Exola DAC

Barryroe Site Survey

Environmental Impact Assessment (EIA) Screening

Ref: P1223-04-01

February 2019

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Abbreviations

CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
cSAC	candidate Special Area of Conservation
DCHG	Department of Culture, Heritage and the Gaeltacht (formerly Department of Arts, Heritage and the Gaeltacht; DAHG)
dB	Decibel
dB re 1µPa	Decibels relative to one micro-Pascal
DCCAE	Department for Communications, Climate Action and the Environment
DCENR	Department for Communications, Energy and Natural Resources (now DCCAE)
EC	European Commission
EIA	Environmental Impact Assessment
EU	European Union
Exola	Exola DAC
FLO	Fisheries Liaison Officer
Hertz	Hz
ICES	International Council for the Exploration of the Seas
IMO	International Maritime Organisation
IOGP	International Association of Oil & Gas Producers
IOSEA	Irish Offshore Strategic Environmental Assessment
IRCG	Irish Coastguard
kHz	Kilohertz
km	Kilometre
km^2	Square kilometre
LR S&G	LR Survey & GeoEngineering
m	Metre
MBES	Multi-Beam Echosounder
MMO	Marine Mammal Observer
NIS	Natura Impact Statement
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine and Fisheries Service
Pa	Pascal
PE	Parabolic Equation
PReCAST	Policy and Recommendations from Cetacean Acoustics, Surveying and Tracking
PTS	Permanent Threshold Shift

rms	Root mean square
SAC	Special Area of Conservation
SBES	Single-Beam Echosounder
SBP	Sub-bottom profiler
SEL	Sound Exposure Level
SEL_{cum}	Cumulative sound exposure level
SEL 1/11	Standard Exploration Licence 1/11
SOPEP	Shipboard Oil Pollution Emergency Plan
SPA	Special Protection Area
SPL	Sound Pressure Level
SSS	Side Scan Sonar
Subacoustech	Subacoustech Environmental Ltd
TS	Threshold Shift
TTS	Temporary Threshold Shift
UK	United Kingdom
VSP	Vertical Seismic Profile

1 Introduction

1.1 Background

Exola DAC, a wholly owned subsidiary of Providence Resources P.l.c. (hereafter referred to as 'Exola') is proposing to conduct a site survey within the Barryroe licence area (SEL 1/11); situated in the North Celtic Sea Basin approximately 43 kilometres (km) south east of the closest coastline at Ballymacshoneen, Butlerstown North, County Cork on the south coast of Ireland.

The site survey will comprise a seabed and shallow geophysical survey and an environmental baseline and habitat assessment survey to be conducted over three survey areas, encompassing four potential well locations, within two separate survey vessel activity areas at the Barryroe location, as illustrated in Figure 1.1, together with a single environmental control point located approximately 10 km to the east-southeast. The two survey vessel activity areas cover a total area of approximately 99 km^2 (25 km^2 and 74 km^2 respectively) and allow for a 1 km buffer around the survey areas within which the survey vessel may manoeuvre during line turns and during equipment deployment and recovery.

The survey vessel is anticipated to be working on location for approximately 16 days, excluding transit, port calls and weather downtime. Operations are proposed to take place between the 1st April 2019 and 30th November 2019, subject to regulatory approval and vessel availability. If the survey has not commenced within this timeframe, the operations will be undertaken sometime between 1st February 2020 and 30th November 2020, again subject to regulatory approval and vessel availability.

The key objective of the site survey is to collect data to inform the planning process for an appraisal drilling programme at Barryroe. Specifically, the site survey aims to:

- Accurately determine water depths and provide information on depth of sediments overlying chalk bedrock and to identify and map any chalk exposures;
- Provide information on seabed and sub seabed conditions to ensure the safe emplacement and operation of a semi-submersible drilling rig at four proposed well locations;
- Provide information on the cultural potential of the survey area, including the location of any shipwrecks or other underwater cultural heritage features;
- Assess the survey area for the presence of any Annex 1 habitats (as defined in the EC Habitats Directive 92/43/EC);
- Obtain environmental baseline samples across the survey area to establish a benchmark for ongoing environmental monitoring as per OSPAR guidelines.

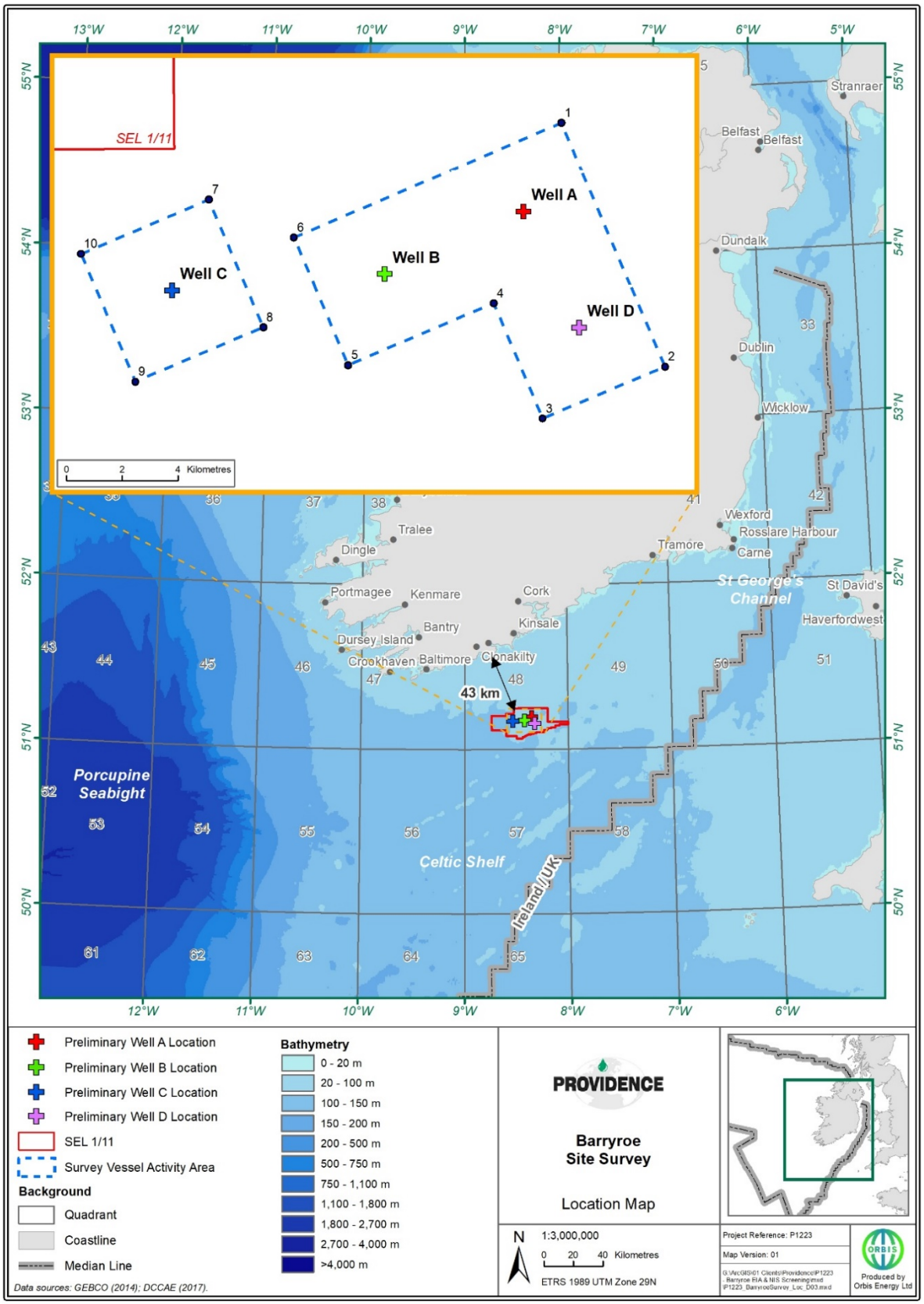
This site survey will not require the acquisition of 2D High Resolution seismic data, which would normally be included in the scope of a site survey. It is estimated that it would have taken up to 29 days, excluding weather downtime, to acquire 2D High Resolution seismic data over the survey areas (assuming IOGP guidelines for survey design were followed). Instead, Exola has utilised a specific High Resolution Short Offset processing product from the existing 3D seismic data which was acquired in 2011. The ability to utilise the existing 3D seismic data avoids the need to use airguns during the site survey, significantly reducing the potential impact of the proposed operations on marine life.

This Environmental Impact Assessment (EIA) Screening Report has been prepared to accompany the Application for Approval to Conduct a Geophysical or other Exploration Survey, Site Survey or Route Survey, as required under Part 2 of the Rules & Procedures Manual for Offshore Petroleum Exploration and Appraisal Operations (DCENR, 2014). The report has been prepared in accordance with the European Commission's Environmental Impact Assessment of Projects Guidance on Screening (Directive 2011/92/EU as amended by 2014/52/EU) (2017).

In light of the terms of the Order made by the High Court on 30 January 2019, in High Court Proceedings Record No. 2018/943J.R., in relation to the permission previously granted on 9th October, 2018, Exola is now seeking a new permission for the same type and specification of work, which has

now been refined to a smaller area. This new application is supported by this updated EIA Screening Report, an updated Appropriate Assessment (AA) Screening Statement and a Natura Impact Statement.

Figure 1.1: Barryroe Site Survey Area Location Map



1.2 EIA Screening

The EIA Directive, Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, as amended in 1997, 2003 and 2009, codified in Directive 2011/92/EU of 13 December 2011 and further amended by Directive 2014/52/EU of 16 April 2014 (the 2014 Directive), has the objective of ensuring that projects likely to have significant effects on the environment are subject to a comprehensive assessment prior to development consent being given.

Article 4 of the EIA Directive has been amended, and Annex IIA introduced, as part of the 2014 amendments. Article 4(4) has been substituted to introduce Annex IIA regulating the information that the developer must provide for screening of Annex II Projects and requiring the developer to take into account the available results of other relevant assessments of the effects on the environment carried out pursuant to EU legislation other than the EIA Directive.

Annex IIA specifies the information to be provided by the developer to enable the competent authority to make an informed Screening Decision about the need for an EIA. The information to be provided includes:

- A description of the project, including in particular:
    - A description of the physical characteristics of the whole project and, where relevant, of demolition works;
    - A description of the location of the project, with particular regarding the environmental sensitivity and of the geographical areas that are likely to be affected;
- A description of the aspects of the environment likely to be significantly affected by the project;
- A description of any likely significant effects, to the extent of the information available on such impacts, of the project on the environment resulting from:
    - The expected residues and emissions and the production of waste, where relevant;
    - The use of natural resources, soil, land, water, and biodiversity in particular.

The report has been prepared so as to ensure that the competent authority is able to make an informed Screening Decision about the need for an EIA in respect of the proposed Barryroe site survey, in accordance with the provisions of the 2014 Directive, including Annex IIA.

The decision to be made for EIA screening is whether the proposed project is or is not likely to have significant effects on the environment. Where, as in this instance, a case-by-case examination is carried out, the competent authority is required to consider relevant Annex III criteria. Annex III of the EIA Directive includes information concerning the issues that should be considered when determining whether significant environmental effects are likely to result from a project. Indeed, certain of these requirements stem from the 2014 amendments to the EIA Directive.

In Ireland, for oil and gas exploration activities, the EIA Directive is implemented through the European Union (Environmental Impact Assessment) (Petroleum Exploration) Regulations 2013, which allows the Minister for Communications, Climate Action and the Environment to determine on a case by case basis if an EIA is required for any petroleum activities, including geophysical or site surveys,.

Exola has conducted an EIA screening exercise for the proposed Barryroe site survey, the results of which are documented in this report. This has identified that the only source of impact that has the potential to significantly impact the marine environment is the underwater noise generated from the proposed geophysical survey equipment and from the survey vessel itself. This report therefore focuses on the potential impact to species listed under Annex IV of the EU Habitats Directive 92/43/EEC Article 12[1], which are considered to be the most sensitive receptors to the underwater noise which would be produced from the proposed Barryroe site survey operations. In addition, as

[1] In Irish waters Annex IV species include all cetaceans, some turtle species, and otter.

underwater noise may indirectly impact Annex IV species through its effects on prey abundance, behaviour, and distribution; potential impacts to fish and plankton are also assessed.

1.3 Screening Appraisal for Annex IV Species

The Directive 92/43/EC on the Conservation of Habitats, Flora and Fauna (92/43/EEC), referred to as "the Habitats Directive", was adopted in 1992, came into force in 1994 and was transposed into Irish law from 1997 onwards.

The main aim of the Habitats Directive is to contribute towards the conservation of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species listed on the Annexes to the Directive at a favourable conservation status. These Annexes list habitats (Annex I) and species (Annexes II, IV and V) which are considered threatened in the EU territory.

Article 12 of the Habitats Directive requires that Member States take the requisite measures to establish a system of strict protection for Annex IV listed species, including all cetaceans, in their natural range, prohibiting:

- All forms of deliberate capture or killing of individuals in the wild;
- Deliberate disturbance of these species, particularly during breeding, rearing, hibernation and / or migration;
- Deliberate destruction or taking of eggs from the wild;
- Deterioration of or destruction of breeding sites or resting places.

In Ireland, the Habitats Directive is transposed into national legislation via the European Communities (Birds and Natural Habitats) Regulations 2011 to 2015. These regulations apply within Ireland's 200 nautical mile limit for the protection of species (i.e., within the Exclusive Fishery Zone, also termed the Exclusive Economic Zone or EEZ) and to the Continental Shelf for habitats.

Additionally, the Wildlife Acts 1976 to 2018 (conferring specific protection on seals, whales, dolphins and porpoises) currently extend in scope to waters within Ireland's Territorial Sea (i.e. within the 12 nautical mile limit from the baselines).

This screening appraisal has therefore been prepared to demonstrate that the proposed Barryroe site survey will not result in a significant impact on the Annex IV listed species of the Habitats Directive.

1.4 Appropriate Assessment (AA)

A separate AA Screening and Natura Impact Statement (NIS) report is being submitted in conjunction with this report and accompanies the application for permission in respect of the proposed Barryroe site survey.

European sites in Ireland form part of the Natura 2000 network of marine and onshore nature conservation protected areas that are designated under the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (2009/147/EC) to protect species and habitats of conservation importance. They include Special Areas of Conservation (SACs) and candidate SACs (cSACs) and for the protection of certain habitats (Annex I) and species (Annex II) and Special Protection Areas (SPAs) and proposed SPAs for the protection of qualifying bird species (particularly breeding or overwintering populations). Specific conservation objectives have been developed for European sites in relation to their qualifying interests (i.e. habitats and/or species).

In Ireland, Part 5 of the European Communities (Birds and Natural Habitats) Regulations 2011, as amended, deals with appropriate assessment of plans and projects which are not subject to the development consent application provisions of the Planning and Development Act 2000, as amended. Regulation 42(1) requires public authorities, including the Minister for Communications, Climate Action and the Environment, to screen for appropriate assessment for a plan or project which is not directly connected with or necessary to the management of the site as a European site, in view of best scientific knowledge and the conservation objectives of the site, and to assess the plan or project not only individually, but also in combination with other plans or projects likely to have a significant effect on the European site.

The Stage One AA Screening Statement has concluded, on the basis of objective information, that the possibility of significant effects from the proposed Barryroe site survey operations on the qualifying interest species of the following European sites cannot be ruled out: Roaringwater Bay and Islands cSAC, Lower River Shannon cSAC, Saltee Islands cSAC, Blasket Islands cSAC, West Connacht Coast cSAC and Rockabill to Dalkey Island cSAC.

Having ascertained during the screening that it is not possible to rule out, as a matter of scientific certainty, that the proposed site survey operations is either likely to have a significant effect on these European sites, or that any such likelihood is uncertain or cannot be ruled out, an NIS has been prepared as a precautionary measure to inform and assist the competent authority, in carrying out its AA as to whether or not the proposed Barryroe site survey operations will adversely affect the integrity of these European sites either alone or in combination with other plans and projects, taking into account the conservation objectives of the European sites. Mitigation measures are set out within the NIS which ensure that any impacts on the conservation objectives of European sites will be avoided during the proposed site survey operations such that there will be no risk of adverse effects on these European sites.

The NIS has objectively concluded following an examination, analysis and evaluation of the relevant information, including in particular the nature of the predicted impacts from the proposed site survey operations and with the implementation of the mitigation measures proposed, that the proposed Barryroe site survey will not pose a risk of adversely affecting (either directly or indirectly) the integrity any European site, either alone or in combination with other plans or projects, and there is no reasonable scientific doubt in relation to this conclusion.

1.5 Report Structure

The remainder of this report has been structured as follows:

- **Section 2 - Site Survey Operations:** describes the characteristics and location of the proposed Barryroe site survey operations.
- **Section 3 – Potential Environmental Effects Assessment Methodology:** describes the methodology used to determine the existence and significance of potential environmental impacts from the proposed Barryroe site survey operations.
- **Section 4 - EIA Screening Assessment:** documents the EIA screening exercise which has been undertaken for the proposed Barryroe site survey.
- **Section 5 - Annex IV Species in Irish Waters:** provides an overview of the Annex IV species that may be found within the proposed survey area and the wider area and their seasonality. In addition, as underwater noise may indirectly impact Annex IV species through its effects on prey abundance, behaviour, and distribution; fish and plankton are also considered.
- **Section 6 – Appraisal of Potential Impacts on Annex IV Species:** discusses the potential impacts to Annex IV species from the underwater noise generated by the proposed Barryroe site survey operations.
- **Section 7 – Conclusions**

2 Site Survey Operations

2.1 Overview

The proposed Barryroe site survey will comprise a seabed and shallow soils survey (the geophysical survey scope) and an environmental baseline and habitat assessment survey to be conducted within two separate survey vessel activity areas at Barryroe, as illustrated in Figure 1.1.

Operations are proposed to take place sometime between the 1st April 2019 and 30th November 2019, subject to regulatory approval and vessel availability. If the survey has not commenced within this timeframe, the operations will be undertaken sometime between 1st February 2020 and 30th November 2020, again subject to regulatory approval and vessel availability.

The anticipated duration of the survey is approximately 16 working days (excluding transit, port calls and weather downtime). It should be noted that the geophysical survey will take approximately 6 days to complete with the remaining time (approximately 10 days) spent collecting the environmental data (grab samples, photography and USBL positioning).

The vessel proposed to be used for the survey is the MV Kommander. Prior to the commencement of the proposed site survey operations, if this vessel is no longer available, Exola reserve the right to seek approval from the Department for Communications, Climate Action and the Environment (DCCAE) to use an alternative equivalent survey vessel. The change in vessel will not impact on any of the conclusions drawn in this report.

2.2 Survey Area

The proposed site survey operations at Barryroe will be conducted over three survey areas, targeting four potential well locations:

- 1 x survey area, 8.5 km by 3 km in size, encompassing two potential well locations (labelled 'Well A' and 'Well B');
- 1 x survey area, 3 km by 3 km in size, centred on a potential well location (labelled 'Well C');
- 1 x survey area, 3 km by 3 km in size, centred on a potential well location (labelled 'Well D').

The three site survey areas are located within two separate survey vessel activity areas as shown in Figure 2.1. The two survey vessel activity areas (covering a total area of approximately 25 km^2 and 74 km^2 respectively), allow for a 1 km buffer around the three survey areas within which the vessel may manoeuvre during line turns and during equipment deployment and recovery. Hereafter, these areas are collectively referred to as 'the survey area'.

Figure 2.1 illustrates the example survey line plans centred on the proposed well locations, the surrounding survey vessel activity areas and proposed environmental sampling stations. Outside of the survey vessel activity areas, additional environmental sampling will be conducted at one control location, located approximately 10 km to the east-southeast as shown on Figure 2.1.

The coordinates for the survey vessel activity areas and proposed well locations are listed in Table 2.1.

Table 2.1: Proposed Barryroe Survey Area Coordinates [1]

Survey Corner (see Figure 1.1)	Latitude	Longitude
Survey Vessel Activity Area		
1	51° 13'23.136"N	8° 19' 46.774" W
2	51° 8' 37.747" N	8° 16' 39.081" W
3	51° 7' 38.558" N	8° 20' 26.636" W
4	51° 9' 53.395" N	8° 21' 55.413" W

Survey Corner (see Figure 1.1)	Latitude	Longitude
5	51° 8' 42.78" N	8° 26' 26.032" W
6	51° 11' 12.138" N	8° 28' 4.795" W
Survey Vessel Activity Area		
7	51° 11' 56.87" N	8° 30' 41.621" W
8	51° 9' 27.451" N	8° 29' 2.627" W
9	51° 8' 25.187" N	8° 33' 0.167" W
10	51° 10' 54.551" N	8° 34' 39.338" W
Proposed Well Locations		
Well A	51° 11’ 40.007” N	08° 20’ 58.255” W
Well B	51° 10’ 28.562” N	08° 25’ 16.546” W
Well C	51° 10’ 11.034” N	08° 31’ 50.938” W
Well D	51° 09’ 24.28” N	08° 19’ 16.949” W

Notes
[1] ETRS 1989 UTM Zone 29N.

2.3 Survey Location

The proposed Barryroe survey area is located within Standard Exploration Licence (SEL) 1/11, in the North Celtic Sea Basin (Figure 1.1). Water depths within SEL 1/11 range from around 90 to 110 metres (m) (*GEBCO, 2014*).

The continental shelf, slope and deep oceanic waters around Ireland support a diverse range of important wildlife and habitats due to the warm oceanic currents of the North Atlantic Drift and the Irish shelf front.

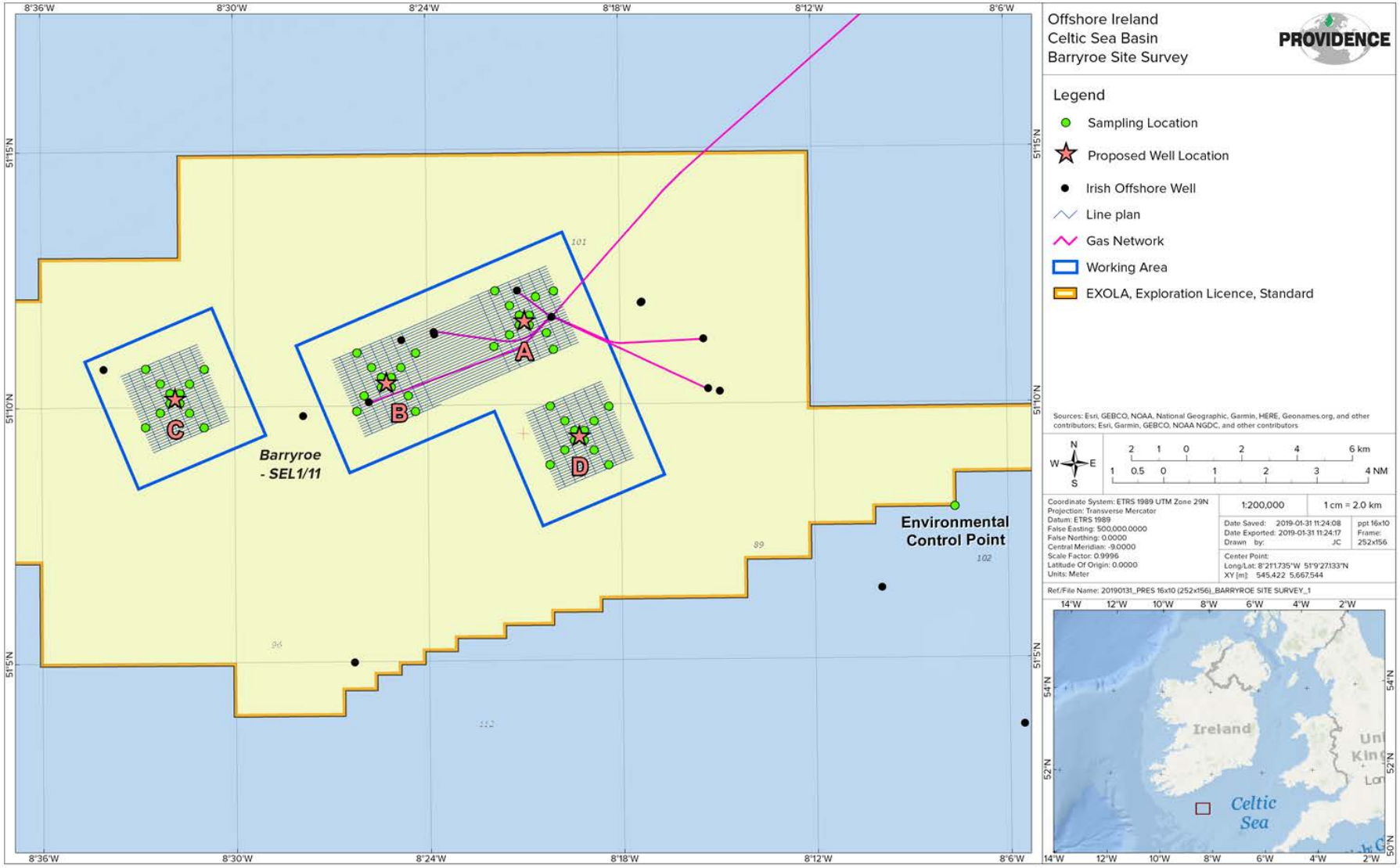
At its closest point the survey area is approximately 43 km south east of the County Cork coastline on the south coast of Ireland. There are a number of European sites with marine features located on the south and south west coast of Ireland. As previously detailed in Section 1.4, a Stage One AA Screening Statement has been undertaken to outline the information required for the competent authority to screen for AA and determine whether the proposed Barryroe site survey, either standalone or in combination with other plans and projects, in view of best scientific knowledge, is likely to have a significant effect on any European site. The AA Screening Statement has concluded, on the basis of objective information that the possibility of significant effects from the proposed Barryroe site survey operations cannot be ruled out for the following European sites: Roaringwater Bay and Islands cSAC, Lower River Shannon cSAC, Saltee Islands cSAC, Blasket Islands cSAC, West Connacht Coast cSAC and Rockabill to Dalkey Island cSAC.

A NIS has therefore been undertaken to examine and analyse, in light of the best scientific knowledge, with respect to the above-mentioned European sites, the potential impact sources and pathways from the proposed site survey operations, how these could impact on the sites' qualifying interests and whether the predicted impacts would adversely affect the integrity of the European sites. Mitigation measures are set out within the NIS which will ensure that any impacts on the conservation objectives of European sites will be avoided during the proposed site survey operations such that there will be no risk of adverse effects on these European sites.

The nearest international boundary to the survey area is the Ireland / UK median line, which lies approximately 71 km to the south east.

The licence area SEL 1/11 contains existing oil and gas infrastructure operated by PSE Kinsale Energy Limited, namely wells associated with the Seven Heads gas fields and pipelines which connect the Seven Heads field with the Kinsale Head gas field (see Figure 2.1).

Figure 2.1. Provisional location of proposed survey lines, seabed samples and proposed future well locations identified as A, B, C & D



2.4 Survey Scope

2.4.1 Geophysical Survey

The purpose of the geophysical survey is to accurately determine water depths, provide information on depth of sediments overlying chalk bedrock and to identify and map any chalk exposures, and locate and identify any seabed and sub seabed features or obstructions to ensure the safe emplacement and operation of a semi-submersible drilling rig at the proposed well locations.

The data obtained from the geophysical survey will also be analysed to assess the survey area for the presence of any Annex 1 habitats (as defined in the EC Habitats Directive 92/43/EC) and provide information on the cultural potential of the survey area, including the location of any shipwrecks or other underwater cultural heritage features.

The geophysical survey will use the following equipment: side scan sonar, single-beam echosounder and multi-beam echosounder, magnetometer and pinger sub-bottom profiler. This equipment will be hull mounted or towed behind the survey vessel. In addition, a subsea Ultra Short Baseline (USBL) beacon system will be utilised during the both the geophysical survey and the environmental baseline and habitat assessment survey to position the survey equipment.

Further details on the typical characteristics of geophysical survey equipment, which are representative of the equipment to be used during the proposed Barryroe site survey operations, are provided below:

- **Dual Frequency Side Scan Sonar**

  Side Scan Sonar (SSS) is used for the mapping of the upper layers of the seabed to determine the texture, topography and character of the seabed and sediments and detect anomalies such as boulders, outcrops, pipelines or reefs. This data is used to assess suitable locations for environmental sampling as well as providing information to conduct an archaeological assessment and indications of any near seabed drilling hazards. SSS emits an acoustic sonar signal towards the seabed that spreads out into a fan shape, or swathe. The SSS then analyses the intensity of the return (or reflectivity) from the seabed, which varies depending on the target characteristics.

  A typical SSS used for site survey activities is a dual frequency Edgetech 4200, operating at 120 and 410 kHz with an expected pulse interval of approximately 200 ms. High frequencies tend to record higher resolution but have a poorer penetration of the seabed and lower frequencies have a greater penetration, therefore dual frequency optimises acquisition. The SSS will be towed subsea behind the survey vessel at a sufficient height in the water column suitable for the penetration of the primary frequency and at a depth to avoid any seabed obstructions.

- **Single-beam Echosounder and Multi-beam Echosounder**

  Single-beam echosounders (SBES) and multi-beam echosounders (MBES) are usually used in conjunction with SSS. They are used to survey bathymetry and seabed topography by emitting pulses of sound that reflect from the seabed. Unlike SSS, which measures the strength of the return signal, echosounders measure the time for a signal to return to the transmitter. MBESs produce a fan of beams and can produce high-resolution bathymetry maps of the seabed. The typical frequency range of a lower frequency MBES system is 70 kHz to 100 kHz, while the typical frequency range of a SBES is 10 to 200 kHz (Genesis, 2011).

  For the purpose of this assessment, it is assumed that the following typical echosounder equipment will be used:

  - SBES: Kongsberg EA400 operating at 200 kHz at an expected pulse interval of approximately 200 ms;
  - MBES: Kongsberg EM710 operating between 70 and 100 kHz at an expected pulse interval of approximately 1,500 ms.

The SBES and MBES data will also be used to assess suitable locations for environmental sampling as well as providing information to conduct an archaeological assessment. Both echosounders will be hull-mounted.

- **Pinger Sub-bottom Profiler**

  Geophysical pingers are used to achieve information from the seabed immediately below the surface layers. Pingers offer a very high resolution, but limited penetration dependent upon the seabed sediments (a few tens of metres in mud, much less in sand or rock). Pingers periodically emit a high frequency 'ping' and typically operate on a range of single frequencies between 3.5 - 7 kHz (Genesis, 2011). This data is used to provide information to conduct an archaeological assessment as well as indications of any shallow drilling hazards.

  A typical pinger sub-bottom profiler (SBP) used for site survey activities is the 16 element Kongsberg GeoPulse, operating at 3.5 kHz, with an expected pulse interval of approximately 200 ms. The SBP will be hull-mounted.

- **Magnetometer**

  Magnetometers are used to identify magnetic anomalies on the seabed. The equipment takes passive measurements (i.e. does not actively emit a source signal) and is therefore not considered to produce a significant level of noise. The magnetometer will be towed behind the survey vessel.

- **USBL**

  A USBL system is normally used to confirm positioning of underwater equipment. For site survey activities, a typical USBL is the Sonardyne Ranger 2, operating between 26.5 and 33.5 kHz at an expected pulse interval of approximately 500 ms.

As a worst case, this assessment assumes the SBES, MBES, SSS, SBP and USBL are operational at the same time along with vessel noise.

2.4.2 Environmental Baseline and Habitat Assessment Survey

The survey area will be assessed for habitats and / or species of conservation importance such as Annex I habitats or evidence of any species or habitats on the OSPAR List of Threatened and / or Declining Species (OSPAR, 2019). Any potentially sensitive habitats identified from anomalies on the geophysical survey data (e.g. MBES and SSS) will be investigated (ground-truthed) using high-resolution video or camera stills.

Seabed (benthic) samples will also be taken using a day grab, box corer or dual Van Veen grab, as appropriate. These samples will be used to ground-truth geophysical and visual survey data, provide information on benthic faunal community composition and physico-chemical characteristics of the sediments including particle size distribution, total organic matter content, heavy and trace metals content and hydrocarbon content.

Figure 2.1 shows the provisional location of 53 environmental stations (labelled 'sample locations'). There are 13 stations surrounding each proposed well location; however, it should be noted that the number and location of seabed sampling stations will be defined by the number of habitats delineated by the geophysical survey. A control station will also be sampled in an area not expected to be impacted by the proposed drilling operations, approximately 10 km east-southeast of the proposed well locations.

It is estimated that approximately $1m^2$ of seabed will be disturbed at each sampling location when obtaining the seabed samples.

2.5 Emissions, Discharges & Waste

2.5.1 Atmospheric Emissions

Atmospheric emissions will be generated during the proposed Barryroe site survey operations from the combustion of hydrocarbons for power generation by the survey vessel. It is estimated that the

proposed survey vessel will consume between 4 and 5 tonnes of fuel per day (at survey speed), equating to 80 tonnes over the course of the duration of the proposed site survey operations, excluding transit, port calls and weather downtime. Table 2.2 provides a worst-case estimate of the emissions to the atmosphere arising from the proposed site survey operations.

Table 2.2: Estimated Atmospheric Emissions Generated During the Proposed Site Survey Operations

Fuel Use (tonnes / day)	No. of Days on Site	Total Fuel Use (tonnes)	Total Emissions (tonnes) [1]							
			CO_2	CO	NO_X	N_2O	SO_2	CH_4	VOC	$C0_2$ eq
5	16	80	256	1.26	4.75	0.02	0.32	0.01	0.16	262

[1] Emissions factors from DECC (2008).

2.5.2 Routine Marine Discharges

It is estimated that a maximum of approximately 200 litres per person per day of grey water will be generated during the proposed site survey operations, as well as 5 litres of black water (sewage) per person per day (MARPOL guidelines). Assuming, as a worst case, 40 people will be onboard the survey vessel, this equates to 131,200 litres (131 m^3) of waste water generated over the duration of the survey period (i.e. 16 days). Other routine marine discharges generated from the survey vessel will include macerated food waste, bilge water and ballast water. All routine marine discharges will be controlled in line with MARPOL requirements, implementing Irish regulations and IMO guidelines.

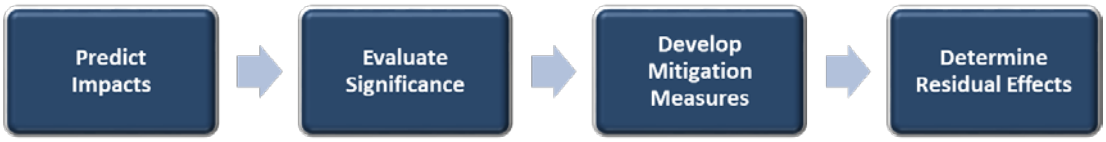
2.5.3 Waste

A small amount of solid waste (estimated to be less than 5 tonnes) will be produced on board the vessel during the proposed site survey operations. This may include, for example, recyclables (glass, aluminium and tin cans, cardboard, paper and plastic), scrap metals, batteries, and electrical equipment. Solid waste will be appropriately stored on the vessel and returned to shore for handling in accordance with the Sea Pollution (Prevention of Pollution by Garbage from Ships) Regulations 2012.

3 Potential Environmental Effects Assessment Methodology

The process which has been used to determine the existence and significance of potential environmental effects from the proposed Barryroe site survey operations is illustrated in Figure 3.1.

Figure 3.1: Potential Environmental Effects Assessment Process



3.1 Impact Identification

The process commences with the identification of the project activities (or aspects) that could potentially impact the environment, with consideration given to both planned (routine) and unplanned (accidental) events, noting that impacts can be:

- Direct: resulting from a direct interaction between the project and a receptor; and
- Indirect: whereby impacts are not a direct result of the project often produced away from or as a result of a complex pathway.

For the proposed Barryroe site survey operations, potential environmental impacts have been identified through a systematic process whereby the activities associated with the project have been considered with respect to their potential to interact with the environment, with reference to the requirements of Annex IIA of the 2014 Directive, the European Commission EIA Screening Guidance (2017) and relevant DCCAE (formerly the Department for Communications, Energy and Natural Resources; DCENR) Irish Offshore SEA (IOSEA) documents.

Based on the characteristics of the project, as described in Section 2, and the location of the proposed survey area in the North Celtic Sea Basin, those activities which could result in potential environmental impacts are presented in Table 3.1.

In summary, the following potential impacts have been identified:

- **Planned Events**
  - Disturbance to shipping, including leisure vessels / ferries and commercial fishing activities from the physical presence of the survey vessel and equipment;
  - Disturbance to seabed communities, underwater cultural heritage features or existing seabed infrastructure due to grab sampling at the proposed environmental stations;
  - Disturbance / injury to sensitive marine fauna including marine mammals, fish and shellfish, marine reptiles and plankton from the underwater noise generated from the geophysical survey equipment as well as from the survey vessel itself;
  - Impacts to air quality due to atmospheric emissions generated from the combustion of hydrocarbons for power generation by the survey vessel;
  - Impacts to water quality due to routine marine discharges from the survey vessel, namely grey water, black water (sewage), macerated food waste, bilge water and ballast water.
- **Unplanned Events**
  - Accidental spill of diesel fuel or other utility fluid during normal operations or through accidental damage to the survey vessel as a result of collision with another vessel.
  - Risk of injury to marine mammals from collision with the survey vessel or equipment.

Table 3.1: Potential Interactions between the Proposed Barryroe Site Survey Operations and the Environment

Project Activity / Hazard	Physical Environment			Biological Environment							Human Environment					
	Sediment Quality	Water Quality	Air Quality	Plankton	Seabed Communities	Fish & Shellfish	Seabirds	Marine Mammals	Marine Reptiles	Designated Habitats & Species	Shipping	Commercial Fisheries	Cultural Heritage	Existing Seabed Infrastructure	Recreation & Tourism	Human Health
Planned Events																
Physical presence of the survey vessel and equipment											■	■			■	
Seabed disturbance from day grab, box corer or dual Van Veen grab sampling					■	■				■			■	■		
Underwater noise generated from geophysical equipment and the survey vessel				■		■		■	■	■						
Routine marine discharges from the survey vessel		■														
Atmospheric emissions due to energy requirements of the survey vessel			■													
Unplanned Events																
Accidental spill of diesel fuel or other utility fluid		■		■	■	■	■	■	■	■	■	■			■	
Risk of injury to marine mammals from collision with the survey vessel or equipment								■								

■ Receptor has the potential to be impacted by the proposed site survey operations

The proposed site survey operations will not interact with the receptor or will have a negligible impact

3.2 Evaluation of Significance

To help determine whether any of the identified impacts are likely to result in significant effects on the environment, an EIA screening assessment has been completed, as documented in Section 4 of this report, the format of which is based on the DCCAE EIA Screening Table for Seismic (DCCAE, 2019) and the European Commission EIA Screening Guidance (2017).

When completing the assessment, to ensure the evaluation process was as objective and transparent as possible, the following defined scoring methodology has been applied. Note, where uncertainty affects the evaluation of significance, a worst-case approach has been used.

3.2.1 Planned Events

For planned events, the significance of environmental impacts has been evaluated by considering the sensitivity of the receptor affected (Table 3.2) in combination with the magnitude of impact that is likely to arise (Table 3.3), taking into account the criteria detailed in Annex III of the 2014 EIA Directive, namely:

- The magnitude and spatial extent of the impact (for example the geographical area and size of the population likely to be affected);
- The nature of the impact;
- The transboundary nature of the impact;
- The intensity and complexity of the impact;
- The probability of the impact;
- The expected onset, duration, frequency and reversibility of the impact;
- The cumulation of the impact with the impact of other existing and / or approved projects and / or projects not yet approved, but that Exola are aware of;
- The possibility of effectively reducing the impact.

Table 3.2: Determining Sensitivity

		Vulnerability of Receptor / Resource		
		Low: generally tolerant of effect. Immediate recovery and easily adaptable to changes.	*Medium*: some tolerance / ability to adapt to effect. Recovery to an acceptable status over the short to medium term.	*High*: limited tolerance / ability to adapt to effect. Recovery not expected for an extended period or that cannot be readily rectified.
Importance of Receptor	*Low*: receptor of low value or importance	**Low**	**Low**	**Medium**
	Medium: receptor is of local or regional importance	**Low**	**Medium**	**High**
	High: receptor is of high value or is of national or international importance	**Medium**	**High**	**High**

Table 3.3: Determining Magnitude of Impact

Magnitude	Definition
Large	Permanent or long-term substantial change in baseline environmental conditions. Impact may be experienced over a wide area. Routine exceedance in quality standards.
Medium	Medium-term discernible change in baseline environmental conditions. Impact may be regional in scale. Occasional exceedance in quality standards. No permanent impacts are predicted.
Small	Short-term and/or localised discernible change in baseline environmental conditions. Impact would not result in exceedance of relevant quality standards.
Negligible	Immeasurable, undetectable or within the range of normal natural variation.

The sensitivity of the receptor affected and the magnitude of impact are then combined using the matrix shown in Table 3.4 to determine the overall significance of the potential environmental impact.

Table 3.4: Significance Evaluation Matrix for Planned Events

		Magnitude of Impact			
		Negligible	**Small**	**Medium**	**Large**
Sensitivity of Receptor	**Low**	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Major
	High	Negligible	Minor	Moderate	Major

Significance Definitions

Major	**Considered to be significant:** the level of effect on the environment is unacceptable. Measures are required to eliminate, reduce or otherwise mitigate potentially significant adverse effects on the environment.
Moderate	**Considered to be potentially significant:** further assessment is required to determine the level of significance. Mitigation measures may be required.
Minor	**Not considered to be significant:** effects on the environment are usually managed through good industry practice and operational plans and procedures.
Negligible	**Not considered to be a significant:** no action required.

For the purposes of this assessment, impacts ranked as Major are considered to result in significant effects on the environment. Impacts ranked as Moderate may result in significant effects, but require further assessment. Where necessary, measures may need to be taken to avoid or prevent significant adverse effects on the environment through design or operational mitigation measures. Impacts ranked as Minor or Negligible are not considered to result in significant effects on the environment.

3.2.2 Unplanned Events

For unplanned events, such as accidental hydrocarbon releases, significance has been determined using the following oil and gas industry standard risk assessment approach:

Risk = Likelihood of Occurrence (Frequency / Probability) x Magnitude of Impact (Consequence)

The criteria used to define the likelihood of an event occurring, the magnitude of impact and the overall risk are provided in Tables 3.5 to 3.7, again taking into consideration the criteria detailed in Annex III of the 2014 Directive.

For the purposes of this assessment, High risk events are considered to have the potential to result in significant effects. Medium risk events are those which may result in significant effects, but require further assessment. Low risk effects are not considered to result in significant effects.

Table 3.5: Determining Likelihood of Occurrence

Likelihood	Definition
Remote	Event is extremely unlikely to occur during the project given the industry best practises and procedures that are in place
Possible	Event has occurred in a minority of similar projects, but is unlikely to occur during the project
Likely	Event could easily occur during the project
Very Likely	Event is almost certain to occur during the project

Table 3.6: Determining Magnitude of Impact

Magnitude	Definition
Severe	Widespread, long-term or potentially irreversible effects on the ecosystem. Persistent severe environmental and socio-economic damage that will lead to loss of commercial or recreational use over a wide area for an extended period of time. Major transboundary effects expected. Intervention by national and international governmental bodies.
Major	Major, medium-term effects on the ecosystem at a regional or national level. Medium-term loss of commercial or recreational use from localised areas. Transboundary effects expected. Possible intervention by national governmental bodies.
Moderate	Moderate, short to medium-term effects on the ecosystem at a regional or local level. Transboundary effects possible. Regional / local public concerns at the community or broad interest or group level.
Minor	Short-term, limited effects on the ecosystem at a local level. Unlikely to result in transboundary effects. Limited stakeholder concern or public interest.
Negligible	Immeasurable, undetectable or within the range of normal natural variation.

Table 3.7: Significance Evaluation Matrix for Unplanned Events

		Likelihood			
		Remote	**Possible**	**Likely**	**Very Likely**
Consequence	**Negligible**	Low	Low	Low	Low
	Minor	Low	Low	Medium	Medium
	Moderate	Medium	Medium	Medium	Medium
	Major	Medium	Medium	High	High
	Severe	Medium	High	High	High

Significance Definitions

High	**Considered to be significant:** the level of risk is unacceptable.
Medium	**Considered to be potentially significant:** further assessment is required to determine if the level of risk is acceptable. Mitigation measures may be required.
Low	**Not considered to be significant:** the risk can be managed through good industry practice and operational plans and procedures.

4 EIA Screening Assessment

Table 4.1 documents the EIA screening assessment which has been undertaken for the proposed Barryroe site survey to help determine whether any of the impacts identified in Section 3 are likely to result in significant effects on the environment. The structure of the assessment is based on the DCCAE EIA Screening Table for Seismic (DCCAE, 2019) and the European Commission EIA Screening Guidance (2017).

The EIA screening assessment identified that the only source of impact that has the potential to result in a significant effect is the underwater noise generated from the proposed geophysical survey equipment and from the survey vessel itself. Further assessment work has been undertaken, the results of which are documented in Sections 5 and 6 of this report, to determine the magnitude and spatial extent of the impact to marine fauna and therefore whether the proposed Barryroe site survey is or is not likely to have a significant effect on the environment.

Table 4.1: EIA Screening Assessment

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
1. Will construction, operation or decommissioning of the Project involve actions which will cause physical changes in the locality (topography, land use, changes in waterbodies, etc.)?	Yes – Seabed sampling (day grab, box cores or dual Van Veen grab) will be undertaken at 53 sampling locations (refer to Section 2.3.2) potentially impact seabed communities and underwater cultural heritage features.	No – It is estimated that approximately 1m^2 of seabed will be disturbed at each sampling location when obtaining the seabed samples, equating to a total area of 53m^2. Stations will be investigated prior to sampling using high-resolution video or stills photography to ensure no potentially sensitivity seabed features, including cultural heritage features, are impacted. The sensitivity of the receptors which could potentially be impacted is therefore considered to be Low. Due to the very small area of seabed which would be disturbed by the proposed sampling operations, the magnitude of impact is Small. The impact on the environment is therefore considered to be Minor and no significant effects are predicted.
2. Will construction or operation of the Project use natural resources such as land, water, materials or energy, especially any resources which are non-renewable or in short supply?	Yes – Fuel for power generation, utilities hydrocarbons and water will be used during the survey.	No - The amount of resources required will be limited due to the short duration of the proposed survey operations (approximately 16 days) and the limited number of people on the survey vessel (as a worst case up to 40). Exola will ensure the operations are planned so they are conducted efficiently, minimising fuel consumption. Any impact to the environment is therefore considered Negligible and no significant effects are predicted.
3. Will the Project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health?	Yes – Fuel for power generation, utilities hydrocarbons and some utilities chemicals	No – Appropriate steps will be taken regarding the use and handling of substances that could be harmful to human health or the environment, in accordance with MARPOL, the Sea Pollution (Prevention of Oil Pollution) Regulations 2007 (as amended), the Sea Pollution (Prevention of Pollution by Sewage from Ships) Regulations 2006 (as amended) and the Safety, Health and Welfare at Work Act 2005. Any impact to the environment is therefore considered Negligible and no significant effects are predicted.
4. Will the Project produce solid wastes during construction or operation or decommissioning?	Yes – A small amount of solid waste (estimated to be less than 5 tonnes) will be produced on board the vessel during the proposed site survey operations (refer to Section 2.5.3).	No –Solid waste will be appropriately stored on the vessel and returned to shore for handling in accordance with the Waste Management Hierarchy, MARPOL and the Sea Pollution (Prevention of Pollution by Garbage from Ships) Regulations 2012. Exola will also ensure that the site survey contractor uses authorised waste contractors. A Garbage Management Plan will be in place on the survey vessel in accordance with MARPOL Annex V. There will be no impact to the marine environment and

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
		therefore no significant effects are predicted.
5. Will the Project release pollutants or any hazardous, toxic or noxious substances to air or lead to exceeding Ambient Air Quality standards in Directives 2008/50/EC and 2004/107/EC?	Yes – atmospheric emissions will be generated from the combustion of hydrocarbons for power generation by the survey vessel (refer to Section 2.5.1).	No – Whilst there may be locally elevated concentrations of gases, these will be of short duration given the exposed offshore location of the proposed survey area which will promote the rapid dispersion of emissions and therefore any impact to local air quality will be Negligible and no significant effects are predicted. Atmospheric emissions also have the potential to result in wider scale impacts as they may contribute to anthropogenic global warming, attributable to greenhouse gas emissions notably carbon dioxide (CO_2) and methane (CH4); ground level ozone formation, caused by reactions between volatile organic compounds (VOCs) and nitrogen oxide (NOx) and acidification, caused by emissions of acid gases such as NOx and sulphur oxides (SOx). However, given the small scale and temporary nature of the proposed site survey operations, any impacts in a national or global context will be Negligible and no significant effects are predicted. For example, greenhouse gas emissions in Ireland were 60.75 million tonnes carbon dioxide equivalent (Mt CO_2 eq) in 2017 (EPA, 2018). Therefore the emissions from the survey vessel will only account for a very small percentage (less than 0.0015 %) of the total annual CO_2 eq emissions in Ireland. Exola will ensure that the site survey contractor complies with the Merchant Shipping (Prevention of Air Pollution from Ships) (Amendment) Regulations 2014 and the MARPOL Convention 73/78 Appendix VI on atmospheric emissions.
6. Will the Project cause noise and vibration or release of light, heat energy or electromagnetic radiation?	Yes – Underwater noise will be emitted from the geophysical survey equipment and the survey vessel. Light will be emitted from the survey vessel in low light conditions.	No - Many marine species are vulnerable to anthropogenic noises that may disrupt their ability to perceive their surrounding environment. In order to determine the magnitude and spatial extent of the impact to marine fauna from the underwater noise generated by the geophysical survey equipment and the survey vessel and therefore whether significant effects are likely, further assessment work has been undertaken. The results of this assessment are documented in Sections 5 and 6 of this report. This has concluded that no significant effects are predicted. Any impacts from light emissions emitted by the survey vessel are considered Negligible. No significant effects are predicted as a result of

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
		light emissions.
7. Will the Project lead to risks of contamination of land or water from releases of pollutants onto the ground or into surface waters, groundwater, coastal waters or the sea?	Yes – There is a risk of an accidental spill of diesel fuel or other utility fluid being released to the marine environment through accidental damage to the survey vessel as a result of collision with another vessel. This could reduce water quality and result in toxicity effects on marine fauna. In addition, there will be routine marine discharges from the survey vessel (refer to Section 2.5.2).	No –Given the offshore location of the proposed survey area, any discharges to sea will rapidly disperse and the survey vessel will be compliant with MARPOL. Any impact to water quality due to routine marine discharges from the survey vessel is therefore considered to be Negligible. In addition, the likelihood of a collision occurring is remote due to the various positioning systems / automatic identification system (AIS) / radar on the survey vessel. A FLO will be appointed to maintain good communication with local fisheries and co-ordinate activities throughout the proposed site survey operations. In addition, notifications will be made to 'regular runners' and local fisheries organisations via Notices to Mariners through the Irish Coast Guard and notifications will be made to government departments and agencies as stipulated in the DCCAE Exploration and Appraisal Rules and Procedures Manual (DCENR, 2014). Refuelling of the survey vessel will be undertaken in port. The survey vessel will have a Shipboard Oil Pollution Emergency Plan (SOPEP) in place in accordance with Annex I of MARPOL. Small spill kits will also be on board the survey vessel to clean up any deck spills and prevent them entering the sea. In the unlikely event of an accidental release of diesel, the impact would be minor as diesel is a light oil; once spilt it is likely to remain on the sea surface and be subject to high rates of evaporation as it has a large percentage of light and volatile compounds (ITOPF, 2011). The risk of an accidental spill is therefore Low and no significant effects are predicted.
8. Will there be any risk of accidents during construction or operation of the Project which could affect human health or the environment?	Yes – There is a risk of an accidental spill of diesel fuel or other utility fluid being released to the marine environment through accidental damage to the survey vessel as a result of collision with another vessel. There is also a risk of injury to marine mammals from collision with the survey vessel or equipment.	No – The presence of the survey vessel will only marginally increase the level of overall vessel activity within and adjacent to the proposed survey area. The risk of an accident occurring, such as a collision is Low (likelihood is remote and magnitude of impact is minor). The likelihood of a collision occurring is remote due to the various positioning systems / automatic identification system (AIS) / radar on the survey vessel. Competent contractors will be selected with good health, safety and environmental (HSE) performance. A FLO will be appointed to maintain good communication with local fisheries and co-ordinate activities throughout

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
		the proposed site survey operations. In addition, notifications will be made to 'regular runners' and local fisheries organisations via Notices to Mariners through the Irish Coast Guard and notifications will be made to government departments and agencies as stipulated in the DCCAE Exploration and Appraisal Rules and Procedures Manual (DCENR, 2014). No significant effects are therefore predicted. With regards to the risk of injury to marine mammals from a collision, the survey vessel is not expected to regularly exceed 5 knots, and therefore will be travelling below the speed threshold where most lethal and serious injuries occur (Laist *et al.,* 2001). No significant effects are therefore predicted.
9. Will the Project result in environmentally related social changes, for example, in demography, traditional lifestyles, employment?	No – The survey is located offshore and the proposed operations are temporary (approximately 16 days).	No significant effects are predicted.
10. Are there any other factors which should be considered such as consequential development that could lead to environmental impacts or the potential for cumulative impacts with other existing or planned activities in the locality?	Yes – Potential cumulative impacts could arise as a result of impacts from the proposed site survey operations in combination with impacts from other users of the sea, namely commercial shipping and fishing activities. Exola is also aware of the following consented or planned projects which have the potential to have a cumulative impact with the proposed Barryroe site survey operations: • PSE Kinsale Energy Limited plan to decommission the Kinsale Area gas fields and facilities, located in the Celtic Sea approximately 15 km north east of the Barryroe survey area. The decommissioning work will occur following cessation of production, which is scheduled to occur between 2020 and 2021; • Nexen Petroleum U.K. Ltd plans to drill a single	No – In the overall context of shipping, including leisure vessels / ferries, and commercial fishing intensity in the Celtic Sea, the additional disturbance from the survey vessel will not result in significant cumulative effects, particularly given the temporary and short term nature of the proposed operations. In addition, no significant cumulative effects are predicted on the receiving environment as result of the proposed Barryroe site survey operations in combination with the proposed Kinsale decommissioning work, given the short term and temporary nature of the operations and the fact that the two projects will not occur concurrently. In addition, given the distance between the Barryroe survey area and the proposed drilling and site survey operations planned to occur in the Porcupine Basin, no significant cumulative effects are predicted. Exola also acknowledges that to date 14 wells have been drilled within SEL 1/11 between 1973 and 2012; of these 7 have been plugged and abandoned, 5 are gas producers (associated with the Seven Heads gas field), 1 is a suspended gas well and 1 is a suspended oil well (DCCAE, 2017). The following six wells are located within the proposed Barryroe survey area:

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
	exploration well in the Iolar prospect in the Porcupine Basin approximately 337 km west of the Barryroe survey area. The earliest start date for drilling operations is April 2019. • Eni Ireland BV is planning to conduct a site survey, scheduled between June and September 2019, targeting the Dunquin South formation in the Porcupine Basin, approximately 256 km to the west of the Barryroe survey area.	• 48/24-7 (gas producer drilled in 2003) and 48/24-5 (gas producer drilled in 2001) adjacent to the potential Well A location; • 48/24-1 (plugged and abandoned in 1974) and 48/24-6 (gas producer drilled in 2003) between the potential Well A and Well B locations; • 48/23-2 (plugged and abandoned in 2003) and 48/23-3 (suspended, drilled in 2006) adjacent to the potential Well B location. In addition, parts of the pipelines connecting the Seven Heads to Kinsale gas fields cross through the proposed survey area. However, as the proposed site survey operations will have little interaction with the seabed, limited to seabed sampling only, which will be conducted at least 200 m from the existing pipeline infrastructure, and given the time which has lapsed since the last drilling activity within SEL 1/11, no significant cumulative effects are predicted.
11. Is the Project located within or close to any areas which are protected under international or national or local legislation for their ecological, landscape, cultural or other value, which could be affected by the Project?	Yes – The survey area is located within the Western European Waters Particularly Sensitive Sea Area (PSSA) designated by the IMO. There are no European sites within or immediately adjacent to the proposed survey area, although a large number of European sites designated for their marine features are located on the south and south west coast of Ireland. The closest of these is located approximately 41 km to the north west (refer to Section 2.3).	No - Many marine species are vulnerable to anthropogenic noises that may disrupt their ability to perceive their surrounding environment. In order to determine the magnitude and spatial extent of the impact to marine fauna from the underwater noise generated by the geophysical survey equipment and the survey vessel and therefore whether significant effects are likely, further assessment work has been undertaken. The results of which are documented in Sections 5 and 6 of this report. This has concluded that no significant effects are predicted.
12. Are there any other areas on or around the location which are important or sensitive for reasons of their ecology e.g. wetlands, watercourses or other waterbodies, the coastal zone, mountains, forests or woodlands, which could be affected by the Project?	No.	No significant effects are predicted.
13. Are there any areas on or around the location	Yes – The continental shelf, slope and deep oceanic waters around	No - Many marine species are vulnerable to anthropogenic noises that may disrupt their

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
which are used by protected, important or sensitive species of fauna or flora e.g. for breeding, nesting, foraging, resting, overwintering, migration, which could be affected by the Project?	Ireland support a diverse range of important wildlife and habitats due to the warm oceanic currents of the North Atlantic Drift and the Irish shelf front (refer to Section 5).	ability to perceive their surrounding environment. In order to determine the magnitude and spatial extent of the impact to marine fauna from the underwater noise generated by the geophysical survey equipment and the survey vessel and therefore whether significant effects are likely, further assessment work has been undertaken. The results of which are documented in Sections 5 and 6 of this report. This has concluded that no significant effects are predicted.
14. Are there any inland, coastal, marine or underground waters (or features of the marine environment) on or around the location which could be affected by the Project?	Yes – The proposed survey will be undertaken in the marine environment and could impact on marine fauna.	No - Many marine species are vulnerable to anthropogenic noises that may disrupt their ability to perceive their surrounding environment. In order to determine the magnitude and spatial extent of the impact to marine fauna from the underwater noise generated by the geophysical survey equipment and the survey vessel and therefore whether significant effects are likely, further assessment work has been undertaken. The results of which are documented in Sections 5 and 6 of this report. This has concluded that no significant effects are predicted.
15. Are there any areas or features of high landscape or scenic value on or around the location which could be affected by the Project?	No – The survey area is located offshore, approximately 43 km from the nearest coastline.	No– The survey vessel will not be visible from shore. No significant effects are predicted.
16. Are there any routes or facilities on or around the location which are used by the public for access to recreation or other facilities, which could be affected by the Project?	No – The survey area is located offshore, approximately 43 km from the nearest coastline.	No – Public routes or facilities will not be impacted. No significant effects are predicted.
17. Are there any transport routes on or around the location that are susceptible to congestion or which cause environmental problems, which could be affected by the Project?	Yes – the coastal regions of the Celtic Sea experience generally high volumes of shipping, with the majority of ships relating to short haul shipping and ferries from Cork, Youghal and Kinsale to Europe. There are also a number of ferry services to the UK and France from Cork and Rosslare. The nearest high density shipping lane is around 41 km to the north east of the proposed survey area	No – The sensitivity of shipping is considered to be Low; the receptor is of regional importance, however, there is adequate sea room for shipping to re-route or avoid the area, as necessary. As the proposed site survey operations are limited in duration and extent, the magnitude of impact on shipping is Small. Various positioning systems / automatic identification system (AIS) / radar will be in use on the survey vessel. Notifications will be made to 'regular runners' via Notices to Mariners through the Irish Coastguard. Notifications will also be

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
	(DCENR, 2011).	made to government departments and agencies as stipulated in the DCCAE Exploration and Appraisal Rules and Procedures Manual (DCENR, 2014). Any impact to shipping is therefore considered to be Minor and no significant effects are predicted.
18. Is the Project in a location where it is likely to be highly visible to many people?	No – The survey area is located offshore, approximately 43 km from the nearest coastline.	No - The survey vessel will not be visible from shore. No significant effects are predicted.
19. Are there any areas or features of historic or cultural importance on or around the location which could be affected by the Project?	No – There are no known features within the survey area; however, an objective of the survey is to provide information on the cultural potential of the survey area, including the location of any shipwrecks or other underwater cultural heritage features.	No – The environmental stations will be investigated prior to sampling using high-resolution video or stills photography to ensure no features of historic or cultural importance are impacted. No significant effects are predicted.
20. Is the Project located in a previously undeveloped area where there will be loss of greenfield land?	No – The survey area is located offshore, approximately 43 km from the nearest coastline Existing oil and gas infrastructure (wells and pipelines) are located within the survey area as illustrated in Figure 2.1 (Section 2).	No – There will be no loss of greenfield land. No significant effects are predicted.
21. Are there existing land uses on or around the location e.g. homes, gardens, other private property, industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying which could be affected by the Project?	Yes – The Celtic Sea is a productive fishing ground with shellfish, demersal and pelagic fisheries operating in the area. The survey area is located in a very active area for demersal fisheries. There is considerable fishing for prawn (*Nephrops*) and mixed whitefish (Sinbad Offshore, 2018). In addition, the licence area SEL 1/11 contains existing oil and gas infrastructure operated by PSE Kinsale Energy Limited, namely wells associated with the Seven Heads gas fields and pipelines which connect the Seven Heads field with the Kinsale Head gas field.	No – Although commercial fisheries is considered to be of high importance, the fishing vessels are able to switch to other fishing grounds in the short-term as the fish stock present in the vicinity of the proposed survey area is not exclusive to this area. The sensitivity of commercial fisheries is therefore considered to be Medium. As the proposed site survey operations are limited in duration and extent the magnitude of impact on commercial fisheries is Small. Dissemination of information to fishery stakeholders will commence as early as possible and effective lines of communication will be maintained during the proposed site survey operations. Notifications will be made to 'regular runners' and local fisheries organisations via Notices to Mariners through the Irish Coast Guard. Notifications will also be made to government departments and agencies as stipulated in the DCCAE Exploration and Appraisal Rules and Procedures Manual (DCENR, 2014). A Fisheries Liaison Officer (FLO) will be appointed to

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
		maintain good communication with local fisheries and co-ordinate activities. Any impact to commercial fisheries is therefore considered to be Minor and no significant effects are predicted. There will be no significant effects on existing gas production activities in licence area SEL 1/11. The proposed site survey operations will have little interaction with the seabed, limited to seabed sampling only, which will be conducted at least 200 m from the existing pipeline infrastructure.
22. Are there any plans for future land uses on or around the location which could be affected by the Project?	No.	No – The proposed site survey operations are temporary and short-term. On completion of the survey the vessel will leave the area and there will be no evidence of the survey having been undertaken. No significant effects are predicted.
23. Are there areas within or around the location which are densely populated or built-up, which could be affected by the Project?	No - The survey area is located offshore, approximately 43 km from the nearest coastline and will not impact densely populated or built-up areas.	No significant effects are predicted.
24. Are there any areas within or around the location which are occupied by sensitive land uses e.g. hospitals, schools, places of worship, community facilities, which could be affected by the Project?	No – There are no sensitive land uses which could be affected by the Project.	No significant effects are predicted.
25. Are there any areas on or around the location which contain important, high quality or scarce resources e.g. groundwater, surface waters, forestry, agriculture, fisheries, tourism, minerals, which could be affected by the project?	Yes – The Celtic Sea is a productive fishing ground with shellfish, demersal and pelagic fisheries operating in the area. The survey area is located in a very active area for demersal fisheries. There is considerable fishing for prawn (*Nephrops*) and mixed whitefish (Sinbad Offshore, 2018). In addition, the licence area SEL 1/11 contains existing oil and gas infrastructure operated by PSE Kinsale Energy Limited, namely wells associated with the Seven Heads gas fields and pipelines which connect the Seven Heads field with the	No – The sensitivity of commercial fisheries is Medium, the receptor is considered to be of high importance but fishing vessels are able to switch to other fishing grounds in the short-term as the fish stock present in the vicinity of the proposed survey area is not exclusive to this area. As the proposed site survey operations are limited in duration and extent the magnitude of impact on commercial fisheries is Small. Dissemination of information to fishery stakeholders will commence as early as possible and effective lines of communication will be maintained during the proposed site survey operations. Notifications will be made to 'regular runners' and local fisheries organisations via Notices to Mariners through the Irish Coast Guard. Notifications

Questions to be considered	Yes / No? Briefly describe	Is this likely to result in a significant effect? Yes / No? – Why?
	Kinsale Head gas field.	will also be made to government departments and agencies as stipulated in the DCCAE Exploration and Appraisal Rules and Procedures Manual (DCENR, 2014). A Fisheries Liaison Officer (FLO) will be appointed to maintain good communication with local fisheries and co-ordinate activities. Any impact to commercial fisheries is therefore considered to be Minor and no significant effects are predicted. There will be no significant effects on existing gas production activities in licence area SEL 1/11. The proposed site survey operations will have little interaction with the seabed, limited to seabed sampling only, which will be conducted at least 200 m from the existing pipeline infrastructure.
26. Are there any areas within or around the location which are already subject to pollution or environmental damage e.g. where existing legal environmental standards are exceeded, which could be affected by the Project?	No.	No significant effects are predicted.
27. Is the project location susceptible to earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions e.g. temperature inversions, fogs, severe winds, which could cause the Project to present environmental problems?	Yes – The proposed survey area is located within an exposed area of the Celtic Sea, which is often subject to poor weather conditions, potentially increasing the risk of a vessel incident resulting in the accidental release of diesel fuel or other utility fluid into the marine environment.	No – The likelihood of a collision occurring is remote due to the various positioning systems / automatic identification system (AIS) / radar on the survey vessel. The survey contractor will be experienced in working in poor weather conditions. Operating criteria for weather conditions (e.g. wind, waves and visibility) will be established and operations suspended if the criteria are exceeded. The magnitude of impact is minor as diesel is a light oil; once spilt it is likely to remain on the sea surface and be subject to high rates of evaporation as it has a large percentage of light and volatile compounds (ITOPF, 2011). The level of risk is therefore Low and no significant effects are predicted.

5 Annex IV Species in Irish Waters

5.1 Introduction

This section focuses on the Annex IV species found in Irish waters, which includes all species of cetaceans (whales, dolphins and porpoises), four species of marine reptile and the European otter (*Lutra lutra*), as these species have the potential to be significantly impacted by the underwater noise generated from the proposed Barryroe site survey operations. As Annex IV species may be impacted through effects on prey abundance, behaviour, and distribution; fish and plankton are also considered. In addition, the grey seal (*Halichoerus grypus*) and the harbour seal (*Phoca vitulina*) are the two pinniped (seal) species native to Irish waters (DCENR, 2015; NPWS, 2018a). Although seals are not Annex IV species, they are listed under Annex II of the Habitats Directive (i.e. species of community interest whose conservation requires the designation of SACs). The potential presence of seals within the vicinity of the proposed survey area has therefore been considered for completeness as seals are known to be sensitive to underwater noise generated by geophysical surveys.

The waters comprising Ireland's continental shelf, slope and deep oceanic waters contain a diversity of important habitats that support a number of Annex IV species and a number of factors determine their distribution and abundance (DCENR, 2015). A feature that may play an important role in the distribution and abundance of Annex IV species in the region is the North Atlantic Drift. These warm oceanic currents, meeting the western European continental shelf water body, result in seasonal climatic, sea temperature and salinity conditions and regional upwelling of deep nutrient-rich oceanic water, giving areas of seasonally high productivity along Ireland's Atlantic Margin (DCENR, 2015). In addition, the Irish Shelf front, a persistent and predictable frontal system, is situated to the south and west of Ireland around the 150 m isobath (approximately 190 km to the west of the proposed survey area; refer to Figure 5.1; Reid *et al.,* 2003).

Figure 5.1. Location of Major Fronts in North-West European Waters (from Reid *et al.,* 2003).

Notes

Blue marker indicates approximate location of the proposed Barryroe survey area. The positions of the fronts indicated are approximate as there is a significant degree of temporal and spatial variation in their occurrence (Reid *et al.,* 2003).

Frontal systems occur where water masses of differing densities meet. These differences may be caused by variation in temperature, salinity or both. Turbulence caused by the mixing of the different water masses leads to more nutrients being supplied from depths and promoting the growth of phytoplankton, and thereby leading to productive 'hotspots' (Lalli & Parsons, 1997). As a result, the Irish Atlantic attracts a number of resident and migratory species of conservation importance. Those Annex IV species likely to be found within the proposed Barryroe survey area and the wider area are discussed in the following sub-sections.

It should be noted that although the European otter is widely found in the coastal and riverine systems around Ireland, individuals do not venture far offshore or spend considerable periods of time in the marine environment as they still require freshwater for bathing and terrestrial areas for resting and breeding (JNCC, 2018). Given the location of the proposed Barryroe survey area, approximately 43 km off the south coast of Ireland, the European otter will not be present within the vicinity of the survey area. This species is therefore not considered further in this report.

5.2 Cetaceans

To date, 25 species of cetacean have been recorded in Irish waters, 18 of which are commonly observed in Irish waters and waters in the North East Atlantic, and seven of which are rarely recorded and are considered to be vagrants (Table 5.1) (Wall, 2013; DAHG, 2014). Many of the species that are considered to be rare are only known from occurrences of strandings on the Irish coast (Wall, 2013).

All species of cetacean are protected under EU, Irish and international law. As well as the Habitats Directive and implementing Irish legislation, the Wildlife Acts 2000 – 2018 affords all cetaceans protection, including from disturbance and intentional harm (Wall, 2013). In addition, the harbour porpoise is on the OSPAR List of Threatened and / or Declining Species and Habitats (OSPAR, 2019). As a signatory to the OSPAR Convention, Ireland is obliged to address recommendations on the protection and conservation of listed species and habitats (Wall, 2013).

The waters comprising Ireland's continental shelf, slope and deep oceanic waters contain important and varied habitats for cetaceans, with some species preferring shallower coastal waters and others deeper open ocean. The shelf edge, around 190 km to the west of the Barryroe licence area (SEL 1/11), is thought to be a highly productive area with nutrient upwellings leading to high densities of plankton and fish species. Additionally, areas of complex bathymetry such as canyon systems are of importance to deep diving species, such as beaked whales, that have a strong affinity for this habitat (DCENR, 2015). In contrast, background evidence indicates that the Celtic Sea is an area of lower species richness for cetaceans than the west of Ireland, but there is moderate abundance of dolphin and porpoise species along with seasonal occurrences of minke and fin whales (O'Cadhla *et al.,* 2004).

A summary of the cetacean abundance and distribution in Irish waters is provided in Table 5.2. This information is largely based on aerial surveys conducted as part of the ObSERVE Aerial project from 2015 to 2017 (Rogan *et al.,* 2018), information on the known ranges of cetaceans (NPWS, 2013a), as well as ship and aircraft-based visual cetacean line transect surveys undertaken as part of the PReCAST project (Policy and Recommendations from Cetacean Acoustics, Surveying and Tracking) between 2008 and 2011 (Wall, 2013), surveys undertaken in conjunction with seabirds surveys by the Coastal Marine Resources Centre in Cork (O'Cadhla *et al.,* 2004), the Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) Project (Hammond *et al.,* 2009) and the earlier Atlas of Cetacean distribution in north-west European waters (Reid *et al.,* 2003). Reid *et al*. (*2003*) provides seasonal sightings data by ICES Rectangle and as the proposed survey area lies within ICES Rectangle 31E1, data for this area has been included in Table 5.2. The seasonal data is only available for a limited number of species and has therefore only been provided where available.

In addition, data on marine mammal sightings was recorded during the 3D seismic survey over the Barryroe licence area (SEL 1/11) undertaken by Providence Resources Plc between 9th June and 1st July 2011 (IWDG, 2011a). Where relevant, this sightings data has also been included in Table 5.2.

Table 5.1: Marine Mammal Species Occurring in Irish waters (Wall, 2013; IUCN Red List – Accessed January 2019)

Common Name	Scientific Name	Occurrence	IUCN Red List Status
Baleen whales:			
Humpback whale	*Megaptera novaeangliae*	May – Aug	Least concern
Blue whale	*Balaenoptera musculus*	Jul – Mar	Endangered
Fin whale	*Balaenoptera physalus*	All year	Vulnerable
Sei whale	*Balaenoptera borealis*	All year	Endangered
Northern minke whale	*Balaenoptera acutorostrata*	All year	Least concern
Northern right whale	*Eubalaena glacialis*	Vagrant	Endangered
Bowhead whale	*Balaena mysticetus*	Vagrant	Least concern
Toothed whales:			
Sperm whale	*Physeter macrocephalus*	All year	Vulnerable
Pygmy sperm whale	*Kogia breviceps*	Vagrant	Data deficient
False killer whale	*Pseudorca crassidens*	Jun – Nov	Near threatened
Long-finned pilot whale	*Globicephala melas*	All year	Least concern
Cuvier's beaked whale	*Ziphius cavirostris*	May –Aug	Least concern
Northern bottlenose whale	*Hyperoodon ampullatus*	May – Aug	Data deficient
Gervais' beaked whale	*Mesoplodon europaeus*	Vagrant	Data deficient
Sowerby's beaked whale	*Mesoplodon bidens*	All year	Data deficient
True's beaked whale	*Mesoplodon mirus*	All year	Data deficient
Beluga whale	*Delphinapterus leucas*	Vagrant	Least concern
Killer whale	*Orcinus orca*	All year	Data deficient
Dolphins:			
Risso's dolphin	*Grampus griseus*	Mar – Jul	Least concern
Bottlenose dolphin	*Tursiops truncatus*	All year	Least concern
Common dolphin	*Delphinus delphis*	All year	Least concern
Striped dolphin	*Stenella coeruleoalba*	May – Sep	Least concern
White-beaked dolphin	*Lagenorhynchus albirostris*	All year	Least concern
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	All year	Least concern
Porpoises:			
Harbour porpoise	*Phocoena phocoena*	All year	Least concern

Table 5.2. Summary of Cetacean Distribution in Irish Waters

Species	Occurrence / Distribution	Seasonality
Harbour porpoise (*Phocoena phocoena*)	Harbour porpoise is one of the most common cetaceans around the UK and Ireland (Rogan *et al.,* 2018) and has been observed in all inshore waters around the entire coastline (Berrow *et al.,* 2010). Sightings are more common in the summer months, with the Celtic Sea recording the second highest harbour porpoise densities in Ireland during the ObSERVE Aerial surveys (0.227 animals per km^2) after the Irish Sea (Rogan *et al.,* 2018). This decreases to 0.060 animals per km^2 in winter with no sightings recorded in the Celtic Sea in winter 2016-2017 (Rogan *et al.,* 2018). Total abundances were lower across Irish waters as a whole, with 0.079-0.113 animals per km^2 recorded in summer and 0.042-0.057 animals per km^2 observed in winter (Rogan *et al.,* 2018). Spring is reported to record the lowest abundances when it is thought that this species may move offshore to calve (Berrow *et al.,* 2010). This species is known to breed in Irish waters. In Ireland, three cSACs are designated due to the presence of harbour porpoises; Roaringwater Bay and Islands cSAC (approximately 64 km north west of the proposed Barryroe survey area) and Blasket Islands cSAC (approximately 160 km north west of the proposed survey area); both on the south west coast of Ireland, and Rockabill to Dalkey Island cSAC north of Dublin (approximately 271 km north east of the proposed survey area) (NPWS, 2013b). Harbour porpoise have been recorded within the vicinity of the proposed Barryroe survey area during marine mammal surveys (*Reid et al., 2003; Wall, 2013*) and were sighted in June during the 2011 Barryroe 3D seismic survey (IWDG, 2011a). Reid *et al*. (*2003*) recorded low numbers (0.01-1 individuals per hour of search effort) of harbour porpoise in the vicinity of the proposed survey area (ICES Rectangle 31E1) during February, July and August. The overall conservation status of the harbour porpoise in Irish waters is considered to be favourable (NPWS, 2013a).	Throughout the year, however there is a summer peak with low numbers recorded in winter and in inshore areas during the spring in both the Celtic Sea and Irish waters as a whole (Berrow *et al.,* 2010; Rogan *et al.,* 2018).
Short-beaked common dolphin (*Delphinus delphis*)	This species was the most abundant and widespread species observed in surveys of cetacean distribution around the UK and Ireland (Reid *et al.,* 2003; O'Cadhla *et al.,* 2004; SCANS-II, 2008; Wall, 2013), barring ObSERVE Aerial where bottlenose dolphin was the most frequently sighted cetacean (Rogan *et al.*, 2018).. This species is predominantly found in neritic waters, notably in the Celtic Sea and Western Approaches to the Channel, and off southern and western Ireland (Reid *et al.,* 2003; Rogan *et al.,* 2018). PReCAST data shows a strong seasonal trend in common dolphin distribution and abundance, with common dolphins being recorded at lower relative abundance and with a restricted inshore and southerly distribution during the winter and spring and at high relative abundance with a wider distribution spreading into shelf and offshore habitats in the summer (Wall, 2013). In autumn high numbers have been found off the south and west coasts of Ireland and this appears to be linked to the presence of schooling pelagic fish in these areas during that time of year (Wall, 2013). However, the results of the ObSERVE Aerial project are more unclear, with greater abundances recorded in the Irish Sea during winter (0.039-0.225 animals per km^2) than in summer (0.040-0.124 animals per km^2) (Rogan *et al.,* 2018). This trend in sightings was also observed in the Celtic Sea with an abundance of 0.637 animals per km^2 in winter and 0.044 animals per km^2 observed during summer	Throughout the year, with some uncertainty regarding seasonality though the most recent data indicate a summer peak in both the Celtic Sea and Irish waters as a whole (Wall, 2013; Rogan *et al.,* 2018).

Species	Occurrence / Distribution	Seasonality
	(Rogan *et al.*, 2018). In addition, sightings of common dolphins were found to have occurred over a wider spatial distribution in winter than in summer, opposing the conclusion from PReCAST. This species is also known to breed in Irish waters. Common dolphin have been recorded within the vicinity of the proposed survey area during marine mammal surveys (SCANS-II, 2008; Wall, 2013) and were sighted in June during the 2011 Barryroe 3D seismic survey (IWDG, 2011a). Reid *et al*. (*2003*) recorded common dolphin in the vicinity of the proposed survey area (ICES Rectangle 31E1) during August in low numbers (0.01-1 individuals per hour of search effort), during March, September and December in moderate numbers (1-10 individuals per hour of search effort) and during November in high numbers (10-100 individuals per hour of search effort). The overall conservation status of the common dolphin is considered to be favourable (NPWS, 2013a).	
Bottlenose dolphin (*Tursiops truncatus*)	The bottlenose dolphin is recorded all around the Irish coast, although it is mainly seen along the west coast (Reid *et al.,* 2003; IWDG, 2015b). Distinct populations are recognized in Irish waters – the offshore, inshore and Shannon estuary populations (Wall, 2013; IWDG, 2015b). During the ObSERVE Aerial surveys, the bottlenose dolphin was the most frequently sighted cetacean species, with sightings occurring in every area of the study (Rogan *et al.,* 2018). Bottlenose dolphin were observed in greater numbers in winter (0.098-0.929 individuals per km^2) than in summer (0.062-0.088 individuals per km^2). There also appears to be greater inter-annual variance in bottlenose dolphin encounter rates than was common for other cetacean species (Rogan *et al.,* 2018). There are two resident populations present, one at the mouth of the River Shannon (approximately 162 km north west of the proposed Barryroe survey area) and another off the west Connacht coast (approximately 280 km north west of the proposed survey area); both areas have been designated due to the presence of this species (the Lower River Shannon cSAC and the West Connacht Coast cSAC, respectively; NPWS, 2013c). A small apparently resident group of bottlenose dolphin have been seen regularly at outer Cork Harbour (Wall, 2013; NPWS, 2015b). Bottlenose dolphins, including offshore populations, are known to breed in Irish waters. Bottlenose dolphin has been recorded within the vicinity of the proposed Barryroe survey area during marine mammal surveys (SCANS-II, 2008) and in June during the 2011 Barryroe 3D seismic survey (IWDG, 2011a). The overall conservation status of the bottlenose dolphin is considered to be favourable (NPWS, 2013a).	Throughout the year with peak numbers in the winter months (Rogan *et al.,* 2018).
White-beaked dolphin (*Lagenorhynchus albirostris*)	Occurring mainly in waters over the continental shelf and slope, white-beaked dolphins are a cold temperate and sub-polar species mainly recorded in Irish Atlantic waters, but they may also be observed coastally or occasionally in the Celtic Sea or Irish Sea (NPWS, 2013a). Data from PReCAST and the Cetaceans Atlas had a notable lack of sightings around Ireland and other surveys have suggested that this species is predominantly Atlantic in nature and that its Irish range only represents a small proportion of its natural range. There were also no sightings of the species in the Celtic Sea during the ObSERVE Aerial	Possibly throughout the year and further evidence in the summer months in Irish waters (Rogan *et al.,* 2018)

Species	Occurrence / Distribution	Seasonality
	survey (Rogan *et al.,* 2018). It is thought that a lack of sightings may also be a result of increasing average sea temperatures affecting the distribution of this cold-water species (O'Cadhla *et al.,* 2004; IWGD, 2010; Wall, 2013) or may be a result of anomalously high frequencies in other surveys. Despite a lack of sightings in some surveys, this species is known to breed in Irish waters with a greater presence in Irish waters in summer (0.021 individuals per km^2) than in winter (0.002-0.010 individuals per km^2) and may be present within the proposed survey area (albeit in low numbers) (Rogan *et al.*, 2018). The overall conservation status of the white-beaked dolphin is considered to be favourable (*NPWS, 2013a*).	
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	In Irish waters Atlantic white-sided dolphins have mostly been recorded from very deep ocean habitats to continental shelf waters, with the exception of the Irish Sea (NPWS, 2013a). The abundance of this species is relatively low around western Ireland and in the south-west Approaches to the Channel and Celtic Sea (Reid *et al.,* 2003) and is not generally recorded in coastal waters (O'Cadhla *et al.,* 2004). This species is confirmed as breeding in Irish waters with a greater presence in summer (0.006 individuals per km^2). This species has not been recorded within the vicinity of the proposed Barryroe survey area during previous marine mammal surveys (O'Cadhla *et al.,* 2004; SCANS-II, 2008; Wall, 2013; Rogan *et al.,* 2018), however it may still be present, albeit in low numbers. The overall conservation status of the white-sided dolphin is considered to be favourable (*NPWS, 2013a*).	Possibly throughout the year and further evidence in the summer months in Irish waters (Rogan *et al.,* 2018).
Risso's dolphin (*Grampus griseus*)	Risso's dolphins are recorded annually in small numbers around the coast and some groups of the species may be repeat visitors to local bays, islands and other coastal features. The species also occurs offshore where its distribution appears to be mainly in waters over the continental shelf and slope (NPWS, 2013a; Rogan *et al.,* 2018). Risso's dolphin have been confirmed to breed in Irish waters. This species is generally recorded during marine mammal surveys in shallow coastal waters (<200 m deep), and has been recorded in the vicinity of the proposed survey area by Reid *et al.* (*2003*), O'Cadhla *et al.* (*2004*), Wall (*2013*) and Rogan *et al.* (*2018*). In addition, Risso's dolphin were sighted during the Barryroe 3D seismic survey in June 2011 (IWDG, 2011a). Due to limited information on numbers and ecology in Irish waters and a number of pressures on this species, the overall conservation status of Risso's dolphin in Ireland is currently unknown (NPWS, 2013a).	Throughout the year, with a possible movement inshore in late spring leading to a peak in sightings between May and July in Irish waters (Berrow *et al.,* 2010).
Striped dolphin (*Stenella coeruleoalba*)	The striped dolphin is one of the smallest dolphin species occurring in Irish waters. Occurring in waters over the continental shelf, slope and deep ocean basins, striped dolphins are mainly considered a warm temperate or sub-tropical species and are not commonly observed in Irish waters, although strandings are recorded quite frequently (NPWS, 2013a). While the proposed Barryroe survey area lies within the range of this species (NPWS, 2013a), the majority of marine	Possibly throughout the year and further evidence from July to November in Irish waters (Wall, 2013;

Species	Occurrence / Distribution	Seasonality
	mammal surveys recorded no sightings in the vicinity of the proposed survey area (Reid *et al.,* 2003; O'Cadhla *et al.,* 2004; Wall, 2013; Rogan *et al.,* 2018). This is potentially due to the challenge of differentiating common and striped dolphins. The overall conservation status of the striped dolphin is considered to be favourable in Irish waters.	Rogan *et al.,* 2018).
Long-finned pilot whale (*Globicephala melas*)	The long-finned pilot whale is one of the most frequently recorded cetacean species in offshore Irish waters, particularly along the Atlantic continental margin. While most records are from waters deeper than 200 m (Rogan *et al.,* 2018), groups are occasionally recorded closer to shore, particularly off the west and south west coasts (Berrow *et al.,* 2010; NPWS, 2013a); however, no pilot whales were sighted in the Celtic Sea during the ObSERVE Aerial project (Rogan *et al.,* 2018). This species is often sighted in large groups in a number of cetacean surveys (Reid *et al.,* 2003; Wall, 2013) and calves have been recorded in Irish waters from February through to September (Wall, 2013). In addition, this species has been confirmed as breeding in Irish waters. Long-finned pilot whales have previously been sighted in the general vicinity of the proposed survey area (Berrow *et al.,* 2010). The overall conservation status of the long-finned pilot whale is considered to be favourable (NPWS, 2013a).	Throughout the year in Irish waters.
Sperm whale (*Physeter macrocephalus*)	The sperm whale is the largest member of the odontocetes and is widely found in deeper Irish Atlantic waters throughout the year. Most records are thought to be males of the species and they mainly occur over the continental slope and deep ocean basins such as the Rockall Trough and Porcupine Seabight (NPWS, 2013a). The proposed Barryroe survey area is located outside of the expected range of sperm whales in Irish waters (NPWS, 2013a). In addition, this species was not recorded in the Celtic Sea during previous marine mammal surveys (Reid *et al.,* 2003; O'Cadhla *et al.,* 2004; Wall, 2013; Rogan *et al.,* 2018). As such it is considered unlikely that this sperm whale will be present in the vicinity of the proposed survey area. Due to global declines in numbers, limited information on numbers and ecology in Irish waters and a number of pressures on this species, the overall conservation status of the sperm whale in Irish waters is currently unknown (NPWS, 2013a).	February to September in Irish waters (Wall, 2013). However, strandings records suggest this species could be found all year round (O'Cadhla *et al.,* 2004).
Fin whale (*Balaenoptera physalus*)	The fin whale is the second largest whale species in the world. Fin whales are recorded in all Irish waters from deep ocean basins to continental slope and shelf areas, and even in some coastal waters particularly off the south west, south and south east coasts. Although it is thought that they undertake some migratory movement to warmer waters in the winter, in Ireland fin whales are recorded in all seasons (NPWS, 2013a). The fin whale was the most commonly sighted baleen whale in the PReCAST surveys in both shallow shelf waters (<200 m deep) and deeper waters (>200 m deep) but this species does appear to prefer deep waters beyond the	Throughout the year in Irish waters, with higher numbers around the south coast during the autumn (Wall, 2013).

Species	Occurrence / Distribution	Seasonality
	continental shelf edge. Sightings of fin whales off the south coast of Ireland in autumn are linked to foraging on pelagic schooling fish such as herring and sprat (Wall, 2013). Although fewer individuals were sighted in other surveys, similar distributions were also identified by Reid *et al.* (2003) and O'Cadhla *et al.* (2004). This species has been recorded within the vicinity of the proposed survey area during previous marine mammal surveys (Reid *et al.,* 2003; O'Cadhla *et al.,* 2004; Wall, 2013). However, fin whales were not sighted within the Celtic Sea during the recent ObSERVE Aerial project (Rogan *et al.,* 2018). The overall conservation status of the fin whale is considered to be favourable in Irish waters (NPWS, 2013a).	
Minke whale (*Balaenoptera acutorostrata*)	Minke whales are the smallest of the baleen whales and are recorded in Irish waters far more frequently than their larger relatives, the blue whale, sei whale and fin whale. Minke whales are recorded in all Irish coastal waters and offshore mainly in waters over the continental shelf and slope. They are also known to enter coastal bays or be seen close to headlands (NPWS, 2013a). It is thought that this species could be found all year round in Irish waters, however, seasonal increases during the autumn are believed to coincide with an increase in abundance of their pelagic schooling prey fish such as herring and sprat off the south and south west coast (Wall, 2013). Other surveys found a similar pattern of abundance in autumn (Reid *et al.,* 2003; O'Cadhla et al., 2004). The ObSERVE Aerial project found that minke whale density in the Celtic Sea was 0.013 animals per km^2 across summer and winter, although in Irish waters as a whole densities were higher in the summer (0.019-0.020 individuals per km^2) than the winter (0.006 individuals per km^2) (Rogan *et al., 2*018). Minke whale have been recorded within the vicinity of the proposed Barryroe survey area during previous marine mammal surveys (Reid *et al.,* 2003; O'Cadhla *et al.,* 2004; Wall, 2013; Rogan *et al.,* 2018) and in June during the 2011 Barryroe 3D seismic survey (IWDG, 2011a). Reid *et al*. (2003) recorded minke whale in the vicinity of the proposed survey area (ICES Rectangle 31E1) during July in low numbers (0.01-1 individuals per hour of search effort). The overall conservation status of the minke whale is considered to be favourable in Irish waters (NPWS, 2013a).	March to November in Irish waters, possible throughout the year, with a peak in autumn off south and south west coasts (Wall, 2013).
Killer whale (*Orcinus orca*)	The killer whale is the largest member of the dolphin family occurring in Irish waters. Killer whales are recorded annually in small numbers mostly around the north, west and south Irish coasts. The species also occurs offshore where its distribution appears to be mainly in waters over the continental shelf and slope (NPWS, 2013a). In the north east Atlantic they have been shown to make long range movements spanning hundreds of kilometres which may be linked to the distribution of particular prey such as herring and mackerel (NPWS, 2013a). Killer whales have been recorded within the vicinity of the proposed Barryroe survey area during previous marine mammal surveys (Reid *et al.,* 2003; O'Cadhla *et al.,* 2004; Wall, 2013; Rogan *et al.,* 2018), albeit in low numbers. Due to limited information on numbers and ecology in Irish waters and a number of pressures on this species, the overall conservation status of killer whales in Ireland is currently unknown (NPWS, 2013a).	Possible throughout the year in Irish waters (Reid *et al.,* 2003). Thought to be present in southern and western Irish coastal waters and in the Celtic Sea between July and October (O'Cadhla *et al.,* 2004).

Species	Occurrence / Distribution	Seasonality
Humpback whale (*Megaptera novaeangliae*)	Sightings records of humpback whales are infrequent in Irish waters based on a number of cetacean surveys. Individual whales commonly move between cold, high latitude feeding grounds in summer and tropical waters in winter during which calving and mating occurs (NPWS, 2013a). A known humpback whale foraging ground is located off the south east coast of Ireland during the autumn and winter (Wall, 2013; Rogan *et al.,* 2018). During this period, the whales feed on pelagic schooling fish such as spawning herring and sprat, which are abundant off the south coast in autumn (Wall, 2013). In recent years records have increased close to the Irish coast and some individuals have been shown to return repeatedly to forage in waters off the south west, south and south east coasts (NPWS, 2013a). Data held by the IWDG indicates that casual sightings of humpback whales in Ireland (up to 2009) were generally low during the summer months and peaked strongly in November and the majority of sightings were from south and south west coasts in counties Cork (56%) and Wexford (16%) (Berrow *et al.,* 2010). Humpback whales have previously been observed in the vicinity of the proposed Barryroe survey area (Wall, 2013). Due to limited information on numbers and ecology in Irish waters and a number of pressures on this species, the conservation status of humpback whales in Ireland is currently unknown (NPWS, 2013a).	Late summer, autumn and winter in Irish waters (IWDG, 2015a).
Blue whale (*Balaenoptera musculus*)	The blue whale is Ireland's largest mammal but it is the most rarely observed baleen whales in Irish waters possibly due to its highly migratory nature and severe population declines due to historical whaling. In general, this species is recorded in deeper offshore Atlantic waters and Irish waters are considered to only comprise a small proportion of its wider seasonal North Atlantic migratory range. The proposed Barryroe survey area is outside of the expected range of blue whales in Irish waters (NPWS, 2013a). In addition, this species was not recorded in the Celtic Sea during previous marine mammal surveys (Reid *et al.,* 2003; O'Cadhla *et al.,* 2004; Wall, 2013; Rogan *et al.,* 2018). As such, blue whales are not expected to be present in the proposed survey area. Due to limited information on numbers and ecology in Irish waters and a number of pressures on this species, the overall conservation status of blue whales in Ireland is currently unknown (NPWS, 2013a).	Seasonal distribution in Irish water is unclear, but may be present during migration between cold, high latitude waters in summer and warmer temperate or tropical waters in winter (NPWS, 2013a).
Beaked whales (*Ziphiidae* spp.)	Beaked whales spend a significant proportion of their time (up to 93%) below the water's surface. This, along with their low profile morphology, makes them difficult to survey visually and as such, they are one of the least known families of cetacean. Acoustic surveys of beaked whales have found them associated with deep canyon and slopes systems off the coast of Ireland, particularly off the north west coast around the Rockall Trough, Hatton/Rockall region and along the northern margin of the Porcupine Bank (Boisseau *et al.,* 2014; Rogan *et al.,* 2018). The proposed Barryroe survey area falls inside the range of northern bottlenose whale (*Hyperoodon ampullatus*), the largest member of the beaked whale family (NPWS, 2013a). In addition, Cuvier's beaked whale (*Ziphius cavirostris*) has also been sighted off the south west coast of Ireland (Reid *et al.,* 2003). As such, despite preferring deeper waters both of these species have the potential to be present in the vicinity of the proposed survey area.	March to September in Irish waters, however this may be a result of increased survey effort during this period (Wall, 2013).

Species	Occurrence / Distribution	Seasonality
	The overall conservation status of northern bottlenose whale and Cuvier's beaked whale in Ireland is currently unknown (NPWS, 2013a).	
Sei whale (*Balaenoptera borealis*)	The sei whale is the third largest whale species found in Irish waters but is one of the least frequently recorded. There is limited data on the abundance of these animals in Irish waters. Mostly found in deep temperate waters (500 – 3,000 m; Reid *et al.,* 2003). The sei whale tends to follow shelf contours and plankton gatherings (IWDG, 2015c). The proposed Barryroe survey area lies within the range of the sei whale (NPWS, 2013a), however only the Cetacean Atlas surveys recorded this species in the Celtic Sea (Reid *et al.,* 2003). Although this may be partially influenced by the fact that Sei whales and fin whales are difficult to differentiate at sea, sei whales are not generally sighted at these latitudes. Due to limited information on occurrence and ecology in Irish waters, the overall conservation status of sei whales in Ireland is currently unknown (NPWS, 2013a).	Seasonal distribution is unclear (NPWS, 2013a). Thought to move north through Irish waters during spring and south during autumn (O'Cadhla *et al.,* 2004).

5.3 Marine Reptiles

A total of four marine reptile species have been encountered in Irish waters: the leatherback turtle (*Dermochelys coriacea*), Kemp's ridley turtle (*Lepidochelys kempii*), loggerhead turtle (*Caretta caretta*) and the hawksbill turtle (*Eretmochelys imbricata*) (Kingston, 2012). Of these species however, only the leatherback turtle is considered to be a regular visitor.

Leatherback turtles are listed on Annex IV of the Habitats Directive, are protected under the Irish Wildlife Acts and are also included on the OSPAR List of Threatened and / or Declining Species and Habitats (OSPAR, 2018). The leatherback turtle is the most widely distributed and largest living reptile species and undertakes extensive pan-oceanic migrations (Doyle, 2007; NPWS, 2013a). The leatherback turtle moves between warm tropical breeding and nesting grounds to the northern latitudes to feed in cooler temperate waters during the spring / summer months before returning to warmer waters as temperatures decline further (Doyle, 2007; Wall, 2013). The appearance of leatherback turtles in the North East Atlantic and Irish waters correlates with the appearance in their gelatinous zooplankton (jellyfish) prey (Doyle *et al.,* 2008; NPWS, 2013a). Blooms of jellyfish, gelatinous ctenophores (comb jellies) and siphonophores are a regular occurrence in Irish Atlantic waters during the spring and summer (Doyle, 2007).

The entire North Atlantic is considered to be a priority habitat for this species. However, Irish waters are not considered to be a critical habitat (Doyle, 2007). This species is consistently identified year-on-year around Irish waters both offshore and nearshore and is often recorded tangled in fishing gears (Doyle, 2007). In terms of oceanic waters, tracking studies have indicated that the European continental shelf edge, particularly the Rockall Area, Porcupine Bight and Porcupine Bank may support appreciable densities of foraging leatherback turtles due to the dense aggregations of gelatinous zooplankton that occur in these areas (Doyle, 2007; Witt *et al.,* 2007). In addition, a study by Houghton *et al.* (*2006*) indicates that distinct coastal 'jellyfish hotspots' in the Irish Sea may be important foraging areas for leatherbacks in coastal waters (Doyle, 2007).

The proposed Barryroe survey area lies within the range of the leatherback turtle (NPWS, 2013a); three individuals were sighted during the PReCAST survey off the south west coast of Ireland, however only one was over shallow water (<200 m deep; Wall, 2013). In addition, three individuals were sighted in the summer of 2015 and 2016 in Irish waters during the ObSERVE Aerial survey, with no individuals sighted in the winter months (Rogan *et al.*, 2018). As such, while this species may be present within the vicinity of the proposed survey area, it is not expected to be encountered in any significant numbers.

The overall conservational status of leatherback turtles in Irish waters is assessed as unknown (NPWS, 2013a).

5.4 Pinnipeds

Grey and harbour seals are known to have colonies located around the south and south west coast of Ireland and are predominantly found in inshore waters over the Irish Shelf in water depths less than 200 m deep (Wall, 2013). Tracking studies of harbour seals have demonstrated they have more of an affinity for coastal waters than grey seals, which may travel up to 100 km from their haul-out sites (Russell *et al.,* 2013).

Grey seal generally breed in Irish Waters from September to December and shed their fur during the spring months, remaining ashore for the majority of this time (NPWS, 2018a). Harbour seals come to shore during June to give birth and mate again around this time but usually in the water. Harbour seals also come to shore to moult (shed their fur) during July and August often forming large groups on sheltered shores (NPWS, 2018a).

In Ireland, 10 cSACs are designated due to the presence of grey seals (NPWS, 2018a). Of these, three are located on the south and south west coast of Ireland: Roaringwater Bay and Islands cSAC (approximately 64 km to the north west of the proposed survey area), Saltee Islands cSAC (approximately 147 km north east of the proposed survey area), Blasket Islands cSAC (approximately 160 km north west of the proposed survey area). In addition, 13 cSACs are designated due to the presence of harbour seals (NPWS, 2018a). Of these, three are on the south and south west coast of

Ireland: Glengarriff Harbour and Woodland cSAC (approximately 92 km to the north west of the proposed survey area), Kenmare River cSAC (approximately 107 km north west of the proposed survey area) and Slaney River Valley cSAC (approximately 175 km north east of the proposed survey area).

The overall status of the grey and harbour seal population in Ireland is considered to be favourable given current knowledge of the species' population size, distribution, ecology and prevailing pressures on the species (NPWS, 2013a).

While both grey and harbour seals were recorded in inshore waters during the PReCAST survey, only grey seals were sighted in the vicinity of the proposed survey area (Wall, 2013). In addition, studies tracking grey seals tagged on the Great Blasket Island (between February and December 2009) and harbour seals tagged in south west Ireland (between 2006 and 2008) did not record usage of the County Cork coastline, which is adjacent to the proposed Barryroe survey area, by either species (Cronin *et al.,* 2011; Seal Tagging Project, 2018). With grey seals tending to move north towards Scotland, rather than south, and harbour seals tending to stay fairly local to their haul-out sites.

Haul-out count data collected between 1996 and 2015 indicates that small numbers (up to 10 individuals) of both grey and harbour seals haul-out on the coastline around Cork, approximately 48 km north of the proposed Barryroe survey area (Russel *et al.,* 2017).

Models of marine usage by harbour and greys seals in the UK and Ireland indicate that the estimated at-sea usage of both these species in the vicinity of the proposed site survey area is very low (with a mean of up to 1 individual per 25 km^2 at any given time) (Russel *et al,.* 2017). Along the adjacent Irish coast to the proposed site survey area, the estimated at-sea usage by harbour seals is also very low and by grey seals is low (with a mean of 1-5 individuals per 25 km^2 at any given time), this increases to moderate (with a mean of 5-10 individuals per 25 km^2 at any given time) for grey seals and high-moderate (with a mean of 10-50 individuals per 25 km^2 at any given time) for harbour seals on parts of the south west coast, approximately 82 km north west of the proposed survey area (Russel *et al.,* 2017).

As such, while seals may be present within the vicinity of the proposed Barryroe survey area, they are not expected to be encountered in any significant numbers (expected density of up to 1 individual per 25 km^2 at any given time).

5.5 Fish and Shellfish

5.5.1 Distribution of Adults

Irish shelf and coastal waters are productive and support a diverse community of fish and shellfish species (Hartley Anderson, 2005). In shelf and coastal waters the distribution of fish is generally governed by the sediment type, water temperature and water depth.

Demersal fish species, many of which are of commercial importance, are present over much of the shelf. These species include anglerfish (*Lophius piscatorius*), cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), hake (*Merluccius merluccius*), lemon sole (*Microstomus kitt*), megrim (*Lepidorhombus whiffiagonis*), plaice (*Pleuronectes platessa*), sandeels (*Ammodytes* sp.), sole (*Solea solea*) and whiting (*Merlangius merlangus*) (DCENR, 2015; Sinbad Offshore Support, 2018). The distributions of many of these species are dynamic with feeding, spawning or migratory movements between coastal waters, the shelf and upper parts of the continental slope (DCENR, 2015). Of these species, cod is listed on the OSPAR List of Threatened and/or Declining Species (OSPAR, 2019).

Pelagic species that may be present in the overlying water column include mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), herring (*Clupea harengus*), blue whiting (*Micromesistius poutassou*), boarfish (*Capros aper*), hake (*Merluccius merluccius*), sprat (*Sprattus sprattus*) (DCENR, 2015; Sinbad Offshore Support, 2018). Species such as mackerel, horse mackerel and herring are present within Irish waters largely on a seasonal basis, migrating between spawning and feeding grounds (DCENR, 2015).

Shellfish species likely to be present in the vicinity of the proposed Barryroe survey area include, *Nephrops* (or Dublin Bay prawn; *Nephrops norvegicus*) which burrow in soft muddy sediments of the

Celtic Sea, and king scallop (*Pecten maximus*) which is found on coarser sediments (Sinbad Offshore Support, 2018).

Ten cephalopod species were caught during a Marine Institute survey to the west and south west of Ireland, with similar results in the Celtic Sea Area (Lordan *et al.,* 2001) and may therefore inhabit waters of the proposed survey area. The veined squid (*Loligo forbesi*) was the most abundant species recorded, the lesser flying squid (*Todaropsis eblanae*) was the second most abundant and the broadtail shortfin squid (*Illex coindetii*) the third most abundant. In addition, the European common squid (*Alloteuthis subulata*) and elegant cuttlefish (*Sepia elegans*) were found to be relatively common and widespread.

Elasmobranchs are a group of fish which encompasses sharks, skates and rays. Based on a survey conducted by Cefas, six species of elasmobranch may be present within the general vicinity of the proposed survey area; including common skate (*Diturus batis*), cuckoo skate (*Leucoraja naevus*), lesser-spotted dogfish (*Scyliorhinus canicula*), shargeen skate (*Leucoraja fullonica*), spurdog (*Squalus acanthias*) and thornback ray (*Raja clavata*) (*Ellis et al., 2004*). Of these species, common skate, spurdog and thornback ray are listed on the OSPAR list of threatened and/or declining species and habitats (OSPAR, 2019).

Basking shark (*Cetorhinus maximus*) may also be present (Sims *et al.,* 2005; Wall, 2013). Basking sharks are listed on the OSPAR List of Threatened and / or Declining Species (OSPAR, 2019) and receive further protection through the Bonn Convention (Convention on Migratory Species), a European treaty on the Conservation of Migratory Species, and they are also listed in Appendix II of the Convention on International Trade in Endangered Species (CITES) and are identified as Vulnerable in the North East Atlantic by the International Union for the Conservation of Nature (IUCN, 2018).

Spawning and Nursery Areas

The waters offshore Ireland contain some of the most important fish spawning and nursery areas in the North Atlantic (Marine Institute, 2018a). The proposed Barryroe survey area lies within International Council for the Exploration of the Sea (ICES) Rectangles 31E1. Potential spawning areas and nursery grounds for fish species within this ICES Rectangle are detailed in Table 5.3. It should be noted that these areas are not fixed and are highly likely to vary spatially over time as fish populations naturally move through surrounding areas. In addition, fish species may spawn earlier or later in response to seasonal variations in environmental conditions (Coull *et al.,* 1998). Of these species, cod, common skate and spurdog are listed on the OSPAR List of Threatened and/or Declining Species (OSPAR, 2019).

Table 5.3: Fish Spawning and Nursery Areas in the Vicinity of the Proposed Survey Area (ICES Rectangle 31E1) (Coull *et al.*, 1998; Marine Institute, 2009; Ellis *et al.*, 2012)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Anglerfish[1] *Lophius piscatorius*			N	N	N	N	N	N	N			
Blue whiting *Micromesistius poutassou*				N	N	N						
Cod *Gadus morhua*												
Common skate [2] *Dipturus batis*-complex	N	N	N	N	N	N	N	N	N	N	N	N
European hake *Merluccius merluccius*					N	N	N	N	N			
Haddock *Melanogrammus aeglefinus*				N	N	N	N					
Horse mackerel *Trachurus trachurus*			N	N	N	N						
Lemon Sole *Microstomus kitt*						N	N	N	N	N	N	
Ling *Molva molva*				N	N	N	N					
Mackerel *Scomber scombrus*					N	N	N	N	N			
Megrim *Lepidorhombus whiffiagonis*			N	N	N	N						
Nephrops	N	N	N	N	N	N	N	N	N	N	N	N
Sprat *Sprattus sprattus*												
Spurdog [3] *Squalus acanthias*	N	N	N	N	N	N	N	N	N	N	N	N
Whiting *Merlangius merlangus*				N	N	N	N	N				

Key:

	Peak Spawning		Low Intensity Spawning		Without Spawning Period	N	Nursery		Indicates the period when survey may occur [4]

[1] Spawning locations for anglerfish in the area are not known due to limited information.

[2] Insufficient information on spawning and nursery periods. As such conservatively assumed to occur throughout the year.

[3] Viviparous species (gravid females can be found all year) (Ellis *et al.*, 2012).

[4] The survey vessel is anticipated to be working on location for approximately 16 days, excluding weather downtime. Operations are proposed to take place sometime between the 1st April 2019 and 30th November 2019, subject to regulatory approval and vessel availability. If the survey has not commenced within this timeframe, the operations will be undertaken sometime between 1st February 2020 and 30th November 2020, again subject to regulatory approval and vessel availability.

5.5.2 Migratory Fish

The following migratory fish also occur in Ireland; Atlantic salmon (*Salmo salar*), river lamprey (*Lampetra fluviatilis*), sea lamprey (*Petromyzon marinus*) and twaite shad (*Alosa fallax fallax*) (NPWS, 2018b). Although these fish species are not Annex IV listed species, they are all listed under Annex II of the Habitats Directive, and all except sea lamprey are also listed under Annex V.

In Ireland:

- One SAC and 25 cSACs are designated due to the presence of Atlantic salmon (NPWS, 2018c), of which seven are on the south and south west Irish coasts;
- 12 cSACs are designated due to the presence of sea lamprey (NPWS, 2018c), of which six are on the south and south west Irish coasts;
- 10 cSACs are designated due to the presence of river lamprey (NPWS, 2018c), of which six are on the south and south west Irish coasts;
- Four cSACs are designated due to the presence of twaite shad (NPWS, 2018c), all of which are on the south and south west Irish coasts.

The nearest of these SACs/cSACs to the proposed Barryroe survey area is the Blackwater River (Cork/Waterford) cSAC, located approximately 86 km to the north east, which supports sea lamprey, river lamprey, twaite shad and Atlantic salmon. It is possible therefore, that migratory fish species could be present in the vicinity of the proposed survey area during the adult migrations upstream and smolt (juvenile) migration downstream.

With regards to Atlantic salmon, spawning generally takes place during the winter (November to January) and smolts then tend to leave Irish rivers in the spring (March and May; Marine Institute, 2018b). The salmon population is low in Ireland in comparison to previous decades and so, in the absence of a recovery, the overall status is assessed as inadequate (NPWS, 2013a).

Adult sea lamprey migrate in spring into freshwater to spawn and young adult sea lamprey can be found migrating downriver to estuarine waters and the open sea in late autumn – winter (NPWS, 2013a). Sea lamprey juveniles are rarely encountered and, when found, numbers are very low. The overall status of this species in Ireland is assessed as bad (NPWS, 2013a).

Adult river lamprey enter freshwater rivers and streams to spawn in spring. Upon becoming young adult fish, they attach to and feed on larger fish in coastal waters. On reaching maturity they re-enter freshwater to spawn. The overall status of river lamprey in Ireland is assessed as favourable (NPWS, 2013a).

The twaite shad spends most of its life in estuaries and coastal waters, but migrates upriver to spawn in late spring (NPWS, 2013a). It should be noted that there is limited evidence for any recent spawning outside the River Barrow and the River Blackwater (NPWS, 2013a). The overall status of this species in Irish waters is assessed as bad (NPWS, 2013a).

It should be stressed that the proposed Barryroe survey is a significant distance (approximately 86 km or more) from the above listed SACs/cSACs designated for Annex II migratory fish species.

5.6 Plankton

Plankton is important for the wider food web as it forms the basis of marine life. It can be broadly divided into a plant component (phytoplankton) and an animal component (zooplankton) that drift with the prevailing currents. The composition and abundance of plankton communities at any time is variable and is strongly influenced by several factors such as depth, tidal mixing, temperature stratification, nutrient concentrations and the location of oceanographic fronts. Species distribution is directly influenced by temperature, salinity, water inflow and the presence of local benthic (bottom dwelling) communities.

Phytoplankton (comprising primarily diatoms and dinoflagellates, and some smaller ciliates) are the primary producers in the marine environment. In the plankton community in the North East Atlantic a ‘bloom’ of phytoplankton occurs every spring, often followed by a smaller peak in the autumn.

Phytoplankton, particularly diatom, blooms are normally initiated by the establishment of thermal stratification in spring, as a result of increased light and temperature. Dinoflagellate communities are associated with post-spring bloom conditions, when surface waters are limited by the amount of nutrients left after the initial diatom bloom as they have lower nutrient requirements compared to diatoms (Williams and Lindley, 1980).

Zooplankton includes herbivores and carnivores as well as the eggs and larvae of fish and benthic species. Zooplankton abundance and distribution is patchy at local and regional scales and influenced by differences in the abundance of phytoplankton, predation pressures and water currents (DCENR, 2015).

The zooplankton communities within the Irish and Celtic Seas are dominated in terms of biomass and abundance by copepods, particularly the large copepod species *Calanus helgolandicus* and *Calanus finmarchicus* (DCENR, 2015).

As previously discussed, turbulence caused by the mixing of different water masses leads to more nutrients being supplied from depths and promoting the growth of phytoplankton. The nearest frontal system to the proposed survey area is the year-round Irish Shelf Front (Huang *et al.,* 1991), situated to the south and west of Ireland around the 150 m isobaths (approximately 190 km to the west of the proposed Barryroe survey area; refer to Figure 5.1). The next nearest frontal system is the seasonal Celtic Sea Front which begins to develop in late April/early May (Mcginty *et al.,* 2014). This front is situated at the southern margin of the Irish Sea broadly in St George's Channel, around 170 km to the north east of the proposed survey area (refer to Figure 5.1). These fronts are associated with high plankton productivity and are considered to be productive 'hotspots' which attract higher tropic level organisms including cetaceans and other predators.

6 Appraisal of Potential Impacts on Annex IV Species

In accordance with the European Commission EIA Screening Guidance (2017) and the DAHG Guidance to Manage the Risk to Marine Mammals from Man-Made Sound Sources in Irish Waters (DAHG, 2014), it has been assumed that the effects of sound produced from the proposed Barryroe site survey operations could be significant and therefore should undergo a screening assessment to determine the potential effects on marine fauna. The potential impacts to Annex IV species, namely cetaceans and turtles, are therefore discussed in the proceeding sections. As Annex IV species may be impacted through effects on prey abundance, behaviour, and distribution; potential impacts on fish and plankton are also assessed. In addition, for completeness, potential impacts on pinnipeds (an Annex II species) are discussed.

6.1 Underwater Noise Transmission

As sound spreads underwater, it decreases in intensity (attenuates) with distance from the source. The rate of attenuation is affected by sound absorption or scattering by organisms in the water column, reflection or scattering of the sound wave at the seabed, which varies depending on sediment type, and the temperature, pressure, water column stratification, salinity and even weather (Munk and Zachariasen, 1991; Richardson *et al.,* 1995). It also reflects and scatters at the sea surface, which varies depending on sea state conditions. Consequently, actual sound transmission has considerable temporal and spatial variability that is difficult to quantify.

In order to assess the expected underwater noise levels from the proposed Barryroe site survey operations, Subacoustech Environmental Ltd (hereafter referred to as 'Subacoustech') was commissioned to carry out underwater noise modelling. The modelling was undertaken in accordance with the recommendations in the National Physical Laboratory Good Practice Guide 133 for Underwater Noise (Robinson *et al.,* 2014).

Modelling of underwater noise is complex and can be approached in several different ways. Subacoustech has used a numerical approach that is based on two different computational modelling methods, or solvers:

- A parabolic equation (PE) solver for lower frequencies (16 Hz to 125 Hz); and
- A ray tracing solver for higher frequencies (250 Hz and above).

The PE method is widely used within the underwater acoustics community but has computational limitations at high frequencies. Likewise, ray tracing is more computationally efficient at high frequencies but is not suited to calculating low frequencies (Etter, 1991). Choosing both methods provides the most robust model across all frequencies. This study implements these numerical solutions using the dBSea software (v2.2.4).

A wide array of input parameters including bathymetry, sediment data, sound speed and source frequency content have been input into the model to ensure the results are as accurate as possible. The modelling parameters, such as source noise level, the duration of activity operation and its location have been selected to be worst case, to avoid the risk of underestimating an impact.

A summary of the source levels (a measure of the acoustic output of a source) used are provided in Table 6.1. These are considered typical for the equipment which will be used during the proposed Barryroe site survey operations, as detailed in Section 2.4.1. Alternative equipment (different manufacture or model) would not be expected to have a significant effect on the modelling results.

With regards to Table 6.1, the following different metrics have been reported:

- Sound Pressure Level (SPL) – a logarithmic measure in decibels (dB) of the average pressure level in water, with respect to a standard reference pressure (i.e. one micro-Pascal; µPa). SPL is quoted at a standard range from the source, usually one metre (dB re 1µPa @ 1 metre) and represents the amplitude of a sound's waveform. It may be measured in a number of ways including peak (as per Table 6.1) or peak-to-peak (for short duration sounds) and root mean square (rms) estimates (for continuous sounds).

- Sound Exposure Level (SEL) – a measure of sound energy over a given duration, i.e. time integral of instantaneous sound pressure squared, normalised to a 1 second period (i.e. dB re 1 µPa^{2}s) taking into account the interval and repeat rate of multiple pulse sources. This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis. SEL is based on the assumption that sounds of equivalent energy will have similar effects on the auditory systems of exposed individuals, even if they differ in SPL, duration and/or temporal exposure pattern (Genesis, 2011).

Table 6.1. Typical SPL_{peak} and SEL source levels for the noise sources considered for this study[1]

Noise Source	Sound Type [2]	Frequency Range (see Section 2.4.1)	SPL_{peak} source level (dB re 1 µPa @ 1m)	SEL source level (dB re 1 µPa^{2}s @ 1m)
USBL	Impulsive	26.5 kHz - 33.5 kHz	206.3	154.6
SBES	Impulsive	200 kHz	227.0	180.0
MBES	Impulsive	70 kHz - 100 kHz	224.9	169.5
SSS	Impulsive	120 kHz & 410 kHz	210.0	163.0
SBP	Impulsive	3.5 kHz	223.5	176.7
Survey Vessel [3]	Non-impulsive	< 1 kHz	N/A	151.1

[1] Source levels have been derived using data from manufacturers, vessel contractors and from measurements of similar equipment from Subacoustech's noise measurement database.
[2] Underwater sound has been categorised by NMFS (2018) as impulsive and non-impulsive. Impulsive sources produce sounds that are typically transient, brief (less than 1 second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay. Non-impulsive sources produce sounds that can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do.
[3] The continuous noise produced by a vessel is not conducive to the SPL_{peak} metric or criteria and so this noise source is considered using SEL.

All the geophysical sound sources are directional, as the sound is designed to be discharged directly down towards the seabed. The source levels detailed in Table 6.1 therefore represent the level of sound directly under the source. Especially with high frequency sources, the sound that will 'leak' to the side is a fraction of this level. A conservative correction for this directivity has therefore been applied to the geophysical sounds in the modelling.

As previously noted, the survey equipment is expected to be operational at the same time along with survey vessel noise. Subacoustech has created a source level and frequency input for the concurrent noise source scenario by combing the frequency spectra. This results in an SEL source level of 182.0 dB re 1 µPa^{2}s @ 1 m; like vessel noise the combined source is considered non-impulsive.

The modelling has been undertaken at two locations for the various noise sources at the east and west edges of the proposed Barryroe survey area. Although the survey vessel will be constantly moving during the survey activities, this extreme selection of location, assuming that all of the noise emitted is from a single location at the sides of the site, provides a worst case assessment.

The results of the modelling are summarised in Section 6.2, with reference to the criteria used to assess the noise impact on relevant marine species.

It should be stressed that while the modelling results present specific ranges at which impact thresholds are met, these ranges should be considered worst case in determining whether receptors will experience environmental effects during the proposed Barryroe site survey operations.

6.2 Assessment of Potential Impacts

6.2.1 Potential Impacts to Plankton

As noted in Section 5.6, plankton is important for the wider food web as it forms the basis of marine life; changes to plankton could therefore adversely impact other marine species, including cetaceans, pinniped and fish.

The first large-scale field experiment on the impact of seismic activity on zooplankton was undertaken by McCauley *et al.* (2017). This reviewed the impacts of a seismic survey, using a 150 cubic inch airgun, on plankton off southern Tasmania in 2015. The results of the study suggest seismic surveys cause significant mortality to zooplankton populations, with impacts observed out to the maximum 1.2 km range sampled, as opposed to the previously assumed impact range of 10 m. The resulting reported morbidity rates have however been questioned by the scientific community due to concerns on sampling procedures and resulting statistical analysis (Richardson *et al*., 2017).

Applying the mortality rate from McCauley *et al.* (2017), Richardson *et al*. (2017) estimated the spatial and temporal impact of seismic activity on zooplankton on the Northwest Shelf from a large-scale seismic survey, accounting for typical growth rates, natural mortality rates, and the ocean circulation in the region. This simulation indicated some impact within 15 km of the survey area, however, these impacts were barely discernible within 150 km of the survey area. Richardson *et al.,* went on to note that zooplankton populations recovered quickly (2-6 days) after seismic exposure due to their fast growth rates, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region.

An airgun will not be utilised for the proposed Barryroe site survey, therefore the source levels from the geophysical survey equipment are significantly lower than levels observed with seismic airguns. As such, any potential impacts to plankton would be expected to occur over a smaller area to that noted by Richardson *et al*., (2017). In addition, the proposed Barryroe survey area is situated over 190 km from the nearest major productive 'hotspot' for plankton (refer to Section 5.6). Consequently, any impacts to the plankton populations at the Irish Shelf Front and the Celtic Sea Front are predicted to be Negligible and therefore no significant knock-on effects to higher tropic level organisms (including those listed as Annex IV) are anticipated.

6.2.2 Potential Impacts on Fish and Shellfish

Introduction

Sounds produced by fish are predominantly related to reproduction or conveying territorial aggression or predation (DOSITS, 2017). As such, many fish species have developed sensory mechanisms for detecting, locating and interpreting underwater sounds. Hearing ability is highly variable between fish species. Species with a connection between the inner ear and the swimbladder, a gas-filled organ primarily used for buoyancy, are more sensitive to sound (Hawkins, 1993; Moyle and Cech, 2004; Popper, 2012). Fish may tentatively be separated into:

- Category I - Fish with no swim bladder or other gas volume (particle motion detectors), such as flatfish, mackerel and sharks, skates and rays (Myrberg, 2001) and sandeels (Mason, 2013);
- Category II - Fish with a swim bladder or other gas volume, and therefore susceptible to barotrauma (injury caused by increased air or water pressure), but where the organ is not involved in hearing (particle motion detectors);
- Category III - Fish with a swim bladder or other gas volume, and therefore susceptible to barotrauma, where the organ is also involved in hearing (sound pressure and particle motion detectors), such as cod and herring and relatives (Hawkins, 1993; Popper et al., 2014; DOSITS, 2017).

As discussed in Section 5.5, the fish community in the vicinity of the proposed Barryroe survey area is a mixture of demersal, pelagic and shellfish species. Many demersal species have a small or reduced swim bladder or a swim bladder that is not in close proximity, or mechanically connected to the ears

(DOSITS, 2017) and would therefore be classified as Category II Fish. These species therefore tend to have relatively poor auditory sensitivity, and generally cannot hear sounds at frequencies above 1 kHz (DOSITS, 2017).

Potential effects on fish from noise sources range from behavioural changes including fish moving away from an area or ceasing feeding, to physiological changes such as temporary hearing loss, tissue damage or even death (DOSITS, 2017). Physiological damage is of particular concern for fish eggs and larvae, since unlike adult fish they are unable to move away from a noise source and are therefore at greater risk of injury or mortality (Turnpenny and Nedwell, 1994).

There is little information on the impacts of loud underwater noises on marine invertebrate species and the hearing mechanisms of these species are currently not well known. However, most marine invertebrates lack air filled spaces, and can thus only perceive sound as a physical force (vibration). Sound therefore has a limited likelihood of having physiological or behavioural effects on marine invertebrates. McCauley (1994) found little evidence of either behavioural or physiological effects, except in cases where the organisms were within a few metres of a powerful noise source.

Impact Assessment Criteria

For this study, the effects of noise on fish have been assessed using noise criteria from Popper *et al.* (2014), which groups species of fish by whether they have a swim bladder and whether the swim bladder is involved in hearing and gives specific criteria for different noise sources. Most of the proposed site survey noise sources would be assessed against the sonar criteria from Popper *et al.* (2014), but as the majority of these sources are considered high-frequency sonar (frequencies in excess of 10 kHz) no criteria are given as fish are unable to perceive the high frequencies that characterise these sources. The pinger SBP falls within the mid-frequency sonar range (1 kHz to 10 kHz). All the noise sources have also been assessed using the continuous (and shipping) noise group.

Modelling Results

The modelling results predict that any impact to fish will be in a localised area, in close proximity to the source, with the majority of noise sources featuring rapid attenuation that results in predicted impact ranges of less than 10 m.

The SBES and SBP, and subsequently the combined noise source scenario results in the largest predicted impact ranges, with Category III fish experiencing temporary threshold shift (TTS; i.e. recoverable hearing loss) out to a maximum distance of 30 m from the source, when considering the Popper *et al.* (2014) unweighted SPL root mean squared (SPL_{RMS})[2] continuous sounds criteria for fish.

Assessment of Impacts

As most noise produced by fish is related to reproduction, many fish are more receptive and therefore more sensitive to introduced noise during reproductive periods and spawning events. In addition, disturbance to fish during key lifecycle events may have greater impacts at a population level as it could deter individuals away from crucial habitats. The waters surrounding the proposed survey area have been identified as spawning and nursery grounds for a number of fish species throughout the period when the proposed site survey operations could occur (refer to Section 5.5). However, for the majority of fish species in the area with spawning and / or nursery periods that overlap with the proposed geophysical site survey operations, the area likely to be impacted is considered to represent only a small proportion of the spawning and nursery grounds available to each fish species. In addition, studies into the effects of acoustic disturbance to fish indicate that direct injuries to species (at any lifecycle stage) will only occur within a few metres of the source (Swan *et al.,* 1994).

[2] Root mean square (rms) sound pressure level measures the total sound intensity, then divides it by the duration of the signal. It is an appropriate metric to use for certain types of continuous sounds such as shipping (Genesis, 2011).

Behavioural studies of fish species during seismic surveying activity indicate that the noise produced may be of no more than a nuisance to fish and any displacement of fish due to disturbance will be local and temporary (APPEA, 2013). *S*hort-term behavioural effects may be expected in very close proximity to the noise source (within a few metres) with reversion to normal behaviour once the noise source is removed. As previously noted, an airgun will not be utilised for the proposed Barryroe site survey, therefore the source levels from the geophysical survey equipment are significantly lower than levels observed with seismic airguns. Although behavioural impacts to individuals may occur as a result of the proposed Barryroe site survey operations, impacts at the population level are not expected and any effects will be temporary.

Low densities of migrating diadromous fish (Atlantic salmon, sea lamprey and river lamprey) may pass through the ensonified area during the proposed site survey operations, but will not remain in the area. Atlantic salmon migrate through Irish waters, travelling northwards along the west coast to Greenland and the Norwegian Sea and modelling of known migration routes suggests little salmon activity in the waters of the southern Irish coast (Mork *et al.,* 2012). Twaite shad and allis shad migrate to the sea to feed but are predominantly limited to coastal waters (Nexen, 2018). Consequently, any potential adverse effect on diadromous fish would be localised, of short duration and only likely to affect a small number of individuals. There is also no evidence that any displacement would have any long-term effect on migratory behaviour (DECC, 2011).

The sensitivity of fish to underwater noise emissions is considered to be High; the receptor is of high value, but has some tolerance / ability to adapt to effects. Based on the assessment as detailed above, the magnitude of impact is predicted to be Small as any impacts will be in close proximity to the source affecting only a few individuals and will be temporary in nature. In addition, the period during which fish may encounter sound from the proposed operations is relatively short. The majority of the geophysical equipment will only be used for approximately 6 days. The exception to this is the USBL beacon system and possibly the echosounders which will be used during the environmental survey, predicted to take approximately 10 days to complete. Any impacts to fish are therefore considered to be Minor and are not considered to result in significant effects on the environment. Measures will be implemented, as outlined in Section 6.3, to ensure any impacts are minimised as much as possible.

It is also noted that fish are an important food source for cetaceans. As such, cetaceans could be indirectly impacted by changes in the abundance of fish; however, given the small impact range for fish, indirect impacts on cetaceans will not be significant.

6.2.3 Potential Impacts on Cetaceans

Introduction

Cetaceans rely on sound to communicate, protect themselves, locate prey, navigate and understand their surroundings and maintain social structures (DAHG, 2014; DOSITS, 2017). Cetaceans use echolocation as their principle means of navigation, communication, prey detection and predator avoidance. The individual emits a series of short impulsive sounds, such as clicks, and monitors reflections or echoes that are reflected back that help it glean more information about the surrounding environment (Weilgart, 2007; Ansmann, 2005; Potter and Delory, 1998).

Reactions of cetaceans to anthropogenic noise are variable and dependent on the noise intensity and frequency, as well as the individuals hearing thresholds. In addition, newborn and younger individuals may have the greatest hearing sensitivity with hearing ability declining over time due to age, exposure to harmful sound levels and disease (DAHG, 2014).

Species will only hear sounds that are within their hearing threshold (DOSITS, 2017) and therefore hearing sensitivity is reduced outside a species' audible frequency range. As such, it may also be effective to assess the impact to individuals related to their hearing ability at the operating frequency of the source (DAHG, 2014). The frequency at which marine mammals can detect noise is species-specific with odontocetes (toothed whales, dolphins and porpoises) having a wider hearing frequency range compared to mysticetes (baleen whales).

The latest guidance from the U.S. National Marine and Fisheries Service (NMFS) (2018) concerning underwater noise and its effects on marine mammals, groups marine mammals into functional hearing groups and applies filters to unweighted noise to approximate the hearing response for each receptor group. Although the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014) recommends using the marine mammal noise exposure criteria proposed by Southall et al. (2007); the NMFS (2018) guidelines have been used for this study as they represent more up-to-date thinking by many of the Southall et al. (2007) authors and are based on the best available research on the effects of noise on marine mammals.

Table 6.2 presents the cetacean species that may be present within the proposed survey area, at various times throughout the year, by their functional hearing group and associated estimated hearing range, as classified by NMFS (2018). It should be noted, however, that most species have only been recorded in low to moderate numbers within the offshore waters in the vicinity of the proposed Barryroe survey area and in some cases their presence cannot be confirmed (see Section 5.2).

Table 6.2. Cetacean Hearing Groups that may be present in the Vicinity of the Survey Area and their Generalised Hearing Range (NMSF, 2018)

Hearing Group	Generalised Hearing Range	Species which may be present in the vicinity of the Survey Area (refer to Table 5.2)
Low-frequency cetaceans *(e.g. baleen whales)*	7 Hz – 35 kHz	Minke whale, Fin whale, Humpback whale, Blue whale, Sei whale
Mid-frequency cetaceans *(most toothed whales, dolphins)*	150 Hz – 160 kHz	Bottlenose dolphin, White-sided dolphin, White-beaked dolphin, Short-beaked common dolphin, Risso's dolphin, Long-finned pilot whale, Sperm whale, Killer whale, Striped dolphin, Beaked whales
High-frequency cetaceans *(certain toothed whales, porpoises)*	275 Hz -160 kHz	Harbour porpoise

Physiological Impacts on Cetaceans

Few conclusive studies have been undertaken on the physiological effects of noise on marine mammals. Studies that have been undertaken usually focus on individuals in artificial conditions, usually in captivity, and of single species and therefore are not a true representation of a wild population (Southall *et al.,* 2007; DAHG, 2014).

The mammalian inner ear is the most sensitive organ to noise exposure and is the most at risk to sound-derived damage (Southall *et al.,* 2007). Potential physiological impacts of underwater noise on marine mammals can be hearing damage or tissue damage, as these systems are adapted to respond to changes in pressure in the marine environment (DAHG, 2014). As well as the ear, noise also has the potential to affect other organs and tissues e.g. via trauma from the pressure component of the sound wave or bubble formation and bubble growth in tissues (DAHG, 2014) potentially leading to embolisms. Low-level physiological responses to noise may include changes in cardiac rate and respiratory patterns, which may in turn affect metabolism (Southall *et al.,* 2007). Studies of physiological indicators of stress reactions in marine mammals are limited; however, changes in stress hormone levels have been observed in odontocetes exposed to high-level sounds, as well as changes in dive cycles, lowered immune response and altered energy stores and metabolism, which may have subsequent physiological and immune effects (Southall *et al.,* 2007). In general, well established cause and effect cases linking specific anthropogenic sounds sources and lethal effects on cetaceans are uncommon (DAHG, 2014) and there are no definitive cases of mortality of cetaceans as a result of geophysical surveys.

Evidence has shown episodes of mass strandings of beaked whales that are suspected to result from episodes of anthropogenic noise, particularly mid-frequency sonar (Boisseau *et al.,* 2014; DAHG, 2014). Beaked dolphins may be particularly susceptible to the effects of anthropogenic noise as they

tend to be associated with specific habitat types, namely slopes and canyons (Boisseau *et al.,* 2014). As such, activities that may lead to degradation of key habitat may have a more significant effect on species that exhibit greater reliance on a specific habitat.

When marine mammals are exposed to intense sound, an elevated hearing threshold may occur, known as a threshold shift (TS). If the hearing threshold returns to the pre-exposure level after a period of time, the TS is known as a temporary threshold shift (TTS). If the threshold does not return to the pre-exposure level, it is known as a permanent threshold shift (PTS) (Finneran *et al.,* 2000; Southall *et al.,* 2007). Both TTS and PTS arise as a result of physiological changes to the auditory systems of marine mammals. According to the DAHG Guidelines, it is considered that anthropogenic sound sources with the potential to induce TTS in an individual may have the potential for both disturbance and injury due to temporary changes in hearing sensitivity, which could have an effect on an individual to use natural sounds (DAHG, 2014). However, where the effects result in PTS, they may represent direct physical injury to the individual.

Assessment Criteria for Physiological Impacts

For impulsive noise, NMFS (2018) presents unweighted SPL_{peak} and cumulative weighted sound exposure level (SEL_{cum})[3] criteria for PTS, where unrecoverable hearing damage may occur and TTS, where a temporary, recoverable reduction in hearing sensitivity may occur. To account for the fact that different species groups use and hear sound differently, the thresholds in the weighted SEL_{cum} metric incorporate auditory weighting functions. As dual metrics, NMFS considers onset of PTS to have occurred when either one of the two metrics is exceeded. For non-impulsive noise only weighted SEL_{cum} criteria are presented. This criteria is summarised in Table 6.3.

Table 6.3. NMFS (2018) PTS and TTS Onset Thresholds for Cetaceans

Hearing Group	Impulsive Noise		Non-impulsive Noise
	Unweighted SPL_{peak} (dB re 1 µPa)	Weighted SEL_{cum} (dB re 1 µPa^{2}s)	Weighted SEL_{cum} (dB re 1 µPa^{2}s)
PTS Criteria			
Low-frequency cetaceans	219	183	199
Mid-frequency cetaceans	230	185	198
High-frequency cetaceans	202	155	173
TTS Criteria			
Low-frequency cetaceans	213	168	179
Mid-frequency cetaceans	224	170	178
High-frequency cetaceans	196	140	153

Note, for the SEL_{cum} modelling a fleeing animal model has been assumed. The fleeing animal model assumes that marine mammals flee from the source at a constant rate of 1.5 ms^{-1} (Otani *et al.*, 2000), with the exception of low frequency cetaceans, which flee at a rate of 3.25 ms^{-1} (Blix and Folkow, 1995). Where SELcum criteria are used, a worst-case assumption of continuous 24-hour operation has been assumed.

Modelling Results

The predicted worst case PTS and TTS impact ranges for cetaceans for the various noise sources associated with the proposed Barryroe site survey operations are summarised in Table 6.4.

[3] SEL can be computed for multiple pulses or signals to generate a value equivalent to a single exposure for the cumulative sound energy (SELcum).

Table 6.4: Predicted maximum impact ranges to the NMFS (2018) PTS and TTS criteria for cetaceans

Noise Source	Maximum Predicted Impact Range		
	Low-frequency cetacean	Mid-frequency cetacean	High-frequency cetacean
NMFS (2018) PTS Criteria			
USBL	< 10 m	< 10 m	10 m
SBES [1]	< 10 m	< 10 m	190 m
MBES [1]	< 10 m	< 10 m	80 m
SSS	< 10 m	< 10 m	10 m
SBP	< 10 m	< 10 m	40 m
Vessel	< 10 m	< 10 m	< 10 m
Combined	< 10 m	< 10 m	10 m
NMFS (2018) TTS Criteria			
USBL	< 10 m	< 10 m	270 m
SBES [1]	< 10 m	10 m	480 m
MBES [1]	< 10 m	< 10 m	650 m
SSS	< 10 m	< 10 m	150 m
SBP	70 m	< 10 m	5.8 km
Vessel	< 10 m	< 10 m	< 10 m
Combined	< 10 m	10 m	310 m

[1] In practise, the model is likely to have significantly over estimated the potential impact as a much lower noise level will be present to the side (i.e. off-axis) of the SEBS / MBES.

Assessment of Impacts

Table 6.4 shows it is possible that the proposed Barryroe site survey operations could result in onset of PTS to high-frequency cetaceans out to a maximum distance of 190 m from the SBES noise source, although the PTS impact ranges for mid-frequency and low-frequency cetaceans are predicted to be less than 10 m from all the noise sources. The sensitivity of cetaceans to PTS impacts is High; the receptor is of international importance and has limited tolerance / ability to adapt to the effect. As individuals may be physically injured the magnitude of impact is Large. Impacts to cetaceans from PTS are therefore predicted to be Major. However, the possibility of injury to cetaceans will be significantly reduced with the use of a 500 m Monitored Zone, since the start-up of the sound source will not occur until visual monitoring confirms that the area is clear of cetaceans (refer to Section 6.3). As no cetaceans will be present within the zone where PTS impacts could occur, any residual impacts to cetaceans are predicted to be Negligible and would not result in significant effects on the environment.

With regards to TTS, it can be seen from Table 6.4 that the largest impact ranges are predicted for high-frequency cetaceans out to a maximum distance of 5.8 km from the SBP noise source. Due to the lower frequency components of the SBP, the noise travels much further than for the other high frequency sources. For low-frequency cetaceans, TTS impacts are predicted to occur out to a maximum distance of 70 m from the SBP noise source, whilst for mid-frequency cetaceans TTS impacts are predicted to occur out to a maximum distance of 10 m from all the noise sources.

The possibility that cetaceans may experience a temporary, recoverable reduction in hearing sensitivity is also significantly reduced by the use of the 500 m Monitored Zone, as discussed above, although it is acknowledged that outside of this area high-frequency cetaceans (i.e. harbour porpoise) could be impacted out to a maximum distance of 5.8 km from the SBP noise source, which equates to an area of approximately 106 km^2.

To determine the magnitude of impact to harbour porpoises, it is possible to calculate the number of animals which may be exposed to TTS onset using the density and abundance estimates from the ObSERVE Aerial project (Rogan *et al.,* 2018) as detailed in Table 6.5.

Table 6.5. Estimated Number of Harbour Porpoise Potentially Experiencing TTS Onset

Species	The Celtic Sea (Stratum 4) [1]				Max number of animals subject to TTS Onset [2]		% of reference population potentially affected	
	Density - summer (animals per km^2)	Density – winter (animals per km^2)	Abundance – summer (individuals)	Abundance – winter (individuals)	Summer	Winter	Summer	Winter
Harbour porpoise	0.227	0.060	14,189.8	3,752.0	< 25	< 7	< 0.2%	< 0.2%

[1] Density estimates from Rogan *et al.,* 2018 for the S4 stratum (The Celtic Sea area).
[2] Calculated as the density estimate x TTS onset area (as a worst case it is assumed TTS is experienced out to a maximum distance of 5.8 km, which equates to an area of approximately 106 km^2).

It can be seen from Table 6.5 that as a worst case estimate, less than 25 individuals are predicted to be affected from the proposed Barryroe site survey operations during the summer, with less than 7 individuals affected during the winter. The number of individual animals that may experience TTS as a result of the proposed Barryroe site survey operations, based on the reference population in the Celtic Sea, is small enough that there would be no effect at the population level. In addition, the period during which these individuals may encounter sound from the proposed operations is relatively short. The majority of the geophysical equipment, including the SBP, will only be used for approximately 6 days. The exception to this is the USBL beacon system and possibly the echosounders which will be used during the environmental survey, predicted to take approximately 10 days to complete. In addition, individuals are likely to move out of the area of impact once the proposed site survey operations have commenced. Given this, the magnitude of impact is predicted to be Small. The sensitivity of cetaceans to TTS impacts is High; the receptor is of international importance, but is able to recover once operations have ceased. Impacts through TTS to cetaceans are therefore predicted to be Minor and are not considered to result in significant effects. Measures will be implemented, as outlined in Section 6.3, to ensure any impacts are minimised as much as possible.

Behavioural Impacts on Cetaceans

Behavioural reactions to acoustic exposure are variable, context-dependent, and less predictable than the effects of noise exposure on physiology. This is because behavioural responses are highly variable, even within species, and are difficult to quantify. Examples of behavioural responses include orientation or attraction to or from the noise source, increased alertness, modification of their own sound production characteristics, change in movement or diving behaviour, temporary change in habitat use and, in severe cases, panic, fleeing, or stranding behaviour, which may indirectly result in injury or death. In addition, exposure to noise sources may also mask intra-species communications and other biologically important sounds (DAHG, 2014). Some animals or individuals may not exhibit any avoidance when exposed to a certain sound source, this may not mean they have not detected the sound, but that they may be habituated to it, or it may just be innate differences in their general behavioural responses (Southall *et al.,* 2007).

In terms of the behavioural impact that geophysical surveys can have on marine mammals, Southall *et al*. (2007) notes that seismic activities tend to generate short-duration, impulsive sounds that are more likely to cause startle or flight responses in marine mammals. Weilgart (2013) observed that the dominant behavioural response to geophysical survey noise, predominantly seismic noise sources, is avoidance and vacating of the area. However, many species will return to the area once the operations have ceased therefore suggesting that avoidance is short-lived. It is therefore likely that, upon commencement of the proposed Barryroe site survey operations, cetaceans may move away from the sound source but that individual distribution and behaviour will recover once complete.

Other studies have identified groups of whales changing swimming direction to avoid seismic sources of up to 192 dB re 1µPa at one metre (Nowacek *et al.,* 2007) and a reduction in vocalisations of bottlenose dolphins during airgun activity (Goold, 1996), although in this instance vocalisations of bottlenose dolphins recovered to normal levels after a week of seismic pulses continuing, suggesting that individuals became habituated to the noise (Goold, 1996). Short-term avoidance has been observed in harbour porpoises, but effects were short-lived as individuals returned to the survey area within hours of sound source ceasing (Thompson *et al.,* 2013). As an airgun will not be utilised for the proposed Barryroe site survey, the source levels from the geophysical survey equipment are significantly lower than levels observed with seismic airguns and therefore it is expected that any impacts would be reduced from those observed in previous studies.

Studies of the effects of sonar (including depth sounding sonar such as MBES and SSS) has demonstrated that certain species demonstrated certain behavioural responses including changes in dive patterns and avoidance of the noise source by both moving away from the source and / or orientating away from the source (OSPAR, 2009). It should be noted, however, that much of the literature focuses on the impact from large-scale military sonar exercises and seismic survey activity, often with extended durations of exposure compared to the proposed Barryroe site survey (*OSPAR, 2009*).

The presence of vessels has been known to lead to an increase in ambient noise levels in the sea, particularly in coastal waters or important shipping lanes (DOSITS, 2017) the long-term impacts of which are poorly understood. Vessel noise is emitted at frequencies that overlap with cetacean hearing, thereby increasing the potential for auditory masking, avoidance or other disturbance effects (DAHG, 2014). Some cetaceans such as the harbour porpoise, Atlantic white-sided dolphin and minke whale are known to actively avoid vessels in some situations (Palka and Hammond, 2001). In addition, some species have been observed changing swimming direction in response to approaching vessels (OSPAR, 2009). Tagging studies have indicated that some species will alter their heading and dive depth in response to some vessel noise (Nowacek *et al.,* 2004; OSPAR, 2009). Underwater acoustic monitoring of beaked whales also indicated that a Cuvier's beaked whale reduced vocalisations in response to a passing cargo vessel (Aguilar Soto *et al.,* 2006).

It is an offence to disturb and injure a marine mammal. To assess whether a disturbance is significant reference can be made to the definition of the favourable conservation status of a species given in Article 1(i), on the basis of the following factors:

- 'Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable element of its natural habitats'. *Any event, activity or process contributing to the long-term decline of the population of the species on the site can be regarded as a significant disturbance;*
- 'The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future' *Any event, activity or process contributing to the reduction or to the risk of reduction of the range of the species within the site can be regarded as a significant disturbance;*
- 'There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis'. *Any event, activity or process contributing to the reduction of the size of the available habitat of the species can be regarded as a significant disturbance.*

Factors such as intensity, frequency and duration of the disturbance may be taken into account to determine its significance, which may vary from one species to another and according to different times and different conditions (e.g. food resources, or through the presence of sufficient undisturbed areas nearby) (European Commission, 2018).

Assessment Criteria for Behavioural Disturbance

NMFS (2018) does not provide guidance on behavioural thresholds for cetaceans. Instead, behavioural disturbance criteria for marine mammals based on the interim guidance from NOAA (2013) have been used in this study. These are:

- 160 dB re 1 µPa (Unweighted SPL_{RMS}) – behavioural disturbance for impulsive noise;

- 120 dB re 1 µPa (Unweighted SPL_{RMS}) – behavioural disturbance for continuous (non-impulsive) noise.

Modelling Results

Table 6.6 presents the predicted worst case behavioural impact ranges for cetaceans. It can be seen from this that the largest impact ranges are predicted from the SBP noise source, with behavioural change effects potentially experienced out to a distance of 11 km, which equates to an area of approximately 380 km^2. For the combined sources; the largest predicted ranges are similar to the largest of the single source impact ranges, as this single source (the SBP) dominates the combined source level.

Table 6.6: Predicted maximum impact ranges to the NOAA (2013) behavioural criteria for cetaceans

Noise Source	Maximum Predicted Impact Range
USBL	230 m
SBES	570 m
MBES	560 m
SSS	240 m
SBP	11 km
Vessel	190 m
Combined noise sources	11 km

Assessment of Impacts

It should be noted that behavioural changes such as moving away from an area for short periods of time, reduced surfacing time, masking of communication signals or echolocation clicks, vocalisation changes and separation of mothers from offspring for short periods, do not necessarily imply that detrimental effects will result for the animals involved (JNCC, 2010). In addition, temporarily affecting a small proportion of a population would be highly unlikely to result in population level effects.

During the proposed survey period, a number of cetacean species are likely to be present in the vicinity of the proposed survey area including bottlenose dolphin, common dolphin, striped dolphin, Risso's dolphin, harbour porpoise, pilot whale and minke whale (refer to Section 5.2). All of these species are considered to be regularly occurring in the waters of the Celtic Sea and it is acknowledged that many of these species have peak occurrence in the autumn and early winter months off the south and south west coast of Ireland, coinciding with a peak abundance in pelagic fish prey abundance (notably herring).

To determine the magnitude of impact in terms of the actual number of animals impacted, it is possible to calculate the number of animals likely to experience some sort of behavioural impact using the density and abundance estimates from the ObSERVE Aerial project (Rogan *et al.,* 2018).

The number of individual animals potentially affected for species known to be present in the vicinity of the proposed survey area is detailed in Table 6.7.

Table 6.7. Estimated number of animals experiencing behavioural changes as a result of the proposed Barryroe site survey operations

Species	The Celtic Sea (Stratum 4)[1]				Max number of animals subject to Behavioural Changes [2]		% of reference population potentially affected	
	Density - summer (animals per km^2)	Density – winter (animals per km^2)	Abundance – summer (individuals)	Abundance – winter (individuals)	Summer	Winter	Summer	Winter

Species	The Celtic Sea (Stratum 4)[1]				Max number of animals subject to Behavioural Changes [2]		% of reference population potentially affected	
	Density - summer (animals per km²)	Density – winter (animals per km²)	Abundance – summer (individuals)	Abundance – winter (individuals)	Summer	Winter	Summer	Winter
Bottlenose dolphin	0.075	0.514	4,717	32,432	< 29	< 196	< 0.7	< 0.7
Common dolphin	0.044	0.637	2,759.6	39,898.7	< 17	< 243	< 0.7	< 0.7
Striped dolphin [3]	0.041	0.639	2,554	40,027.4	< 16	< 243	< 0.7	< 0.7
Risso's dolphin	0.0128	0.0006	809.0	39.9	< 5	< 1	< 0.7	< 3
Harbour porpoise	0.227	0.060	14,189.8	3,752.0	<87	< 23	< 0.7	< 0.7
Pilot whale	-	0.002	-	99	-	< 1	-	< 1.1
Minke whale	0.029	0.012	793.3	760.5	< 12	< 5	< 2	< 0.7

[1] Average density estimates from Rogan *et al.,* 2018 for the S4 stratum (The Celtic Sea area).
[2] Calculated as the density estimate x behavioural onset area (as a worst case it is assumed behavioural impacts are experienced out to a maximum distance of 11 km, which equates to an area of approximately 380 km²).
[3] For the ObSERVE data there was a lack of sightings of striped dolphin, theorized due to the difficulties in differentiating between common and striped dolphin. Therefore, both were combined into one category termed common + common / striped dolphin for estimation analysis (Rogan *et al.,* 2018).

It can be seen from Table 6.7 that whilst the presence of these species in the potential disturbance area during the proposed Barryroe site survey operations cannot be ruled out, the number of individual animals that are likely to exhibit some form of change in behaviour for the period in which they encounter sound from the project is small compared to the Celtic Sea abundance estimates from the ObSERVE Aerial project. In addition, the period during which these individuals may encounter sound from the proposed operations is relatively short. The majority of the geophysical equipment will only be used for approximately 6 days. The exception to this is the USBL beacon system and possibly the echosounders which will be used during the environmental survey, predicted to take approximately 10 days to complete. Individuals are likely to move out of the area of impact once the proposed site survey operations have commenced. Any behavioural impacts will be short term and temporary and will cease once the survey operations have been completed. There will therefore be no long-term decline of the population of any of the species impacted and no long-term reduction in the size of their available habitat, with individuals returning to the survey area on completion of the operations. Given this, the magnitude of impact is predicted to be Small.

The sensitivity of cetaceans to behavioural impacts is Medium; the receptor is of international importance, but is generally tolerant of behavioural effects and will immediately recover once operations cease. Behavioural impacts to cetaceans are therefore predicted to be Minor and are not considered to result in significant effects on the environment. Measures will be implemented, as outlined in Section 6.3, to ensure any impacts are minimised as much as possible.

6.2.4 Potential Impacts on Marine Reptiles

The leatherback turtle is the only marine reptile considered to be a regular visitor in Irish waters (refer to Section 5.3). Given the abundance of marine reptiles in offshore Irish waters is low, interactions with the proposed site survey operations are possible but unlikely.

Sea turtles may be affected by marine sound both physiologically and behaviourally, however, effects in the natural environment are largely unknown because of a lack of information on hearing capabilities and behavioural responses to sound. Similarly to marine mammals, turtles may

experience a change in hearing sensitivity (PTS or TTS) in response to noise sources within their frequency range of hearing (Dow Piniak *et al.,* 2012).

Much of the data on hearing ability comes from auditory brainstem responses from captured individuals. These have indicated that sea turtles can hear low- to mid-frequency sounds, albeit with a poorer sensitivity than marine mammals (DOSITS, 2017). Sea turtles appear to hear best between 0.2 kHz and 0.75 Hz and do not respond well to sounds above 1 kHz (DOSITS, 2017). Therefore, as the noise sources associated with the proposed geophysical survey equipment are high-frequency sounds above 1kHz (see Section 6.1) any impacts to sea turtles are predicted to be Negligible and are not considered to result in significant effects on the environment. However, the measures which will be implemented as outlined in Section 6.3 are still considered applicable to sea turtles.

6.2.5 Potential Impacts on Pinnipeds

The grey seal and the harbour seal are native to Irish waters and are classified as phocid pinnipeds (earless or true seals). The generalised hearing range of phocid pinnipeds (underwater) is between 50 Hz and 86 kHz (NMFS, 2018).

Assessment Criteria for Physiological Impacts

As with cetaceans, for impulsive noise, NMFS (2018) presents unweighted SPL_{peak} and cumulative weighted sound exposure level (SEL_{cum}) criteria for PTS, where unrecoverable hearing damage may occur and TTS, where a temporary, recoverable reduction in hearing sensitivity may occur. For non-impulsive noise only SEL_{cum} criteria are presented. This criteria is summarised in Table 6.8.

Table 6.8. NMFS (2018) PTS and TTS Onset Thresholds for Pinnipeds

Hearing Group	Impulsive Noise		Non-impulsive Noise
	Unweighted SPL_{peak} (dB re 1 µPa)	Weighted SEL_{cum} (dB re 1 µPa^2s)	Weighted SEL_{cum} (dB re 1 µPa^2s)
PTS Criteria			
Phocid pinnipeds (PW) (underwater)	218	185	201
TTS Criteria			
Phocid pinnipeds (PW) (underwater)	212	170	181

Modelling Results

The modelled maximum impact ranges for PTS and TTS to pinnipeds are presented in Table 6.9. With the exception of the SBP noise operations which result in a maximum impact range of 90 m for pinnipeds when considering the NMFS (2018) criteria for TTS, all other impacts ranges are less than 10 m.

Table 6.9: Predicted maximum impact ranges to the NMFS (2018) PTS and TTS criteria for pinnipeds

Noise Source	Max Predicted Impact Range	
	PTS Criteria	TTS Criteria
USBL	< 10 m	< 10 m
SBES	< 10 m	< 10 m
MBES	< 10 m	< 10 m
SSS	< 10 m	< 10 m
SBP	< 10 m	90 m
Vessel	< 10 m	< 10 m

Noise Source	Max Predicted Impact Range	
	PTS Criteria	TTS Criteria
Combined noise sources	< 10 m	< 10 m

Assessment of Impacts

Table 6.9 shows that although it is possible that pinnipeds may be injured or experience a temporary, recoverable reduction in hearing sensitivity as a result of the proposed Barryroe site survey operations, any impact will only arise in a very localised area, in very close proximity to the source.

The sensitivity of pinnipeds to underwater noise emissions is considered to be High; the receptor is of high value, but has some tolerance / ability to adapt to effects. The magnitude of impact is predicted to be Small given the small zone of impact, coupled with the temporary nature of the operations and the fact that very few individuals are likely to be impacted as the abundance of pinnipeds in the vicinity of the Barryroe survey area is expected to be very low (the expected density is up to 1 individual per 25 km^2 at any given time). In addition, the period during which pinnipeds may encounter sound from the proposed operations is relatively short. The majority of the geophysical equipment will only be used for approximately 6 days. The exception to this is the USBL beacon system and possibly the echosounders which will be used during the environmental survey, predicted to take approximately 10 days to complete. Impacts to pinnipeds from underwater noise emissions will therefore be Minor and are not considered to result in significant effects on the environment. In addition, PTS and TTS impacts will be significantly reduced with the use of a 500 m Monitored Zone, which will ensure the start-up of the sound source will not occur until the visual monitoring confirms that the area is clear of pinnipeds (refer to Section 6.3).

6.3 Mitigation Measures

As noted in Section 1.1, this proposed Barryroe site survey will not require the acquisition of 2D High Resolution seismic data, which would normally be included in the scope of a site survey. It is estimated that it would have taken up to 29 days, excluding weather downtime, to acquire 2D High Resolution seismic data over the survey area (assuming IOGP guidelines for survey design were followed). Instead, Exola has utilised a specific High Resolution Short Offset processing product from the existing 3D seismic data which was acquired in 2011. The ability to utilise the existing 3D seismic data avoids the need to use airguns during the site survey, significantly reducing the potential impact of the proposed operations on marine life.

Exola and its survey contractor will also adhere to the DAHG Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014), which provides mitigation measures for the protection of Annex IV species from geophysical acoustic surveys as well as a number of other offshore operations. Of note is that these measures apply specifically to marine mammals, however, observations shall also be undertaken for marine reptiles and the same procedures applied, where possible.

The mitigation measures that will be adopted by Exola for the proposed Barryroe site survey operations are summarised below (DAHG, 2014):

- Two qualified Marine Mammal Observers (MMOs) will be appointed to monitor marine mammals and log all data according to the standardised forms provided in the DAHG Guidance and provide an MMO report to the Regulatory Authorities;
- Acoustic surveying will not commence if marine mammals are detected within a 500 m radius around the acoustic sources (referred to as the Monitored Zone);
- Sound-producing survey activities will only be commenced in daylight hours where effective visual monitoring, as determined by the MMO, can be achieved;
- For sound-producing survey activities, as water depths across the proposed survey area are less than 200 m, pre-start-up monitoring will be conducted by the MMO at least 30 minutes before any activity using the acoustic sources is due to commence. Sound-producing survey

activity using the acoustic sound sources will not commence until at least 30 minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO. This pre-start monitoring will be followed by the soft-start procedure;

- Commencement of sound-producing survey activities will be undertaken using a 'soft-start' (ramp-up and gradual increase in energy/noise source) procedure for any equipment where the output peak SPL exceeds 170 dB re 1µPa at 1 metre. The build-up of acoustic energy output will occur in consistent stages to provide a steady and gradual increase in power (over a period of 20 minutes). Where the power of acoustic noise sources cannot be increased gradually, due to operational parameters of the device, the device will be switched "on" and 'off" in a consistent sequential manner for a period of 20 minutes prior to commencement of the full necessary output;
- Where a soft-start procedure is employed, the delay between the end of the soft-start and the start of the survey will be minimised to prevent unnecessary high-level sound introduction;
- Once the soft-start procedure has commenced, there is no requirement to halt or discontinue the procedure at night or in poor weather or visibility conditions or if marine mammals are sighted within the Monitored Zone;
- Where there is a break in sound output (e.g. in the event of equipment failure, shut-down etc.) from the acoustic sources for more than 30 minutes, all soft-start procedures must be undertaken before activity can recommence;
- Full reporting on MMO operations and mitigation measures undertaken must be provided to the relevant Regulatory Authorities in accordance with the Guidance.

6.4 Cumulative Impacts

In accordance with the EIA Directive (2011/92/EU) as amended by Directive (2014/52/EU), the cumulative impact that proposed plans and projects could have on the receiving environment with other plans and projects in the area must be considered.

Exola is aware of the following consented or planned projects which have the potential to have a cumulative impact with the proposed Barryroe site survey operations:

- PSE Kinsale Energy Limited plan to decommission the Kinsale Area gas fields and facilities, located in the Celtic Sea approximately 15 km north east of the Barryroe survey area. The decommissioning work will occur following cessation of production, which is scheduled to occur between 2020 and 2021. However, no significant cumulative impacts are predicted on the receiving environment given the short term and temporary nature of the proposed Barryroe site survey operations and the fact that the two projects will not occur concurrently.
- Nexen Petroleum U.K. Ltd plans to drill a single exploration well in the Iolar prospect in the Porcupine Basin approximately 337 km west of the Barryroe survey area. The well will be drilled using a floating drill ship with the earliest start date for drilling operations being April 2019. The total duration of the drilling and suspension/abandonment operations is expected to be 100 to 150 days and therefore the drilling operations could coincide with the proposed Barryroe site survey operations. During the proposed Iolar drilling operations underwater noise will be generated by both the drill ship and a proposed Vertical Seismic Profile (VSP) survey. Nexen (2018) has calculated that the worst case behavioural change impact zones to cetaceans resulting from continuous noise (drilling / drill ship / support vessel) and impulsive noise (VSP) sources are 590 m and 2,795 m respectively. In comparison, the worst case behavioural change impact zone to cetaceans resulting from proposed Barryroe site survey operations is 11 km. However, given the distance between the two projects, coupled with the short duration of the VSP (8 – 12 hours); no significant cumulative impacts are predicted even if the two projects were ongoing at the same time.

- Eni Ireland BV is planning to conduct a site survey, scheduled between June and September 2019, targeting the Dunquin South formation in the Porcupine Basin, approximately 256 km to the west of the proposed Barryroe survey area. However, given the distance between the two proposed survey areas no significant cumulative impacts are predicted even if the two surveys were ongoing at the same time.

Exola is also aware that Europa Oil & Gas may conduct three site surveys and that Nexen may conduct two site surveys in the future in the Porcupine and Slyne / Erris basins; however, no further details on these surveys are currently available. All future planned activities will be the subject of separate applications for approval submitted to DCCAE, during which any potential cumulative impacts of those projects will be considered.

In addition, Exola acknowledges that the licence area SEL 1/11 contains existing oil and gas infrastructure, namely wells associated with the Seven Heads gas fields and pipelines which connect the Seven Heads field with the Kinsale Head gas field (refer to Section 2.3). However, as the proposed site survey operations will have little interaction with the seabed, limited to seabed sampling only, and given the time which has lapsed since the last drilling activity within SEL 1/11, no significant cumulative effects are predicted.

7 Conclusions

This EIA Screening appraisal has been undertaken so as to ensure that the competent authority is enabled to make an informed Screening Decision about the need for an EIA in respect of the proposed Barryroe site survey, in accordance with the provisions of the amended EIA Directive, including Annex IIA.

The decision to be made for EIA screening is essentially whether the proposed Barryroe site survey is or is not likely to have significant effects on the environment. Where, as in this instance, a case-by-case examination is carried out, the competent authority is required to consider relevant Annex III criteria. Annex III of the EIA Directive includes information concerning the issues that should be considered when determining whether significant environmental effects are likely to result from a project. Indeed, certain of these requirements stem from the 2014 amendments to the EIA Directive

This EIA Screening Report has identified that the only source of impact that has the potential to result in a likely significant effect on the environment is the underwater noise generated from the proposed geophysical survey equipment and from the survey vessel itself. It should be noted, however, that the proposed Barryroe site survey will not require the acquisition of 2D High Resolution seismic data, which would normally be included in the scope of a site survey. It is estimated that it would have taken up to 29 days, excluding weather downtime, to acquire 2D High Resolution seismic data over the survey area (assuming IOGP guidelines for survey design were followed). Instead, Exola has utilised a specific High Resolution Short Offset processing product from the existing 3D seismic data which was acquired in 2011. The ability to utilise the existing 3D seismic data avoids the need to use airguns during the site survey, significantly reducing the potential impact of the proposed operations on marine life.

Based on the nature and duration of the proposed site survey operations, this EIA screening appraisal has concluded that although Annex IV species, fish, pinnipeds and plankton may be impacted by the underwater emissions generated from the proposed geophysical survey equipment and from the survey vessel itself, impacts will be mitigated by adherence to the DAHG Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014) such that no significant residual effects are predicted.

In summary, this EIA Screening Report has concluded that the proposed Barryroe site survey is not likely to have a significant effect on the environment, including Annex IV species, and it is therefore considered that an EIA is not required in this instance.

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