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Seagreen Project Operations and Maintenance Phase and remaining construction works – European Protected Species Risk Assessment

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01	29/09/2023	Draft for review	SMRU Consulting	[Redacted]	
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1. Introduction

Seagreen Wind Energy Limited (hereafter referred to as 'Seagreen') was awarded Section 36 Consents (S36 Consents) under the Electricity Act 1989 by Scottish Ministers in October 2014 for the Seagreen Alpha and Seagreen Bravo Offshore Wind Farms (OWF) and the Offshore Transmission Asset (OTA), collectively referred to as the 'Seagreen Project'.

The Seagreen Project is located in the North Sea, in the outer Firth of Forth and Firth of Tay region. Phase 1 of the OWF comprises the wind turbine generators (WTGs), their foundations, associated inter-array array cables (IACs) and the WTGs to offshore substation platform (OSP) cables. Phase 1 of the OTA includes one OSPs, its foundations and the offshore export cables up to mean high water on the Angus coast.

In September 2021, a Construction phase EPS licence was obtained to cover disturbance associated with piling, acoustic deterrent device use and geophysical surveys; this licence (EPS/BS-00009336) expires on 31 December 2023. Construction of Phase 1 of the Seagreen Project is nearing completion, with the project now transitioning into the Operations and Maintenance (O&M) phase. This risk assessment relates to both the O&M phase activities along with the completion of two remaining construction campaigns scheduled for 2024: landfall duct burial and outstanding IAC rock protection placement. Certain activities during the Seagreen Project O&M phase and 2024 construction activities will generate underwater noise which may present a risk of physical and/or auditory injury or disturbance to noise-sensitive protected species, namely marine mammals. These activities include the use of high-resoltuon geophysical survey equipment and acoustic positioning and communication systems associated with post-construction as-laid surveys, asset monitoring surveys, general seabed surveys, and ad hoc environmental monitoring studies.

As European Protected Species (EPS) listed on Annex IV of the EU Habitats Directive, it is an offence to kill, injure or disturb **cetaceans**; if such an offence is likely to occur, an EPS licence is required. Further details of offences and their legislative context are provided in Section 1.1. While **seals** are not EPS, they are also sensitive to underwater noise, and in Scottish inshore waters it is an offence to kill, injure or take a seal, or harass a seal at a designated haul-out site (Table 1.1). Additionally, seals may be interest features of protected sites, including Special Areas of Conservation (SACs) under the Habitats Directive. Therefore, potential effects on harbour and grey seals are also assessed.

This risk assessment considers the potential effects of the Seagreen Project O&M and remaining construction works on marine EPS in the context of relevant legislation and guidance (see Sections 1.1 and 1.2), therefore assessing the need for an EPS licence(s) and providing the information required by the Marine Directorate Licensing Operations Team (MD-LOT) in support of any such applications[1]. Consideration is also given to the potential for the planned activities to impact seals and relevant protected sites (i.e. marine protected areas for cetaceans and seals; see Section 6).

[1] For example, this document provides the 'Cetacean Risk Assessment' described in: Marine Scotland. 2020. The protection of Marine European Protected Species from injury and disturbance. Guidance for Scottish Inshore Waters (July 2020 Version).

1.1 Legislative context

Annex IV of the EC Habitats Directive (*European Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna*) lists species of European interest in need of strict protection – European Protected Species (EPS). All species of cetacean whose natural range includes waters around the UK are marine EPS.

The Habitats Directive is transposed into UK and Scots law by different regulations which, along with accompanying guidance, define offences in relation to EPS. These have been retained in domestic law following the exit of the UK from the EU though various EU Exit amendment legislation. Other legislation defines offences related to seals. Regulations of relevance to this risk assessment are described in Table 1.1.

Table 1.1. Legislation and offences relating to EPS and seals in Scottish inshore and offshore waters.

Legislation and offences relating to EPS in Scottish inshore and offshore waters
Legislation: *The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)**   **Applicable to:** Scottish inshore waters (<12 nm)   **Offence(s): Regulation 39(1)** makes it an offence to deliberately or recklessly to capture, injure, kill, harass or disturb a wild animal of a European protected species;   further, **Regulation 39(2)** provides that it is an offence to deliberately or recklessly disturb <u>any</u> dolphin, porpoise or whale (cetacean). This offence is considered to relate to disturbance at the individual level.   *Retained in UK law through the *Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations* 2019.
Legislation: *The Conservation of Offshore Marine Habitats and Species Regulations 2017**   **Applicable to:** UK offshore waters (>12 nm)   **Offence(s): Part 3 (Section 45)** states that it is an offence to deliberately capture, kill or injure any wild animal of a European protected species. It is also an offence to deliberately disturb wild animals of any such species, with disturbance defined as that which is likely to impair their ability to: survive, breed, reproduce, or nurture young; migrate or hibernate; or, which might affect significantly its local distribution or abundance.   *Retained in UK law through the *Conservation of Habitats and Species (Amendment) (EU Exit) Regulations* 2019.
Legislation and offences relating to seals in Scottish inshore waters
Legislation: *Marine (Scotland) Act 2010*   **Applicable to:** Scottish inshore waters (< 12 nm)   **Offence(s):** Under **Section 107** it is an offence to intentionally or recklessly kill, injure or take a seal except under licence or to alleviate suffering.   Further, under **Section 117,** harassing a seal (intentionally or recklessly) at a haul-out site is an offence. Haul-out sites are those designated under *The Protection of Seals (Designated Sea Haul-out Sites) (Scotland) Order 2014*.

Should an EPS licence be required, for it to be granted the Habitats Regulations specify three tests which need to be met: (i) there must be a licensable purpose; (ii) there must be no satisfactory alternative; and, (iii) the activity must not be detrimental to the maintenance of the population of the species concerned at favourable conservation status in their natural range. This third test relates to impacts which might damage the status of the species in the long-term.

Specifically, the conservation status will be taken as 'favourable' when:

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

This risk assessment provides the necessary information to determine the third test relating to favourable conservation status.

1.2 Relevant guidance

This risk assessment has been prepared with consideration of the following guidance:

- JNCC et al. (2010). The protection of marine European Protected Species from injury and disturbance. Guidance for the marine area in England and Wales and the UK offshore marine area (June 2010 – Draft).
- Marine Scotland (2020). The protection of Marine European Protected Species from injury and disturbance. Guidance for Scottish Inshore Waters (July 2020 Version).
- JNCC (2017) guidelines for minimising the risk of injury to marine mammals from geophysical surveys.

1.3 Existing impact assessments

This EPS Risk Assessment has been informed by impact assessments and a subsequent Environmental Statement (ES) to inform applications for consents to build and operate the Seagreen Alpha and Seagreen Bravo offshore wind farms (Seagreen, 2012). The wind farms were subsequently consented in 2014. A subsequent Environmental Impact Assessment Report (EIA Report) was prepared and submitted in 2018 in support of consent applications for an optimised design for the same wind farm projects (Seagreen, 2018a).

In 2015, an Appropriate Assessment (Marine Scotland, 2015) concluded that the Forth and Tay Developments, either alone or in-combination, will not adversely affect the integrity of relevant marine mammals SACs, including the Isle of May SAC, the Berwickshire & North Northumberland Coast SAC, Firth of Tay and Eden Estuary SAC and Moray Firth SAC, subject to compliance with relevant conditions[2]. A Habitats

[2] Conditions are listed from page 58 of https://marine.gov.scot/sites/default/files/appropriate_assessment_1.pdf

Regulations Appraisal within the 2018 EIA Report for the optimised design reached the same conclusion. Further information on these sites is provided in Section 6.

This EPS Risk Assessment has also been informed by previous EPS risk assessments related to the Seagreen site and export cable corridors (including for geophysical surveys, UXO clearance activities and construction), including feedback received from statutory consultees.

2. Description of activities

2.1 Time period

The design life of the Seagreen Project assets is 30 years, throughout which O&M activities will take place. However, this risk assessment is intended to support the potential need for an EPS licence for the first **three years** of the project's O&M phase, including remaining construction works scheduled for 2024, from 01 January 2024 to 31 December 2026.

2.2 Location and infrastructure

The location of the Seagreen Project and its key components is shown in Figure 2.1. Phase 1 of the Seagreen Project consists of 114 Wind Turbine Genertors (WTGs) installed on three-legged steel jackets, each installed on suction bucket caissons; one Offshore Substation Platform (OSP), installed on 12 pin pile foundations; and a network of 286 km of inter-array subsea cables (IACs) to connect strings of WTGs together, further connecting these WTGs to the OSP. The OWF site (WTGs and OSP) is entirely within offshore Scottish waters (>12 nm from shore), with a minimum distance of approximately 27 km to shore near Johnshaven on the Aberdeenshire coast. The IACs were buried where possible; in instances where burial is not possible, cable protection is being installed. Three parallel subsea export cables, each of c. 60 km length, transmit electricity from the OSP to the landfall at Carnoustie, Angus; these were buried where possible and where burial was not possible cable protection was installed.

The Seagreen Project shall be managed out of the Seagreen O&M base in Montrose, which includes the facilities of Montrose Harbour from which crew transfer vessels (CTVs) and the Service Operations Vessel (SOV) will operate. Montrose also houses the Seagreen Marine Co-ordination Centre (MCC) for marine surveillance, emergency response coordination and other operations tasks.

This risk assessment covers O&M activities within the OWF site and the export cable corridor and geophysical surveys to support the remaining construction works in the OWF site and intertidal area of the export cable corridor.

The remaining infrastructure for the Seagreen Project (inclusive of up to 36 further WTGs, one or more further OSPs, a network of inter-array cables and a single HVDC export cable to Cockenzie, East Lothian) will be installed in a subsequent phase ('Phase 1A') and is not detailed in or covered by this EPS risk assessment.

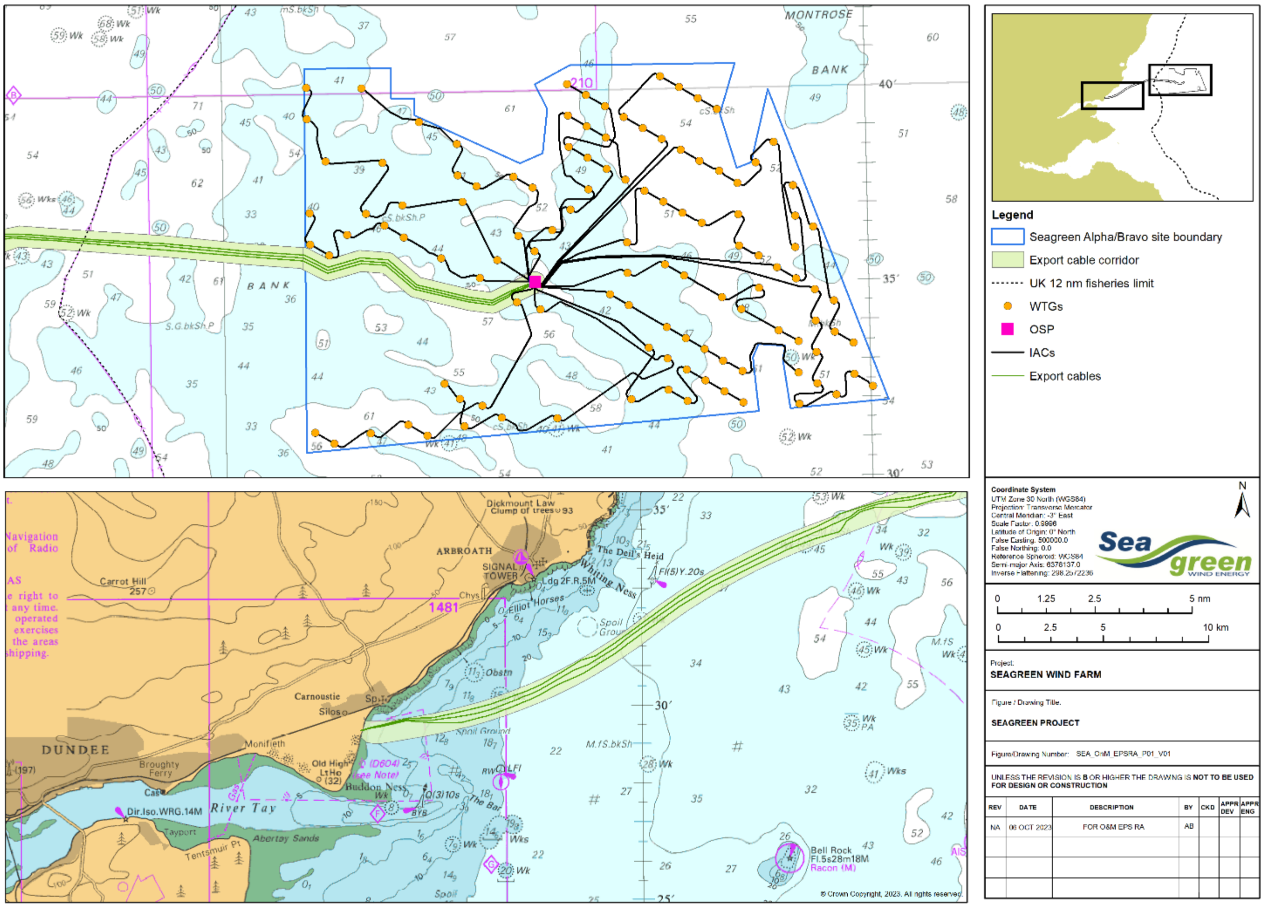

Figure 2.1. Seagreen Project (Phase 1), including OWF site (top) and export cable landfall (bottom).

2.3 Planned activities and anticipated frequency

A detailed description of O&M activities is presented in the Operations and Maintenance Programme (Wind Farm Assets) (Doc ref. LF000009-CST-OF-PRG-000), prepared in adherence with consent conditions. This and other relevant plans to this assessment of O&M activities are listed in Table 2.1. The EPS Risk Assessment supporting construction activities (Doc ref. LF000009-CST-OF-LIC-REP-0008) described activities and plans relevant to the remaining construction works scheduled for 2024. It is not intended to reproduce such a level of detail here; rather, provide an overview of activities of relevance to EPS in sufficient detail to inform an assessment of the risk of an injury or disturbance offence to EPS under the relevant regulations.

Table 2.1. Consent plans relevant to O&M of the Seagreen Project of relevance to the current EPS Risk Assessment

Document	Document Ref No.
Operational Environmental Management Plan (OEMP)	LF000009-CST-OF-PLN-0001
Project Environmental Monitoring Programme (PEMP)	LF000009-CST-OF-PRG-0003
Vessel Management Plan (VMP)	LF000009-CST-OF-PLN-0006
Operational Environmental Management Plan (OEMP)	LF000009-CST-OF-PLN-0001
Marine Pollution Contingency Plan (MPCP)	LF000009-CST-OF-PLN-0012

To ensure the Wind Farm Assets and export cables operate safely and in an optimised state they are subjected to a number of routine inspection and maintenance activities. In addition, there are occasions when unscheduled activities may be required to carry out repairs or other remedial works to return the assets to a serviceable condition. Inspection and maintenance of subsea assets such as jackets and cables will require the use of high-resolution geophysical survey (HRGS) equipment and/or Remotely-Operated Vehicles (ROVs) with acoustic positioning systems, in addition to the possible use of an acoustic modem to transmit data, all of which introduce noise into the marine environment and require an assessment of the potential for effects on EPS.

Survey platforms may include survey vessels, uncrewed surface vessels (USVs) or ROVs. Activities may occur at any time.

O&M activities and remaining construction works which will use HRGS equipment and/or ROVs with acoustic positioning and communication systems will include:

- Visual inspection (by ROV) of subsea sections of jackets. Scheduled: Annual (subset). Unscheduled: as required where need identified.
- ROV survey of IACs to assess cable burial depth and movement to identify any free spans and potential risk of future exposure. Scheduled: Initial survey of identified ‘at-risk’ areas approximately one year post-installation. Frequency of subsequent routine ROV survey to be informed by initial survey. Unscheduled: as required where a fault is detected, a dragged anchor occurs, or the IAC remote thermal monitoring system indicates a change in burial depth.
- Post-construction bathymetry and burial depth surveys of the landfall duct and IACs following final rock placement. Scheduled for spring 2024 (landfall duct) and late spring to October (IACs), but may extend beyond this dependent on programme.
- Bathymetry and cable burial depth survey of the export cables.
- Ad-hoc environmental monitoring surveys (primarily bathymetry).
- ROV use during unscheduled major activities such as any infrastructure repair or replacement.

Unless specified otherwise, it is anticipated that the majority of the aforementioned activities will occur within the OWF site, where they will be conducted from a combination of platforms including ROV, survey vessels and uncrewed surface vessels (USVs). Surveys of the export cables will most likely be conducted by a USV, but depending on outcomes of discussions with potential suppliers, in some circumstances ROVs or survey vessels may be chosen as preferable platforms.

2.3.1 Characteristics of acoustic equipment

Several active acoustic sources will be used during O&M and remaining construction activities for the purposes of seabed and infrastructure investigations. Key characteristics of these sources are provided in Table 2.2. A summary description of these sources is provided below; more detailed descriptions can be found in reviews by Hartley Anderson Ltd (2020) and Jiménez-Arranz et al. (2020). The exact geophysical equipment is subject to change, but their specifications, in terms of operating frequencies and source levels, will fall within the ranges presented in Table 2.2 and assessed here. Multiple sources may be used simultaneously.

<u>Geophysical survey equipment</u>

Equipment may include **SBES** (single-beam echo-sounder), **MBES** (multi-beam echo-sounder), **SSS** (side-scan sonar), Pangeo **SBI** (Sub-bottom Imager), **SBP** (Sub-bottom profiler: CHIRP, pinger or parametric). ROVs may also be equipped with very high-resolution object tracking and imaging sonars.

A **MBES** comprises one or more transducers which emit a fan-shaped acoustic signal covering a swath of seabed along a survey transect to provide detailed bathymetric information. Unlike MBES, **SBES** emits a single, narrow beam which surveys areas of the seabed to provide detailed bathymetric information. **SSS** uses two transducers to emit conical or fan-shaped signals directed obliquely at the seafloor to provide information on the surface of the seabed through analysis of reflected sound, including object identification. The SSS is likely to be mounted on an ROV or towed at depth behind a survey vessel or USV in a tow fish. While the beam produced by MBES and SSS is wide in the plane perpendicular to the vessel's path (across-track), the along-track beam is narrow. While some energy will also be transmitted horizontally (for example from side-lobes), this has been shown to be of significantly reduced intensity to that of the main beam (Crocker and Fratantonio, 2016). The same applies to ROV-mounted imaging and tracking sonars, which emit a narrow swathe of energy at a high frequency to provide high resolution information on objects at close range.

SBPs and **SBIs** provide information about the layers of sediment and objects below the seabed, and will be used in Seagreen O&M and remaining construction activities to acquire information about buried infrastructure, primarily cables. All use one or more transducers to emit a pulse of sound toward the seafloor, portions of the pulse that penetrate the seabed are then reflected and refracted as they pass across sediment, buried objects and rock strata, with the returning signals providing information such as the thickness and positioning of different strata and objects. A **CHIRP** SBP is a more advanced version of a **pinger**, which uses a frequency-modulated signal to achieve a better trade-off between seabed penetration and the resolution of geological strata. A **parametric** SBP generates a primary signal in a very narrow beam (typically 1 degree) at two slightly different higher frequencies which interact in the water column to produce a lower frequency secondary signal which can penetrate the seabed; while the primary signal is often of a high source level (e.g. 230+ dB), the resulting secondary signal is of much lower amplitude (e.g. 200 dB). The Pangeo **SBI** is a specific type of sonar for acquiring real-time high-resolution 3D imagery of the shallow sub-seabed (up to 8 m), which uses an array transducers to generate a freqyency-modulated signal. The SBI is generally deployed at depth on an ROV or towfish and operates at a much lower source level than the aforementioned SBPs.

Pinger, CHIRP and parametric SBPs and SBIs, along with SBES, are all highly-directional sources which direct energy vertically down to the seabed in a narrow beam. Sound levels outside of this main beam will be substantially lower.

Acoustic positioning systems

A **USBL** system will be used to obtain accurate vessel and equipment positioning. This system consists of a transceiver mounted under the vessel, and a transponder on deployed equipment including tow fish and ROV. The transceiver transmits an acoustic pulse which is detected by the subsea transponder, followed by a reply of an acoustic pulse from the subsea transponder. This pulse is detected by the transceiver and the time from transmission of the initial pulse is measured by the USBL system and converted into a range (distance) and angle (Bai and Bai, 2014).

A Doppler Velocity Log (**DVL**) may also be used for navigational purposes on ROVs, towfish or USVs. These small, high frequency devices include a cluster of transducers to track the platform's movements.

Underwater communications

Acoustic modems may be used to transmit data and video from deployed equipment such as ROVs to a receiving platform up to a max range of a few kilometres. In fairly shallow-water applications such as the Seagreen Project, they emit a signal which is omnidirectional in the horizontal plane.

Table 2.2. Indicative characteristics of active acoustic sources to be used during Seagreen O&M activities and remaining construction works

Equipment	Planned operational frequency	Estimated peak source sound pressure level (dB re 1 µPa @ 1m)
Geophysical survey equipment		
MBES and SBES	200 – 400 kHz	180 – 240
SSS	200 – 800 kHz	190 – 230
SBP	0.5 – 12 kHz (CHIRP) 4 or 100 kHz (Pinger) 85 – 115 kHz (Parametric, primary)	200 – 230 (CHIRP) 200 – 235 (Pinger) 200 – 240 (Parametric)
'Pangeo' SBI	4 – 12.5 kHz	192
Sonar (object tracking)	375kHz – 3 MHz	190 – 230
Sonar (3D scanning)	200 – 300 kHz	190 – 230
Acoustic positioning equipment		
USBL	19.5 – 33.5 kHz	170 – 200
DVL	420 kHz – 1 MHz	190 – 220
Underwater communications		
Acoustic modem	48 – 78 kHz	194

Note: The exact geophysical equipment is subject to change, but their specifications, in terms of operating frequencies and source levels, will fall within the ranges presented here.

2.3.2 Survey platforms

As noted above, a combination of DP-rated survey vessels, ROVs and USVs will act as platforms from which geophysical surveys and associated acoustic positioning and communications will operate. Any of the equipment listed in Table 2.2 could be operated from any of these platforms, although the following arrangements are more likely:

- ROV: MBES, SBES, SSS, SBI, very high-res scanning and tracking sonars, USBL, DVL, acoustic modem
- USV: MBES, Parametric SBP, SSS, USBL
- Survey vessel: MBES, SBES, SSS, SBP (pinger, CHIRP, parametric), USBL

An indicative USV, which has successfully been used to deploy MBES at other SSE projects, is the XOcean (https://xocean.com/technology/). Typical specifications of XOceans's catamaran USV are a weight of 750 kg, electric motors for propulsion, a speed of 4 knots, maximum endurance of 18 days, and a variety of navigational aids.

3. Marine mammal occurrence in the Seagreen area

A relatively wide range of cetacean species can potentially occur in Scottish waters; however, based on the available literature (e.g. that reviewed by Hague et al., 2020), as well as site-specific surveys, the Seagreen EIA (Seagreen, 2012) identified a restricted sub-set of four cetacean (EPS) and two seal species as key marine mammals in relation to the focus of the impact assessment. The same species were the focus of the 2018 EIA Report (Seagreen, 2018a) and 2020 Piling Strategy (Seagreen, 2020). The species are as follows:

- harbour porpoise (*Phocoena phocoena*);
- bottlenose dolphin (*Tursiops truncatus*);
- minke whale (*Balaenoptera acutorostrata*);
- white-beaked dolphin (*Lagenorhynchus albirostris*);
- harbour seal (*Phoca vitulina*); and,
- grey seal (*Halichoerus grypus*).

Although the Risk Assessment focuses upon the above species, it should be noted that together this group includes representatives of all Southall et al. (2019) functional hearing groups of marine mammals which may occur in Scottish waters: very high-, high- and low-frequency cetaceans, as well as phocid carnivores (grey and harbour seal).

Table 3.1 outlines the relevant species-specific density estimates and management unit abundance data for marine mammals used in the 2018 EIAR (presented in Volume 3 Appendix 10A: Marine Mammal Baseline Technical Report (2018) and updated where more recent information has become available (IAMMWG, 2022; Gilles et al., 2023; SCOS, 2023).

Table 3.1. Species-specific Management Units (MU), MU estimates and density estimates taken forward for impact assessment

Species	MU	MU estimate	MU Source	Density Estimate	Density Source
Harbour porpoise	North Sea (ICES Assessment Unit)	346,601	(IAMMWG, 2022)	SCANS IV Block NS-D 0.599 porpoise/km^2 SCANS III Block R 0.599 porpoise/km^2	SCANS IV (Gilles et al., 2023) SCANS III (Hammond et al., 2017)
Bottlenose dolphin	Coastal East Scotland	224	Arso Civil et al. (2021)	95 bottlenose dolphins spread evenly across the area inshore of 20 m depth contour	Agreed in consultation on Seagreen Optimised project assessment (2017 Scoping Opinion); updated to reflect revised MU size
Minke whale	Celtic and Greater North Seas	20,118	(IAMMWG, 2022)	SCANS IV Block NS-D 0.042 whales/km^2 SCANS III Block R 0.039 whales/km^2	SCANS IV (Gilles et al., 2023) SCANS III (Hammond et al., 2017)
White-beaked dolphin	Celtic and Greater North Seas	43,951	(IAMMWG, 2022)	SCANS IV Block NS-D 0.080 dolphins/km^2 SCANS III Block R 0.243 dolphins/km^2	SCANS IV (Gilles et al., 2023) SCANS III (Hammond et al., 2017)
Harbour seal	East Scotland	364	Scaled SCOS (2023) count†	5x5 km grid cell-specific relative density*	Carter et al. (2022)
Grey seal	East Scotland	10,783	Scaled SCOS (2023)count†	5x5 km grid cell-specific relative density*	Carter et al. (2022)

Notes: † MU estimates for seals are derived from August counts scaled to the species-specific estimated proportion of animals hauled out at that time; for grey seals this is based on a count of 2,712 and proportion hauled out of 25.15% (SCOS, 2023); for harbour seals a count of 262 (SCOS, 2023) and proportion hauled out of 72% (Lonergan et al., 2013).

**Relative density estimates in Carter et al. (2022) can be scaled to the current at-sea population estimates for the British Isles to provide absolute density.*

3.1 Cetaceans

3.1.1 Harbour porpoise

Harbour porpoise are the smallest and most abundant cetacean species in UK waters (Reid et al., 2003). They are typically sighted in small groups between one and three individuals. Animals are frequently sighted throughout coastal habitats with studies suggesting they are highly mobile and cover large distances (Nabe-Nielsen et al., 2011). The most recent UK assessment of the conservation status of harbour porpoise (in contribution to the fourth Article 17 Habitats Directive Report) concluded an 'Unknown' conservation status, but with 'Favourable' range and future prospects (JNCC, 2019b). An overall 'Unknown' status was concluded for all cetacean species regularly occurring in UK waters, largely due to insufficient data on the status of the population (i.e. trends) and habitat (JNCC, 2019b).

Breeding occurs mainly between May and August, with a peak in June, though some calves can be born as early as March. Social groups often gather in late summer (August-September) for mating (Anderwald and Evans, 2010). The gestation period of the harbour porpoise is ten months, with peak mating activity likely to occur in August. Evidence for social and sexual activity in late summer has been widely reported. Females are believed to nurse their calves for between eight and twelve months. Weaning is a gradual process with young starting to take solid food after a month or two.

Site-specific boat-based survey data presented in 2010 and 2011 showed sightings of harbour porpoise in the Seagreen wind farm area in most months; however, encounter rates were generally highest in the spring and summer and relatively low in autumn and winter. The site-specific surveys and a wide range of other data sources, such as SCANS and ECOMMAS, demonstrate that harbour porpoise are common in the study area and there is potential for animals to be impacted by the planned activities.

3.1.2 Bottlenose dolphin

In the UK, bottlenose dolphins have been assessed as having an 'Unknown' overall conservation status, with 'Favourable' range (JNCC, 2019a). The Coastal East Scotland population of bottlenose dolphins is the only known remaining resident population in the North Sea and it was for this reason that the Moray Firth SAC was established in order to protect this population. The conservation objectives of the Moray Firth SAC are to avoid the deterioration of the bottlenose dolphin habitat, to achieve a favourable conservation status and to ensure the population size and distribution of the bottlenose dolphins is maintained in the long-term.

The number of individuals using the SAC between 2001 and 2015 has remained stable, albeit with some inter-annual variability, whilst an assessment of the total abundance of the east coast population indicates that the overall population is increasing (Cheney et al., 2018). This means that the proportion of the population that uses the SAC has declined (Graham et al., 2016). Whilst the Moray Firth is clearly an important area for this population, these animals are highly mobile, and have a large range that extends east along the outer Moray Firth coastline and south to the Firth of Tay, Firth of Forth and coastal waters off north-east England (Cheney et al., 2013; Quick et al., 2014; Arso Civil et al., 2019).

The resident Coastal East Scotland bottlenose dolphin population is strictly coastal with most animals encountered in waters less than 20 m deep and within 2 km from the coastline. Activities within the wind farm site are unlikely to have potential to impact upon bottlenose dolphin, with the possible exception of any far-reaching disturbance effects from pile driving. Activities closer to shore associated with the planned activities have the potential to interact with bottlenose dolphin.

3.1.3 Minke whale

Minke whales are widely distributed around the UK, with higher densities recorded on the west coast of Scotland and the western North Sea (Reid et al., 2003). They occur mainly on the continental shelf in water depths less than 200 m and are sighted more frequently in the summer months between May and September. Minke whales in the UK are considered to be part of a single, large MU: the Celtic and Greater North Seas MU (IAMMWG, 2021); their overall conservation status has been assessed as 'Unknown' with 'Favourable' range (JNCC, 2019e).

During site-specific boat-based surveys in 2010 and 2011 minke whale were seen throughout the Seagreen wind farm area. A strong seasonal pattern was recorded, with most minke whales encountered during the spring and summer months in 2010 and 2011, with high rates in May 2010 and June 2011. This seasonal pattern is supported by Anderwald and Evans (2010).

Site-specific surveys, together with other information sources such as SCANS, confirm that although minke whale are present at low densities they have been sighted relatively often in the study area, and more frequently in the summer months. Therefore, they have the potential to be impacted by the planned activities.

3.1.4 White-beaked dolphin

White-beaked dolphins are wide-spread across the northern European continental shelf. The species is the most abundant cetacean in the North Sea after the harbour porpoise (Banhuera-Hinestroza et al., 2009), and the waters off the coast of Scotland and north-east England are one of the four global centres of peak abundance. The species occurs mainly in waters of 50-100 m depth (Reid et al., 2003). Evidence supports the assumption that white-beaked dolphins from around the British Isles and North Sea represent one population, with movement between Scottish waters and the Danish North Sea and Skagerrak (Banhuera-Hinestroza et al., 2009).

During site-specific boat-based surveys of the Seagreen wind farm site, white-beaked dolphins were recorded most often during the summer in both 2010 and 2011. Site-specific surveys, together with other information sources such as SCANS, confirm that white-beaked dolphins have been sighted occasionally in the wind farm area, and, similar to minke whales, are seen more frequently in the summer months. Although present at low densities, they have the potential to be impacted by the planned activities.

3.2 Pinnipeds

3.2.1 Harbour seal

The harbour seal is the smaller of the two seal species resident in UK waters. Seals forage at sea and haul-out on land to rest, moult and breed. Harbour seals normally feed within 40 to 50 km around their haul-out sites and take a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish, octopus and squid (SCOS, 2019).

Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups in June and July and moult in August. At these, as well as other times of the year, harbour seals haul-out on land regularly in a pattern that is often related to the tidal cycle.

Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, the Moray Firth and the Firth of Forth. The harbour seal is a qualifying feature of the Firth of Tay and Eden Estuary SAC, located 46 km south-west of the wind farm site.

Harbour seals were recorded in low numbers during the boat-based surveys of the wind farm site in 2010-2011. Modelled at-sea densities in the wind farm and adjacent areas are estimated to be low (< 1 seal per 5x5 km grid cell); higher densities are estimated closer to the coast, within inshore waters, particularly in the Firth of Forth (Russell et al., 2017). Recently published habitat preference-based modelling of harbour seal at-sea distribution (Carter et al., 2020) show a similar pattern, with areas closer to the coast of greater importance to harbour seal and very low estimated densities of ≤ 0.1 seals per 5x5 km grid cell across the wind farm site. Predicted densities in the export cable route are higher nearer the coast, ranging between approximately 2-7 seals per 5x5 km grid cell (up to 0.3 seals per km^2) close to landfall.

In the UK, the harbour seal has been assessed as having an overall conservation status of 'Unfavourable – Inadequate' (JNCC, 2019d). Population trajectories vary considerably between regions around the UK; however, populations in the East Scotland MU (and North Coast & Orkney MU) have declined considerably over the past two decades and are continuing to decline (SCOS, 2020).

Harbour seals have the potential to be impacted by the effects of operation and maintenance activities, although they are present in very low numbers in the wind farm site and adjacent waters, consistent with the relatively large distance from the principal haul-out sites in the region. Slightly higher numbers may be exposed to activities occurring closer to shore.

3.2.2 Grey seal

The grey seal is the larger of the two seal species resident in UK waters. Grey seals haul-out on land to rest, moult and breed and forage at sea where they range widely, frequently travelling for up to 30 days with over 100 km between haul-out sites (SCOS, 2019). Approximately 38% of the worlds grey seal population breeds in the UK with 86% of these breeding in Scotland. Grey seal population data are assessed using pup counts during the autumn breeding season when females haul-out to give birth. The number of pups throughout Britain has grown steadily since the 1960s but there is clear evidence that the population growth is levelling off in all areas, except the central and southern North Sea where growth rates remain high. The grey seal is considered to have a Favourable Conservation Status in the UK (JNCC, 2019c).

The grey seal is a qualifying feature of the Isle of May SAC, located 52 km south-west of the wind farm site, and the Berwickshire and North Northumberland Coast SAC, located 64 km south of the wind farm site.

Grey seals were recorded in the wind farm site throughout the boat-based surveys in 2010 and 2011, with highest encounter rates in June in both years. Modelled at-sea densities in the wind farm and immediately adjacent areas are estimated to be variable, ranging between 3 and 44 seals per 5x5 km grid cell, and averaging ~11 seals per grid cell (Russell et al., 2017). Higher densities are estimated closer to the coast within the Firth of Tay and St Andrews Bay. Recently published habitat preference-based modelling of grey seal at-sea distribution (Carter et al., 2020) show a similar pattern, with density estimates ranging between 10 and 38 seals per 5x5 km grid cell across the wind farm site and immediately adjacent areas. Predicted densities in the export cable route are higher nearer the coast, ranging between approximately 40-75 seals per 5x5 km grid cell (up to 3 seals per km^2) close to landfall.

It is therefore likely that grey seals will be present in and around the wind farm site and export cable corridor during O&M and remaining construction activities and there is potential for animals to be impacted by the effects of underwater noise from survey equipment.

4. Assessment of potential effects of O&M activities and remaining construction works

4.1 Auditory sensitivity of marine mammals

An essential step in assessing the potential for effects on relevant species is a consideration of their auditory sensitivities. Marine mammal hearing groups and injury criteria from Southall et al. (2019) and corresponding species of relevance to this assessment, are summarised in Table 4.1. There are no data available for the audiometry of low-frequency cetaceans; therefore, audiometry predictions are based on the hearing anatomy for each species and considerations of the frequency range of vocalisations. Further to the information provided in Table 4.1, for functional hearing groups, anatomical modelling specifically for minke whale suggests 10 Hz to 34 Hz, with vocalisations spanning 50 Hz to 9 kHz (reviewed in Southall et al., 2019). Harbour porpoise hearing is most sensitive at high frequencies between approximately 100 kHz and 140 kHz (Kastelein et al., 2002; Southall et al., 2007), with maximum sensitivity occurring at 125 kHz across multiple tested individuals (Kastelein et al., 2017). Auditory evoked potential studies suggest grey seals have a hearing range of < 1.4 kHz to 100 kHz (Ridgway and Joyce, 1975). Behavioural study data suggest harbour seals have a hearing range of < 0.1 kHz to 79 kHz (Terhune, 1988; Kastelein et al., 2009; Reichmuth et al., 2013; Cunningham and Reichmuth, 2016).

Table 4.1. Marine mammal functional hearing groups, estimated hearing range and sensitivity, injury criteria and corresponding species relevant to this assessment (Southall et al., 2019).

Estimated hearing range	Estimated region of greatest sensitivity † [peak sensitivity]	Injury criteria (Permanent threshold shift, PTS) for impulsive sounds		Injury criteria (PTS) for non-impulsive sounds
		SPL_{peak} dB re 1 µPa (unweighted)	SEL_{cum} dB re 1 µPa^{2}s (weighted)	SEL_{cum} dB re 1 µPa^{2}s (weighted)
Low-frequency (LF) cetaceans (minke whale)				
7 Hz – 35 kHz	200 Hz – 19 kHz	219	183	199
High-frequency (HF) cetaceans (white-beaked dolphin, bottlenose dolphin)				
150 Hz – 160 kHz	8.8 – 110 kHz [58 kHz]	230	185	198
Very high-frequency (VHF) cetaceans (harbour porpoise)				
275 Hz – 160 kHz	12 – 140 kHz [105 kHz]	202	155	173
Phocid carnivores in water (PCW) (grey seal, harbour seal)				
50 Hz – 86 kHz	1.9 – 30 kHz [13 kHz]	218	185	201

Notes: † Region of greatest sensitivity represents low-frequency (F_1) and high-frequency (F_2) inflection points, while peak sensitivity is the frequency at which the lowest threshold was measured (T_0) (Southall et al., 2019).

4.2 Evidence of noise levels, propagation from relevant HRG sources and potential for effects on marine mammals

The source characteristics of the majority of HRG sources have now been well investigated (Crocker and Fratantonio, 2016; Crocker et al., 2019). While there are fewer publicly-available data available on noise propagation from HRG sources in open water, those which are available support the assertion of negligible risk of injury and very low potential for disturbance to marine mammals.

For example, Hannay and Warner (2009) describe open water noise measurements from geophysical survey equipment in the Beaufort Sea in water depths of 20-50 m, including a pinger SBP. Within 500 m of the source, measured SPL_{peak} was 175 dB re 1 µPa for the pinger. A level of SPL_{rms} 160 dB re re 1 µPa, used by the US National Marine Fisheries Service (NMFS) as a threshold for behavioural disturbance ('Level B harrassment'), was recorded at an estimated 140 m of the pinger SBP (extrapolated from a level of < 160 dB re 1 µPa at the minimum measurement distance of 190 m).

Subacoustech (2018) present results of a sound source verification in shallow waters (c. 30 m deep) off the coast of New Jersey, USA, including an Innomar parametric SBP operating at a primary frequency of 85-115 kHz and maximum power. Recorded noise levels were higher at seabed positions compared to mid-water. Seabed measurements at 100 m were SPL_{peak} 168.9 dB re 1 µPa and SPL_{rms} 129.2 dB re 1 µPa, with an estimated effective source level at the seabed of SPL_{peak} 215 dB re 1 µPa and SPL_{rms} 169.1 dB re 1 µPa. It was commented that noise levels decreased rapidly with range such that the noise from the SBP could not be easily identified above background noise at 1 km distance. For both seabed and midwater positions, distances to instantaneous PTS-onset thresholds were < 10 m.

A recent sound source verification exercise in the Danish North Sea reported measured noise levels from several HRG sources, including an Innomar parametric SBP, sparker SBP and USBL, at sampling stations with closest points of approach of 0 m, 100 m and between 500 m and 2 km (Pace et al., 2021). MBES and SSS were also used, but the primary operating frequencies were largely above the recording capabilities of the noise loggers used. For the parametric SBP, an in-beam effective source level of 237 dB re 1 µPa^2 @1 m (SPL_{rms}) was reported, with noise levels reducing to ≤ 137.7 dB re 1 µPa^2 (SPL_{rms}) and ≤ 158.8 dB re 1 µPa^{2}s (per pulse SEL, 90-105 kHz range) at 100 m horizontal distance. The pulse interval was sufficiently short (c. 73 ms) that the parametric SBP was recommended to be categorised as a continuous source, and the transmission loss of c. 44logR indicated a strong downward beam pattern. At 500 m from the source, the sound was barely detectable above background noise. These results indicate a negligible risk of auditory injury from the parametric SBP, and a very low potential for behavioural disturbance.

In the same study, Pace et al. (2021) reported noise levels for a USBL operating at 25-40 kHz attached to a SSS operating at 100 and 900 kHz. The effective source level estimated for the combined SSS and USBL was 184 dB re 1 µPa^2 @1 m (SPL_{rms}). At 100 m distance, broadband received levels were 147.9 dB re 1 µPa^2 (SPL_{rms}), while received levels in the 20-30 kHz band, of relevance to the USBL, were 140.4 dB re 1 µPa^{2}s (per pulse SEL). The USBL appeared fairly omnidirectional with an estimated transmission loss of c. 15logR. When the USBL was active, the combined source was detectable above background noise at 2 km; however, application of VHF cetacean (harbour porpoise) frequency weighting indicated noise levels of < 120 dB re 1 µPa^2 ($SPL_{rms,}$ VHF frequency-weighted) at a distance of c. 1 km from the source. These results illustrate no potential for instantaneous PTS-onset from the USBL source tested, and the potential for behavioural disturbance within a limited spatial extent (i.e. a few hundred metres).

The test-tank measurements of a variety of HRG sources reported in Crocker et al. (2019) were followed by measurements in shallow (≤ 100 m depth) open-water environments to investigate sound propagation (Halvorsen and Heaney, 2018). While it is acknowledged that these results suffered from challenges in data collection and are incompletely calibrated (Labak, 2019), it is worth noting some general patterns observed from the open-water tests, which were summarised in a review by Hartley Anderson Ltd (2020). Broadband received levels from all CHIRP SBPs, MBES and SSS devices tested were rapidly attenuated with distance from source in all test environments, including particularly pronounced fall-off when the receiver was outside of the source's main beam (Halvorsen and Heaney, 2018). In all open-water test environments, broadband received levels did not exceed an SPL_{rms} of 160 dB re 1µPa beyond a few hundred metres from any SBP, echo-sounder or SSS device tested (Halvorsen & Heaney 2018). While recognising the limitations of the above results, these limited data (Hannay and Warner, 2009; Halvorsen and Heaney, 2018), combined with source characterisations (Crocker et al., 2019) and numerous project-specific modelling exercises, illustrate the highly directional nature of most sources and the rapid attenuation of noise levels with distance to source.

Drawing heavily on the results of Crocker et al. (2019), Ruppel et al. (2022) provide a comprehensive assessment of the potential for a variety of active acoustic sources to result in 'incidental take' of marine mammals, this being exposure of animals to noise levels exceeding the NMFS exposure criterion of SPL_{rms} 160 dB re 1 µPa for behavioural disturbance ('Level B harassment'). Based on criteria including radiated sound levels, transmission frequency, beamwidth, degree of exposure and regulatory precedent, the authors assess the likelihood that each source could result in a 'take' of marine mammals in US waters. Based on one or more criteria, the authors concluded that MBES, SBES, SSS, SBPS (pinger, CHIRP, parametric), ADCPs, and some acoustic positioning systems (among other sources) could be categorised as "*de minimis* sources" i.e. not likely to result in incidental take of marine mammals. Additionally, it was assessed that surveys that simultaneously deploy multiple, non-impulsive *de minimis* sources are also unlikely to result in incidental take of marine mammals.

It is noted that Ruppel et al. (2022) did not have calibrated measurements of parametric SBPs on which to draw their conclusions, but relied instead on an assessment made by the US regulator, NMFS, in response to incidental take applications. NMFS (2020) determined that, "*based on the very narrow beam width of this source (i.e., 2 degrees), it is extremely unlikely that a marine mammal would be exposed to sound emitted from this particular source. In addition, baleen whales are unlikely to hear signals from this source, which operates at 85–115 kHz. Therefore, we have determined the potential for this source to result in take of marine mammals is so low as to be discountable.*" Within the same ruling, reference was made to the source verification results presented in Subacoustech (2018) as described above.

4.3 Assessment of potential for auditory injury

The following active acoustic sources which may be used have source levels which exceed the lowest relevant marine mammal threshold for instantaneous auditory injury (202 dB, harbour porpoise): MBES, SSS, very high-res sonar (tracking, scanning), SBP (pinger, CHIRP, parametric) and DVL. However, as illustrated by Appendix 1, noise levels from these largely high frequency sources are expected to rapidly attenuate with distance from source to drop below 202 dB within 150 m or less of the source, even when not accounting for the highly directional nature of all these sources. Were a conservative -15 dB reduction in amplitude to account for horizontal propagation outside of the main beam for all directional sources, then received levels would be below the threshold for instantaneous PTS-onset for all species within a few metres or tens of metres from the source for all acoustic sources.

Considering these indicative estimates of noise propagation, in combination with the evidence presented in Section 4.2 and the low anticipated densities of marine mammals in the area of operations, the risk of injury to any EPS or seals from operation of any of the geophysical survey sources or DVL positioning equipment or acoustic modem is assessed as negligible. The source levels of USBL, the acoustic modem, and Pangeo SBI are all below the minimum instantaneous threshold for PTS-onset for marine mammals and therefore pose no risk of injury to EPS or seals.

Therefore, it is proposed that an EPS licence for injury is not required for either offshore or inshore waters. A discussion of potential mitigation measures is provided in Section 5.

4.4 Assessment of potential for behavioural disturbance

The central operating frequencies of the following survey equipment are such that they may be audible to, and potentially cause disturbance to, all relevant EPS and seals: SBPs (pinger, CHIRP, parametric), Pangeo SBI, USBL, Acoustic modem. One exception is minke whale and acoustic modems.

There are currently no empirical data available on the behavioural responses of marine mammals to any of these sources. However, as illustrated in Appendix 1 and from the evidence presented in Section 4.2, the noise emitted from these sources will be rapidly attenuated with distance from source such that noise levels at which behavioural disturbance would be anticipated to occur will be of small spatial extent. In particular, it is noted that those sources with higher source levels (pinger, CHIRP and parametric SBPs), along with the Pangeo SBI, are highly directional, with noise levels outside of the main beam considerably lower and therefore with limited horizontal propagation of noise levels. JNCC et al. (2010) EPS Guidance concludes that the use of SBPs in geophysical surveys "*Could, in a few cases, cause localised short-term impacts on behaviour such as avoidance. However, it is unlikely that this would be considered as disturbance in the terms of the Regulations. It is unlikely that injury would occur as an animal would need to locate in the very small zone of ensonification and stay in that zone associated with the vessel for a period of time, which is also unlikely.*"

While USBL and acoustic modems are more omnidirectional sources that may be result in greater horizontal propagation of noise, the source levels are lower and disturbance effects would not be anticipated to extend beyond a few hundred metres from the source. This conclusion is supported by the limited available field measurements (Pace et al., 2021) and assessments of Ruppel et al. (2022) (see Section 4.2).

Considering the evidence outlined above, any disturbance caused by the O&M activities and remaining construction works assessed here is likely to be short-term, temporary and of a spatial extent unlikely to exceed a few hundred metres of the source. While survey activities will take place sporadically over several years, disturbance will be short-term and transient as activities move between different sampling locations in the area, temporarily affecting no more than a few animals at any one time. To provide an indication of the number of animals that may be disturbed by the activities at any given point in time, a precautionary disturbance radius of 1 km (3.14 km^2) has been applied to animal densities and results are provided in Table 4.2. Estimated numbers of animals disturbed and the proportion of corresponding management units (MUs) are provided for both SCANS-III (2016) and SCANS-IV (2022) survey density estimates, noting that MU sizes are taken from IAMMWG (2022) and have not been updated to reflect SCANS-IV survey results. As the more recent data, estimated numbers of animals disturbed based on SCANS-IV density will be used in EPS license applications.

For all species, the number of individuals which may be disturbed are ≤ 2, representing ≤ 0.1% of the relevant management unit for each species. It is noted that the EPS for which the highest proportion of the MU is estimated to be disturbed is bottlenose dolphin. Bottlenose dolphin are only likely to be present within coastal waters generally of 20 m water depth or less (Section 3.1.2), and therefore are not expected to be present within the OWF site or the majority of the Project area. As such, any disturbance to bottlenose dolphins is expected to be limited to activities at landfall and nearshore areas of the export cables.

To account for the transient nature of potential disturbance from the relevant activities, Table 4.2 also provides a conservative example of the number of EPS which could be disturbed if a survey platform were to cover the entire 60 km length of the export cable route (disturbing an area of 120 km^2). Based on a survey vessel speed of 4 knots, such a distance could be achieved within a single day, although a more likely survey pattern would be running parallel survey lines within a more spatially restricted block, therefore covering a much smaller area. This scenario does not apply to bottlenose dolphin as the 1 km radius already encompasses the expected 2 km offshore limit too this population's distribution. It is noted that two-thirds of the export cable route fall within Scottish inshore waters, and so numbers disturbed based on a 1 km radius and 40 km survey line (disturbing an area of 80 km^2) are also presented in Table 4.2.

Table 4.2. Estimated numbers of EPS disturbed and proportion of the management unit for a nominal precautionary disturbance radius of 1 km from the operation of acoustic survey equipment as part of O&M activities and remaining construction works.

Species	**Density source**	**Density (animals per km^2) - see Table 3.1**	**Estimated number disturbed [% relevant MU] for a 1 km disturbance radius**	**Estimated number disturbed [% relevant MU; % relevant UK MU] for a 1 km disturbance radius around a 60 km survey line**	**Estimated number disturbed within inshore waters for a 1 km disturbance radius around the maximum inshore survey line (c. 40 km)**
Bottlenose dolphin†	See Table 3.1	0.07	< 1 [0.1]	< 1 [0.1; 0.1]	< 1

Species	Density source	Density (animals per km²) - see Table 3.1	Estimated number disturbed [% relevant MU] for a 1 km disturbance radius	Estimated number disturbed [% relevant MU; % relevant UK MU] for a 1 km disturbance radius around a 60 km survey line	Estimated number disturbed within inshore waters for a 1 km disturbance radius around the maximum inshore survey line (c. 40 km)
Harbour porpoise*	SCANS-III	0.599	2 [<0.01]	72 [0.02; 0.05]	48
	SCANS-IV	0.599	2 [<0.01]	72 [0.02; 0.05]	48
Minke whale	SCANS-III	0.039	< 1 [<0.01]	5 [0.03; 0.05]	3
	SCANS-IV	0.042	< 1 [<0.01]	5 [0.03; 0.05]	3
White-beaked dolphin	SCANS-III	0.243	< 1 [<0.01]	29 [0.06; 0.09]	19
	SCANS-IV	0.080	< 1 [<0.01]	10 [0.02; 0.03]	6

*Notes: † Bottlenose dolphin are only likely to be present within coastal waters generally of 20 m water depth or less and 2 km offshore, and therefore are not expected to be present in offshore waters. * At a resolution of 3 decimal places, the density estimates for harbour porpoise for the relevant block are identical from both SCANS-III and SCANS-IV surveys.*

Seals lie outside EPS permitting and are considered in relation to protected sites in Section 8. For less common species, such as cetacean species which are potentially occurring, but unlikely to be present, include short-beaked common dolphin; white-sided dolphin; Risso's dolphin; killer whale; sperm whale; long-finned pilot whale; fin whale; humpback whale (Marine Scotland, 2014). A range of additional species, as listed in Marine Scotland (2020) EPS Guidance, may occur very rarely or as vagrants. It is probable that no individuals of these species will be present in the vicinity of the O&M activities or remaining construction works and therefore subject to disturbance; however, should these species be present and disturbed, the number of animals present and the nature of the disturbance would not be considered significant.

When considering the short-term, temporary and localised nature of disturbance predicted from the O&M activities and remaining construction works, the low numbers of individuals disturbed and very small proportions of the relevant management units, such disturbance effects would not be likely to impair the ability of an animal to survive or reproduce or result in any significant impacts to the local populations or distribution. **Therefore, it is proposed that an EPS licence <u>is not required</u> for disturbance within offshore waters.**

Notwithstanding the conclusions of no significant disturbance, there is potential for the O&M activities and remaining construction works, when occurring within the export cable corridor and at landfall, will result in disturbance of individual EPS within Scottish inshore (< 12 nm) waters. **Therefore, it is proposed that an EPS licence <u>is required</u> for disturbance within Scottish inshore waters.**

4.5 Consideration of cumulative effects

Other noise-generating activity will occur in the wider region during the Seagreen O&M activities and remaining construction works, including geophysical survey and construction activities associated with other offshore wind farm projects in the Forth and Tay region such as Neart na Gaoithe and potentially from other planned projects such as Inch Cape and Berwick Bank. More locally, noise will be generated during the planned Phase 2 of construction of the Seagreen Project (Seagreen 1A). These activities will have the potential to generate disturbance to EPS across the region, and potentially at the same time as disturbance from Seagreen activities. However, considering the predicted extent of disturbance resulting from Seagreen activities, including the short-term, intermittent nature of disturbance and limited number of animals affected, significant disturbance arising from cumulative effects is not expected in association with other relevant activities at the Seagreen site or in the wider region. It is noted that any construction activity associated with Seagreen 1A will be subject to a separate EPS risk assessment and consideration of any necessary mitigation measures to minimise impacts.

4.6 Assessment of potential impact on favourable conservation status

Considering the numbers of animals which are predicted to be disturbed, the nature of the disturbance (i.e. temporary avoidance), and the spatial and temporal extent (short-term, intermittent over many years) over which activities will occur, it is concluded that the planned O&M activities and remaining construction works will not result in impacts which might damage the status of any EPS in the long-term, either alone or in combination with other relevant activities, and therefore there will be no impact on the favourable conservation status of any EPS.

5. Mitigation measures

5.1 Geophysical survey activities

The JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (JNCC, 2017) provide recommended measures to reduce the risk of injury to marine mammals from geophysical surveys to negligible levels. Additionally, Marine Scotland (2020) guidance states that mitigation measures should be put in place whenever there is concern that an activity is likely to cause an offence, and should be proportionate to the risk of injury or disturbance. JNCC (2017) provide general recommendations are made for HRG sources, including SBPs, MBES and SSS, noting that advice will be provided on a case-by-case basis.

As described in Section 4.3, the risk of injury from use of HRG sources in planned Seagreen O&M activities and remaining construction works, in addition to all other active acoustic sources, is assessed as negligible. Critical to this is the highly directional nature of the HRG sources to be used, along with the emerging evidence from field measurements, source characterisations, modelling exercises and risk assessments which have concluded that these specific types of HRG source present a negligible risk of injury to marine mammals (see Section 4.2). Therefore, it is proposed that Seagreen Wind Energy and its contractors will not implement the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys for any of the O&M activities or remaining construction works to which this risk assessment relates.

Notwithstanding the above, the following best practice procedures will be adopted:

1. For all acoustic sources, the lowest practicable power setting will be used to achieve the objectives of the task.
2. Where a parametric SBP, pinger SBP or CHIRP SBP is deployed from a crewed survey vessel, the following procedures will be followed:
    a. A non-dedicated, appropriately-briefed member of the crew will conduct a 20 min pre-shooting visual search of a 300 m mitigation zone around the vessel/sound source and delay equipment activation if a marine mammal is observed within the mitigation zone, ensuring a minimum of 20 minutes delay form the time of last detection until commencing equipment start.
    b. If breaks in equipment activation exceed 60 minutes, then a pre-shooting search as described in (2a) will be required prior to equipment activation.
3. Where a parametric SBP, pinger SBP or CHIRP SBP is deployed from a crewed survey vessel or uncrewed surface vessel (USV), where practicable, the power of the acoustic source will be ramped up in a uniform manner.

5.2 **Other considerations**

A Vessel Management Plan (VMP) has been developed which will be implemented throughout the O&M period and during remaining construction works (see link in Table 2.1). One of the purposes of the VMP is to fulfil the S36 Consent Condition 15: “To mitigate disturbance or impact to marine mammals and birds”. The VMP states that: “Vessels will also take due regard of any additional available information as to areas which may impact upon displacement and disturbance in relation to ornithology and marine mammals and guidance (for example, the Scottish Marine Wildlife Watching Code) where necessary will be provided to relevant vessels at mobilisation.”

The SNH Scottish Marine Wildlife Watching Code describes mitigation methods such as:

- Reducing speed to the safest minimum when passing close to marine mammals
- Ensuring that vessel movements are steady and predictable
- Maintaining recommended minimum distances.

The vessel crew will be briefed on the sensitivity of the location and the potential for vessel disturbance, including advice on how to recognise signs of disturbance in marine mammals, in line with the SNH Guide to Best Practice for Watching Marine Wildlife. While the SNH Scottish Marine Wildlife Watching Code and the Guide to Best Practice for Watching Marine Wildlife were created for the purposes of reducing impacts from wildlife watching, their application as part of the VMP will ensure that vessel operations, particularly during transit to and from the array area, will minimise the risk of disturbance to marine mammals.

6. Conclusions

Considering the conclusions of the risk assessment presented in Section 4.3, the risk of auditory injury to EPS or seals from Seagreen O&M activities and remaining construction works is considered to be negligible and therefore it is proposed that an EPS licence is not required for injury under either *The Conservation of Offshore Marine Habitats and Species Regulations 2017* (>12 nm) or *The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)* (inshore waters, <12 nm). As such, no mitigation measures are considered necessary, but certain best practice procedures will be followed as described in Section 5.

The planned O&M activities and remaining construction works are predicted to result in behavioural disturbance to EPS. However, considering the results of the impact assessment presented in Section 4.4, including the number of animals predicted to be disturbed and the nature of the disturbance, the impacts are not considered to result in a disturbance offence under *The Conservation of Offshore Marine Habitats and Species Regulations 2017* (>12 nm) and it is therefore proposed that an EPS licence is not required for disturbance within offshore waters.

Some O&M activities and remaining construction works (landfall duct burial) will occur in Scottish inshore waters (<12 nm) and may disturb individuals of EPS. Therefore, an EPS licence is required for disturbance under *The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)*.

7. Protected sites

7.1 Special Areas of Conservation

A number of SACs supporting certain marine mammal species that are potentially sensitive to underwater noise were identified during the 2012 ES (Seagreen, 2012) and these remained unchanged in the 2018 EIAR (Seagreen, 2018a); these sites are detailed in Table 7.1.

Table 7.1. Special Areas of Conservation considered in EPS Risk Assessment

SAC	Qualifying features of relevance to this risk assessment	Minimum distance to OWF site	Minimum distance to export cable corridor
Isle of May	Grey deal	51 km	33 km
Berwickshire and North Northumberland Coast	Grey seal	65 km	64 km
Firth of Tay and Eden Estuary	Harbour seal	46 km	0 km (minor overlap); landfall is c. 130 m from site boundary
Moray Firth	Bottlenose dolphin	~ 200 km (26 km to coastal 20 m depth contour)	~ 200 km (minor overlap with 20 m depth contour near landfall)

While cetaceans and seals are wide-ranging and frequently occur beyond the boundaries of protected sites, these sites encompass areas of favourable habitat supporting higher densities of the species than other areas of UK waters and, in the case of seals, key breeding sites. Harbour seals exhibit strong site fidelity throughout the year, foraging within approximately 50 km of their breeding colony (Jones et al., 2015). Grey seals forage more widely, and may move between haul-out sites outside of the breeding season (Russell et al., 2013; Jones et al., 2015), but are considered to remain relatively close to colonies during the breeding season[3]. It is noted that there is minor overlap between the export cable corridor (1 km wide) and the Firth of Tay and Eden Estuary SAC (harbour seal); however, the landfall location is 130 m north of the site boundary at an existing artificial rock revetment at Carnoustie, and c. 3 km north of the nearest reported haul-out locations at Buddon Ness at the mouth of the Tay (SMRU aerial survey data).

[3] NatureScot advice received on previous EPS applications for the Seagreen site is that grey seals tend to stay within 20 km of breeding colonies during the breeding season.

The Coastal East Scotland bottlenose dolphin population associated with the Moray Firth SAC have a large range that extends east along the outer Moray Firth coastline and south to the Firth of Tay, Firth of Forth and coastal waters off north-east England (Cheney et al., 2013; Quick et al., 2014; Arso Civil et al., 2019). In this region, the population is understood to be strictly coastal with most animals encountered in waters less than 20 m deep and within 2 km from the coastline. Boat-based surveys have indicated relatively high encounter rates at the entrance of the Tay Estuary, although fewer sightings immediately north of this area where the export cable makes landfall (Quick et al., 2014).

7.1.1 Habitats Regulations Appraisal

Under the *Conservation (Natural Habitats, &c.) Regulations 1994* (the 'Habitats Regulations'), all competent authorities must consider whether any plan or project, either alone or in combination with other plans or proposal, will have a 'likely significant effect' on a European site (including SACs and SPAs). If so, they must carry out carry out an 'appropriate assessment' (AA) to determine if the planned activities will have an adverse effect on site integrity, in terms of its conservation objectives. The conservation objectives relate to the long-term maintenance of the quality of the site such that it continues to make an appropriate contribution to the qualifying features achieving or maintaining a favourable conservation status. This process is known as Habitats Regulations Appraisal (HRA)[4].

In 2015, an Appropriate Assessment (Marine Scotland, 2015) concluded that the Forth and Tay Developments, either alone or in-combination, will not adversely affect the integrity of relevant marine mammals SACs, including the Isle of May SAC, the Berwickshire & North Northumberland Coast SAC, Firth of Tay and Eden Estuary SAC and Moray Firth SAC, subject to compliance with relevant conditions[5]. A Habitats Regulations Appraisal within the 2018 EIA Report for the optimised design reached the same conclusion (Seagreen, 2018b).

It is suggested that the conclusions of previous HRA and AA in support of the Seagreen Project, as referenced above, remain valid, such that it can be concluded that the planned O&M activities and remaining construction works will not result in the long-term deterioration of the qualifying feature(s) and its habitats of relevant SACs.

7.1.2 Designated seal haul-outs

It is also noted that under Section 117 of the *Marine (Scotland) Act 2010*, it is also an offence to harass seals at haul-out sites in Scotland designated under *The Protection of Seals (Designated Sea Haul-out Sites) (Scotland) Order 2014*. However, considering the location of the planned activities relative to the nearest designated haul-out site (≥ 67 km, Fast Castle), there is no potential for harassment of seals at designated haul-out sites.

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[4] Further information is available at: https://www.nature.scot/professional-advice/planning-and-development/environmental-assessment/habitats-regulations-appraisal-hra

[5] Conditions are listed from page 58 of https://marine.gov.scot/sites/default/files/appropriate_assessment_1.pdf

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9. Appendix 1 – Illustration of approximate reduction in noise levels within 1 km of active acoustic sources that may be used in Seagreen O&M activities and remaining construction works

In the table overleaf (Table 9.1), some simple calculations are provided, to illustrate how simple geometric spreading and absorption loss may influence single pulse sound pressure levels (SPLs) from geophysical survey equipment to a horizontal distance of up to 1 km from the source. No information is provided on the more complex calculation of sound energy levels (SEL), either from single pulses of frequency-weighted cumulative exposure levels.

Modelling the propagation of noise underwater is a complex task, with many influencing factors such as the directionality of the source, the frequency spectrum, bathymetry, seabed substrate, sea surface roughness, and sound speed profile of the water column. The calculations provided below generally do not consider these factors, and so should not be used to quantify the potential impact range for receptor species. Critically, no attempt is made for the directionality of the source, and so all values are only of relevance to the propagation of sound in the main beam, and so are highly conservative in terms of horizontal propagation for particularly directional sources, which include all those planned to be used in Seagreen O&M and remaining construction activities, with the exception of USBL and acoustic modems which may be omnidirectional. Therefore, sound levels propagated horizontally (outside of the main beam) would be of a significantly lower intensity than those illustrated below. For example, first side lobes emitted by MBES and SSS measured by Crocker & Fratantonio (2016) were between 14-25 dB lower in amplitude than the main beam. Similarly, field measurements of parametric SBPs (one of the highest power sources that may be used in the planned activities) have indicated that noise levels from these sources are rapidly reduced with distance, with sound levels outside of the main beam several tens of dB lower than manufacturer stated source levels (Subacoustech, 2018; Pace et al., 2021). Furthermore, even airgun arrays, which are typically considered a fairly omnidirectional source, are generally considered to be 20 dB lower in amplitude in the horizontal plane compared to the vertical (Hartley Anderson Ltd, 2020). This contrasts to sound sources such as pile-driving or explosive detonation, which are more omnidirectional.

Nonetheless, by applying a commonly-used geometric spreading law of 15log*R* (*R* = range from source) and an estimation of absorption loss (Ainslie and McColm, 1998), a basic, highly conservative illustration can be made of the approximate rate at which sound pressure levels reduce within a few hundred metres of the source, and the relative influence of source level and signal frequency.

Table 9.1. Illustration of approximate estimated reduction in noise levels within 1 km of source

		MBES / SBES	SSS	Sonar (tracking, scanning)	SBI – Pangeo	SBP – parametric (primary)	SBP – parametric (secondary)	SBP - CHIRP	SBP - Pinger	USBL	DVL	Acoustic modem
Assumed source sound pressure level (dB re 1 µPa @ 1m)		240	230	230	192	240	200	230	235	200	220	194
Assumed frequency of signal (kHz) for absorption loss [1]		200	200	200	4	100	4	0.5	4	19.5	420	48
Assumed absorption loss (dB/km) [2]		56.066	56.066	56.066	0.253	34.341	0.253	0.022	0.253	3.271	106.757	14.819
Estimated sound pressure levels at distance from source (dB re 1 µPa)	10 m	224	214	214	177	225	185	215	220	185	204	179
	50 m	212	202	202	167	213	175	205	210	174	189	168
	100 m	204	194	194	162	207	170	200	205	170	179	163
	150 m	199	189	189	159	202	167	197	202	167	171	159
	250 m	190	180	180	156	195	164	194	199	163	157	154
	500 m	171	161	161	151	182	159	190	194	158	126	146
	1,000 m	139	129	129	147	161	155	185	190	152	68	134

Notes: 1 The assumed frequency is taken as the lowest of the range of values provided for each source; 2 Absorption loss calculated following Ainslie & McColm (1998) and assuming seawater at zero metres depth and a temperature of 10 degrees. For all calculations, a geometric spreading loss factor of 15logR is intermediate to spherical (20logR) and cylindrical (10logR) spreading loss often used for waters depths deeper than and shallower than R, respectively – for further information see Richardson (1995). Darker grey shading are distance bands where noise levels meet or exceed the lowest instantaneous hearing injury threshold (harbour porpoise, 202 dB SPL); lighter grey are distance bands where noise levels meet or exceed the NMFS 160 dB SPL_{rms} behavioural disturbance threshold.