Thistle Wind Partners
CLUARAN EAR-THUATH (NE2) AND CLUARAN DEAS EAR (E3) GEOPHYSICAL SURVEYS FOR THE ARRAY AREAS

European Protected Species and Basking Shark Licence Supporting Information

EOR0764
Cluaran Ear-Thuath and
Cluaran Deas Ear
Geophysical Surveys
Version 02
02 February 2023

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
02a	Draft	[redacted]			

Prepared by:

RPS

[redacted]

Senior Consultant

Goldvale House
27-41 Church Street West
Woking, Surrey GU21 6DH

T [redacted]

E [redacted]@rpsgroup.com

Prepared for:

Thistle Wind Partners

[redacted]

Offshore Wind Environmental Manager

1 Johns Place
Leith, Edinburgh, EH6 7EL

T [redacted]

E [redacted]@thistlewindpartners.scot

Contents

Tables

Figures

Appendices

List of Abbreviations, Definitions and Units

Term	Definition/ Description
CGNSMU	Celtic and Greater North Seas Management Unit.
ECOMMAS	East Coast Marine Mammal Acoustic Study.
EPS	European Protected Species. Animals listed in Annex IV(a) of the Habitats Directive, whose natural range includes any area in Great Britain. Animals also listed in Schedule 2 of the Habitats Regulations and Schedule 1 of the Offshore Marine Regulations.
FCS	Favourable Conservation Status. Determined by Article 1(I) of the Habitats Directive.
GNSMU	Greater North Sea Management Unit.
HESS	High Energy Seismic Survey.
HF	High Frequency.
Hz	Hertz. Unit of measure commonly used to measure wave frequencies, including sound waves.
JNCC	Joint Nature Conservation Committee.
LF	Low Frequency.
MMRU	Marine Mammal Research Unit.
MBES	Multibeam Echosounder.
MU	Management Unit.
NMFS	National Marine Fisheries Service.
NSMU	North Sea Management Unit.
PTS	Permanent Threshold Shift.
SAC	Special Area of Conservation.
SBP	Sub Bottom Profiler.
Scottish Territorial Waters	Part of the sea adjacent to the coast of Scotland that is considered to be part of the territory of that state and subject to its sovereignty (extends to 12 nautical miles from coastline).
SEL	Sound Exposure Level.
SPL	Sound Pressure Level.
SSS	Side Scan Sonar.
TTS	Temporary Threshold Shift.
USBL	Ultra-Short Base Line.
VHF	Very High Frequency.

1 INTRODUCTION

1.1 Background

1.1.1 Thistle Wind Partners (hereafter referred to as 'TWP') have been awarded two offshore wind (OWF) project sites located off the east coast of Scotland (i.e. Cluaran Ear-Thuath within the NE2 plan option area and Cluaran Deas Ear within the E3 plan option area) as part of the ScotWind seabed leasing round (Figure 1.1 and Figure 1.2). Cluaran Ear-Thuath is located approximately 33 km off the east coast of Orkney and Cluaran Deas Ear approximately 47 km off the coast of Aberdeenshire. The water depths across the two OWF array areas vary between 50 and 100 metres.

1.1.2 Following TWP's award of the two sites in the ScotWind leasing round in January 2022, geophysical surveys are due to commence in March 2023.

1.1.3 Noise from the geophysical survey equipment is readily transmitted underwater and there is potential for sound emissions from the survey to affect marine mammals and fish. As there is potential for European Protected Species (EPS) and basking shark to be disturbed by the proposed geophysical survey, this EPS and basking shark assessment and EPS licence applications are required.

1.2 Purpose of this document

1.2.1 This Supporting Information Document provides a summary of the legislative context with respect to EPS and basking shark (Section 1.3), an overview of the licensable operations that will be undertaken as part of the Cluaran Ear-Thuath and Cluaran Deas Ear geophysical surveys (Section 1.4), and the relevant EPS that have been identified within the operational area (Section 3).

1.2.2 This document provides evidence to inform considerations relevant to the three EPS Licence tests: "Overriding Public Interest" (see Section 4.1) and "No Satisfactory Alternatives" tests (see Section 4.2). This document also informs consideration of the "Favourable Conservation Status" test (see Section 4.3). These are defined and discussed in Section 1.3 below.

1.3 Legislative Context

1.3.1 The European Commission (EC) Habitats Directive (92/43/EEC) lists all cetaceans in Annex IV, i.e., species for which a system of strict protection needs to be established across their entire natural range. There is a requirement to consider EPS through the Habitats Directive which is transposed into UK law in Scotland by the Conservation (Natural Habitats) Regulations 1994 (as amended) (out to 12 nautical miles (nm)) (the "Habitats Regulations"). Beyond 12 nm, for all UK administrations, the Conservation of Offshore Marine Habitats and Species Regulations 2017 consolidate and update the Offshore Marine Conservation (Natural Habitats &c) Regulations 2007 (the "Offshore Marine Regulations").

1.3.2 An EPS Licence can only be granted for specific purposes set out in the Conservation (Natural Habitats) Regulations 1994 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017. For the Licence to be granted, the relevant regulations provide that the regulating authority will need to be satisfied the following criteria are met:

- Test 1 (Overriding Public Interest Test) – If the competent authority is satisfied that, there being no alternative solutions, the plan or project must be carried out for imperative reasons of overriding public interest (IROPI), which may be of a social or economic nature (Regulation 44(2));
- Test 2 (No Satisfactory Alternatives Test) – There are no satisfactory alternative locations for the Development or alternative methods to the Licensable Operations (Regulation 44(3)(a)); and
- Test 3 (Favourable Conservation Status Test) – The Licensable Operations will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status (FCS) in their natural range (Regulation 44(3)(b)).

1.3.3 This EPS Licence Application is for dolphins, porpoises and whales as cetacean EPS. Five cetacean species have the potential to occur in the vicinity of the Cluaran Ear-Thuath and Cluaran Deas Ear and have been considered in the risk assessment. These include harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*) and minke whale (*Balaenoptera acutorostrata*).

1.3.4 The Habitats Regulations and the Offshore Marine Regulations make it an offence to deliberately kill, injure, or capture any individual of a EPS, as listed under Annex IV of the Habitats Directive. In addition, the Habitats Regulations 1994 (as amended in Scotland) make it an offence to deliberately disturb wild animals of EPS.

1.3.5 Regulation 39(2) provides additional protection to cetaceans to ensure protection at all times, regardless of the circumstances of the mammal at the time of the disturbance. Therefore, this is a catch-all regulation that goes beyond the specific circumstances set out in Regulation 39(1).

1.3.6 If there is a risk of injury or disturbance to EPS that cannot be removed or sufficiently reduced by using alternative methods to those associated with the activity and/or mitigation measures, then the activity may still be able to go ahead under licence provided that the three tests described above are satisfied.

1.3.7 Article 1(i) of the Habitats Directive defines Favourable Conservation Status (FCS) of a species. The status of each EPS considered in this Licence has been presented in the species-specific assessments in Section 3.

1.3.8 If an activity taking place in the Scottish Territorial Sea is likely to cause disturbance or injury to basking shark (*Cetorhinus maximus*), 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).

1.3.9 Considering the location of Cluaran Ear-Thuath and Cluaran Deas Ear (Figure 1.1 and Figure 1.2), the following licences are applied for:

- Cluaran Ear-Thuath (NE2) – EPS licence applications under both the Habitats Regulations (within 12 nm) and the Offshore Marine Regulations (beyond 12 nm). A barking shark application under the Wildlife and Countryside Act 1981 (as amended).
- Cluaran Deas Ear (E3) – an EPS licence application under the Offshore Marine Regulations.

1.4 Licensable Operations

1.4.1 In the context of this EPS Licence Application, the Licensable Operations are those aspects of the geophysical survey methodology which have the potential to cause direct or indirect effects (including injury or disturbance) on marine mammals.

1.4.2 The surveys will involve the use of the following geophysical equipment:

- Multibeam Echosounder (MBES);
- Side Scan Sonar (SSS);
- Sub Bottom Profiler (Chirp / Pinger / Boomer) (SBP);
- Ultra-Short Base Line (USBL); and
- Sparker.

1.4.3 In consideration of the activities (described above) involved in the geophysical surveys of Cluaran Ear-Thuath and Cluaran Deas Ear, it is considered that the use of these equipment may result in

sound sources that could constitute a disturbance offence under the Habitats Regulation and is therefore a Licensable Operation.

1.4.4 It is anticipated that the earliest planned start date for the geophysical surveys is 1st March 2023, with the last completion date planned for 29th February 2024. Both sites will be surveyed consecutively using the same vessel and equipment. The surveys at both sites are expected to take approximately 100 days but additional time has been included to account for bad weather and technical downtime (Table 1.1). The Licensable Operations will be carried out within the survey area which will cover up to 755 km^2 for both sites

1.4.5 The vessel turning area is used for manoeuvring the vessel, as well as to enable soft-start and line run-out. The vessel turning area is included within the survey area.

Table 1.1: Survey characteristics for Cluaran Ear-Thuath and Cluaran Deas Ear surveys

Project Detail	Cluaran Ear-Thuath (NE2)	Cluaran Deas Ear (E3)
Number of working days	52	47
Array area (km^2)	200	187
Survey area (km^2)	419	336
Distance from landfall (survey area) (km)	15	36

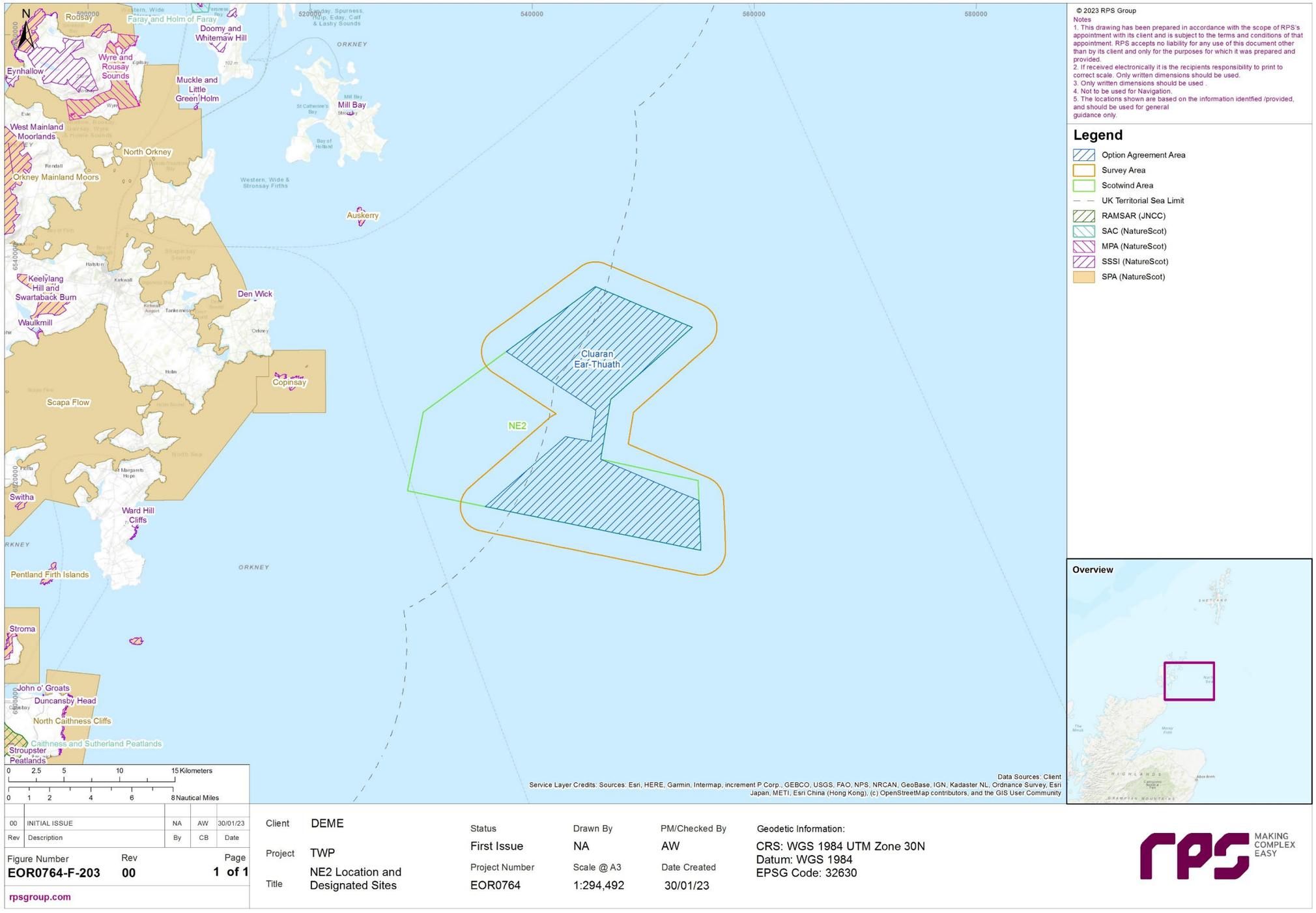

Figure 1.1: Cluaran Ear-Thuath (NE2) Survey Site.

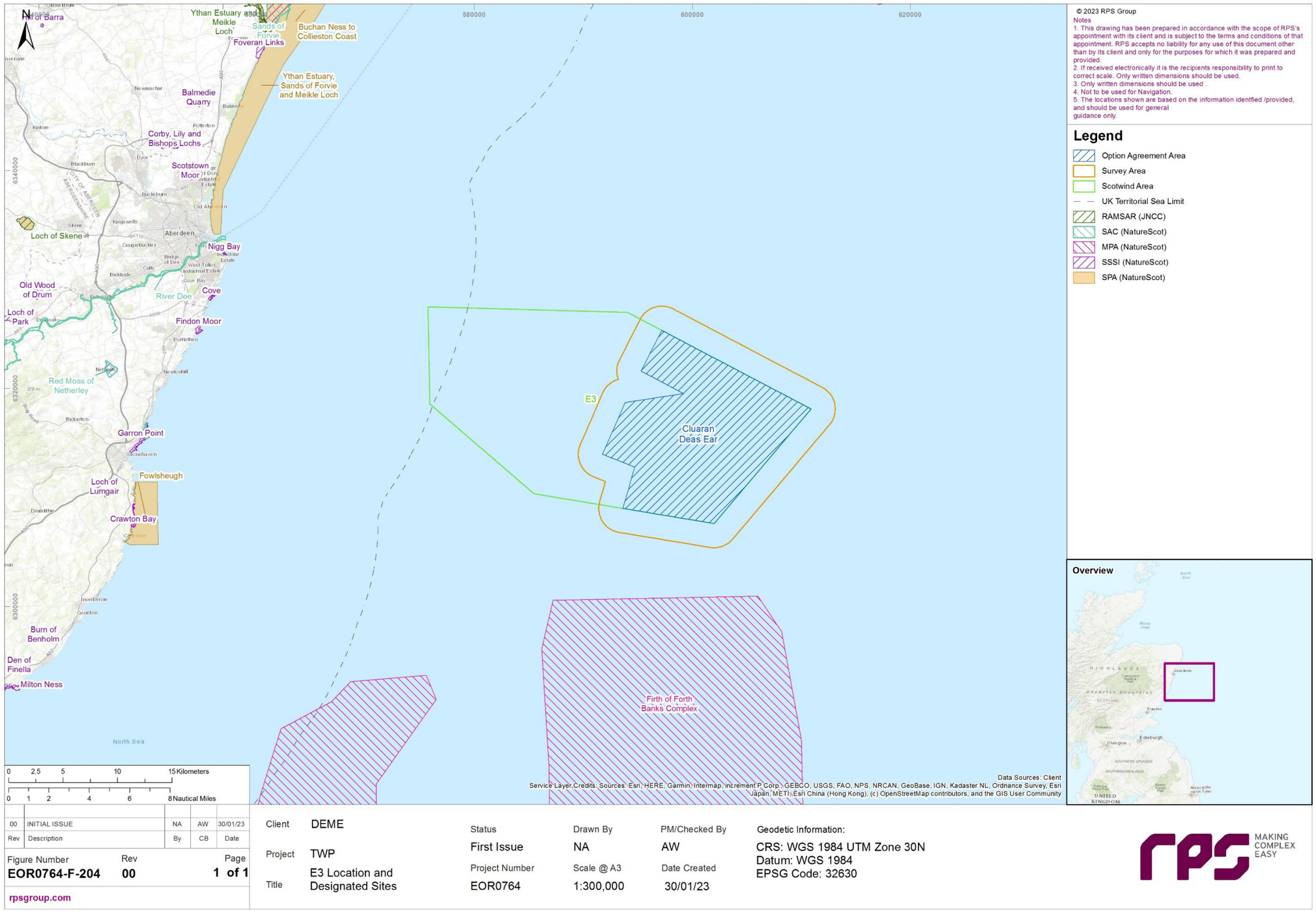

Figure 1.2: Cluaran Deas Ear (E3) Survey Site.

2 SUBSEA NOISE ASSESSMENT

2.1 Introduction

2.1.1 Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Richardson *et al.* (1995) defined four zones of noise influence which vary with distance from the source and level. These are:

- **The zone of audibility:** this is the area within which the animal can detect the sound. Audibility itself does not implicitly mean that the sound will affect the marine mammal.
- **The zone of masking:** this is defined as the area within which noise can interfere with the detection of other sounds such as communication or echolocation clicks. This zone is very hard to estimate due to a paucity of data relating to how marine mammals detect sound in relation to masking levels (for example, humans can hear tones well below the numeric value of the overall noise level).
- **The zone of responsiveness:** this is defined as the area within which the animal responds either behaviourally or physiologically and is said to be disturbed. The zone of responsiveness is usually smaller than the zone of audibility because, as stated previously, audibility does not necessarily evoke a reaction.
- **The zone of injury / hearing loss:** this is the area where the sound level is high enough to cause tissue damage in the ear. This can be classified as either Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS). At even closer ranges, and for very high intensity sound sources (e.g., underwater explosions), physical trauma or even death are possible.

2.1.2 For this study, it is the zones of injury and disturbance (i.e., responsiveness) that are of concern (there is insufficient scientific evidence to properly evaluate masking). To determine the potential spatial range of injury and disturbance, a review has been undertaken of available evidence, including international guidance and scientific literature. The following sections summarise the relevant thresholds for onset of effects and describe the evidence base used to derive them.

2.1.3 To inform the cetacean risk assessment, a subsea noise assessment was undertaken for cetacean EPS in order to determine the spatial extent of potential effects from the proposed activities, on key species. The assessment considered the potential for injury effects (physiological damage) and behavioural disturbance to occur as a result of the geophysical survey.

2.1.4 The subsea noise assessment used sound source data for the types of equipment likely to be used, provided by the appropriate manufacturers. The sonar (non-impulsive) and impulsive survey equipment likely to be used in the assessment are detailed in Table 2.1 and Table 2.2, respectively.

Table 2.1: Sonar (Non-impulsive) Survey Equipment Parameters Used in Assessment (Seiche, 2022).

Survey Type	Equipment	Frequency, kHz	Source Level, dB re 1 µPa re 1 m (rms)	Pulse rate, s-1	Pulse Width, ms	Beam Width (Degrees)
Multibeam Echo Sounder	R2 Sonic 2024	170–450 kHz	191–221 dB	Up to 60	0.015–1	0.45 x 0.9 at 450 Khz (Across track x along track)
Side Scan Sonar	Edgtech 4200	300 kHz (LF) 600 kHz (HF)	213 dB 214 dB	Not provided by manufacturer	Up to 10 (300 kHz) Up to 5 (600 kHz)	Horizontal beam: 0.26 Vertical beam: 50

Survey Type	Equipment	Frequency, kHz	Source Level, dB re 1 µPa re 1 m (rms)	Pulse rate, s-1	Pulse Width, ms	Beam Width (Degrees)
Parametric Sub Bottom Profiler	Innomar SES2000	85–115	248	Up to 40	0.07–1.3	2.5
Ultra-Short Base Line	Kongsberg µPAP 201-3	20–30	190	Not provided by manufacturer – assumed constant operation	Not provided by manufacturer – assumed constant operation	80°

Table 2.2: Impulsive Survey Equipment Parameters Used in Assessment (Seiche 2022).

Source	Equipment	Source Level, dB re 1 µPa re 1 m (0 pk)	Source SEL, dB re 1 µPa2s re 1 m
Sparker	Sparker GSO 360	229 dB re: 1µPa (pk-pk)	182 dB re: 1µPa2-s

2.1.5 The metrics used to describe sound in the assessment include:

- Peak Sound Pressure Level (SPL) – the difference between the lowest pressure variation (rarefaction) and the highest-pressure variation (compression);
- Root Mean Square (rms) – SPL as a description of the average amplitude of the variations in pressure over a specific time window; and
- Sound Exposure Level (SEL) – measure of the total sound energy of an event or a number of events (e.g., over the course of the survey period) and normalised to one second.

2.2 Assessment Criteria

2.2.1 Injury (Permanent Threshold Shift)

2.2.1 Auditory injury in marine mammals can occur as PTS, where there is no hearing recovery in the animal.

2.2.2 Injury criteria were proposed for two different types of sound as follows (Southall *et al.,* 2019):

- Impulsive sounds – typically transient, brief (less than 1 second), broadband, consisting of high peak sound pressure with rapid rise time and decay (ANSI 1986; NIOSH 1998; ANSI 2005). The impulsive sounds category includes sound sources such as seismic surveys, impact piling and underwater explosions; and
- Non-impulsive sounds – can be broadband, narrowband or tonal, can be brief or prolonged, continuous or intermittent, and typically without high peak sound pressure with rapid rise time and decay (impulsive sounds) (ANSI 1995; NIOSH 1998). The non-impulsive sounds category includes sound sources such as continuously running machinery, sonar and vessels.

2.2.3 The injury criteria proposed by Southall *et al.* (2019) are based on linear (i.e., un-weighted) peak pressure levels and mammal hearing-weighted (M-weighted) SELs. The peak pressure is the

maximum level the animal may experience, and this is relevant because it assesses the potential for injury to occur instantaneously. SEL allows the assessment to consider whether the total energy that the animal receives as it flees the area will cumulatively lead to injury over the period of time assessed.

2.2.4 The relevant criteria proposed by Southall *et al.* (2019) are summarised in Table 2.3.

Table 2.3: Summary of Permanent Threshold Shift (PTS) Onset Acoustic Thresholds (Southall *et al.*, 2019).

Hearing Group	Parameter	Impulsive	Non-impulsive
Low-frequency (LF) Cetaceans (e.g., Minke Whale)	SPL (dB re 1 µPa (Peak)), Unweighted	219	-
	SEL (dB re 1 µPa^{2}s), LF Weighted	183	199
High-frequency (HF) Cetaceans (e.g., Bottlenose Dolphin, White-beaked Dolphin, Atlantic White-Sided Dolphin)	SPL (dB re 1 µPa (Peak), Unweighted	230	-
	SEL (dB re 1 µPa^{2}s), HF Weighted	185	198
Very High-frequency (VHF) Cetaceans (e.g., Harbour Porpoise)	SPL (dB re 1 µPa (Peak), Unweighted	202	-
	SEL (dB re 1 µPa^{2}s), VHF Weighted	155	173

2.2.2 Behaviour

2.2.1 There is also the potential for impacts on behaviour from underwater sound sources. Significant (i.e., non-trivial) disturbance may occur when there is a risk of animals experiencing sustained or chronic disruption of behaviour or when animals are displaced from an area, with subsequent redistribution being significantly different from that occurring due to natural variation.

2.2.2 This assessment adopts a conservative approach and uses the US National Marine Fisheries Service (NMFS 2005a) Level B harassment thresholds for impulsive and non-impulsive sounds. Level B Harassment is defined as having the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. This description of non-trivial disturbance has therefore been used as the basis for onset of behavioural change in this assessment.

2.2.3 Appropriate guidance sets the marine mammal level B harassment threshold for continuous noise at 120 dB re 1 µPa (rms) (NMFS, 2005). This value sits mid-way between the range of values identified in Southall *et al.* (2007) for continuous sound but is lower than the value at which the majority of mammals responded at a response score of 6 (i.e., once the received rms sound pressure level is greater than 140 dB re 1 µPa). Considering the lack of data and high-level variation of data relating to onset of behavioural effects due to continuous sound, it is recommended that any ranges predicted using this number are viewed as probabilistic and potentially over-precautionary.

2.2.4 The High Energy Seismic Survey (HESS) workshop on the effects of seismic sound on marine mammals concluded that mild behavioural disturbance to impulsive sound would most likely occur at sound levels greater than 140 dB re 1 µPa (rms) (HESS, 1997). This workshop drew on multiple studies but recognised that there was some degree of variability in reactions between different studies and mammal groups. This value is similar to the lowest threshold for disturbance of low-frequency cetaceans noted in Southall *et al.* (2007). It is, however, considered unlikely that a

threshold for the onset of mild disturbance effects could be defined as significant disturbance. Consequently, this study utilises the NMFS (2005) marine mammal level B harassment threshold of 160 dB re 1 µPa (rms) as a proxy for significant disturbance due to impulsive sound.

2.2.3 Modelling Approach and Assumptions

2.2.1 The propagation and sound exposure calculations were conducted over a range of water column depths in order to determine the likely range for injury and disturbance. It should be noted that the effect of directivity has a strong bearing on the calculated zones for injury and disturbance because a marine mammal could be directly underneath the sound source for greater distances in deep water compared to shallow water.

2.2.2 Exposure modelling was based on the assumption of an animal swimming at a constant speed (1.5 ms^{-1}) in a perpendicular direction away from a moving vessel.

2.2.3 Full details of the noise modelling approach and assumptions can be found in Appendix B.

2.3 Results

2.3.1 Injury

2.3.1 The results of the subsea noise modelling for the multiple survey types (Table 2.4 to Table 2.8) showed that the range at which injury could occur for all species is somewhat localised, with a maximum of 342 m based on SEL (maximum radius using sub bottom profiler (SBP) at Cluaran Deas Ear, E3) for harbour porpoise as the most sensitive species (with the lowest threshold for injury) (Table 2.6).

2.3.2 Behaviour

2.3.1 Behavioural effects are predicted to be limited in extent with likely behavioural disturbance occurring out to a maximum of 1,643 m from the source (maximum radius using Ultra Short Base Line (USBL) at Cluaran Ear-Thuath, NE2) (Table 2.7). Distances have not been given for soft start since the benefits of this technique are greater at shorter ranges from the source. This is because at smaller distances the sound level is higher and falls away at a faster rate, so an animal swimming at a constant speed will observe a larger relative reduction in sound compared to if it starts further away.

Table 2.4: Marine Mammal Noise Modelling Results for Multibeam Echo Sounder (Non-impulsive) Surveys and the Summary of Potential Injury and Disturbance Zones in Cluaran Ear-Thuath and Cluaran Deas Ear

Survey Type	Potential Effect	Radius of Effect, (m)		
		LF Cetacean (Minke Whale)	HF Cetacean (Bottlenose Dolphin, White-beaked Dolphin, Atlantic White-Sided Dolphin)	VHF Cetacean (Harbour Porpoise)
Cluaran Ear-Thuath (NE2)				
Multibeam Echo Sounder	SEL of mammal swimming away from survey vessel	N/E	66	77
	RMS behavioural change	410		
Cluaran Deas Ear (E3)				

Multibeam Echo Sounder	SEL of mammal swimming away from survey vessel	N/E	75	89
	RMS behavioural change	455		

Table 2.5: Marine Mammal Noise Modelling Results for Side Scan Sounder (Non-impulsive) Surveys and the Summary of Potential Injury and Disturbance Zones in Cluaran Ear-Thuath and Cluaran Deas Ear

Survey Type	Potential Effect	Radius of Effect, (m)		
		LF Cetacean (Minke Whale)	HF Cetacean (Bottlenose Dolphin, White-beaked Dolphin, Atlantic White-Sided Dolphin)	VHF Cetacean (Harbour Porpoise)
Cluaran Ear-Thuath (NE2)				
Side Scan Sonar	SEL of mammal swimming away from survey vessel	N/E	45	75
	RMS behavioural change	265		
Cluaran Deas Ear (E3)				
Side Scan Sonar	SEL of mammal swimming away from survey vessel	N/E	47	88
	RMS behavioural change	278		

Table 2.6: Marine Mammal Noise Modelling Results for Sub Bottom Profiler (Non-impulsive) Surveys and the Summary of Potential Injury and Disturbance Zones in Cluaran Ear-Thuath and Cluaran Deas Ear

Survey Type	Potential Effect	Radius of Effect, (m)		
		LF Cetacean (Minke Whale)	HF Cetacean (Bottlenose Dolphin, White-beaked Dolphin, Atlantic White-Sided Dolphin)	VHF Cetacean (Harbour Porpoise)
Cluaran Ear-Thuath (NE2)				
Sub Bottom Profiler	SEL of mammal swimming away from survey vessel	75	78	320
	RMS behavioural change	1,345		

Cluaran Deas Ear (E3)

Sub Bottom Profiler	SEL of mammal swimming away from survey vessel	88	92	342
	RMS behavioural change	1,348		

Table 2.7: Marine Mammal Noise Modelling Results for Ultra Short Base Line (USBL) (Non-impulsive) Surveys and the Summary of Potential Injury and Disturbance Zones in Cluaran Ear-Thuath and Cluaran Deas Ear

Survey Type	Potential Effect	Radius of Effect, (m)		
		LF Cetacean (Minke Whale)	HF Cetacean (Bottlenose Dolphin, White-beaked Dolphin, Atlantic White-Sided Dolphin)	VHF Cetacean (Harbour Porpoise)
Cluaran Ear-Thuath (NE2)				
Ultra-Short Base Line	SEL of mammal swimming away from survey vessel	N/E	N/E	65
	RMS behavioural change	1,590		
Cluaran Deas Ear (E3)				
Ultra-Short Base Line	SEL of mammal swimming away from survey vessel	N/E	N/E	60
	RMS behavioural change	1,643		

Table 2.8: Marine Mammal Noise Modelling Results for Sparker (Impulsive) Surveys and the Summary of Potential Injury and Disturbance Zones in Cluaran Ear-Thuath and Cluaran Deas Ear

Survey Type	Potential Effect	Radius of Effect, (m)		
		LF Cetacean (Minke Whale)	HF Cetacean (Bottlenose Dolphin, White-beaked Dolphin, Atlantic White-Sided Dolphin)	VHF Cetacean (Harbour Porpoise)
Cluaran Ear-Thuath (NE2)				

Sparker	SEL of mammal swimming away from survey vessel	N/E	N/E	17
	RMS behavioural change (mild, strong)	562, 83		

Cluaran Deas Ear (E3)

Sparker	SEL of mammal swimming away from survey vessel	N/E	N/E	17
	RMS behavioural change (mild, strong)	547, 80		

3 RISK ASSESSMENT

3.1 Introduction

3.1.1 Within the coastal waters of the east coast of Scotland, the more commonly recorded cetacean species include the harbour porpoise, bottlenose dolphin, white-beaked dolphin, and minke whale, with Atlantic white-sided dolphin occurring more typically in deeper waters (Table 3.1). A summary of the distribution and abundance for each of the key cetacean EPS is provided below together with an assessment of the risk of injury or disturbance based on the results of the subsea noise assessment (Section 2).

Table 3.1: Summary of Cetacean Species Found in Cluaran Ear-Thuath and Cluaran Deas Ear. Sources: Weir (2001), Hammond *et al.*, (2013), Hammond *et al.*, (2021) and Marine Scotland Maps NMPi (2022).

Species	Occurrence in the northern North Sea	Description
Toothed Whales, Dolphins, and Porpoises		
Harbour porpoise *Phocoena phocoena*	Abundant	Abundant and widespread throughout the northern North Sea, most frequently reported cetacean in the North Sea
Bottlenose dolphin *Tursiops truncatus*	Common	Occurs throughout the northern North Sea, the Moray Firth supports the only known remaining resident population in the North Sea
White-beaked dolphin *Lagenorhynchus albirostris*	Abundant	Abundant and widespread throughout the northern North Sea, second most frequently reported cetacean in the North Sea
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Occasional	Occurs typically in deep waters along continental shelf although regularly enters the North Sea over summer months.
Baleen Whales		
Minke whale *Balaenoptera acutorostrata*	Common	Range widely and can be observed throughout the northern North Sea

3.2 Harbour Porpoise

3.2.1 Baseline

3.2.1 The harbour porpoise has a large population and is extensively distributed throughout the North Sea, making it the most abundant cetacean species within the North Sea (Hammond *et al.*, 2017; Chevallard *et al.*, 2019; Evans and Waggitt, 2020). Harbour porpoise diets are diverse, vary regionally, and predominantly consist of cephalopods and an assortment of fish species (Ransijn *et al.,* 2019). Historical studies of harbour porpoise in Scottish waters have illustrated that sandeel and whiting dominate the species' diet (Santos and Pierce, 2003; Baines *et al.*, 2012; Ransijn *et al.*, 2019). Long-term passive acoustic data collected near the Moray Firth, Scotland has shown that harbour porpoises were increasingly detected during sunrise, sunset and throughout the night in deeper areas with muddy substrate, but in shallow, sandy areas during the day, suggesting the importance of multiple habitat types necessary to ensure species success (Williamson *et al.*, 2017). According to the Marine Mammal Research Unit (MMRU), harbour porpoises have a typical life expectancy of around 8–12 years (MMRU, 2022).

3.2.2 The East Coast Marine Mammal Acoustic Study (ECOMMAS) utilised acoustic recorders (C-PODs) to collect data on the relative abundance of harbour porpoises in 30 locations off the east coast of Scotland (NMPi, 2022; Hague *et al.*, 2020; Williamson, 2018). Deployments were undertaken twice per year, with data covering the months of April to November (Hague *et al.*, 2020). The nearest C-POD deployments to Cluaran Ear-Thuath and Cluaran Deas Ear were those located at Latheron and Stonehaven, respectively. Data collected from 2013–2016 illustrated that the greatest presence

of harbour porpoise within the vicinity of Cluaran Ear-Thuath and Cluaran Deas Ear were detected at Fraserburgh and Spey Bay, situated approximately 80km and 100km south of Cluaran Ear-Thuath, respectively, and Arbroath, located approximately 18km west of Cluaran Deas Ear. C-PODs located at Stonehaven had relatively low harbour porpoise detection rates from 2014–2016, further demonstrating the species preference for offshore, deep-water habitats along the 20 to 50 m isobath (Chevellard *et al.*, 2019; Robinson *et al.*, 2007).

3.2.3 Species-specific densities have been based on SCANS III Survey Block R densities for Cluaran Deas Ear and Survey Block S for Cluaran Ear-Thuath (Hammond *et al.*, 2021). The abundance estimates for harbour porpoise within Survey Block R were 38,646 individuals, with a density of 0.599 animals/km^2 (Hammond *et al.*, 2021). The abundance estimates for harbour porpoise within Survey Block S were 6,147 individuals, with a density of 0.152 animals/km^2 (Hammond *et al.*, 2021). The conservation status of the harbour porpoise in UK waters was assessed as Favourable (JNCC, 2013a) but this has subsequently been revised to Unknown for the latest assessment (JNCC, 2019a).

3.2.4 Cluaran Ear-Thuath and Cluaran Deas Ear are located within the North Sea Management Unit (NSMU) for harbour porpoise (IAMMWG, 2022). This abundance of harbour porpoise in the NSMU is estimated at 346,601 individuals (CV (coefficient of variation) of 0.09). Within the UK portion of the NSMU, it is estimated there are 159,632 harbour porpoise (CV of 0.12) (IAMMWG, 2022).

3.2.2 Risk Assessment

3.2.1 Audiogram data for the harbour porpoise indicate that it is responsive to noise at frequencies from 100–170 kHz, with peak hearing sensitivity occurring over the frequency range 20–150 kHz. Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Section 2.

3.2.2 The noise assessment (Section 2, Appendix A) showed that a harbour porpoise exposed to subsea noise from the survey equipment may experience auditory injury at a range of up to 342 m (SEL; maximum radius using SBP at Cluaran Deas Ear, E3). Behavioural disturbance has the potential to occur out to a maximum distance of 1,643 m (8.5 km^2) (maximum radius using USBL at Cluaran Deas Ear, E3) (see Appendix A).

3.2.3 The noise modelling demonstrated that without the implementation of mitigation, and for all equipment, less than one harbour porpoise is predicted to have the potential to experience auditory injury at any one time within the Cluaran Ear-Thuath and Cluaran Deas Ear survey areas (see Appendix A).

3.2.4 Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to harbour porpoise is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical activities due to audible and visual cues during movement of the boats used to place the survey equipment. Proposed mitigation to further reduce potential for impact is presented in Section 3.8.

3.2.5 Up to approximately five harbour porpoise may be disturbed as a result of the survey activities at any one time (maximum number using USBL at Cluaran Deas Ear). Disturbance has the potential to occur over an area of up to 8.5 km^2 using USBL at Cluaran Deas Ear. The potential for disturbance is highest at Cluaran Deas Ear to up to 0.0015% of the NSMU population, or up to 0.003% of the UK portion of the NSMU population at each of the survey locations (see Appendix A).

3.2.6 Therefore, there is a low risk of disturbance, however an EPS Licence is required in respect of this disturbance for the proposed geophysical surveys.

3.3 Bottlenose Dolphin

3.3.1 Baseline

3.3.1 Scotland is home to a small, resident population of bottlenose dolphin that are protected through a Special Area of Conservation (SAC) in the Moray Firth (Chevellard *et al.*, 2019; JNCC, 2021). The Moray Firth comprises the sole, year-round resident population of bottlenose dolphin in the North Sea (Robinson *et al.*, 2017). Bottlenose dolphin have also been recorded off the western Isles of Scotland and are commonly found in inshore and deep coastal waters (Avant 2008). However, the Moray Firth population has been known to show high site fidelity and the Moray Firth area is understood as their core location (Fernandez-Betelu *et al.*, 2019). Bottlenose dolphin have been known to exhibit high flexibility in both their foraging behaviour and habitat use (Fernandez-Betelu *et al.*, 2019). Prey availability and prey concentration drive species' habitat preference, with their foraging behaviours known to adapt accordingly (Genov *et al.*, 2019; Garagouni *et al.*, 2019). The majority of female bottlenose dolphins found in the Moray Firth were found to give birth from six to 13 years of age, with calves born predominantly from May to October, peaking during the summer months with increased water temperatures (Robinson *et al.*, 2017).

3.3.2 ECOMMAS data collected from 2013–2016 illustrated that the greatest presence of bottlenose dolphin were detected at Cromarty, situated approximately 150 km southeast of Cluaran Ear-Thuath and 170 km northeast of Cluaran Deas Ear (NMPi, 2021).

3.3.3 Species-specific densities have been based on SCANS III Survey Block R densities for Cluaran Deas Ear and Survey Block S for Cluaran Ear-Thuath (Hammond *et al.*, 2021). The abundance estimate for bottlenose dolphin within Survey Block R is 1,924 individuals, with a density of 0.03 animals/km^2 (Hammond *et al.*, 2021). The abundance estimate for bottlenose dolphin within Survey Block S is 151 individuals, with a density of 0.004 animals/km^2 (Hammond *et al.*, 2021). The conservation status of the bottlenose dolphin in UK waters was assessed as Favourable (JNCC, 2013b) but this has subsequently been revised to Unknown for the latest assessment (JNCC, 2019b). The Moray Firth coastal population of bottlenose dolphin has recently shown signs of increased range extension, occurring off the eastern coast of Scotland and England (Cheney *et al.*, 2014; Evans and Waggitt, 2020).

3.3.4 Cluaran Ear-Thuath and Cluaran Deas Ear are located within the Greater North Sea Management Unit (GNSMU) for bottlenose dolphin (IAMMWG, 2022). This abundance of bottlenose dolphin in the GNSMU is estimated at 2,022 individuals (CV of 0.75). Within the UK portion of the GNSMU, it is estimated there are 1,885 bottlenose dolphin (CV of 0.8) (IAMMWG, 2022).

3.3.2 Risk Assessment

3.3.1 Audiogram data for the bottlenose dolphin indicate that it is responsive to noise at frequencies from 150–160 kHz. Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Section 2.

3.3.2 The noise assessment (Section 2, Appendix A) showed that a bottlenose dolphin exposed to subsea noise from the survey equipment would be likely to experience auditory injury at a range of up to 92 metres (SEL; maximum radius using SBP at Cluaran Deas Ear). Behavioural disturbance has the potential to occur out to a maximum distance of 1,643 m (8.5 km^2) (maximum radius using USBL at Cluaran Deas Ear) (see Appendix A).

3.3.3 The noise modelling demonstrated that without the implementation of mitigation, and for all equipment, less than one bottlenose dolphin is predicted to have the potential to experience auditory injury at any one time within the Cluaran Ear-Thuath and Cluaran Deas Ear survey areas (see Appendix A).

3.3.4 Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to bottlenose dolphin is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical

activities due to audible and visual cues during movement of the boats used to place the survey equipment. Proposed mitigation to further reduce potential for impact is presented in Section 3.8.

3.3.5 Less than one bottlenose dolphin may be disturbed as a result of the survey activities at any one time (maximum number using SBP at Cluaran Ear-Thuath). Disturbance has the potential to occur over an area of up to 8.5 km^2 using USBL at Cluaran Deas Ear. The potential for disturbance is highest at Cluaran Deas Ear to up to 0.01% of the GNSMU population, or up to 0.01% of the UK portion of the GNSMU population at each of the survey locations (see Appendix A).

3.3.6 Therefore, there is a low risk of disturbance, however an EPS Licence is required in respect of this disturbance for the proposed geophysical surveys.

3.4 White-beaked Dolphin

3.4.1 Baseline

3.4.1 The white-beaked dolphin is endemic to the North Sea, with an estimated population of nearly 36,000 individuals (IJsseldijk *et al.*, 2018). The white-beaked dolphin is the second most common cetacean species present in the North Sea following the harbour porpoise (Schick *et al.*, 2020). This species is typically found along continental shelf waters between 50–100 m in depth, predominantly in the western portion of the central and northern North Sea (Hammond *et al.*, 2013). Analysis of stomach contents from North Sea white beaked dolphins have illustrated that cod, gobies, haddock, and whiting play an important role in the species diet (Schick *et al.*, 2020). Sexual maturity has been found to range between six to 10 years in females and seven to 12 years in males (Schick *et al.*, 2020). Although little is known regarding the species reproductive behaviours, calving is believed to take place in summer months from May to September (IJsseldijk *et al.*, 2018), coinciding with peak densities found along the Scottish coast (Gilles *et al.*, 2019). Temperature has been found to be a critical factor in determining the white-beaked dolphins' distribution. Several authors have emphasised the potential impacts of increased water temperatures due to ramifications of climate change and their effects on prey abundance and distribution, altering white-beaked dolphin habitat and foraging preferences (Macleod *et al.*, 2008; Evans and Bjørge, 2013; IJsseldijk *et al.*, 2018).

3.4.2 As previously stated, the white-beaked dolphin is the second most common cetacean species observed in the North Sea (Schick *et al.*, 2020). Given the known, wide-ranging movements of this species, the Cluaran Ear-Thuath and Cluaran Deas Ear areas of the North Sea likely represent a small portion of the overall area utilised (Hammond *et al.*, 2017). Therefore, the habitat affected through the proposed survey of the sites will comprise a minor proportion of available habitat for the white-beaked dolphin population.

3.4.3 Species-specific densities have been based on SCANS III Survey Block R and S densities (Hammond *et al.*, 2021). The abundance estimate for white-beaked dolphin within Survey Block R is 15,694 individuals, with a density of 0.243 animals/km^2 (Hammond *et al.*, 2021). The abundance estimate for bottlenose dolphin within Survey Block S is 868 individuals, with a density of 0.021 animals/km2 (Hammond *et al.*, 2021). The conservation status of the white-beaked dolphin in UK waters was assessed as Favourable (JNCC, 2013b) but this has subsequently been revised to Unknown for the latest assessment (JNCC, 2019b). Large-scale abundance surveys conducted from 1994–2005 have consistently reported similar numbers, suggesting that the population size has remained relatively stable without significant increase or decrease in total population size within the North Sea (Hammond *et al.*, 2017; Paxton *et al.*, 2016).

3.4.4 Cluaran Ear-Thuath and Cluaran Deas Ear are located within the Celtic and Greater North Seas Management Unit (CGNSMU) for white-beaked dolphin (IAMMWG, 2022). This abundance of white-beaked dolphin in the CGNSMU is estimated at 43,951 individuals. Within the UK portion of the CGNSMU, it is estimated there are 34,025 white-beaked dolphin (IAMMWG, 2022).

3.4.2 Risk Assessment

3.4.1 Thresholds for SPLs at which injury and behavioural disturbance may be induced in HF cetacean species, such as the white-beaked dolphin are described in Section 2.

3.4.2 The noise assessment (Section 2, Appendix A) showed that a white-beaked dolphin exposed to subsea noise from the survey equipment would be likely to experience auditory injury at a range of up to 92 metres (SEL; maximum radius using SBP at Cluaran Deas Ear). Behavioural disturbance has the potential to occur out to a maximum distance of 1,643 m (8.5 km^2) (maximum radius using USBL at Cluaran Deas Ear) (see Appendix A).

3.4.3 The noise modelling demonstrated that without the implementation of mitigation, and for all equipment, less than one white-beaked dolphin is predicted to have the potential to experience injury any one time within the Cluaran Ear-Thuath and Cluaran Deas Ear survey areas (see Appendix A).

3.4.4 Due to the small area over which injury could occur and the low number of animals which may be affected, the risk of injury to white-beaked dolphin is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical survey due to audible and visual cues during movement of the boats used to place the survey equipment. Proposed mitigation to further reduce potential for impact is presented in Section 3.8.

3.4.5 Up to approximately two white-beaked dolphin may be disturbed as a result of the survey activities at any one time assuming the surveys run within the survey window of March to October (maximum number using USBL at Cluaran Deas Ear). Disturbance has the potential to occur over an area of up to 8.5 km^2, and up to 0.005% of the CGNSMU population, or up to 0.006% of the UK portion of the CGNSMU population at each of the survey locations (see Appendix A).

3.4.6 Therefore, there is a low risk of disturbance, however an EPS Licence is required in respect of this disturbance for the Cluaran Ear-Thuath and Cluaran Deas Ear proposed geophysical surveys.

3.5 Atlantic White-sided Dolphin

3.5.1 Baseline

3.5.1 The Atlantic white-sided dolphin inhabits the North Atlantic as its name implies, and prefers deep oceanic waters along the continental shelf, ranging in depth from 100–500 metres (Evans and Waggitt, 2020; Schick *et al.*, 2020). Atlantic white-sided dolphins are known to be highly mobile and can travel long distances as their distribution from the eastern coast of the United States to north of Greenland illustrates (Wall *et al.*, 2013). In the UK, the species is known to primarily occur to the north and northwest of Scotland, with observances being rare in the central and north-eastern North Sea (Gilles *et al.*, 2019). Males are typically larger than females and calving season is known to begin in the early summer months, with the majority of calf sightings ranging from June to September (Weinrich *et al.*, 2001; Schick *et al.*, 2020). This species is usually observed in large pods, which can comprise up to several thousand individuals (Barnes 2008). Atlantic white-sided dolphins have been observed working together to herd schools of fish towards the surface and their diets have been found to mainly consist of cod, herring, squid, shrimp, mackerel and sandeel (HWDT 2021). Additionally, they can often be seen feeding with fin and humpback whales and are known to form mixed groups with other dolphin species (Hammond *et al.*, 2019).

3.5.2 The Atlantic white-sided dolphin is abundant throughout its range with approximately 54% of its population coming from the west coast of Scotland (Macleod, 2004; Hammond *et al.*, 2019). Given the extensive range of the species, the North Sea is likely to only represent a small portion of the total range and habitat utilised by Atlantic white-sided dolphins (Hammond *et al.*, 2017). Additionally, given the species preference for deep oceanic and offshore waters, it is unlikely that Cluaran Ear-Truath and Cluaran Deas Ear represent a key habitat for the species.

3.5.3 Species-specific densities have been based on SCANS III Survey Block R and S densities (Hammond *et al.*, 2021). The abundance estimate for Atlantic white-sided dolphin within Survey Block R is 644 individuals, with a density of 0.01 animals/km^2 (Hammond *et al.*, 2021). No white-sided dolphins were sighted in Block S. The conservation status of the Atlantic white-sided dolphin in UK waters was assessed as Favourable (JNCC, 2013d) but this has subsequently been revised to Unknown for the latest assessment (JNCC, 2019d). The species is known to be widespread and abundant, with population estimates currently exceeding 100,000 individuals (Hammond *et al.*, 2019).

3.5.4 Cluaran Ear-Thuath and Cluaran Deas Ear are located within the Greater North Sea Management Unit (GNSMU) for bottlenose dolphin (IAMMWG, 2022). The abundance of Atlantic white-sided dolphin in the CGNSMU is estimated at 18,128 individuals. Within the UK portion of the CGNSMU, it is estimated there are 12,293 Atlantic white-sided dolphin (IAMMWG, 2022 The species is known to be widespread and abundant, with population estimates currently exceeding 100,000 individuals (Hammond *et al.*, 2019).

3.5.2 Risk Assessment

3.5.1 Thresholds for SPLs at which injury and behavioural disturbance may be induced in HF cetacean species, such as the Atlantic white-sided dolphin are described in Section 2.

3.5.2 The noise assessment (Section 2, Appendix A) showed that an Atlantic white-sided dolphin exposed to subsea noise from the survey equipment may experience auditory injury at a range of up to 92 metres (SEL; maximum radius using SBP at Cluaran Deas Ear). Behavioural disturbance has the potential to occur out to a maximum distance of 1,643 m (8.5 km^2) (maximum radius using USBL at Cluaran Deas Ear) (see Appendix A).

3.5.3 The noise modelling demonstrated that without the implementation of mitigation, and for all equipment, less than one Atlantic white-sided dolphin is predicted to have the potential to experience auditory injury at any one time within the Cluaran Ear-Thuath survey areas (see Appendix A).

3.5.4 Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to Atlantic white-sided dolphin is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical survey due to audible and visual cues during movement of the boats used to place the survey equipment. Proposed mitigation to further reduce potential for impact is presented in Section 3.8.

3.5.5 Less than one Atlantic white-sided dolphin may be disturbed as a result of the survey activities (maximum radius using USBL at Cluaran Deas Ear). Disturbance has the potential to occur over an area of up to 8.5 km^2, up to 0.0005% of the CGNSMU population, or up to 0.0007% of the UK portion of the CGNSMU population at each of the survey locations (see Appendix A).

3.5.6 Therefore, there is a low risk of disturbance, however an EPS Licence is required in respect of this disturbance for Cluaran Ear-Thuath and Cluaran Deas Ear proposed geophysical surveys.

3.6 Minke Whale

3.6.1 Baseline

3.6.1 The minke whale is the smallest, most abundant baleen whale (mysticete) species observed in UK waters (Robinson *et al.*, 2021; Evans and Waggitt, 2020). Recent studies have determined there are approximately 9,000 individuals occurring in the North Sea, with the majority of sightings coming from inshore, shelf waters up to 200 metres in depth along the northern North Sea (Hammond *et al.*, 2017; Robinson *et al.*, 2021). Studies have shown that minke whale are most commonly sighted in summer months, where the species undergo seasonal movements, illustrating their wide spatial distribution (Gilles *et al.*, 2019). However, it is worth noting that while the species has been frequently observed from April to October in coastal waters of the North Sea, sightings have simultaneously been documented year-round (Dolman *et al.*, 2013; Reid *et al.*, 2003). Off the coast of Scotland, sightings peak from July to August, relating to meso-scale oceanographic features which most likely increase minke whale foraging opportunities in the area (Tetley and Robinson, 2008; Robinson *et al.*, 2009). The minke whale diet in Scottish waters primarily consists of sandeel, herring, whiting, and plankton (HWDT, 2021; Pierce *et al.*, 2004). It has been evidenced that minke whales undergo large, seasonal migrations between breeding grounds and foraging grounds, although these have not been conclusively identified (Risch *et al.,* 2014; Risch *et al.*, 2019a). The species' relatively small size and elusive behaviour have resulted in uncertainty regarding their migratory routes and seasonal distributions, making effective conservation and management difficult (Risch *et al.*, 2019b).

3.6.2 Minke whale is a commonly occurring species off the coast of Scotland and more specifically, in the Moray Firth with significant distributions found along the southern coastline. It's been evidenced that minke whales are observed less frequently in the southern North Sea as compared to the northern and central North Sea (Risch *et al.*, 2019a). These highly productive waters are home to rich feeding grounds which attract high densities of minke whales during summer and autumn months, resulting in the designation of the Southern Trench Marine Protected Area (MPA) (Robinson *et al.*, 2021).

3.6.3 Acoustic recordings were collected from May–November 2016 across 10 recording sites within the Moray Firth and the Eastern coast of Scotland (Risch *et al.*, 2019). These recording sites, from north to south include Latheron, Helmsdale, Cromarty, Spey Bay, Fraserburgh, Cruden Bay, Stonehaven, Abroath, St Andrews, and St Abbs. Minke whale acoustic recordings were present at 70% of the recording locations, with most recordings being evidenced in the central and northern Moray Firth, particularly at Helmsdale, Latheron and Spey Bay (Risch *et al.,* 2019). The nearest recording site to Cluaran Ear-Thuath is approximately 78km southwest of the array area at Latheron, which had 37 detection hours of minke whale. The nearest recording site to the Cluaran Deas Ear is approximately 30km west of the array area at Stonehaven, which only had one detection hour (Risch *et al.,* 2019).

3.6.4 Species-specific densities have been based on SCANS III Survey Block R densities for Cluaran Deas Ear and Survey Block S for Cluaran Ear-Thuath (Hammond *et al.*, 2021). The abundance estimate for minke whale within Survey Block S is 2,498 individuals, with a density of 0.039 animals/km^2 (Hammond *et al.*, 2021). The abundance estimates for harbour porpoise within Survey Block S were 383 individuals, with a density of 0.01 animals/km^2 (Hammond *et al.*, 2021). The conservation status of the minke whale in UK waters was assessed as Favourable (JNCC, 2013e) but this has subsequently been revised to Unknown for the latest assessment (JNCC, 2019e).

3.6.5 Cluaran Ear-Thuath and Cluaran Deas Ear are located within the Celtic and Greater North Seas Management Unit (CGNSMU) for minke whale (IAMMWG, 2022). The abundance of minke whale in the CGNSMU is estimated at 20,118 individuals. Within the UK portion of the CGNSMU, it is estimated there are 10,288 minke whale (IAMMWG, 2022).

3.6.2 Risk Assessment

3.6.1 The minke whale, a baleen whale, is most sensitive to noise frequencies in the range from 40 Hz–15 kHz (Ketten and Mountain, unpublished). Thresholds for SPLs at which injury and behavioural disturbance may be induced are described in Section 2.

3.6.2 The noise assessment (Section 2) showed that a minke whale exposed to subsea noise from the survey equipment may experience auditory injury at a range of up to 88 metres (SEL; maximum radius using SBP at Cluaran Deas Ear). Behavioural disturbance has the potential to occur out to a maximum distance of 1,643 m (8.5 km^2) (maximum radius using USBL at Cluaran Deas Ear) (see Appendix A).

3.6.3 The noise modelling demonstrated that without the implementation of mitigation, and for all equipment, less than one minke whale is predicted to have the potential to experience auditory injury at any one time within the Cluaran Ear-Thuath and Cluaran Deas Ear survey areas (see Appendix A).

3.6.4 Due to the small area over which injury could occur and the low number of animals which may be affected (<1), the risk of injury to minke whale is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical survey due to audible and visual cues during movement of the boats used to place the survey equipment. Proposed mitigation to further reduce potential for impact is presented in Section 3.8.

3.6.5 Less than one minke whale may be disturbed as a result of the survey activities (maximum radius using USBL at Cluaran Ear-Thuath). Disturbance has the potential to occur over an area of up to 8.5 km^2, or up to 0.002% of the CGNSMU population, or up to 0.003% of the UK portion of the CGNSMU population at each of the survey locations (see Appendix A).

3.6.6 Therefore, there is a low risk of disturbance, however an EPS Licence is required in respect of this disturbance for the Cluaran Ear-Thuath and Cluaran Deas Ear geophysical surveys.

3.7 Basking Shark

3.7.1 Baseline

3.7.1 The basking shark is the second largest species of fish and has been listed in Appendix II of the Bern Convention, Appendix II of CITES, and is listed as globally endangered according to the IUCN Red List (Gore *et al*., 2016). Despite global interest and concern, basking shark population size is increasingly difficult to discern due to their elusive, deep water and circumglobal nature (Gore *et al*., 2016).

3.7.2 Basking shark migration routes cover large distances from north Africa up to Scotland, using both the continental shelf and oceanic habitats in the upper 50 m to 200 m of the water column (Doherty *et al.* 2017). Distribution has been shown to be influenced by a range of environmental conditions (Austin *et al.* 2019); surface sightings of basking sharks are typically reported where sea surface temperatures range between 15°C and 17.5°C (Cotton *et al.*, 2005; Skomal *et al.*, 2004) where thermal fronts are present (Sims and Quayle, 1998; Jeewoonarain *et al.*, 2000) and where zooplankton is in its greatest abundance (Sims and Quayle, 1998; Sims, 1999). Twenty-eight basking sharks tagged off Scotland and the Isle of Man in summer showed an average migration distance of 1,057 km with movements starting in October (Doherty *et al.* 2017), however, none of the tagged basking sharks migrated to the east coast of Scotland.

3.7.3 Due to the migratory behaviour of basking sharks and routes through Scottish waters, basking sharks have the potential to be present within the Forth and Tay Scottish Marine Region (SMR) and in the vicinity of the Cluaran Ear-Thuath and Cluaran Deas Ear geophysical surveys areas. However, the majority of basking shark sightings are located on the west coast of Scotland.

3.7.2 Risk Assessment

3.7.1 Elasmobranchs have been shown to have a relatively narrow auditory range and reduced sensitivity when compared to many other teleost species (Casper *et al*., 2012; Hart and Collin 2015). It has been suggested that the noise from operational wind farms and marine vessels is unlikely to cause hearing damage and/or loss in shark species, but noise resulting from pile driving (reaching 237 dB re 1µPa at 100-1000 Hz) has the potential to cause short-term decreases in hearing sensitivity (Casper *et al*., 2012; Wilson *et al*., 2020).

3.7.2 While there is no direct evidence of sound causing mortality or stress in basking sharks, it is thought that elasmobranch behaviour can be temporarily altered due to noise (Wilson *et al*, 2020). According to the Marine Life Information Network (MarLIN), the basking shark is most likely resistant to noise and therefore has been awarded a ‘High’ degree of resilience (Wilson *et al.*, 2020).

3.7.3 The noise assessment (Section 2; Appendix B) showed that a basking shark exposed to subsea noise from the survey equipment may experience impairment / mortality at a range of up to 5 m (maximum radius using sparker). It is not possible to model ranges for behavioural disturbance due to a lack of agreed numerical thresholds for fish (see Popper *et al.*, 2014 and Hawkins and Popper, 2016). However, this can be estimated semi-quantitatively and given the relatively low level of basking shark exposure to this type of noise, it is expected that behavioural responses may occur at ranges of between tens and hundreds of metres for the basking shark. There are a limited number of basking sharks in the Northern North Sea and the Pentland Firth, as this area is not considered to be an aggregation ‘hotspot’ for the species (Austin *et al.*, 2019). Therefore, it is expected that very small numbers of animals (i.e. <5 individuals) have the potential to be affected by disturbance as a result of survey activities.

3.7.4 Given that mitigation measures will be implemented to avoid auditory injury (Section 3.8), the remaining behavioural effects will be spatially limited, affecting very small numbers of animals in the context of the wider population.

3.7.5 The proposed geophysical survey will be temporary and will be carried out over a small area (with only a small proportion of that total area affected at any one time) in the context of the North Sea. The use of geophysical survey equipment is not expected to create a barrier to movement for basking shark and is therefore not expected to reduce the range of the basking shark population.

3.7.6 Due to the small area over which injury could occur and the low number of animals that may be injured (<1), the risk of injury to basking sharks is considered to be negligible. It is likely that animals will be displaced from the area of injury risk prior to commencement of the geophysical survey due to audible and visual cues during movement of the boats used to place the survey equipment. Proposed mitigation to further reduce potential for impact is presented in Section 3.8.

3.7.7 Any habitat likely to be affected will constitute a very small proportion of the available habitat to the basking shark population. The overall radius of effect is so small that mortality / impairment only has the potential to occur over an area of 0.001 km^2. This would likely equate to a significantly small portion of basking sharks potentially being present in waters near the survey site. The survey area is not likely to not represent a key habitat in the context of the wider region.

3.8 Mitigation

3.8.1 Marine mammal mitigation activities will be conducted in the field following the JNCC Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from seismic surveys (JNCC, 2017). The following specific mitigation measures are proposed for the planned geophysical surveys.

3.8.2 Up to three dedicated marine mammal observers (MMO) / passive acoustic monitoring (PAM) operatives (potentially dual role for PAM) will operate from the vessel bridge during daylight hours as per current JNCC guidelines (JNCC, 2017). Monitoring will be carried out with particular attention given to a 500 m exclusion zone around the geophysical survey equipment source and given the water depth of the NE2 and E3 sites (< 200 metres) from 30 minutes before start of geophysical equipment, throughout the 20 minute soft-start period until the start of acquisition (therefore ~50 minutes before start of line).

3.8.3 Each time the seismic source is activated, there will be a gradual build -up (or soft-start) of source power over the 20-minute period, as per the soft-start procedures and current JNCC guidelines (JNCC, 2017). This soft-start procedure is utilised while commencing underwater activities to gradually increase the sound intensity over a specific period of time and area. Effectively, this procedure aims to deter marine mammals from the surrounding area prior to full volume being reached so that the noise exposure to marine mammals and the associated risk of injury is reduced and/or mitigated.

3.8.4 Towed passive acoustic monitoring (PAM) provides an opportunity to detect and indicate the location of marine mammal vocalisations at sea relative to a towed hydrophone streamer and is useful when visual searching is not possible (i.e. during periods of low visibility or darkness). Marine mammal species are identified by the specific characteristics of the detected click and whistle sounds, the interpretation of which requires a specialised operator. PAM can be used to detect vocalising cetaceans, but it is not applicable for detection of pinnipeds or non-vocalising animals.

3.8.5 The MMO/PAM operative(s) will monitor an agreed mitigation zone and advise if any marine mammals are present within the zone. The standard radius of the mitigation zone is 500 m, estimated from the centre of the noise source location (noting that this exceeds the 220 m maximum modelled unmitigated injury zone as described in Section 2 and Appendix A).

3.8.6 The flexibility of the PAM towing arrangement and ease of deployment/recovery methods must also be considered in relation to existing in-sea equipment in order to ensure that the PAM system can be used without additional risk to vessel personnel and equipment either during geophysical data acquisition or equipment maintenance schedules during typical line changes or periods of poor weather.

3.8.7 It should be noted that PAM in-sea equipment deployment is dependent on operational constraints. Therefore, PAM will be used as practically and continuously as possible. TWP will advise Marine Scotland and NatureScot in the event of any significant periods where PAM is not available. PAM efforts will focus on providing a marine mammal monitoring capability of the area within 500 m of the source array, during the 30-minute monitoring period prior to soft-start at night or during periods of poor visibility.

3.8.8 In the event that marine mammals are detected within the mitigation zone, the procedures outlined in the JNCC (2017) guidance will be followed with respect to delaying the soft start (i.e. there must be a minimum of a 20 minute delay from the time of the last detection within the mitigation zone and the commencement of the soft -start).

3.8.9 A marine mammal mitigation protocol (MMMP) will be produced and implemented to ensure the appropriate mitigation measures are followed in line with the JNCC guidance for minimising the risk of injury to marine mammals from geophysical surveys (2017).

4 THREE EPS LICENCING TESTS

4.1 Test 1: Overriding Public Interest

4.1.1 With regard to Test 1 there are several different purposes for which an EPS licence can be granted including, under Regulation 44(2)(e) of the Habitat Regulations and Regulation 49(6)(1) of the Offshore Marine Regulations, for 'preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment'.

4.1.2 NatureScot Guidance states that, when determining an EPS Licence application, it will be taken into account whether an activity or development is required to meet, or contribute to meeting, a specific need such as maintaining the environment of Scotland's people (including sustainable development and renewable or green energy), complying with national planning policies and supporting economic or social development (including nationally important infrastructure development projects and employment).

4.1.3 While the marine surveys associated with the proposed ScotWind Offshore Wind farms present a temporary disturbance to a localised marine environment, this work will allow an important addition to Scotland's growing contributions to the UK's renewable energy sector. The UK has an urgent need for new electricity generation capacity due to the closure of coal fired stations, the aging of thermal power stations and the closure of nuclear power programmes. Offshore wind provides the opportunity to deliver this new capacity, not only from a renewable, low carbon resource, but a resource which is indigenous and does not depend upon the geo-economic and geo-political risks attendant with importing fuels.

4.1.4 The UK and Scotland has committed to meeting national and international commitments to greenhouse gas reduction including the Paris Agreement (2016), which sets out a global action plan towards climate neutrality with the aims of stopping the increase in global average temperature to below 2 °C above pre-industrial levels, and to pursue efforts to limit global warming to 1.5 °C. A number of pieces of UK and Scottish legislation have also been enacted with a view to achieving these targets for reduction in greenhouse gasses, including, but not limited to:

- The Climate Change Act 2008, which the UK committed to a net reduction in GHG emissions by 2050 of 80% against the 1990 baseline;
- The Energy Act 2013 which makes provisions to incentivise investment in low carbon electricity generation, ensure security of supply, and help the UK meet its emission reduction and renewables targets. And
- The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 which amends the Climate Change (Scotland) Act 2009, and introduces binding targets on the Scottish Government to reduce net Scottish greenhouse gas emissions by at least 100% by 2045 from 1990 levels:

4.1.5 As the UK follows these legislation and policies to meet its national and international commitments to greenhouse gas reduction, additional demands will be placed on domestic electricity supply as use of, for example, electric vehicles, increases. The project will provide additional support to the UK government's national and international commitments to reduce greenhouse gases, which will bring long-term benefits. The UK currently aims to reach their zero emissions target by 2050 and a new plan is aiming for at least 68% reduction in GHG emissions by the end of the decade, compared to 1990 levels. The UK has committed to reducing emissions by the fastest rate of any major economy and in doing so, aims to create and support 250,000 jobs whilst eradicating contributions to climate change.

4.1.6 ScotWind offers the deployment of a proven technology in a location with a recognised wind resource and to deliver a low-cost, low-carbon supply of electricity at a time when the UK urgently needs new generation capacity to maintain a secure, affordable supply of power. The proposed

development will also provide multiple opportunities of employment over the course of the project's lifetime.

4.1.7 If the works do not proceed, the progression of the ScotWind offshore developments would not be possible, making it more difficult for the UK to reach its ambitions environmental goals and having a direct impact on the local economy and job market.

4.2 Test 2: No Satisfactory Alternatives

4.2.1 Regulation 44(3)(a) of the Habitat Regulations 1994 requires the Scottish Ministers to be satisfied that there is no satisfactory alternative before an EPS Licence can be issued for the Licensable Operations.

4.2.2 TWP have considered several options in relation to the requirements of the geophysical surveys:

4.2.3 Option 1: Do not undertake the geophysical survey works or use subsurface positional equipment. This would result in excessive project risk and potential abandonment of the project. This would mean TWP being unable to develop the design for the ScotWind site, or conduct the environmental assessments necessary to support the consent applications. These surveys are therefore fundamental to the project development and without them the wind farm development would be prevented. TWP do not consider this to be an appropriate or responsible option. The risk of not progressing the development of the wind farm could hamper the potential for Scotland, and UK, to reach net-zero emissions by 2045 and 2050, respectively.

4.2.4 Option 2: Carry out surveys in different or smaller location. The site was awarded a lease by the Crown Estate Scotland and therefore TWP can only develop the wind farm in this location- we have no alternative locations to develop on. TWP do not consider this to be an appropriate or responsible option. The risk of not progressing the development of the wind farm could hamper the potential for the UK to reach net-zero emissions by 2050.

4.2.5 Option 3: Carry out the surveys at another time. The timing of the surveys has been scheduled in to take into account favourable weather, avoiding winter whereby harsh weather conditions and sea states have the potential to have health and safety risks to crew. Likewise carrying out the survey in winter conditions has the potential to prolong the survey duration due to slower rate of survey, this has the potential to increase the disturbance of EPS to a greater extent. Carrying out the survey during another period would also mean that further surveys may be required as the survey would be undertaken in sub-optimal times meaning that data gathered might not be of sufficient quality to help address the projects engineering and environmental uncertainties. This too has the potential to mean further surveys and disturbance to EPS may be experienced. TWP do not consider this to be an appropriate or responsible option. The risk of not progressing the development of the wind farm could hamper the potential for the UK and Scotland to reach net-zero emissions by 2050 and 2045, respectively.

4.2.6 Option 4: Smaller survey windows/smaller survey times. Conducting the surveys over a number of visits is not deemed a viable option as extra survey time would be required to ensure the survey covered the entire area. Again, this option would likely increase the overall survey period and therefore has potential to increase disturbance to EPS. TWP do not consider this to be an appropriate or responsible option. The risk of not progressing the development of the wind farm could hamper the potential for the UK to reach net-zero emissions by 2050.

4.2.7 Option 5: To undertake the geophysical survey works and use subsurface positional equipment, in conjunction with undertaking a Marine Mammal / EPS Risk Assessment. The EPS Risk Assessment will identify, quantify and determine a mitigation strategy for the works such that the conservation status of EPS & Marine Mammals present in the works area, or in adjacent waters, where a disturbance could be perceived, are minimised through the use of mitigation tools i.e. MMO and PAM following the JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (August 2017).

4.2.8 TWP has determined that Option 5 will be progressed, as the survey activities will provide TWP with an in depth understanding of the project site, while maintaining favourable conservation status of cetaceans within the works or adjacent areas.

4.2.9 If the works do not proceed, as previously stated, it would make the UK's ambitious target to reach net zero by 2050 more difficult to attain, resulting in the underutilisation of a strong and renewable resource off the Scottish coast.

4.3 Test 3: Favourable Conservation Status (FCS)

4.3.1 Regulation 44(3)(b) of the Habitat Regulations 1994 and Regulation 55(4)(b) of the Offshore Marine Regulations 2017 requires the regulatory authority to be satisfied that the licensed activities must not be detrimental to the maintenance of the population of species concerned at FCS in their natural range. The EU Habitats Directive includes the definitions for FCS below:

The "conservation status" of a species means, "the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations […]"

The "favourable conservation status" of a species means:

"population dynamics data on the species concerned indicate 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."

4.3.2 The risk assessment (Section 3) has identified five cetacean species which have the potential to occur in the vicinity of Cluaran Ear-Thuath and Cluaran Deas Ear and for which effects from the Licensable Operation must be assessed against FCS. The species to which this licence application applies are:

- Harbour porpoise,
- Bottlenose dolphin,
- White-beaked dolphin,
- Atlantic white-sided dolphin, and
- Minke whale.

4.3.2 Harbour Porpoise

FCS of Harbour Porpoise

4.3.1 The noise modelling assessment (Section 2; Appendix A) demonstrated that, for very high-frequency cetaceans (without mitigation), less than one individual has the potential to experience auditory injury as a result of the proposed geophysical survey, or up to 6.39 x 10^{-5} % of the NSMU population, or 1.39 x 10^{-4} % of the UK portion of the NSMU (NMFS, 2018). The likelihood of an animal experiencing auditory injury will be reduced with the implementation of mitigation measures as detailed in Section 3.8. Modelling indicated that disturbance could occur out to a distance of up to 1,643 m over an area of up to 8.5 km^2 and has the potential to affect up to approximately five harbour porpoise at any one time. This is the equivalent of approximately 0.0015% of the NSMU, or 0.003% of the UK portion of the NSMU (IAMMWG 2022).

4.3.2 Given that mitigation measures will be implemented to avoid auditory injury, the remaining behavioural effects will be spatially limited and are therefore predicted to affect very small numbers of animals in the context of the wider population. As such, the North Sea harbour porpoise population is likely to continue "maintaining itself on a long-term basis as a viable element of its natural habitats", as defined by the first FCS test.

4.3.3 The proposed geophysical survey will be temporary, taking place over approximately 99 days for Cluaran Ear-Thuath and Cluaran Deas Ear, and will be carried out over a small area (419 km^2 and 336 km^2, respectively), with only a small proportion of that total area affected at any one time in the context of the NSMU (IAMMWG, 2022). The use of geophysical survey equipment is not expected to create a barrier to movement for any EPS and is therefore not expected to reduce the range of the local harbour porpoise population, with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the second FCS status test.

4.3.4 Harbour porpoise are highly mobile utilising habitats over a wide area. Any habitat likely to be affected therefore will constitute a very small proportion of the available habitat to the harbour porpoise population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the third FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain harbour porpoise populations on a long-term basis", will be satisfied.

4.3.3 Bottlenose Dolphin

FCS of Bottlenose Dolphin

4.3.1 The noise modelling assessment (Section 2; Appendix A) demonstrated that, for HF cetaceans (without mitigation), less than one individual has the potential to experience auditory injury as a result of the proposed geophysical survey, or approximately 4.45 x 10^{-5} % of the GNSMU population, or 4.77 x 10^{-5} % of the UK portion of the GNSMU (NMFS, 2018). The likelihood of an animal experiencing auditory injury will be reduced with the implementation of mitigation measures as detailed in Section 3.8. Modelling indicated that disturbance could occur out to a distance of up to 1,643 m over an area of up to 8.5 km^2 and has the potential to affect less than one animal at any one time. This is the equivalent of up to 0.001% of the GNSMU, or 0.002% of the UK portion of the GNSMU (IAMMWG 2022).

4.3.2 Given that mitigation measures will be implemented to avoid auditory injury, the remaining behavioural effects will be spatially limited, and are therefore predicted to affect very small numbers of animals in the context of the wider population. As such, the Greater North Sea MU bottlenose dolphin population is likely to continue "maintaining itself on a long-term basis as a viable element of its natural habitats", as defined by the first FCS test.

4.3.3 The proposed geophysical survey will be temporary, taking place approximately 100 days for Cluaran Ear-Thuath and Cluaran Deas Ear, and will be carried out over a small area (419 km^2 and 336 km^2, respectively), with only a small proportion of that total area affected at any one time) in the context of the GNSMU (IAMMWG, 2022). The use of geophysical survey equipment is not expected to create a barrier to movement for any EPS and is therefore not expected to reduce the range of the local bottlenose dolphin population, with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the second FCS status test.

4.3.4 Bottlenose dolphin have been known to exhibit flexibility in their habitat use and those off the east coast of Scotland demonstrate high site fidelity to the Moray Firth SAC. Any habitat likely to be affected therefore will constitute a very small proportion of the available habitat to the bottlenose dolphin population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the third FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain bottlenose dolphin populations on a long-term basis", will be satisfied.

4.3.4 White-beaked Dolphin

FCS of White-beaked Dolphin

4.3.1 The noise modelling assessment (Section 2; Appendix A) demonstrated that, for HF cetaceans without mitigation, less than one individual has the potential to experience auditory injury as a result of the proposed geophysical survey, which is equivalent to less than 1.11 x 10^{-5} % of the CGNSMU population, or 1.43 x 10^{-5} % of the UK portion of the CGNSMU (NMFS, 2018). The likelihood of an animal experiencing auditory injury will be reduced with the implementation of mitigation measures as detailed in Section 3.8. Modelling indicated that disturbance could occur out to a distance of up to 1,643 m over an area of up to 8.5 km^2 and has the potential to affect up to approximately two animals at any one time. This is the equivalent of less than 0.005% of the CGNSMU, or 0.006% of the UK portion of the CGNSMU (IAMMWG, 2022).

4.3.2 Given that mitigation measures will be implemented to avoid auditory injury the remaining behavioural effects will be spatially limited and are therefore predicted to affect very small numbers of animals in the context of the wider population. As such, the Celtic and Greater North Sea white-beaked dolphin population is likely to continue "maintaining itself on a long-term basis as a viable element of its natural habitats", as defined by the first FCS test.

4.3.3 The proposed geophysical survey will be temporary, taking place over approximately 100 days for Cluaran Ear-Thuath and Cluaran Deas Ear, and will be carried out over a small area (419 km^2 and 336 km^2, respectively), with only a small proportion of that total area affected at any one time) in the context of the CGNSMU (IAMMWG, 2022). The use of geophysical survey equipment is not expected to create a barrier to movement for any EPS and is therefore not expected to reduce the range of the local white-beaked dolphin population, with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the second FCS status test.

4.3.4 The white-beaked dolphin is a highly mobile and wide-ranging species encountered in the North Sea. Any habitat likely to be affected therefore will constitute a very small proportion of the available habitat to the white-beaked dolphin population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the third FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain white-beaked dolphin populations on a long-term basis", will be satisfied.

4.3.5 Atlantic White-sided Dolphin

FCS of Atlantic White-sided Dolphin

4.3.1 The noise modelling assessment (Section 2; Appendix A) demonstrated that, for HF cetaceans without mitigation, less than one individual has the potential to experience auditory injury as a result of the proposed geophysical survey, or up to 1.1 x 10^{-6} % of the CGNSMU population, or 1.63 x 10^{-6} % of the UK portion of the CGNSMU (NMFS, 2018). The likelihood of an animal experiencing auditory injury will be reduced with the implementation of mitigation measures as detailed in Section 3.8. Modelling indicated that disturbance could occur out to a distance of up to 1,643 m over an area of up to 8.5 km^2 and has the potential to affect less than one animal at any one time. This is the equivalent of up to 0.0004% of the CGNSMU, or 0.0008% of the UK portion of the CGNSMU (IAMMWG, 2022).

4.3.2 Given that mitigation measures will be implemented to avoid auditory injury the remaining behavioural effects will be spatially limited and are therefore predicted to affect very small numbers of animals in the context of the wider population. As such, the Celtic and Greater North Sea Atlantic white-sided dolphin population is likely to continue "maintaining itself on a long-term basis as a viable element of its natural habitats", as defined by the first FCS test.

4.3.3 The proposed geophysical survey will be temporary, taking place over approximately 100 days for Cluaran Ear-Theath and Cluaran Deas Ear, and will be carried out over a small area (419 km^2 and 336 km^2, respectively), with only a small proportion of that total area affected at any one time) in the context of the CGNSMU (IAMMWG, 2022). The use of geophysical survey equipment is not

expected to create a barrier to movement for any EPS and is therefore not expected to reduce the range of the local Atlantic white-sided dolphin population, with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the second FCS status test.

4.3.4 The Atlantic white-sided dolphin is known to be highly mobile and can travel long distances as their distribution from the eastern coast of the United States to north of Greenland illustrates. Any habitat likely to be affected therefore will constitute a very small proportion of the available habitat to the Atlantic white-sided dolphin population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the third FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain Atlantic white-sided dolphin populations on a long-term basis", will be satisfied.

4.3.6 Minke Whale

FCS of Minke Whale

4.3.1 The noise modelling assessment (Section 2; Appendix A) demonstrated that, for LF cetaceans without mitigation, less than one individual has the potential to experience auditory injury as a result of the proposed geophysical survey, or up to 3.88x 10^{-6} % of the CGNSMU population, 7.58 x 10^{-6} % of the UK portion of the CGNSMU (NMFS, 2018). The likelihood of an animal experiencing auditory injury will be reduced with the implementation of mitigation measures as detailed in Section 3.8. Modelling indicated that disturbance could occur out to a distance of up to 1,643 m over an area of up to 8.5 km^2 and has the potential to affect less than one animal at any one time. This is the equivalent of less than 0.002% of the CGNSMU, or 0.003% of the UK portion of the CGNSMU (IAMMWG, 2022).

4.3.2 Given that mitigation measures will be implemented to avoid auditory injury the remaining behavioural effects will be spatially limited and are therefore predicted to affect very small numbers of animals in the context of the wider population. As such, the Celtic and Greater North Sea minke whale population is likely to continue "maintaining itself on a long-term basis as a viable element of its natural habitats", as defined by the first FCS test.

4.3.3 The proposed geophysical survey will be temporary, taking place over approximately 100 days for Cluaran Ear-Thuath and Cluaran Deas Ear, and will be carried out over a small area (419 km^2 and 336 km^2, respectively), with only a small proportion of that total area affected at any one time) in the context of the CGNSMU (IAMMWG, 2022). The use of geophysical survey equipment is not expected to create a barrier to movement for any EPS and is therefore not expected to reduce the range of the local minke whale population, with the "natural range of the species neither being reduced nor likely to be reduced for the foreseeable future", as defined by the second FCS status test.

4.3.4 The minke whale is known to have a large spatial distribution, undergoing seasonal movements between foraging and breeding grounds. Any habitat likely to be affected therefore will constitute a very small proportion of the available habitat to the minke whale population. The survey area is not likely to represent a key habitat in the context of the wider region. As such, it is predicted that the third FCS test, namely that "there is, and will probably continue to be, a sufficiently large habitat to maintain minke whale populations on a long-term basis", will be satisfied.

5 PROTECTED SITES

5.1.1 A number of Special Areas of Conservation (SACs) and one Nature Conservation Marine Protected Area (NC MPA) supporting certain marine mammal species, that are potentially sensitive to underwater noise, are located in the regions of both offshore wind development areas (see Table 5.1).

Table 5.1 Protected sites for marine mammals in the region of Cluaran Ear-Thuath and Cluaran Deas Ear

Protected site	Qualifying features of relevance	Approximate distance to survey area
Cluaran Ear-Thuath (NE2)		
Sanday SAC	Harbour seal	30 km
Faray and Holm of Faray SAC	Grey seal	41 km
Southern Trench NC MPA	Minke whale	94 km
Moray Firth SAC	Bottlenose dolphin	108 km
Cluaran Deas Ear (E3)		
Southern Trench NC MPA	Minke whale	42 km
Firth of Tay and Eden Estuary SAC	Harbour seal	92 km
Isle of May SAC	Grey seal	104 km
Berwickshire and North Northumberland Coast SAC	Grey seal	115 km
Moray Firth SAC	Bottlenose dolphin	166 km

5.1.2 Although marine mammals 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[1]. While the proposed surveys may result in some temporary disturbance to a very small number of seals outside of the breeding season, it is considered unlikely to have a likely significant effect on any of the seal SACs.

5.1.3 While surveys are planned to occur within the harbour seal breeding season (June-July), where seals may be more sensitive to disturbance, the distances of the survey area from any seal SACs and limited spatial and temporal extent of activities results in a very low likelihood of temporary

[1] NatureScot advice received on EPS applications for other projects is that grey seals tend to stay within 20 km of breeding colonies during the breeding season.

disturbance when outside the site boundaries. Therefore, it is considered that the proposed surveys are unlikely to have a likely significant effect on any of the seal SACs.

5.1.4 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). Boat-based surveys have indicated relatively high encounter rates at the entrance of the Tay Estuary, although limited sightings within St Andrews Bay (Quick *et al.* 2014, Arso Civil *et al.* 2021). Any disturbance to bottlenose dolphins which may be associated with the Moray Firth SAC arising from the planned survey activities will be short-term and to a limited number of individuals. Therefore, the proposed surveys are unlikely to have a significant effect on the bottlenose dolphins of the Moray Firth SAC.

5.1.5 Due to the distance between the proposed survey area and the Southern Trench NC MPA, it is considered that the proposed activities are not capable of affecting (other than insignificantly) the minke whale feature of the MPA.

6 CONCLUSIONS

6.1.1 The Applicant understands that in order for an EPS licence to be granted for the specific purposes set out in the Conservation (Natural Habitats) Regulations 1994 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017, the regulator would need to be satisfied that the Application passes each of the three tests namely: (1) Overriding public interest; (2) No satisfactory alternatives; and (3) Favourable conservation status. This document, in support of EPS licence applications, has sought to demonstrate compliance with these three tests.

6.1.2 The proposed survey will contribute to long-term strategic economic development and regeneration, in addition to reducing GHG emissions and aiming to mitigate the ramifications of climate change, therefore the Licensable Operations fulfil the requirements of Test 1: Overriding Public Interest. The Licensable Operations are a solution to a fundamental and essential step required for the sustainable construction of the proposed project, and the option of 'do nothing' is not considered to be a realistic option. As such it can be demonstrated that the Licensable Operations fulfil the requirements of Test 2: No Satisfactory Alternatives.

6.1.3 The Applicant has sought to demonstrate that, should the Project Consents be granted, the activities would not be detrimental to the maintenance of the FCS of EPS likely to occur within the zone of potential impact of the Project. Those EPS included harbour porpoise, bottlenose dolphin, white-beaked dolphin, Atlantic white-sided dolphin and minke whale. Project specific noise modelling predicted that, in the absence of mitigation, auditory injury could occur out to a maximum of 342 m across all species and disturbance out a maximum range of 1,643 m across all species.

6.1.4 The assessment found that in the absence of mitigation, less than one individual of each species has the potential to experience auditory injury at any one time across both sites.

6.1.5 The risk of auditory injury to marine mammals from the proposed geophysical survey activities will be mitigated following JNCC mitigation guidelines (JNCC, 2017).

6.1.6 Up to approximately five harbour porpoise and up to two white-beaked dolphin have the potential to experience disturbance across the two surveys. These numbers constitute very small proportions of the relevant management unit populations.

6.1.7 Based on the output of noise modelling, in conjunction with available data on relevant populations, habitat use and natural range, it was demonstrated that for all five species, the number of animals affected in the context of the wider MU populations will be very small and therefore unlikely to significantly affect the population as a whole; the populations of EPS in the vicinity of the survey area will continue to maintain themselves on a long-term basis as a viable component of their natural habitats. In addition, it was demonstrated that for all five EPS, the Licensable Operations are not predicted to create a barrier to movement for EPS and are therefore not likely to reduce the range of populations, with the natural range of each species neither being reduced nor likely to be reduced for the foreseeable future. Finally, it was demonstrated that any habitat likely to be affected by the Licensable Construction Operations will constitute a very small proportion of the available habitat to these EPS and therefore it is predicted that there is, and will probably continue to be, a sufficiently large habitat to maintain EPS populations on a long-term basis. As such the Applicant has demonstrated that the Licensable Operations fulfil the requirements of Test 3: Favourable Conservation Status.

6.1.8 There are no numerical thresholds for injury to basking shark due to high frequency sonar and, therefore, no results are presented for this species. However, due to the nature of the proposed surveys and mitigation, it is considered unlikely that there will be any significant adverse impacts to basking shark.

6.1.9 Due to the temporary and localised nature of the proposed surveys, it is considered unlikely to have a significant effect on any SACs with marine mammals as qualifying features, or be capable of affecting (other than insignificantly) the protected features of any NC MPA.

REFERENCES

ANSI. 1986. S12.7-1986 Method for Measurement of Impulse Noise.

ANSI. 1995. ANSI S3.20-1995 Bioacoustical Terminology. American National Standards Institute.

ANSI. 2005. ANSI S1.13-2005 Measurement of Sound Pressure Levels in Air. American National Standards Institute.

Arso Civil, M., N. Quick, B. Cheney, E. Pirotta, P. Thompson, and P. Hammond. (2019). Changing distribution of the east coast of Scotland bottlenose dolphin population and the challenges of area-based management. Aquatic Conservation Marine and Freshwater Ecosystems. 29(S1):178-196.

Arso Civil, M., N. Quick, S. Mews, E. Hague, B. J. Cheney, P. Thompson, and P. Hammond. 2021. Improving understanding of bottlenose dolphin movements along the east coast of Scotland. Final report. provided to European Offshore Wind Deployment Centre (EOWDC).

Austin, R. A., Hawkes, L. A., Doherty, P. D., Henderson, S. M., Inger, R., Johnson, L., Pikesley, S. K., Solandt, J.-L.,

Speedie, C. and M. J. Witt (2019). Predicting habitat suitability for basking sharks (Cetorhinus maximus) in UK watersusing ensemble ecological niche modelling. Journal of Sea Research, 153, November 2019, 10176.

Avant, P. (2008). *Tursiops truncatus* Bottle-nosed dolphin. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 08-12-2022]. Available from: https://www.marlin.ac.uk/species/detail/1674.

Baines, M. E. and P. G. H. Evans (2012) Atlas of the Marine Mammals of Wales. CCW Monitoring Report No. 68. 2nd Edition. 139pp.

Barnes, M.K.S. (2008). Lagenorhynchus acutus Atlantic white-sided dolphin. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 22-10-2021]. Available from: https://www.marlin.ac.uk/species/detail/116.

Casper, B.M., Halvorsen, M.B. and Popper, A.N., 2012. Are sharks even bothered by a noisy environment?. In The effects of noise on aquatic life (pp. 93-97). Springer, New York, NY.

Cheney, B., Corkrey, R., Durban, J.W., Grellier, K., Hammond, P.S., Uslas-Villanueva, V, Janik, V.M., Lusseau, S.M., Parsons, K.M., Quick, N.J., Wilson, B. and Thompson, P.M. (2014) Long-term trends in the use of a protected area by small cetaceans in relation to changes in population status. Global Ecology and Conservation, 2, 118–128.

Chevallard, P., Culloch, R., Edwards, E., Davies, I. and Brookes, K., 2019. East Coast Marine Mammal Acoustic Survey (ECOMMAS).

Cotton, P.A., Sims, D.W., Fanshawe, s., and M. Chadwick (2005). The effects of climate variability on zooplankton and basking shark (*Cetorhinus maximus*) relative abundance off southwest Britain, Fisheries Oceanography, 14, pp. 151-155.

Doherty, P.D., Baxter, J.M., Gell, F.R., Godley, B.J., Graham, R.T., Hall, G., Hall, J., Hawkes, L.A., Henderson, S.M., Johnson, L. and Speedie, C., (2017). Long-term satellite tracking reveals variable seasonal migration strategies of basking sharks in the north-east Atlantic. Scientific reports, 7, p.42837.

Dolman, S. J., Hodgins, N. K., Macleod, C. D., Pierce, G. J. & Weir, C. R. Harbour porpoises (Phocoena phocoena) and minke whales (Balaenoptera acutorostrata) observed during land-based surveys in The Minch, north-west Scotland. J. Mar. Biol. Assoc. UK 94, 1185–1194 (2013).

Evans, P. and Waggitt, J., 2020. Impacts of climate change on Marine Mammals, relevant to the coastal and marine environment around the UK.

Evans, P.G.H. & A. Bjørge 2013. Impacts of climate change on marine mammals. Marine Climate Change Impacts Partnership (MCCIP) Science Review 2013: 134-148.

Fernandez-Betelu, O., Graham, I.M., Cornulier, T. and Thompson, P.M., 2019. Fine scale spatial variability in the influence of environmental cycles on the occurrence of dolphins at coastal sites. Scientific reports, 9(1), pp.1-12.

Garagouni, M., Pirotta, E., Ingram, S.N. and Rogan, E., 2019. Habitat use of a resident bottlenose dolphin population in the Shannon Estuary. Habitat preferences and movement patterns of bottlenose dolphins at, p.99.

Genov, T., Centrih, T., Kotnjek, P. and Hace, A., 2019. Behavioural and temporal partitioning of dolphin social groups in the northern Adriatic Sea. Marine biology, 166(1), pp.1-14.

Gilles, A., Galatius, A., Aloha, M., Authier, M., Brasseur, S., Carlsson, A., Carlström, J., Chaudry, F., Culloch, R.M., Evans, P.G. and Geelhoed, S.C.V., 2019. Working Group on Marine Mammal Ecology (WGMME).

Hague, E.L., Sinclair, R.R. and Sparling, C.E., 2020. Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters. Scottish Marine and Freshwater Science.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. and Wilson, B., 2019. Lagenorhynchus acutus. The IUCN Red List of Threatened Species 2008: e. T11141A3255721.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2021). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. May 2017, 40 pp.

Hammond, P.S., Macleod, K., Berggren, P., Borchers, D.L., Burt, L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D. and Gordon, J. (2013) Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation, 164, pp.107-122.

Hart, N.S. and Collin, S.P., 2015. Sharks senses and shark repellents. *Integrative zoology*, *10*(1), pp.38-64.

Hebridean Whale and Dolphin Trust (HWDT), 2021. *Atlantic white-sided dolphin*. Available at: https://hwdt.org/atlantic-white-sided-dolphin. Accessed on: 22 October 2021.

Hebridean Whale and Dolphin Trust (HWDT), 2021. *Minke Whale*. Available at: https://hwdt.org/minke-whale Accessed on: 22 October 2021.

High Energy Seismic Survey (HESS) (1997). Summary of Recommendations Made by the Expert Panel at the HESS Workshop on the Effects of Seismic Sound on Marine Mammals In Pepperdine University, Malibu, California.

IAMMWG. 2022. Updated abundance estimates for cetacean Management Units in UK waters (Revised 2022). JNCC Report No. 680, JNCC Peterborough, ISSN 0963-8091.

IJsseldijk, L.L., Brownlow, A., Davison, N., Deaville, R., Haelters, J., Keijl, G., Siebert, U. and ten Doeschate, M.T., 2018. Spatiotemporal analysis in white-beaked dolphin strandings along the North Sea coast from 1991-2017. Lutra, 61(1), pp.153-163.

Jeewoonarain, T., Parsons, E.C.M., Evans, P.G.H. (2000). Operation sightings: sightings of cetaceans in the Southern Hebrides, Scotland, European Research on Cetaceans, 13, 237-241.

JNCC (2013a) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Third Report by the United Kingdom under Article 17 on the implementation of the

Directive from January 2007 to December 2012 Conservation status assessment for S1351 harbour porpoise (*Phocoena phocoena*).

JNCC (2013b) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012 Conservation status assessment for S1349 bottlenose dolphin (*Tursiops truncatus*).

JNCC (2013c) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012 Conservation status assessment for S2032 white-beaked dolphin (*Lagenorhynchus albirostris*).

JNCC (2013d) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012 Conservation status assessment for S2031 Atlantic white-sided dolphin (*Lagenorhynchus acutus*).

JNCC (2013e) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012 Conservation status assessment for S2618 minke whale (*Balaenoptera acutorostrata*).

JNCC (2017) Guidelines for minimising the risk of injury to marine mammals from geophysical surveys, JNCC, Aberdeen, April 2017.

JNCC (2019a) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for S1351 harbour porpoise (*Phocoena phocoena*).

JNCC (2019b) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for S1349 bottlenose dolphin (*Tursiops truncatus*).

JNCC (2019c) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for S2032 white-beaked dolphin (*Lagenorhynchus albirostris*).

JNCC (2019d) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for S2031 Atlantic white-sided dolphin (*Lagenorhynchus acutus*).

JNCC (2019e) European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC): Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for S2618 minke whale (*Balaenoptera acutorostrata*).

JNCC (2021). *Moray Firth Designated Special Area of Conservation (SAC).* Available at: https://sac.jncc.gov.uk/site/UK0019808. Accessed on: 21 October 2021.

Jones, E. L., B. J. McConnell, S. Smout, P. S. Hammond, C. D. Duck, C. D. Morris, D. Thompson, D. J. Russell, C. Vincent, and M. Cronin. (2015). Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. Marine Ecology Progress Series 534:235-249

Ketten, D.R. and Mountain, D., (Unpublished) Modelling minke whale hearing. Report to E&P Sound and Marine Life Programme. Available from: http://www.soundandmarinelife.org/library/project-reports.aspx

MacLeod, C.D Weir, C.R., Santos, M.B. and Dunn, T.E. (2008). Temperature-based summer habitat partitioning between white-beaked and common dolphins around the United Kingdom and Republic of Ireland. Journal of the Marine Biological Association of the UK, 88: 1193-1198.

Macleod, K. 2004. Abundance of Atlantic white-sided dolphin (*Lagenorhynchus acutus*) during summer off northwest Scotland. Journal of Cetacean Research and Management 6(1): 33-40.

Marine Mammal Research Unit. (2022). *Harbour porpoise biology*. Available at: https://mmru.ubc.ca/biology/harbour-porpoise-biology/. Accessed on: 30 November 2022.

National Marine Fisheries Service (NMFS) (2005). *Scoping Report for NMFS EIS for the National Acoustic Guidelines on Marine Mammals.* National Marine Fisheries Service.

National Marine Plan Inspectorate (NMPi), 2021. *Marine Scotland*. Available at: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?availablelayers=1535. Accessed on: 21 October 2021.

NIOSH. 1998. Criteria for a Recommended Standard: Occupational Noise Exposure. National Institute for Occupational Safety and Health.NMFS (2018). “Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts.” National Marine Fisheries Service (NOAA).

Paxton, C.G.M., L. Scott-Hayward, M. Mackenzie, E. Rexstad & L. Thomas 2016. Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resource. JNCC Report & Advisory Note 517. JNCC, Peterborough, UK.

Pierce, G. J., Santos, M. B., Reid, R. J., Patterson, I. A. P. and Ross, H. M. (2004) “Diet of minke whales Balaenoptera acutorostrata in Scottish (UK) waters with notes on strandings of this species in Scotland 1992–2002,” Journal of the Marine Biological Association of the United Kingdom. Cambridge University Press, 84(6), pp. 1241–1244. doi: 10.1017/S0025315404010732h.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W. T., Gentry, R., Halvorsen, M. B., Lokkeborg, S., Rogers, P., Southall, B. L., Zeddies, D. G. and Tavolga, W. N. (2014) ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.

Quick, N. J., M. Arso Civil, B. Cheney, V. Islas, V. Janik, P. M. Thompson, and P. S. Hammond. (2014). The east coast of Scotland bottlenose dolphin population: Improving understanding of ecology outside the Moray Firth SAC. This document was produced as part of the UK Department of Energy and Climate Change's offshore energy Strategic Environmental Assessment programme.

Ransijn, J.M., Booth, C. and Smout, S.C., 2019. JNCC Report No. 633.

Reid, J.B., Evans, P.G.H. and Northridge, S.P. (2003). Atlas of Cetacean distribution in northwest European waters, Joint Nature Conservation Committee (JNCC), Peterborough.

Richardson, William John, Denis H. Thomson, Charles R. Greene, Jr., and Charles I. Malme. 1995. Marine Mammals and Noise. Academic Press.

Risch, D., Castellote, M., Clark, C.W., Davis, G.E., Dugan, P.J., Hodge, L.E., Kumar, A., Lucke, K., Mellinger, D.K., Nieukirk, S.L. and Popescu, C.M., 2014. Seasonal migrations of North Atlantic minke whales: novel insights from large-scale passive acoustic monitoring networks. Movement ecology, 2(1), pp.1-17.

Risch, D., Wilson, S. C., Hoogerwerf, M., van Geel, N. C. F., Edwards, E. W. J., Brookes, K. L. Seasonal and diel acoustic presence of North Atlantic minke whales in the North Sea. Sci Rep. 2019a Mar 5;9(1):3571. doi: 10.1038/s41598-019-39752-8.

Risch, D., Norris, T., Curnock, M. and Friedlaender, A., 2019b. Common and Antarctic minke whales: Conservation status and future research directions. Frontiers in Marine Science, 6, p.247.

Robinson, K. P., Tetley, M. J. & Mitchelson-Jacob, E. G. The distribution and habitat preference of coastally occurring minke whales (Balaenoptera acutorostrata) in the outer southern Moray Firth, northeast Scotland. J. Coast. Conservation 13, 39–48 (2009).

Robinson, K.P., Bamford, C.C., Brown, W.J., Culloch, R.M., Dolan, C.J., Hall, R., Russell, G., Sidiropoulos, T., Spinou, E., Sim, T.M. and Stroud, E., 2021. Ecological habitat partitioning and feeding specialisations of coastal minke whales (Balaenoptera acutorostrata) using a designated MPA in northeast Scotland. bioRxiv.

Robinson, K.P., Baumgartner, N., Eisfeld, S.M., Clark, N.M., Culloch, R.M., Haskins, G.N., Zapponi, L., Whaley, A.R., Weare, J.S. and Tetley, M.J. (2007). The summer distribution and occurrence of cetaceans in the coastal waters of the outer southern Moray Firth in northeast Scotland (UK). Lutra 50(11): 13-26.

Robinson, K.P., Sim, T.M., Culloch, R.M., Bean, T.S., Cordoba Aguilar, I., Eisfeld, S.M., Filan, M., Haskins, G.N., Williams, G. and Pierce, G.J., 2017. Female reproductive success and calf survival in a North Sea coastal bottlenose dolphin (Tursiops truncatus) population. PLoS One, 12(9), p.e0185000.

Russell, D. J. F., B. McConnell, D. Thompson, C. Duck, C. Morris, J. Harwood, and J. Matthiopoulos. (2013). Uncovering the links between foraging and breeding regions in a highly mobile mammal. Journal of Applied Ecology 50:499-509.

Santos, M.B. & Pierce, G.J. 2003. The diet of harbour porpoise (Phocoena phocoena) in the northeast Atlantic. Oceanography and Marine Biology: an Annual Review 41: 355-390.

Schick, L., IJsseldijk, L.L., Grilo, M.L., Lakemeyer, J., Lehnert, K., Wohlsein, P., Ewers, C., Prenger-Berninghoff, E., Baumgärtner, W., Gröne, A. and Kik, M.J., 2020. Pathological findings in white-beaked dolphins (Lagenorhynchus albirostris) and Atlantic white-sided dolphins (Lagenorhynchus acutus) from the South-Eastern North Sea. Frontiers in veterinary science, 7, p.262.

Senior, B., Bailey, H., Lusseau, D., Foote A., and Thompson, P.M. (2008). Anthropogenic noise in the Moray Firth SAC; potential sources and impacts on bottlenose dolphins. Scottish Natural Heritage Commissioned Report No.265 (ROAME No. F05LE02).

Sims, D. A. and V.A. Quayle (1998). Selective foraging behaviour of basking sharks on zooplankton in a small-scale front, Nature, 393, 460-464.

Skomal, G.B., Wood, G. and N. Caloyianis (2004). Archival tagging of a basking shark in the western North Atlantic, Journal of the Marine Biological Association of the United Kingdom, 84 (4), 795-799.

Southall, Brandon L., Ann E. Bowles, William T. Ellison, James J. Finneran, Roger L. Gentry, Charles R. Greene Jr, David Kastak, *et al.* 2007. “Marine Mammal Noise-Exposure Criteria: Initial Scientific Recommendations.” Aquatic Mammals 33 (4): 411–521.

Southall, Brandon L., James J. Finneran, Colleen Reichmuth, Paul E. Nachtigall, Darlene R. Ketten, Ann E. Bowles, William T. Ellison, Douglas P. Nowacek, and Peter L. Tyack. 2019. “Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects.” Aquatic Mammals 45 (2): 125–232.

Speedie, C. (1999). Basking Shark Phenomenon 1998. Glaucus 10: 6-8.

Tetley, M. J., Mitchelson-Jacob, E. G. & Robinson, K. P. The summer distribution of coastal minke whales (Balaenoptera acutorostrata) in the southern outer Moray Firth, NE Scotland, in relation to co-occurring mesoscale oceanographic features. Remote Sensing.

Thompson, P.M., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G. and Merchant, N.D. (2013). Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. Proc R Soc B 280: 20132001. http://dx.doi.org/10.1098/rspb.2013.2001.

Wall, D., Murray, C., O'Brien, J., Kavanagh, L., Wilson, C., Ryan, C., Glanville, B., Williams, D., Enlander, I., O'Connor, I., McGrath, D., Whooley, P., Berrow, S. (2013) Atlas of the distribution and relative abundance of marine mammals in Irish offshore waters 2005 – 2011. Irish Whale and Dolphin Group, Kilrush, Co. Clare, 63pp.

Weinrich MT, Belt CR, Morin D. Behavior and ecology of the Atlantic white-sided dolphin (*Lagenorhynchus Acutus*) in coastal New England waters. Mar Mamm Sci. (2001) 17:231–48. doi: 10.1111/j.1748-7692.2001.tb01268.x

Williamson, L., 2018. Spatio-temporal variation in harbour porpoise distribution and activity (Doctoral dissertation, University of Aberdeen).

Williamson, L.D., Brookes, K.L., Scott, B.E., Graham, I.M. and Thompson, P.M., 2017. Diurnal variation in harbour porpoise detection potential implications for management. Marine Ecology Progress Series, 570, pp.223-232.

Wilson, C.M., Wilding, C.M. and Tyler-Walters, H., 2020. Basking shark (*Cetorhinus maximus*).

Appendix A

EPS Calculation Tables

NE2: Cluaran Ear-Thuath

Apx Table 1: Number of Animals Potentially Affected by Auditory Injury During the Proposed Geophysical Surveys at Cluaran Ear-Thuath (NE2) (N/A = Not Applicable).

Species	Density estimate (animals/ km^2)[2]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
MULTIBEAM ECHOSOUNDER							
Atlantic white-sided dolphin	N/A	18,128	12,293	0.01	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	0.01	<1	1.98×10^{-6}	2.12×10^{-6}
Harbour porpoise	0.152	346,601	159,632	0.02	<1	8.77×10^{-7}	1.90×10^{-6}
Minke whale	0.01	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.021	43,951	34,025	0.01	<1	4.78×10^{-7}	6.17×10^{-7}
SIDE SCAN SONAR							
Atlantic white-sided dolphin	N/A	18,128	12,293	0.01	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	0.01	<1	1.98×10^{-6}	2.12×10^{-6}
Harbour porpoise	0.152	346,601	159,632	0.02	<1	8.77×10^{-7}	1.9×10^{-6}
Minke whale	0.01	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.021	43,951	34,025	0.01	<1	4.78×10^{-7}	6.17×10^{-7}
SUB BOTTOM PROFILER							
Atlantic white-sided dolphin	N/A	18,128	12,293	0.02	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	0.02	<1	3.96×10^{-6}	4.24×10^{-6}
Harbour porpoise	0.152	346,601	159,632	0.32	<1	1.4×10^{-5}	3.05×10^{-5}
Minke whale	0.01	20,118	10,288	0.02	<1	9.94×10^{-7}	1.94×10^{-6}
White-beaked dolphin	0.021	43,951	34,025	0.02	<1	9.56×10^{-7}	1.23×10^{-6}

Species	Density estimate (animals/ km^2)[2]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
ULTRA-SHORT BASE LINE							
Atlantic white-sided dolphin	N/A	18,128	12,293	N/A	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	N/A	N/A	N/A	N/A
Harbour porpoise	0.152	346,601	159,632	0.01	<1	4.39×10^{-7}	9.52×10^{-7}
Minke whale	0.01	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.021	43,951	34,025	N/A	N/A	N/A	N/A
SPARKER							
Atlantic white-sided dolphin	N/A	18,128	12,293	N/A	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	N/A	N/A	N/A	N/A
Harbour porpoise	0.152	346,601	159,632	9.08 x 10-4	<1	3.98×10^{-8}	8.64×10^{-8}
Minke whale	0.01	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.021	43,951	34,025	N/A	N/A	N/A	N/A

Apx Table 2: Number of Animals Potentially Affected by Disturbance During the Proposed Geophysical Surveys at Cluaran Ear-Thuath (NE2) (N/A = Not Applicable).

Species	Density estimate (animals/ km^2)[3]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
MULTIBEAM ECHOSOUNDER							
Atlantic white-sided dolphin	N/A	18,128	12,293	0.53	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	0.53	<1	1.05×10^{-4}	1.12×10^{-4}
Harbour porpoise	0.152	346,601	159,632	0.53	<1	2.32×10^{-5}	5.05×10^{-5}
Minke whale	0.01	20,118	10,288	0.53	<1	2.63×10^{-5}	5.15×10^{-5}
White-beaked dolphin	0.021	43,951	34,025	0.53	<1	2.53×10^{-5}	3.27×10^{-5}
SIDE SCAN SONAR							
Atlantic white-sided dolphin	N/A	18,128	12,293	0.22	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	0.22	<1	4.35×10^{-5}	4.67×10^{-5}
Harbour porpoise	0.152	346,601	159,632	0.22	<1	9.65×10^{-6}	2.09×10^{-5}
Minke whale	0.01	20,118	10,288	0.22	<1	1.09×10^{-5}	2.14×10^{-5}
White-beaked dolphin	0.021	43,951	34,025	0.22	<1	1.05×10^{-5}	1.36×10^{-5}
SUB BOTTOM PROFILER							
Atlantic white-sided dolphin	N/A	18,128	12,293	5.68	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	5.68	<1	1.12×10^{-3}	1.21×10^{-3}
Harbour porpoise	0.152	346,601	159,632	5.68	<1	2.49×10^{-4}	5.41×10^{-4}
Minke whale	0.01	20,118	10,288	5.68	<1	2.82×10^{-4}	5.52×10^{-4}
White-beaked dolphin	0.021	43,951	34,025	5.68	<1	2.71×10^{-4}	3.51×10^{-4}
ULTRA-SHORT BASE LINE							

[3] Data taken from SCANS III surveys (Hammond, 2017)

Species	Density estimate (animals/ km^2)[3]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
Atlantic white-sided dolphin	N/A	18,128	12,293	7.94	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	7.94	<1	1.57×10^{-3}	1.68×10^{-3}
Harbour porpoise	0.152	346,601	159,632	7.94	1.2	3.48×10^{-4}	7.56×10^{-4}
Minke whale	0.01	20,118	10,288	7.94	<1	3.95×10^{-4}	7.72×10^{-4}
White-beaked dolphin	0.021	43,951	34,025	7.94	<1	3.79×10^{-4}	4.9×10^{-4}
SPARKER							
Atlantic white-sided dolphin	N/A	18,128	12,293	N/A	N/A	N/A	N/A
				N/A	N/A	N/A	N/A
Bottlenose dolphin	0.004	2,022	1,885	1	<1	1.98×10^{-4}	2.12×10^{-4}
				0.02	<1	3.96×10^{-6}	4.24×10^{-6}
Harbour porpoise	0.152	346,601	159,632	1	<1	4.39×10^{-5}	9.52×10^{-5}
				0.02	<1	8.77×10^{-7}	1.90×10^{-6}
Minke whale	0.01	20,118	10,288	1	<1	4.97×10^{-5}	9.72×10^{-5}
				0.02	<1	9.94×10^{-7}	1.94×10^{-6}
White-beaked dolphin	0.021	43,951	34,025	1	<1	4.78×10^{-5}	6.17×10^{-5}
				0.02	<1	9.56×10^{-7}	1.23×10^{-6}

E3: Cluaran Deas Ear

Apx Table 3: Number of Animals Potentially Affected by Auditory Injury During the Proposed Geophysical Surveys at Cluaran Deas Ear (E3) (N/A = Not Applicable).

Species	Density estimate (animals/ km^2)[4]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
MULTIBEAM ECHOSOUNDER							
Atlantic white-sided dolphin	0.010	18,128	12,293	0.02	<1	1.10×10^{-6}	1.63×10^{-6}
Bottlenose dolphin	0.030	2,022	1,885	0.02	<1	2.97×10^{-5}	3.18×10^{-5}
Harbour porpoise	0.599	346,601	159,632	0.02	<1	3.46×10^{-6}	7.50×10^{-6}
Minke whale	0.039	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.243	43,951	34,025	0.02	<1	1.11×10^{-5}	1.43×10^{-6}
SIDE SCAN SONAR							
Atlantic white-sided dolphin	0.010	18,128	12,293	0.01	<1	5.52×10^{-7}	8.13×10^{-7}
Bottlenose dolphin	0.030	2,022	1,885	0.01	<1	1.48×10^{-5}	1.59×10^{-5}
Harbour porpoise	0.599	346,601	159,632	0.02	<1	3.46×10^{-6}	7.50×10^{-6}
Minke whale	0.039	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.243	43,951	34,025	0.01	<1	5.53×10^{-5}	7.14×10^{-6}
SUB BOTTOM PROFILER							
Atlantic white-sided dolphin	0.010	18,128	12,293	0.03	<1	1.65×10^{-6}	2.44×10^{-6}
Bottlenose dolphin	0.030	2,022	1,885	0.03	<1	4.45×10^{-5}	4.77×10^{-5}
Harbour porpoise	0.599	346,601	159,632	0.37	<1	6.39×10^{-5}	1.39×10^{-4}
Minke whale	0.039	20,118	10,288	0.02	<1	3.88×10^{-6}	7.58×10^{-6}
White-beaked dolphin	0.243	43,951	34,025	0.03	<1	1.66×10^{-5}	2.14×10^{-5}

[4] Data taken from SCANS III surveys (Hammond, 2017)

Species	Density estimate (animals/ km^2)[4]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
ULTRA-SHORT BASE LINE							
Atlantic white-sided dolphin	0.010	18,128	12,293	N/A	N/A	N/A	N/A
Bottlenose dolphin	0.030	2,022	1,885	N/A	N/A	N/A	N/A
Harbour porpoise	0.599	346,601	159,632	0.065	<1	1.73×10^{-6}	3.75×10^{-6}
Minke whale	0.039	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.243	43,951	34,025	N/A	N/A	N/A	N/A
SPARKER							
Atlantic white-sided dolphin	0.010	18,128	12,293	N/A	N/A	N/A	N/A
Bottlenose dolphin	0.030	2,022	1,885	N/A	N/A	N/A	N/A
Harbour porpoise	0.599	346,601	159,632	0.017	<1	1.57×10^{-7}	3.41×10^{-7}
Minke whale	0.039	20,118	10,288	N/A	N/A	N/A	N/A
White-beaked dolphin	0.243	43,951	34,025	N/A	N/A	N/A	N/A

Apx Table 4: Number of Animals Potentially Affected by Disturbance During the Proposed Geophysical Surveys at Cluaran Deas Ear (E3) (N/A = Not Applicable).

Species	Density estimate (animals/ km^2)[5]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
MULTIBEAM ECHOSOUNDER							
Atlantic white-sided dolphin	0.010	18,128	12,293	0.65	<1	3.59×10^{-5}	5.29×10^{-5}
Bottlenose dolphin	0.030	2,022	1,885	0.65	<1	9.64×10^{-4}	1.03×10^{-3}
Harbour porpoise	0.599	346,601	159,632	0.65	<1	1.12×10^{-4}	2.44×10^{-4}
Minke whale	0.039	20,118	10,288	0.65	<1	1.26×10^{-4}	2.46×10^{-4}
White-beaked dolphin	0.243	43,951	34,025	0.65	<1	3.59×10^{-4}	4.64×10^{-4}
SIDE SCAN SONAR							
Atlantic white-sided dolphin	0.010	18,128	12,293	0.24	<1	1.32×10^{-5}	1.95×10^{-5}
Bottlenose dolphin	0.030	2,022	1,885	0.24	<1	3.56×10^{-4}	3.82×10^{-4}
Harbour porpoise	0.599	346,601	159,632	0.24	<1	4.15×10^{-5}	9.01×10^{-5}
Minke whale	0.039	20,118	10,288	0.24	<1	4.65×10^{-5}	9.01×10^{-5}
White-beaked dolphin	0.243	43,951	34,025	0.24	<1	1.33×10^{-4}	1.71×10^{-4}
SUB BOTTOM PROFILER							
Atlantic white-sided dolphin	0.010	18,128	12,293	5.71	<1	3.15×10^{-4}	4.64×10^{-4}
Bottlenose dolphin	0.030	2,022	1,885	5.71	<1	8.47×10^{-3}	9.09×10^{-3}
Harbour porpoise	0.599	346,601	159,632	5.71	3.4	9.87×10^{-4}	2.14×10^{-3}
Minke whale	0.039	20,118	10,288	5.71	<1	1.11×10^{-3}	2.16×10^{-3}
White-beaked dolphin	0.243	43,951	34,025	5.71	1.4	3.16×10^{-3}	4.08×10^{-3}
ULTRA-SHORT BASE LINE							

[5] Data taken from SCANS III surveys (Hammond, 2017)

Species	Density estimate (animals/ km^2)[5]	MU population	MU population (UK portion)	Area of sea affected in zone of injury (km^2)	Number of animals potentially within zone of injury	Proportion of MU population (%)	Proportion of MU population (UK portion) (%)
Atlantic white-sided dolphin	0.010	18,128	12,293	8.48	<1	4.68×10^{-4}	6.9×10^{-4}
Bottlenose dolphin	0.030	2,022	1,885	8.48	<1	1.26×10^{-2}	1.35×10^{-2}
Harbour porpoise	0.599	346,601	159,632	8.48	5.1	1.47×10^{-3}	3.18×10^{-3}
Minke whale	0.039	20,118	10,288	8.48	<1	1.64×10^{-3}	3.21×10^{-3}
White-beaked dolphin	0.243	43,951	34,025	8.48	2.1	4.69×10^{-3}	6.06×10^{-3}
SPARKER							
Atlantic white-sided dolphin	0.010	18,128	12,293	1	<1	5.52×10^{-5}	8.13×10^{-5}
				0.02	<1	1.1×10^{-6}	1.63×10^{-6}
Bottlenose dolphin	0.030	2,022	1,885	1	<1	1.48×10^{-3}	1.59×10^{-3}
				0.02	<1	2.97×10^{-5}	3.18×10^{-5}
Harbour porpoise	0.599	346,601	159,632	1	<1	1.73×10^{-4}	3.75×10^{-4}
				0.02	<1	3.46×10^{-6}	7.5×10^{-6}
Minke whale	0.039	20,118	10,288	1	<1	1.94×10^{-4}	3.79×10^{-4}
				0.02	<1	3.88×10^{-6}	7.58×10^{-6}
White-beaked dolphin	0.243	43,951	34,025	1	<1	5.53×10^{-4}	7.14×10^{-4}
				0.02	<1	1.11×10^{-5}	1.43×10^{-5}