses might occur are expected to smaller, as indicated by the calculated distances in **Table 5.4**.

5.3.15 No sites designated for the harbour porpoise are located within 200 km of the ECC Search Area, suggesting that porpoises do not preferentially frequent or have any particular site fidelity to the Search Area. Site fidelity is the tendency of an individual to return to an area or remain there over an extended period of time, often associated with larger whales but also exhibited to varying degrees by dolphins and porpoises.

5.3.16 The white beaked dolphin is the next most common species with an estimated maximum average density of 0.243 individuals/ km^2 in Block R. They are categorised as high-frequency hearing animals (Southall *et al*., 2019; NMFS, 2018) and are thus expected to exhibit behavioural responses similar to other species in this group (see **Table 5.4**). No sites designated for the white beaked dolphin are located within 200 km of the Search Area, which is therefore not considered particularly important. This species is not expected to have any specific site fidelity to the area.

5.3.17 The other high-frequency species, the bottlenose dolphin, is unlikely to demonstrate significant behavioural disturbance at either an individual or population level given the low densities of this species within the Search Area (0.0298 individuals/ km^2 in Block R). Higher densities associated with the Moray Firth SAC are approximately 81.1 km from the Search Area, well beyond the maximum TTS/ behavioural effects zone of 2 m for high frequency species (**Table 5.5**).

5.3.18 The only cetacean species in the low frequency group that is likely to be present is the minke whale. The nearshore areas of the survey overlap with the Southern Trench MPA, which is designated for minke whale, and so this area is known to be important for this species. Approximately 535.2 km^2 of the ECC Search Area overlaps with Southern Trench MPA. Despite the overlap with the Southern Trench MPA, this species generally only occurs at low densities (see **Table 5.5**). The implementation of the 500 m MMO mitigation zone far exceeds the behavioural response area of 6 m for low frequency cetaceans. The chance of TTS/ significant disturbance to this species is therefore considered to be low.

5.3.19 There is no evidence to indicate the proposed Search Area represents key habitat for important life-stage activities such as breeding or calving in any of the species known to occur in the area. The wider area is considered to offer ample suitable alternative habitat for feeding and other activities and being highly mobile and free-ranging animals, cetaceans would be able to temporarily relocate to areas outside of the zone of disturbance. Also, as outlined in **Section 6**, there is predicted to be no significant impact to fish and benthic species from the survey activities and therefore no indirect effects to cetacean EPS from a loss or change in prey resource is expected to occur.

Avoidance and Mitigation

5.3.20 The demonstration of avoidance behaviour in cetaceans is often assumed to occur as a result of disturbance from underwater sound, though responses are in fact highly variable and influenced by factors such as site fidelity, motivation to remain in a particular location, life-cycle stage such as breeding and nursing young as well as habituation to anthropogenic underwater sound (Southall *et al.,* 2007).

5.3.21 Significant avoidance behaviour, such as a panic fleeing reaction, could occur for any animals within close proximity to the survey vessels (within the 500 m observation zone) (JNCC, 2017). However, with the adoption of the mitigation measures outlined above, responses are expected to be mainly short-term behavioural avoidance of the moving survey vessel, with animals able to return to an area within a few hours (JNCC, 2017), as the vessel will be moving at around 4 knots (equivalent to 7.4 km/h) within the Search Area.

5.3.22 The implementation of slow vessel speeds and the adoption of the JNCC (JNCC, 2017) mitigation measures outlined above including the pre-survey watch and soft starts will minimise the risk of any panic type avoidance behaviour by cetaceans. Thus, any residual disturbance is expected to comprise minor avoidance behaviours such as a change in swimming direction and moving to an unaffected area. The natural ranges of the populations of cetaceans in the greater North Sea ecoregion will not be significantly reduced by the survey and there will be no long-term change. Thus, only minor disturbance to individual

cetaceans is expected to occur and the impact at population levels is considered to be minor and short-term.

Area of Influence and Individuals Affected

5.3.23 To estimate the number of cetaceans that could experience some TTS, a buffer of 1 km around the ECC Search Area has been adopted for assessment purposes. This 1 km buffer is precautionary and based on the maximum modelled distance of TTS of 316 m for the UHR activity, which was rounded up to the nearest kilometre to ensure conservative estimates were produced. The figures produced for the overall Search Area were then used to estimate the number of individuals that could occur within inshore and offshore waters, based on the percentage of Search Area occurring inshore and offshore as detailed in **Section 3.1**. The figures produced are conservative indications of the numbers of individuals that could be affected.

5.3.24 The abundance data used in this assessment is the maximum density of individuals, which for all species was in Block R. The number of overall individuals within 1 km of the Search Area was calculated by multiplying the density by the Search Area. The percentage of the inshore and offshore area was multiplied by this number to give the number of individuals inshore and offshore. The numbers of individuals inshore and offshore were then divided by the UK portion of the MU to give the percentage of the inshore and offshore population. These numbers are shown in **Table 5.5** below.

Table 5.567 Estimated number of the species within 1 km of the Search Area and inshore and offshore areas using SCANS-III density data and indicative percentage of abundances/ populations that could be affected (Number =No., Individuals = Ind., IAMMWG, 2022)

Species	Max density in Search Area (individuals/ km²)	Overall No. Ind. within 1 km of Search Area	No. Ind. within inshore waters	No. Ind. within offshore waters	Abundance of animals in UK portion of MU	Inshore (%)	Offshore (%)	Total (%)*
Harbour porpoise	0.599	1,934.9	413.4	1,521.5	NS 159,632	0.26	0.95	1.21
Bottlenose dolphin	0.0298	96.3	20.6	75.7	CES 224; GNS 1,885	9.18	4.02	-
White-beaked dolphin	0.243	784.9	167.7	617.2	CGNS 34,025	0.49	1.81	2.31
Minke whale	0.0387	125.0	26.7	98.3	CGNS 10,288	0.26	0.96	1.22

***This figure was calculated by number of individuals within inshore/offshore waters and dividing by the abundance of animals within the UK portion of the Management Units (MU) and multiplying by 100 to calculate the percentage.**

Impact significance

5.3.25 The proportion of the population of the four key cetacean species that could be present in the Search Area, thus potentially subject to behavioural disturbance, is considered low. Across the Search Area, accounting for the density of animals reported by SCANS III, the estimates for observable disturbance are very low (**Table 5.5**). In addition to this, the indicative impact zone of 1 km around the Search Area is considered to be precautionary, particularly for low frequency cetaceans that are likely to exhibit lower levels of response than the high and very high frequency cetaceans based on the survey equipment being used, and therefore the proportions are likely to be conservative. The percentage of the reference population potentially impacted from one noise emission using the 5 km effective deterrence radius (EDR) as recommended by JNCC (2020) has been calculated in **Table 5.6**. For all species this is well below 1% apart from for the bottlenose dolphin Coastal East Scotland MU population which is 1.04%. Although some individuals will be disturbed, only a small proportion of the wider population within Blocks R and T, and across the Greater North Sea Ecoregion, is likely to be affected, and for a relatively short period of time. Thus, the potential impact of the geophysical survey activities on these cetacean EPS is low.

Table 5.6 89 Estimated percentage of species potentially impacted, using the 5 km effective deterrence radius (EDR) from one noise emission (Number =No., Individuals = Ind., JNCC, 2020, IAMMWG, 2022)

Search Area (km^2)	Species	Max density in Search Area (individuals/ km^2)	No. Ind./km^2	Abundance of animals in UK portion of MU	Percent of reference population (%)
3,230.23	Harbour porpoise	0.599	47.05	NS 159,632	0.03
	Bottlenose dolphin	0.0298	2.34	CES 224; GNS 1885	CES 1.04; GNS 0.12
	White-beaked dolphin	0.243	19.09	CGNS 34,025	0.06
	Minke whale	0.0387	3.04	CGNS 10,288	0.03

Assessment of Potential Offence

5.3.26 Assessment of underwater sound generated by geophysical survey equipment concluded that there is a low potential for the sounds emitted to induce PTS or TTS in cetacean EPS only at very close range to the sound source. However, with the mitigation measures this risk is reduced to negligible.

5.3.27 There is potential for some minor disturbance to cetaceans, particularly the harbour porpoise. However, any disturbance is likely to be confined to the direct vicinity of the survey vessel (i.e. only a small zone within the Search Area will be affected at any one time) for a short time. Where affected numbers could be estimated, the percentage of the reference population which has the potential to be disturbed is considered to be negligible. Therefore, it can be concluded that:

- Disturbance from operation of geophysical and positioning equipment during the survey can be considered to be limited, temporary, and unlikely to be detrimental to the maintenance of the range of cetacean populations at a favourable conservation status in their natural range, as defined in the Offshore Regulations 2017. It is considered that disturbance will not be sufficient to result in local or population level effects, **therefore an EPS licence can be issued for the survey in respect of the geophysical survey in offshore waters**.
- Following the 2014 guidance published by Marine Scotland for inshore territorial waters (Marine Scotland, 2014), there is the potential for disturbance of animals from the use of geophysical equipment and positioning systems associated with the proposed survey works. However, this disturbance will not be sufficient to cause any local or population level effects, **therefore it is considered that an EPS licence can be issued for the survey in respect of the geophysical survey in inshore territorial waters**.

5.4 Impact Assessment – Vessel Noise

Vessels and Underwater Noise

5.4.1 The use of vessels associated with the survey work represent a source of underwater sound which has the potential to result in physical impacts to cetaceans such as permanent or temporary hearing loss (PTS or TTS). There is also potential for behavioural responses or masking of naturally occurring sounds produce by cetaceans.

5.4.2 The sound levels generated varies from vessel to vessel because they can generate different frequency characteristics and sound levels depending upon factors such as their size, propulsion system and the use of dynamic positioning systems. Based on the vessel specifications, the inshore vessel is anticipated to be small (12 m) and the offshore is anticipated to be medium sized (71.6 m). The assessment of underwater sound disturbance from vessels noise has therefore been based on the sound produced by a medium vessel as a worst case (Erbe *et al*., 2019).

5.4.3 Medium vessels tend to have relatively slow revving engines and given the frequencies produced, the majority of the sound energy is below 1 kHz. The sound intensity level, given as an SPL_{rms} value, produced by medium sized vessels (i.e. between 50 to 100 m), ranged between approximately 165 and 180 dB re 1 µPa @ 1m (MMO, 2015; Prideaux, 2017 and references therein). Thus, for the purpose of this impact assessment, an average sound source level SPLrms of 173 dB re 1 µPa @ 1m (equivalent to a sound exposure level (SEL) of 173 dB re 1 µPa2/s) has been assumed.

PTS/ TTS and Mitigation

5.4.4 No PTS is predicted for any cetaceans as a result of the operation of the geophysical survey vessel. This is because the modelled sound source levels are not sufficient to result in PTS (Error! Reference source not found.**.7**). TTS is also calculated at a distance of less than 100 m for very high frequency cetaceans only. All cetacean species that could be present in the Search Area are highly mobile and are likely to move away from any uncomfortable underwater sound sources that may come from the geophysical survey vessel.

Table 5.710 Estimated distance (m) at which auditory injury impact threshold may be exceeded for vessel noise

Cetacean hearing group	PTS	TTS
Low frequency	Not reached	Not reached
High frequency	Not reached	Not reached
Very high frequency	Not reached	100

5.4.5 However, some TTS/ behavioural responses could still occur. To avoid any major avoidance behaviour, such as panic reactions, by cetaceans, JNCC guidance (JNCC, 2017) mitigation measures have been adopted, including soft starts where possible and slow vessel movement. Even with this mitigation in place, minor avoidance behaviours may result, such as an alteration in their direction of travel of small cetaceans. The waters

of the north-western North Sea are subject to busy shipping activity, such as ferries, meaning any sound produced by the survey vessel will not be greater than that produced by many other vessels and cetaceans that frequent these seas will be habituated to vessel sound (EMODnet, 2021[13], Marine Traffic, 2022[14], (ABPmer UK, 2017)[15].

Impact Significance

5.4.6 Cetaceans are highly mobile, thus, any risk to individuals from underwater sound is often considered to be low on the assumption that affected animals will leave the area, though marine mammals can display a wide range of behavioural responses (Erbe et al., 2019). Nevertheless, the proposed survey works are temporary, localised and of short duration at any given location. Therefore, any behavioural responses will be short-term and temporary and not expected to have a significant impact either to individuals or populations of cetaceans. In addition, cetaceans are likely to be habituated, to some extent, to vessel noise and movement in a busy sea area such as the North Sea (MMO, 2014).

5.4.7 Overall, the risk of the survey vessel causing auditory injury in any species of cetacean, or to elicit a behavioural response over and above that caused by the usual vessel activity within the area, is considered low. Therefore, any impact from the noise of the survey vessel is expected to be negligible.

5.4.8 There is very little evidence of the effect of vessel noise on turtle behaviour but, based on their expected hearing sensitivity, Popper et al. (2014) reports that the risk of any impairment to hearing is confined to a few metres from the sound source. The risk of behavioural disturbance is estimated to be moderate within a few hundred of metres from the source and low beyond that. With the standard JNCC mitigation measures in place, limiting any sudden and intense underwater sound production in particular, the impact of vessel noise on marine turtles, recorded as low density (Reeds, 2004) in the Search Area is expected to be minor.

Assessment of Potential Offence

5.4.9 Increased underwater sound from movements of marine vessels during the geophysical and geotechnical surveys is unlikely to result in the harassment, injuring or killing of a marine turtle EPS. There is potential for behavioural disturbance in cetaceans, but this is expected to be negligible, with no responses over and above that are caused by the usual vessel activity within a busy shipping area. Vessel movement is therefore unlikely to be detrimental to the maintenance of populations of cetacean EPS at a favourable conservation status level in their natural range, as defined in the regulations for territorial and offshore waters. **Therefore, it is considered that an EPS licence will not be required for the survey in respect of vessel noise for territorial or offshore waters**.

[13] European Marine Observation and Data Network (EMODnet), 2021. Available online: https://www.emodnet-humanactivities.eu/view-data.php
[14] Marine Traffic, 2022, live map. Available online: https://www.marinetraffic.com/en/ais/home/centerx:-0.7/centery:57.3/zoom:7
[15] ABPmer UK 2015 National Dataset for Marine Vessel Traffic, 2017. Available online: https://abpmer.maps.arcgis.com/apps/webappviewer/index.html?id=59a2cde1b2914b36978f608eff806fbb

5.5 Impact Assessment – Collison Risk

Vessel Speed, Strikes and Avoidance

5.5.1 The survey is anticipated to be completed using a small sized vessel (12 m) and a medium sized vessel (71.6 m). The speed at which the vessels will be travelling during the survey will be approximately 4 knots (7.4 km/h). Whilst in transit to the Search Area, the vessels will be travelling at speeds of up to 10 – 15 knots (18.5-27.7 km/h).

5.5.2 Direct strikes from vessels, including sharp objects such as propellers, have the potential to cause serious injury to marine mammals, turtles, seals and basking sharks and to be lethal in some cases (Bexton *et al*., 2012; Speedie *et al.,* 2009). The most lethal and serious injuries to marine megafauna are believed to be caused by large ships, typically 80 m and longer as well as by vessels travelling faster than 14 knots (Laist *et al.,* 2001). Injuries from such collisions can be divided into two broad categories: blunt trauma from impact and lacerations from propellers.

5.5.3 Marine mammals possess a thick subdermal layer of blubber or fat deposits, which provides a level of protection to their vital organs meaning they are reasonably resilient to minor strikes and collisions (Wilson *et al.,* 2007). Basking sharks may also have a level of protection from minor strikes and collisions as their skin is covered in hard interlaced placoid scales or denticles (Basking Shark Scotland, 2022). Turtles are small in size and possess a hard carapace that can reduce the severity of impacts from collisions with marine vessels. However, injuries may result in individuals becoming vulnerable to secondary infections or predation (Wilson *et al.,* 2007).

5.5.4 Marine mammals are fast and agile swimmers, with fast reflexes and good sensory capabilities (Hoelzel, 2002). Avoidance behaviour by cetaceans is often associated with fast, unpredictable boats such as speedboats and jet-skis (Bristow and Reeves, 2001; Gregory and Rowden, 2001), while neutral or positive reactions, particularly in dolphins have been observed with larger, slower moving vessels such as cargo ships (Leung Ng and Leung, 2003; Sini *et al*., 2005).

5.5.5 In contrast, turtles are neither fast nor agile and cannot be reliably avoid vessels travelling faster than approximately 2 knots (3.7 km/h). Individuals are most vulnerable when foraging or swimming in water depths which are insufficient to allow the draft of the vessel and propellers to pass over (e.g. in nearshore areas) (Shimada *et al*., 2017). Individuals that bask or breathe close to the sea surface are also vulnerable to vessel collisions or being struck by propellers.

5.5.6 Basking sharks are considered to exhibit a general lack of awareness of vessel traffic making them more susceptible to vessel strikes, particularly during the summer months when individuals spend a large proportion of time at the surface feeding (Witt *et al*., 2012) (see **Section 4.3** for abundance data).

Impact Significance

5.5.7 The likelihood of the survey vessel colliding with cetaceans, turtles or basking shark is predicted to be low. The addition of one or two vessels within the Search Area will not result in a significant increase in vessel traffic. In addition, the vessels will be slow moving, meaning that individuals (particularly marine mammals) can easily avoid the vessel, greatly reducing the risk of collision. The density of most marine mammals as well as turtles, seals and basking sharks within the proposed Search Area is estimated to be low (see **Section 4**), further reducing any remaining risk.

5.5.8 In UK waters, the issue of injury through collision is not currently thought to be of major concern and so there are no specific mitigation measures recommended by the JNCC (JNCC et al., 2010).

5.5.9 However, the mitigation measures being implemented by the Project in relation to marine mammals (**Section 7.1**) are also suitable for mitigating impacts to basking sharks. Thus, the increase in potential for collision with vessels associated with survey work is considered to be negligible.

Assessment of Potential Offence

5.5.10 It can be concluded that the risk of collision with marine vessels associated with the survey work is very low and is therefore unlikely to result in the harassment, disturbance, injuring or killing of an EPS in inshore and offshore waters, as defined in the regulations. It can also be concluded that the risk of collision with basking sharks in inshore waters is very low. **Therefore, it is considered that an EPS licence will not be required as a result of collision risk from survey vessel movements. It is also considered that a basking shark licence will not be required for the survey as a result of collision risk.**

6. Designated Sites and Priority Marine Features

6.1.1 This section is intended to inform both the EPS Licencing and Basking Shark Licencing process (specifically the requirement to consider designated sites) and the Marine Licencing exemption request to Marine Scotland (MS-LOT), which requires consideration of designated sites and PMFs.

6.2 Other Survey Activities

6.2.1 In addition to the geophysical survey activities outlined in **Section 3**, which can cause underwater sound disturbance to cetaceans and pose a collision risk, geotechnical and environmental surveys include several other testing and sampling activities that have potential to impact designated sites and PMFs. These activities, along with indictive equipment specifications, are outlined in **Table 6.1** below.

Table 6.1 Geotechnical and environmental survey activities and indicative equipment specifications

Survey activity	Equipment specification	Make, model and capacity (where available)
Vibro-coring	The vibro-core shall have a 6 m depth capability and an 84.1 mm core diameter.	High Performance Corer (HPC), 0.03 m^3
Piezocone penetrometer testing (PCPT)	The CPT will provide a rapid and accurate determination of the subsurface soil conditions, to a penetration of up to 15m6m. The standard cone application of the system is 10cm^2 piezo-cones.	Seacalf 100kN CPT system with 10cm2 10cm^2 piezocones (15cm^2 available)
Benthic fauna, particle size analysis (PSA), and contaminant sampling	Collection of sediment samples for analysis of environmental characteristics of benthic habitats and collection of sub-set of sediment samples for analysis of sediment contaminants from the same grab sample.	Dual van Veen grab, 0.1 m^3 or mini Hamon grab
DDV	Collection of seabed images as determined by the geophysical data.	Bowtech Sea Knight or Kongsberg OE14-208

6.2.2 Based on the equipment specifications identified in **Table 6.1** and the number of samples expected to be taken from the Search Area and the volume of sediment to be removed has been calculated (**Table 6.2**).

Table 6.2 Number and volume (m^3) of sediment samples to be collected during geotechnical and environmental surveys[16]

Activity	Equipment	Area	Number of samples***	Volume of each sample (m^3)	Total volume of sediment removed (m^3)
Geotechnical sampling	Vibrocore	OS*	20	0.03	0.683
		NS**	5	0.03	0.1517
Benthic fauna and contaminant samples	Dual van veen grab	OS*	55	0.1	7.5
		NS**	5	0.1	0.5

*** OS = offshore areas >10 m depth**

**** NS = nearshore areas <10 m depth**

***** The number of benthic sampling stations is subject to change following on-board review of the geophysical data during the survey works.** The number of samples taken will also be confirmed pending verification of **water depth limitation**s during the survey.

6.2.3 Collectively, the proposed geophysical, geotechnical and environmental survey works have the potential to impact designated sites and/ or PMFs via a number of impact pathways including:

- Direct loss and physical disturbance to seabed habitats and species;
- Underwater sound disturbance to marine mammals and fish;
- Airborne sound disturbance to seabirds;
- Visual disturbance (including artificial lighting) to fish, marine mammals (cetaceans and seals) and seabirds due to the presence of survey vessels;
- Collison risk between marine vessels and marine mammals (cetaceans and seals), turtles and basking shark; and
- Direct or indirect (via changes in prey resource) disturbance to habitats and species from changes in marine water quality arising from the mobilisation of sediment-bound contaminants and the accidental release of fuel and chemicals (e.g. oil) from vessels.

6.3 Designated Sites

6.3.1 There are 17 designated sites (i.e. Special Protection Areas (SPAs), Special Area of Conservation (SACs), Ramsar sites, Marine Protected Areas (MPAs), Sites of Special Scientific Interest (SSSIs), and National Nature Reserves (NNRs)), that fall within 50 km of

[16] NB: CPT not included as this activity does not involve sediment removal. Depth in this table is referenced from lowest astronomical tide (LAT).

the Search Area and are designated for marine ecological features of relevance to this assessment (or within 150 km for the case of marine mammals, which are both highly mobile and highly sensitive to underwater sound) (**Figure 1.1**). These sites are detailed in **Table 6.3** below and in Error! Reference source not found.. Note that all designated sites that directly overlap with the ECC Search Areas are located within the 12 nm limit.

6.3.2 Firth of Forth Banks Complex MPA is located approximately 68 km from the ECC Search Area, however this site is designated for static benthic features and as such there is considered to be no potential for overlap between survey activities and the designated features of this site, and so it is not considered further here.

Table 6.3 Designated sites that fall within 50 km of the Search Area (or 150 km for sites designated for marine mammals)

Site name	Designation	Proposed or Designated Biodiversity features	Distance from ECC Search Area (km)
Southern Trench	MPA	• Minke whale (*Balaenoptera acutorostrata*) • Burrowed mud • Fronts • Shelf deeps	0
Turbot Bank	MPA	• Sandeels (*Ammodytes marinus* / *Ammodytes tobianus*)	13.2
Buchan Ness to Collieston Coast	SPA	• Fulmar (*Fulmarus glacialis*), breeding • Guillemot (*Uria aalge*), breeding • Herring gull (*Larus argentatus*), breeding • Kittiwake (*Rissa tridactyla*), breeding • Seabird assemblage, breeding • Shag (*Phalacrocorax aristotelis*), breeding	0
Ythan Estuary, Sands of Forvie and Meikle Loch	SPA	• Common tern (*Sterna hirundo*), breeding • Eider (*Somateria mollissima*), non-breeding • Lapwing (*Vanellus vanellus*), non-breeding • Little tern (*Sternula albifrons*), breeding • Pink-footed goose (*Anser brachyrhynchus*), non-breeding	16.6

Site name	Designation	Proposed or Designated Biodiversity features	Distance from ECC Search Area (km)
		• Redshank (*Tringa totanus*), non-breeding • Sandwich tern (*Sterna sandvicensis*), breeding • Waterfowl assemblage, non-breeding	
Loch of Strathbeg	SPA	• Sandwich tern (*Sterna sandvicensis*), breeding • Goldeneye (*Bucephala clangula*), non-breeding • Greylag goose (*Anser anser*), non-breeding • Pink-footed goose (*Anser brachyrhynchus*), non-breeding • Svalbard barnacle goose (*Branta leucopsis*), non-breeding • Teal (*Anas crecca*), non-breeding • Waterfowl assemblage, non-breeding • Whooper swan (*Cygnus cygnus*), non-breeding	1.8
Troup, Pennan and Lion's Heads	SPA	• Fulmar (*Fulmarus glacialis*), breeding • Guillemot (*Uria aalge*), breeding • Herring gull (*Larus argentatus*), breeding • Kittiwake (*Rissa tridactyla*), breeding • Razorbill (*Alca torda*), breeding • Seabird assemblage, breeding	23.9
Fowlsheugh	SPA	• Fulmar (*Fulmarus glacialis*), breeding • Guillemot (*Uria aalge*), breeding • Herring gull (*Larus argentatus*), breeding • Kittiwake (*Rissa tridactyla*), breeding • Razorbill (*Alca torda*), breeding	61.7

Site name	Designation	Proposed or Designated Biodiversity features	Distance from ECC Search Area (km)
		• Seabird assemblage, breeding	
Moray Firth	SPA	• Common scoter (*Melanitta nigra*), non-breeding • Eider (*Somateria mollissima*), non-breeding • Goldeneye (*Bucephala clangula*), non-breeding • Great northern diver (*Gavia immer*), non-breeding • Long-tailed duck (*Clangula hyemalis*), non-breeding • Red-breasted merganser (*Mergus serrator*), non-breeding • Red-throated diver (*Gavia stellata*), non-breeding • Scaup (*Aythya marila*), non-breeding • Shag (*Phalacrocorax aristotelis*), breeding • Shag (*Phalacrocorax aristotelis*), non-breeding • Slavonian grebe (*Podiceps auritus*), non-breeding • Velvet scoter (*Melanitta fusca*), non-breeding	56.2
Ythan Estuary and Meikle Loch	Ramsar	• As per Ythan Estuary, Sands of Forvie and Meikle Loch SPA	16.6
Loch of Strathbeg	Ramsar	• As per Loch of Strathbeg SPA	1.8
Moray Firth	SAC	• Bottlenose dolphin (*Tursiops truncatus*) • Subtidal sandbanks	99.7
Loch of Strathbeg	SSSI	• Breeding bird assemblage • Goldeneye (*Bucephala clangula*), non-breeding • Greylag goose (*Anser anser*), non-breeding • Pink-footed goose (*Anser brachyrhynchus*), non-breeding	0

Site name	Designation	Proposed or Designated Biodiversity features	Distance from ECC Search Area (km)
		• Whooper swan (*Cygnus cygnus*), non-breeding • Saltmarsh • Sand dunes	
Bullers of Buchan Coast SSSI	SSSI	• Guillemot (*Uria aalge*), breeding • Kittiwake (*Rissa tridactyla*), breeding • Maritime cliff	0
Collieston to Whinnyfold Coast	SSSI	• Fulmar (*Fulmarus glacialis*), breeding • Guillemot (*Uria aalge*), breeding • Kittiwake (*Rissa tridactyla*), breeding	9.1
Sands of Forvie and Ythan Estuary	SSSI	• Arctic tern (*Sterna paradisaea*), breeding • Breeding bird assemblage • Common tern (*Sterna hirundo*), breeding • Eider (*Somateria mollissima*), breeding • Little tern (*Sternula albifrons*), breeding • Sandwich tern (*Sterna sandvicensis*), breeding • Saltmarsh • Sand dunes	16.6
Forvie	NNR	• Seal Haul-out Sites Designation Order	16.6

6.4 Priority Marine Features (PMFs)

6.4.1 There is a requirement to submit a marine licence exemption request to Marine Scotland in relation to the proposed geotechnical and environmental surveys. Specifically, an exemption applies to the removal of sediment samples because each sample taken will

measure less than one cubic metre[17]. A marine licence exemption request requires the consideration of both designated sites and PMFs[18].

6.4.2 Several PMFs have the potential to occur in the Search Area and could therefore be affected by geotechnical survey work. These could include:

- benthic habitats;
- cetacean species;
- fish species; and
- shellfish and other invertebrates.

6.4.3 Whilst the precise type and location of PMFs within the Search Area is not well known, it is recognised that some priority features could occur within the Search Area, and as such they are considered in assessments below where relevant. The results of the proposed environmental survey will provide data on the presence of PMFs within the Search Area, which will be of importance to future environmental assessments required for the Project.

6.5 Consideration of Effects on Designated Sites and PMFs

Direct loss and physical disturbance to priority benthic habitats and species

6.5.1 Grabbing, vibro-coring, PCPT and thermal resistivity testing could lead to the direct loss and/ or physical disturbance of benthic habitats and species. No sites designated for the protection of benthic habitats or species occur in proximity to the Search Area. Prior to the completion of geotechnical and environmental sampling, geophysical survey data and DDV data will be reviewed to enable a pre-assessment of seabed habitats, and to identify whether any priority benthic habitats and/ or species may be present at the sampling stations. Should the presence of priority benthic habitats and/or species be confirmed, the precise sampling locations will be adjusted to avoid damage or loss where possible.

6.5.2 With consideration of this mitigation and given the small volume of material expected to be removed from each designated site, the surveys are not predicted to have any significant impact on the extent and integrity of benthic habitats and species. Thus, there is predicted to be no significant effect to any priority benthic habitats or species from direct loss or physical disturbance.

Underwater sound disturbance to marine mammals and priority fish species

6.5.3 The hearing range of fishes varies widely between species. For most species, sensitivity to sound occurs from below 100 Hz to several hundred hertz, or several thousand hertz in a few species (Mann *et al*., 2001; Popper *et al*., 2014). Those with a swim bladder, such as Atlantic cod (*Gadus morhua)* are sound pressure sensitive at the higher frequencies and

[17] Marine Scotland Exempted Activity: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2020/02/marine-licensing-applications-and-guidance/documents/applications/notice-of-exempted-activity/notice-of-exempted-activity/govscot%3Adocument/Notice%2Bof%2Bexempted%2Bactivity.pdf
[18] Priority Marine Feature list, 2022. Available at: https://www.nature.scot/doc/priority-marine-features-scotlands-seas-habitats

some species of herring-like fishes, (though not the Atlantic herring *Clupea harengus)*, can detect ultrasound above 20 kHz (Popper et al., 2014).

6.5.4 As the geophysical survey activities generally use high to very high frequency acoustic signals, beyond the hearing range of any fish in the Project area, there are no likely effects on fish and so the impact of underwater sound on all priority fish species, including basking shark, as well as fish spawning and nursery areas can be scoped out of further assessment. In addition to this, any effects to lesser sandeels (*Ammodytes marinus* and *A. tobianus*), the qualifying feature of Turbot Bank MPA, can also be scoped out of further consideration given the high frequency sound sources are outside of the hearing range of these species.

6.5.5 As described in **Section 4** of this report, a variety of cetacean species could occur within the Search Area. Specially, the harbour porpoise, white beaked dolphin, bottlenose dolphin, and minke whale are likely to occur most regularly and in the highest abundances. Two sites designated for cetacean species including minke whale and bottlenose dolphin are located within 150 km of the Search Area, as described in **Section 6.3** above. As outlined in Sections 5, underwater sound disturbance from the geophysical survey and vessel movements is not predicted to have a significant impact on cetacean species. As such, there is predicted to be no significant effect to any priority cetacean species.

6.5.6 In addition to cetaceans, it is possible seals could also occur in the Search Area at times, as described in **Section 4** of this report. Seals primarily use sound for social and reproductive interactions, and audiograms indicate hearing across a broad range of frequencies from around 100 Hz to several tens of kHz (Southall *et al*., 2007; Southall *et al*., 2019).

6.5.7 Whilst disturbance to seals as a result of underwater sound could occur if seals were located in close proximity to survey activities (within 500 m), due to the fact the survey is adopting JNCC mitigation measures for geophysical surveys for marine mammals (see **Section 7**), the impact of the survey is expected to be minor. Nonetheless, the JNCC guidance for mitigating underwater sound impacts from geophysical surveys also applies to seals and will be implemented for the Project. Thus, there is predicted to be no significant effect to any seal species.

Airborne sound disturbance to seabirds

6.5.8 The temporary presence of marine vessels and survey activities can generate airborne sound which has the potential to disturb breeding and foraging seabirds. Disturbance effects to seabirds might include cessation of foraging or nesting.

6.5.9 There are five SPAs falling within 50 km of the Search Area (**Table 6.3**), two of which overlap with the Search Area (as shown in Error! Reference source not found.). In addition to this, the Search Area overlaps with two SSSIs (one of which is also a Ramsar site).

6.5.10 Stakeholder engagement with NatureScot in 2022 in relation to the MarramWind project has highlighted the sensitivity of the Troup, Pennan and Lion's Heads SPA, the Ythan Estuary, Sands of Forvie and Meikle Loch SPA, and the Buchan Ness to Collieston Coast SPA. NatureScot noted that these SPAs are designated for the protection of breeding seabird populations (and non-breeding lapwing and eider), and that these bird assemblages may be vulnerable to disturbance from survey activities should they take place during the breeding season. NatureScot noted a particular sensitivity where survey works are proposed within 3km of an SPA between mid-March and mid-August. In support of ongoing engagement and decision-making in this regard, the geographical area and duration of works proposed for the ECC survey where the Search Area overlaps with a 3km buffer around SPAs have been calculated.

6.5.11 **Table 6.4** provides information on which designated sites are overlapped by the Search Area, the area of direct overlap, the area of overlap with a 3km buffer, and the anticipated duration of the survey works within these areas.

Table 6.4 Overlap between designated sites of relevance to seabirds and Search Area

Designated Site	Area of direct overlap (km^2)	Percent of designated site overlapped	Duration of works within overlapped area	Area of overlap with SPA 3km buffer (km^2)	Duration of works within 3km buffer
Buchan Ness to Collieston Coast SPA	7.1	13.1%	0.22 days	35.28	1.09 days
Loch of Strathbeg SPA, Ramsar and SSSI	0.1	0.02%	0.003 days	2.79	0.09 days
Bullers of Buchan Coast SSSI	0.09	8.7%	NA	NA	NA

6.5.12 **Table 6.4** indicates that the total area of overlap between the Search Area and any site designated for seabirds is expected to be very low. The SPA with the most overlap is Buchan Ness to Collieston Coast SPA, where it overlaps with the Search Area 7.1 km^2. This area of overlap equates to 0.2 days of noisy geophysical survey activity within the SPA and 1.09 days within 3km of the SPA boundary. All other SPAs would be subject to <0.1 days' worth of noisy geophysical survey activity.

6.5.13 Grab and geotechnical samples as well as drop-down video will be taken along the ECC (see **Table 6.2** for sampling details). These are proposed to be acquired by the survey vessels in direct continuation of the ECC geophysical scope. Any potential for impact resulting from grab and geotechnical sampling would be over a small geographical area, in the region of .

6.5.14 It is noted that during the nesting season, which primarily occurs between April to June, there may be seabirds such as guillemot (for which the Buchan Ness to Collieston Coast SPA is designated) or eider (for which the Ythan Estuary, Sands of Forvey and Meikle Loch SPA) is designated, to be rafting on the sea surface and less able to undertake avoidance behaviour. Given that the survey is being planned to occur between March and September 2023, there is potential for a temporal overlap between the survey and the nesting season and periods of moulting. The potential for likely significant effects (LSE) on the designated interest features of the SPAs overlapped by the Search Area and therefore the potential for Adverse Effects on the Integrity (AeoI) of the designations is described in **Table 6.5**.

Table 6.5 Potential for disturbance or displacement effects on ornithological receptors within SPAs, Ramsar sites and SSSIs overlapped by the Search Area

Designated site	Likely Significant Effect	Mitigation	Potential for Adverse Effect on Integrity
Loch of Strathbeg SPA, RAMSAR and SSSI	Site is designated primarily for terrestrial wetland species including goldeneye, greylag goose, pink-footed goose and Sandwich tern. The works will coincide with the main nesting and moulting period for the sandwich tern (April to August). Sandwich terns have a low disturbance vulnerability index (DVI= 6.7) to shipping traffic compared to other species (e.g. red throated divers DVI= 77.8) and therefore a small increase in the number of vessels over a short period of time is unlikely to have an effect on this species (Fliessbach *et al.*, 2019). **No potential for LSE predicted.**	The potential for impact on sandwich tern as a result of activities set out in this application has been assessed above as being insufficient to lead to a significant impact on the site's conservation objectives. No mitigation is therefore considered necessary for sandwich tern.	**No potential for an AEoI.**
Buchan Ness to Collieston Coast SPA	**Potential for LSE predicted.** Increased vessel activity offshore has the potential to reduce access for birds to important areas for feeding, moulting and loafing. Reduced access to some areas could result in changes to feeding and other behavioural activities. The presence of up to three Project vessels for the works will have short term and localised disturbance and displacement impacts on birds, such as the guillemot.	To reduce the potential for disturbance, slow vessel speeds of 4 knots (equivalent to 7.4 km/h) will be implemented during the survey works within the Search Area. Whilst in transit to, from or within the Search Area (which will be of limited duration), the vessels will travel at speeds of up to 10-15 knots (18.5-27.7km/h).	The suggested mitigation is expected to result in no significant impacts on the designated interest bird species and therefore **no potential for an AEoI.**

Designated site	Likely Significant Effect	Mitigation	Potential for Adverse Effect on Integrity
Bullers of Buchan Coast SSSI	**Potential for LSE predicted.** Increased vessel activity offshore has the potential to reduce access for birds to important areas for feeding, moulting and loafing. Reduced access to some areas could result in changes to feeding and other behavioural activities. The presence of up to three Project vessels for the works will have short term and localised disturbance and displacement impacts on birds, such as guillemot.	To reduce the potential for disturbance, slow vessel speeds of 4 knots (equivalent to 7.4 km/h) will be implemented during the survey works within the Search Area. Whilst in transit to, from or within the Search Area (which will be of limited duration), the vessels will travel at speeds of up to 10-15 knots (18.5-27.7 km/h).	**No potential for an AEoI.**

6.5.15 In addition to this, there is expected to be no significant effect to fish or benthic species, as described in the above assessments, and so no indirect effects to seabirds via reduction in prey resource is expected. Considering the very short-term nature, and hence small magnitude of the impact, airborne sound from vessel operations and survey activities is not predicted to have a significant effect on the designating features of any nearby SPAs or Ramsar sites.

Visual disturbance (including artificial lighting) to priority fish, marine mammals, and seabirds due to the presence of survey vessels

6.5.16 Increased visual stimuli (including artificial light) from the presence of marine vessels can lead to attraction or avoidance behaviour in fish, marine mammals, and seabirds, which could affect breeding or foraging activities, with potential for wider implications for populations.

6.5.17 The offshore survey works vessels are expected to require night-time operational lighting. As good practice, this will be directional and hooded/shaded as required to minimise unnecessary light spill.

6.5.18 Given the low number of vessels, which are required to undertake the offshore surveys and the good practice mitigation outlined above, any change in visual stimuli is predicted to be of low magnitude. Disturbance effects would also be short-term and temporary. As such, there is not predicted to be any significant impacts to fish, marine mammals and seabirds from visual disturbance due to the survey operations. As such, there is predicted to be no significant effect to any PMFs or the qualifying features of any designated sites from visual disturbance, particularly given the requirement for the implementation of standard mitigation measures which would mitigate the potential for any visual disturbance to seal haul-out sites at Forvie NNR.

Collison risk between marine vessels and marine mammals, turtles, and basking sharks

6.5.19 As outlined in **Section 5**, the risk of collisions between survey vessels and marine mammals (cetaceans and seals), turtles and basking shark is predicted to be negligible. Thus, there is predicted to be no significant effect to any PMFs or the qualifying features of any designated sites from collision risk.

Direct or indirect (via changes in prey resource) disturbance to habitats and species from changes in marine water quality arising from the mobilisation of sediment-bound contaminants and the accidental release of fuel and chemicals (e.g. oil) from vessels

6.5.20 The disturbance of sediments can lead to the mobilisation of sediment-bound contaminants (e.g. hydrocarbons), which can pose a risk of toxicity to benthic and pelagic species. The accidental release of fuel and chemicals (e.g. oil) from operational vessels could also lead to deterioration in marine water quality with direct effects to marine habitats and species.

6.5.21 Vessels will be required to comply with all relevant health, safety and environmental legislation. This includes compliance with the International Regulations for Preventing Collisions at Sea (1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) with the aim of preventing and minimising pollution from ships. Most critically, all vessels shall have a contingency plan for marine oil pollution (Shipboard Oil Pollution Emergency Plan). Pollution prevention strategies would also be expected to be developed and implemented in accordance with the relevant Guidance for Pollution Prevention to reduce the potential for, and the scale of any environmental impacts. This includes development and implementation of an Emergency Spill Response Plan and a Waste Management Plan. With consideration of this good practice mitigation, the likelihood of an accidental spillage occurring from any of the operational vessels is considered to be very low. However, should a spill occur, the impact would be of very small magnitude and short-term.

6.5.22 Mobile receptors such as some fish species and life stages (including migratory species) and marine mammals are highly mobile and would be able to move away from adverse water quality conditions and therefore they are considered to have low sensitivity and effects to these receptors would be limited. Although habitats and less mobile species and life stages would be expected to be more vulnerable to deterioration in marine water quality, given the nature of the impact (e.g. short-term and of very small magnitude), it is unlikely that there would be any discernible effect to the abundance, distribution or functioning of habitats and species, even at the local level. As such, the surveys are not predicted to have a significant impact on any designated sites or PMFs via a deterioration in water quality.

7. Survey Execution and Mitigation Measures

7.1 Mitigation measures for EPS

7.1.1 There is potential for physical and/ or auditory injury to cetacean EPS from the operation of geophysical equipment during the survey work, but only within a very close range of the survey activities. Some minor behavioural disturbance is possible in the wider vicinity of the survey and so the mitigation measures recommended in the 2017 JNCC guidelines (JNCC, 2017) for minimising the risk of injury to marine mammals from geophysical surveys will be adopted, as described below:

1. Sound source: the lowest practicable sound source level will be used to meet data collection requirements.
2. Soft-start: A 20-minute soft start will be employed for acoustic sound sources, with a gradual build-up of power/sound level before the full sound source level is reached at the start of geophysical survey operations, and after a break of more than 10 minutes in sound generating activities.
3. Vessel marine mammal observation: A suitably trained member of the vessel crew will undertake marine mammal observations prior to the commencement of any sound generating activities (including after any break in survey activities of more than 10 minutes). The JNCC guidelines (JNCC, 2017) note that typically, a non-dedicated MMO can be used. Geophysical survey activities can only commence after a 30-minute period where no marine mammals have been observed in a 500 m observation zone around the vessel. Where relevant, observers will also refer to the guidelines in the Scottish Marine Wildlife Watching Code (SNH, 2017).
4. Offshore Passive Acoustic Monitoring (PAM): Where an interruption of more than 10 minutes occurs in the hours of darkness or when conditions reduce observer visibility to below the 500 m observation zone, a PAM pre-watch will be required (or the survey will wait until daylight or suitable weather conditions when a new visual observation can take place before commencing a soft start).
5. If several pieces of high-resolution survey equipment are to be started sequentially or interchanged during the operation, only one pre-activity search is required prior to the start of acoustic output, only if there are no gaps in data acquisition of greater than 10 minutes.

7.1.2 Whilst occasional cetacean visitors to UK waters are not considered specifically in this assessment due to their low likelihood of occurrence, mitigation measures put in place for the four key species assessed are equally appropriate for other less commonly occurring species in the ECC Search Area. These mitigation measures for cetacean EPS (JNCC, 2017) are also deemed to be appropriate for seals and basking sharks and will be applied.

7.2 Mitigation measures for designated sites and priority marine features

7.2.1 To minimise the potential disturbance to potential or designated sites and their qualifying features, the following mitigation measures are also proposed in support of the Marine Licence applications:

- Project vessels shall comply with all relevant health, safety and environmental legislation. This includes compliance with the International Regulations for Preventing Collisions at Sea (1972) and regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) with the aim of preventing and minimising pollution from ships. Most critically, all vessels shall have a contingency plan for marine oil pollution (Shipboard Oil Pollution Emergency Plan). Pollution prevention strategies would also be expected to be developed and implemented in accordance with the relevant Guidance for Pollution Prevention to reduce the potential for, and the scale of any environmental impacts. This includes development and implementation of an Emergency Spill Response Plan and a Waste Management Plan.
- Project vessels shall adopt directional and hooded/ shaded lighting as required to minimise unnecessary light spill.
- Sediment sampling (e.g. vibro-coring and grabbing) shall be micro-sited within the survey corridor to avoid sensitive priority benthic habitats and species (e.g. biogenic reefs) where possible.
- As part of the SOPEP and Garbage Management Plan, both vessels use scupper plugs to prevent any on deck spills reaching the sea. All on-board personnel will have a vessel induction within 24 hours of boarding to familiarise themselves with SOPEP kits and drills. Planned maintenance system includes regular inspection of hydraulic hoses.
- Side scan sonar equipment is monitored during operations to avoid collision with the seabed.
- Slow vessel speeds of 4 knots (equivalent to 7.4 km/h) will be implemented during the survey works within the Search Area.
- Whilst in transit to, from or within the Search Area (which will be of limited duration), vessels will travel at speeds of up to 10–15 knots (18.5-27.7 km/h).

7.3 Reporting

7.3.1 A report will be submitted to Marine Scotland and JNCC following the completion of the survey work. This report will include the following information:

- Complete marine mammal recording forms;
- The dates, locations and details of sound generating activity;
- Details of all MMO operator effort including information about any marine mammals detected; and
- Details of any technical problems encountered, and actions taken.

7.3.2 The Marine Noise Registry (MNR)[19] has been developed by JNCC to record human activities in UK seas that produce loud, low to medium frequency (10 Hz – 10 kHz) impulsive noise. The relevant geophysical activities will be entered to the noise registry by MarramWind Limited prior to commencing the survey work, and the survey contractor will be required to comply with all of the requirements of the MNR.

[19] https://mnr.jncc.gov.uk

7.3.3 Where required by the regulator, reporting of any work carried out under licence will also be submitted within the specified period after the completion of the survey works.

8. Conclusions

8.1 EPS

8.1.1 This assessment of the potential for impacts on EPS from activities associated with the geophysical survey work concluded that, post-mitigation:

- There is negligible potential for lethal effects to marine EPS.
- The potential for physical or auditory injury is considered to be negligible.
- The potential for behavioural disturbance is considered to be low within the context of the wider populations of EPS.

8.1.2 For offshore waters, disturbance from the survey work can be considered to be limited, temporary, and unlikely to be detrimental to the maintenance of the range of cetacean populations at a favourable conservation status in their natural range, as defined in the Offshore Regulations 2017. It is considered that disturbance will not be sufficient to result in local or population level effects, therefore it is considered that an EPS licence can be issued under l Conservation of Offshore Marine Habitats and Species Regulations 2017. for the survey in respect of the geophysical survey in offshore waters.

8.1.3 Following 2014 Marine Scotland and NatureScot guidance for inshore territorial waters (Marine Scotland, 2014), there is limited and temporary potential for minor disturbance of animals from the geophysical systems on the vessels involved during the survey works. Disturbance will be insufficient to cause any population level effects, and thus it is considered that an EPS licence to disturb can be issued under Section 39 of The Conservation (Natural Habitats, &c) Regulations 1994 (as amended in Scotland) and the Conservation of Habitats and Species Regulations 2017.

8.2 Basking Shark

8.2.1 This assessment of the potential for impacts on basking shark from activities associated with the geophysical survey work concluded that there was negligible potential for lethal effects, injury, or behavioural disturbance to basking shark. Any impacts will be insufficient to cause any population level effects, and thus a basking shark licence is not considered a requirement for the survey.

8.3 Designated Sites and PMFs

8.3.1 The assessment concludes, with the adoption of the recommended mitigation measures outlined in Section 7, the proposed survey works are not predicted to have any significant impact on designated sites and their qualifying features or any PMFs.

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