North Channel Wind in partnership with RPS — A Tetra Tech Company

HABITATS REGULATIONS ASSESSMENT

SUPPORTING INFORMATION TO INFORM SCREENING FOR APPROPRIATE ASSESSMENT AND APPROPRIATE ASSESSMENT

North Channel Wind 1 Offshore Wind Farm

Geophysical, Environmental and Metocean Marine Surveys

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HRA Report
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1 INTRODUCTION

1.1 Introduction

This report has been prepared by RPS on behalf of the North Channel Wind Ltd. and contains supporting information to assist the competent authority undertake a screening for appropriate assessment by examining whether or not a decision to grant a marine construction licence for proposed Geophysical, Environmental and Metocean Marine Surveys for the North Channel Wind 1 Offshore Wind Farm, is likely to result in a significant effect on any European site.

The report has been prepared to assist the planning and licensing authority in its role as a Competent Authority in fulfilling its duties in accordance with Regulation 43 of the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended).

1.2 Habitats Regulations Assessment

Regulation 43 of the Habitats Regulations states:

1) *"A competent authority, before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which—*
    a) *is likely to have a significant effect on a European site in Northern Ireland or a European offshore marine site (either alone or in combination with other plans or projects), and*
    b) *is not directly connected with or necessary to the management of the site,*

    shall make an appropriate assessment of the implications for the site in view of that site's conservation objectives.
2) *A person applying for any such consent, permission or other authorisation shall provide such information as the competent authority may reasonably require –*
    a) *to enable the competent authority to determine whether an assessment under paragraph (1) is required; or*
    b) *for the purposes of an assessment under paragraph (1).*
3) *In relation to a European site in Northern Ireland, the competent authority shall for the purposes of –*
    a) *determining whether an assessment is required for a plan or project under paragraph (1); or*
    b) *the assessment under paragraph (1)*

    consult the Department and have regard to any representations made by it within such reasonable time as the competent authority may specify.
4) *The competent authority shall, for the purposes of any appropriate assessment relating to a European offshore marine site, consult the Joint Nature Conservation Committee and have regard to any representations made by that committee within such reasonable time as the competent authority may specify.*
5) *The competent authority shall, if it considers it appropriate, take such steps as it considers necessary to obtain the opinion of the general public.*
6) *In the light of the conclusions of the assessment, and subject to regulation 44, the authority shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the European site in Northern Ireland or the European offshore marine site (as the case may be).*
7) *In considering whether a plan or project will adversely affect the integrity of the site concerned, the authority shall have regard to the manner in which it is proposed to be carried out or to any conditions or restrictions subject to which it proposed that the consent, permission or other authorisation should be given.*
8) *This regulation does not apply in relation to a site which is—*
    a) *a European site in Northern Ireland by reason only of regulation 9(1)(c) (site protected in accordance with Article 5(4)); or*
    b) *a European offshore marine site by reason only of its being a site of the kind mentioned in regulation 15(c) (site protected in accordance with Article 5(4)) of the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007.*

These Regulations transpose *inter alia* Articles 6(3) and 6(4) of Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora and remain relevant following the UK's departure from the EU. This approach is in line with the Habitats Regulations as amended, taking into account the effect of the Conservation (Natural Habitats, etc.) Regulations (Amendment) (Northern Ireland) (EU Exit) Regulations 2019. Terminology used in this report is in line with guidance published by DAERA in light of changes to the status of European sites and site within the UK national network of sites following the UK's departure from the EU (DAERA 2020).

In simple terms, a project must be screened for appropriate assessment (HRA screening) to ascertain whether or not likely significant effects on the UK national site network i.e. Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar sites; will occur. This report firstly considers the proposed project by itself and secondly in combination with other relevant plans or projects and has been undertaken in view of best available scientific knowledge and in view of the conservation objectives set for the sites concerned and published by the Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland.

The proposed project is not directly connected with or necessary to the management of any site as a European site or site within the UK national network of site. As such, it will be subject to a screening appraisal shadowing the assessment procedure to be carried out by the competent authority in accordance with the Habitats Regulations.

2 METHODOLOGY

2.1 Guidance on Appropriate Assessment

The Northern Ireland Environment Agency (NIEA) is an Executive Agency of the Department of Agriculture, Environment and Rural Affairs (DAERA). It has published guidance notes on Habitat Regulations Assessment for Competent Authorities (EHS, 2002 and DAERA, 2020).

These guidelines have been followed in the preparation of this report. The following list identifies these and other pertinent guidance documents:

- Communication from the Commission on the Precautionary Principle., Office for Official Publications of the European Communities, Luxembourg (EC, 2000a);
- Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg (EC, 2000b);
- Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Articles 6(3) and (4) of the Habitats Directive 92/43/EEC. Office for Official Publications of the European Communities, Brussels (EC, 2001);
- Habitats Regulations Guidance Notes for Competent Authorities. Environment and Heritage Service. Belfast (EHS, 2002) [*not available online*]
- Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC – Clarification of the concepts of: alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission; (EC, 2007);
- The Appropriate Assessment of Plans in Northern Ireland. RSPB, Belfast (RSPB, 2008);
- Estuaries and Coastal Zones within the Context of the Birds and Habitats Directives - Technical Supporting Document on their Dual Roles as Natura 2000 Sites and as Waterways and Locations for Ports. European Commission (EC, 2009);
- Guidance document on the implementation of the birds and habitats directive in estuaries and coastal zones with particular attention to port development and dredging. European Commission (EC, 2011a);
- Interpretation Manual of European Union Habitats. Version EUR 28. European Commission (EC, 2013);
- European Commission Notice C(2018) 7621 'Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC', Office for Official Publications of the European Communities, Luxembourg (EC, 2019);
- European Commission Notice C(2020) 7730 'Guidance document on wind energy developments and EU nature legislation', Office for Official Publications of the European Communities, Luxembourg (EC, 2020);
- Institute of Air Quality Management 'A guide to the assessment of air quality impacts on designated nature conservation sites (Version 1.1)' (IAQM, 2020);
- Guidance explaining The Conservation (Natural Habitats, etc.) (Amendment) (Northern Ireland) (EU Exit) Regulations 2019 (DAERA, 2020);

- European Commission Notice C(2021) 6913 'Assessment of plans and projects in relation to Natura 2000 sites - Methodological guidance on Article 6(3) and (4) of the Habitats Directive 92/43/EEC', Office for Official Publications of the European Communities, Luxembourg (EC, 2021); and
- European Commission Guidance document on Assessment of plans and projects in relation to Natura 2000 sites - A summary, Office for Official Publications of the European Communities, Luxembourg (EC, 2022).

2.2 Approach

2.2.1 Stages of the Appropriate Assessment Process

An appropriate assessment is a three-stage process:

- The first stage involves a screening for appropriate assessment.
- The second stage arises where, having screened the proposed development, the competent authority determines that an appropriate assessment is required, in which case it must then carry out that appropriate assessment; and
- The third stage is a derogation procedure where adverse effects upon the integrity of a site remain, but the project must nonetheless proceed for imperative reasons of overriding public interest.

According to European Commission Notice C(2021) 6913 'Assessment of plans and projects in relation to Natura 2000 sites - Methodological guidance on Article 6(3) and (4) of the Habitats Directive 92/43/EEC documents 'Assessment of plans and projects significantly affecting Natura 2000 sites' (EC, 2021) and 'Guidance document on wind energy developments and EU nature legislation' (EC, 2020), the obligations arising under HRA establish a step-wise procedure as illustrated in Figure 2.1.

The first part of this procedure consists of a pre-assessment stage ('screening') to determine whether, firstly, a plan or project is directly connected with or necessary to the management of the site, and secondly, whether it is likely to have a significant effect on the site.

The second part of the procedure relates to the appropriate assessment and the decision of the competent national authorities.

A third part of the procedure comes into play if, despite a negative assessment, it is proposed not to reject a plan or project but to give it further consideration. In this case Regulation 44 allows for derogations from Regulation 43 under certain conditions.

The extent to which the sequential steps of appropriate assessment under the Habitats Regulations applies to a given plan or project depends on several factors, and in the sequence of steps, each step is influenced by the previous step. The order in which the steps are followed is therefore essential for the correct application of the Regulations. Each step determines whether a further step in the process is required. If, for example, the conclusion at the end of a Habitats Directive stage one screening appraisal is that significant effects on European sites can be excluded in the absence of any best practice or targeted measures intended to avoid or reduce the harmful effects of the proposed development on European sites, there is no requirement to proceed to the next step.

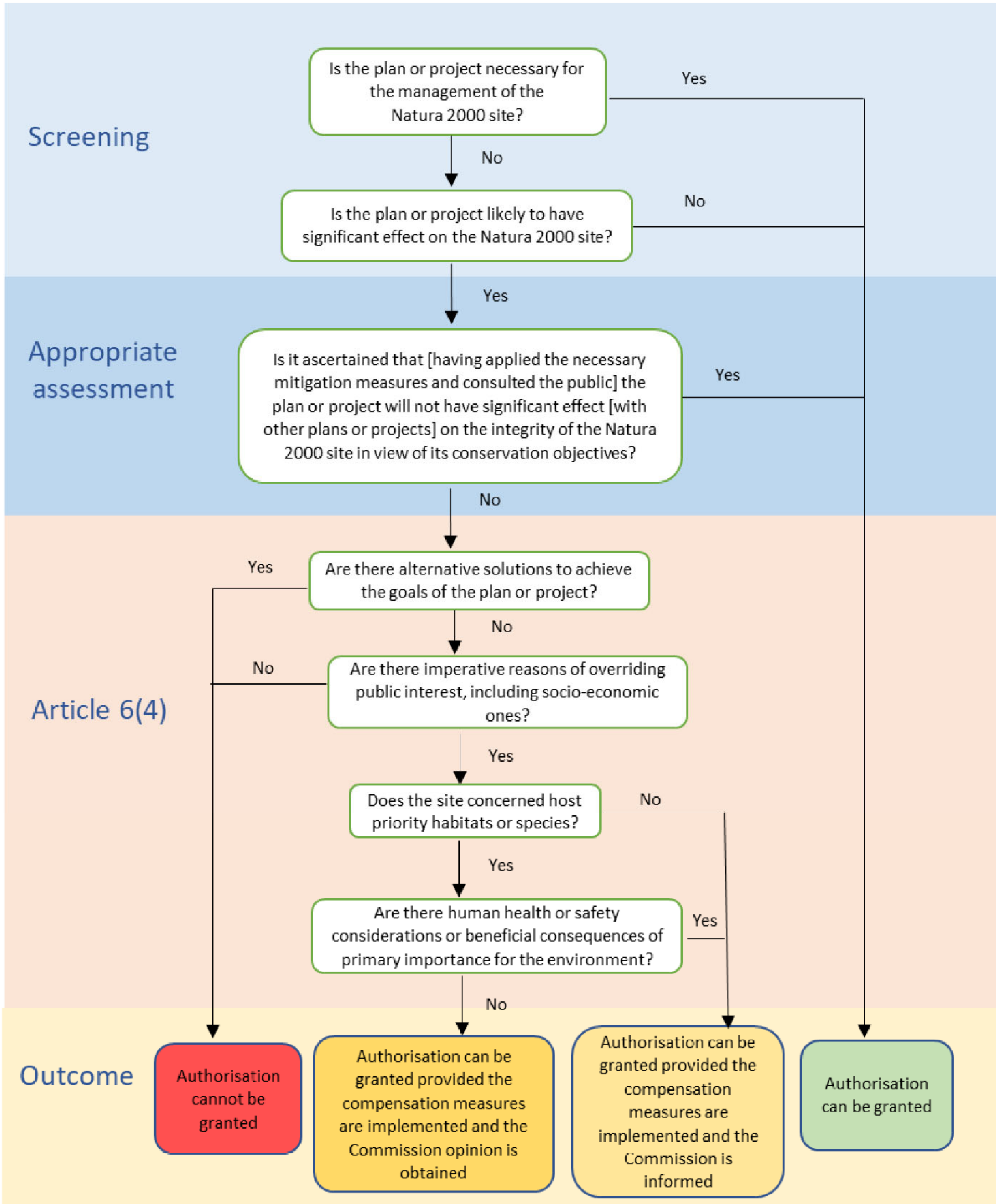


Figure 2.1: Step-wise procedure of Habitats Regulations Assessment (from EC, 2021)

2.2.2 Likely Significant Effect

The Commission's 2018 Notice (EC, 2019) advises that the appropriate assessment procedure under Article 6(3) is triggered not by the certainty but by the likelihood of significant effects, arising from plans or projects regardless of their location inside or outside a protected site. Such likelihood exists if significant effects on the site cannot be excluded. The significance of effects should be determined in relation to the specific features and environmental conditions of the site concerned by the plan or project, taking particular account of the site's conservation objectives and ecological characteristics.

The threshold for a Likely Significant Effect ("LSE") is treated in the screening exercise as being above a de minimis level. A de minimis effect is a level of risk that is too small to be concerned with when considering ecological requirements of an Annex I habitat or a population of Annex II species present on a European site necessary to ensure their favourable conservation condition. If low level effects on habitats or individuals of species are judged to be in this order of magnitude and that judgement has been made in the absence of reasonable scientific doubt, then those effects are not considered to be LSEs.

The analysis involved in a Stage 1 screening appraisal for Appropriate Assessment is described in EC (2021) as comprising of four steps:

- ascertaining whether the plan or project is directly connected with or necessary to the management of a Natura 2000 site;
- identifying the relevant elements of the plan or project and their likely impacts;
- identifying which (if any) Natura 2000 sites may be affected, considering the potential effects of the plan or project alone or in combination with other plans or projects;
- assessing whether likely significant effects on the Natura 2000 site can be ruled out, in view of the site's conservation objectives.

Case law of the Court of Justice of the European Union (CJEU) has confirmed that a significant effect is triggered when:

- there is a probability or a risk of a plan or project having a significant effect on a European site;
- the plan is likely to undermine the site's conservation objectives; and
- a significant effect cannot be excluded on the basis of objective information.

EC (2021) defines a LSE as being "any effect that may reasonably be predicted as a consequence of a plan or project that would negatively and significantly affect the conservation objectives established for the habitats and species significantly present on the Natura 2000 site. This can result from either on-site or off-site activities, or through combinations with other plans or projects".

The requirement that the effect in question be 'significant' exists in order to lay down a de minimis or negligible threshold – thus, plans or projects that have no appreciable or imperceptible effects on the site are thereby excluded. On this point, EHS (2002) notes that any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the site was designated but excluding *de minimis* or inconsequential effects.

2.2.3 **Consideration of Ex-Situ Effects**

EC (2019) advises that Member States, both in their legislation and in their practice, allow for the Article 6(3) safeguards to be applied to any development pressures, including those which are external to European sites but which are likely to have significant effects on any of them.

The CJEU developed this point when it issued a ruling in case C-461/17 ("Brian Holohan and Others v An Bord Pleanála") that determined inter alia that Article 6(3) of Directive 92/43/EEC must be interpreted as meaning that an appropriate assessment must on the one hand, catalogue the entirety of habitat types and species for which a site is protected, and, on the other, identify and examine both the implications of the proposed project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of that site, provided that those implications are liable to affect the conservation objectives of the site.

In that regard, consideration has been given in this assessment to implications for habitats and species located both inside and outside of the European sites considered in the screening appraisal with reference to those sites' Conservation Objectives where effects upon those habitats and/or species are liable to affect the conservation objectives of the sites concerned.

2.2.4 Mitigation Measures at Screening Stage

In determining whether or not likely significant effects will occur or can be excluded in the Stage 1 appraisal, measures intended to avoid or reduce the harmful effects of the proposed development on European sites, (i.e. "mitigation measures") or best practice measures have not been taken into account in this screening stage appraisal. This approach is consistent with EU guidance and the case law of the Court of Justice of the European Union (CJEU).

EC (2001) states that "project and plan proponents are often encouraged to design mitigation measures into their proposals at the outset. However, it is important to recognise that the screening assessment should be carried out in the absence of any consideration of mitigation measures that form part of a project or plan and are designed to avoid or reduce the impact of a project or plan on a Natura 2000 site". This direction in the European Commission's guidance document is unambiguous in that it does not permit the inclusion of mitigation at screening stage.

In April 2018, the Court of Justice of the European Union issued a ruling in case C-323/17 People Over Wind & Peter Sweetman v Coillte Teoranta ("People Over Wind") that Article 6(3) of Directive 92/43/EEC must be interpreted as meaning that, in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site.

The judgment in People Over Wind is further reinforced in EC (2019) which refers to CJEU Case C-323/17.

2.2.5 Conservation Objectives

The conservation objectives ("COs") for each European site are to maintain or restore the favourable conservation condition of the Annex I habitat(s) and/or the Annex II species for which the site has been selected.

The favourable conservation status of a habitat is achieved when:

- its natural range, and area it covers within that range, are stable or increasing;
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and
- the conservation status of its typical species is favourable.

The favourable conservation status (or condition, at a site level) of a species is achieved when:

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

2.2.6 UK Departure from the EU

It is recognised that following the United Kingdom's departure from the European Union, SACs and SPAs in the UK are no longer considered "Natura 2000 sites" for the purpose of an assessment pursuant to Article 6(3) of the Habitats Directive and are instead a part of the UK national site network. However, pursuant to the UK's Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, those sites still retain the same protection under UK law as they did prior to the UK's exit from the EU, and are still referred to in law as European sites.

In the circumstances, and consistent with the UK's obligations as a signatory to the Bern Convention on the Conservation of European Wildlife and Natural Habitats, to which the Birds and Habitats Directives give effect, and in order to ensure the highest level of protection for the species and habitats protected by those Directives, the following screening stage appraisal includes an assessment of any relevant European sites within the EU and forming part of the Natura 2000 network of sites protected under those Directives.

3 THE PROPOSED DEVELOPMENT

3.1 Marine Survey Overview

The proposed development comprises a series of marine surveys to help inform preliminary design of a potential future offshore wind farm, North Channel Wind One (NCW 1).

The NCW 1 project array area or Development Area (DA) will be located between 9 and 23 km from the Co. Antrim coast in approximately 110-160 m of water depth. The NCW 1 DA has a site area of approximately 176 km^2 and the NCW 1 Export Cable Corridor (ECC) region Area of Search (AoS) has a site area of approximately 260 km^2. The NCW 1 DA and its associated ECC AoS is illustrated in **Figure 3.1: Marine Licence Application Area comprising North Channel Wind 1 DA and ECC AoSError! Reference source not found.**.

The proposed survey works will be carried out following award of the Marine Construction License, ideally during the 24 months between Autumn 2024 to Autumn 2026 and subject to weather conditions. Indicative timings are as follows though may move and hence the request for an end date of Autumn 2026:

- **Geophysical survey (including Archaeology)**: Spring 2025
- **Metocean Surveys - current resource monitoring:** Winter 2024/25
- **Offshore Benthic Survey:** Autumn 2024
- **Marine Mammal Acoustic Monitoring:** Winter 2024/25

The objectives of the survey are to:

- Map the seabed and sub-surface to optimise positioning of moorage/anchoring and cable routing within the application area and to enable assessment of cable burial depth;
- Plan the scope and positioning of the geotechnical sampling programme in the application area;
- Identify marine habitat areas from which the benthic survey can be undertaken;
- Identify sensitive marine habitats that may need to be avoided during geotechnical and environmental sampling and infrastructure installation; and
- Provide the geophysical data from which a marine archaeological assessment can be undertaken as part of the consenting process.

The proposed survey operations will be undertaken by offshore survey vessels, inshore survey vessels and potentially support/guard vessels to assist with operations, provide logistical support and ensure the safety and security of the other vessels.

The exact specification of the survey vessels to be used in these surveys has yet to be decided, however, the proposed vessels and survey specifications are indicative and detailed below in **Table 3.1** These vessels could be up to 80 m in length (particularly for offshore survey in the deeper waters of the ECC AoS and the DA), and are assumed to move at 2 knots during surveying (1 m/s) for the purposes of the screening appraisal. This speed affects the time an individual animal is exposed to the sound generated by a survey, and thus a slower speed is precautionary. The actual speed will likely be 3-4 knots (1.5-2.1 m/s). The total estimated duration of the survey is 18 days, but actual timeline may be affected by weather conditions and other operational factors. This will be split between 15 days for the larger offshore vessel, and 3 days for the nearshore smaller vessel.

Both the DA and the ECC AoS will be surveyed using similar geophysical survey equipment. The survey lines layout differs between the surveys and described further below.

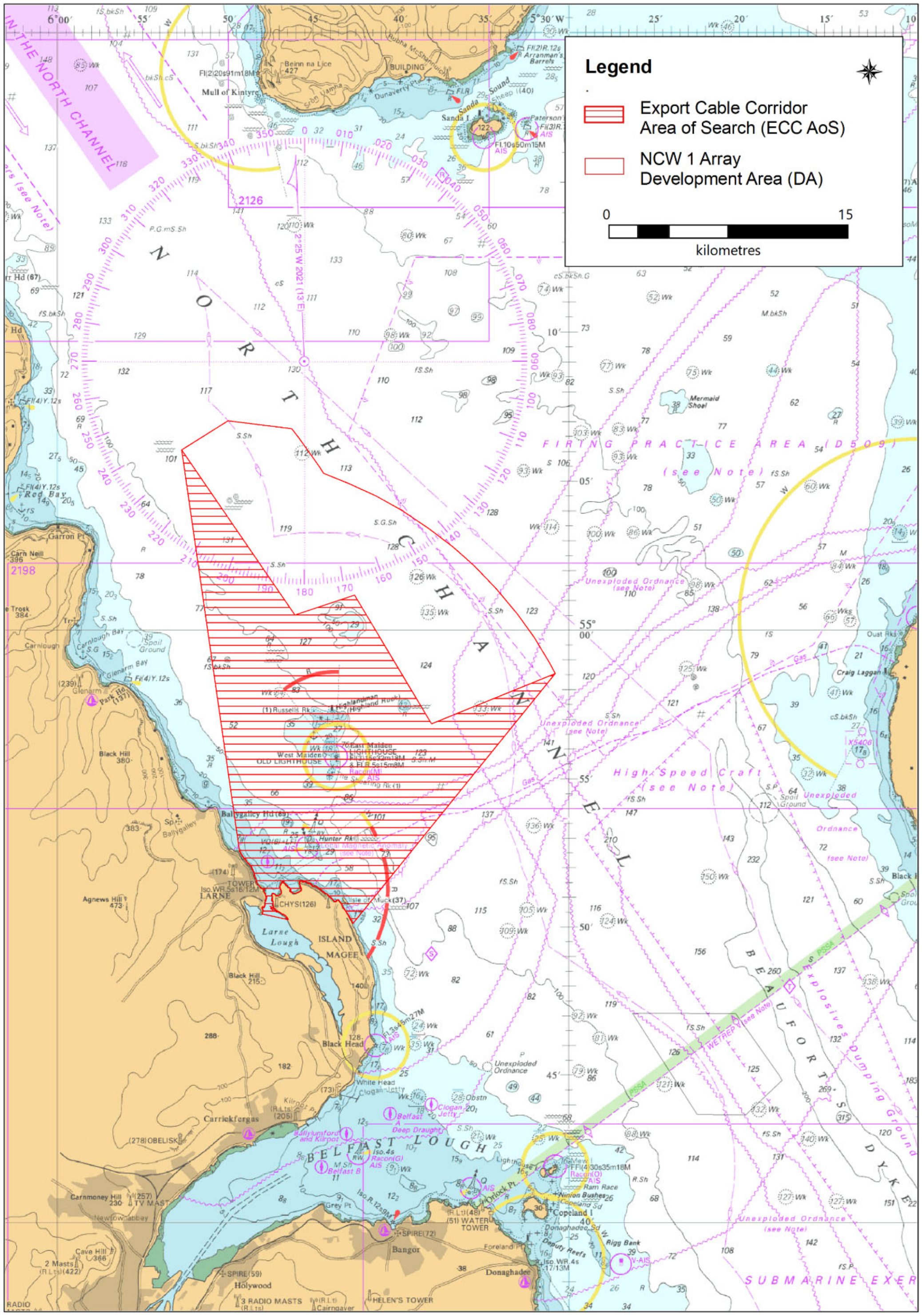


Figure 3.1: Marine Licence Application Area comprising North Channel Wind 1 DA and ECC AoS

Equipment and personnel will be mobilised as per standard procedures and manufacturer's instructions. The chosen port for mobilisation, crew changes, and demobilisation will be confirmed after survey contractor has been appointed.

Calibrations and verifications of the survey equipment will take place during mobilisation and before the commencement of operations.

Mobilisation is considered complete when all systems, tests, trials, calibrations, equipment, personnel, documentation, permits, and consents are in place and functioning correctly.

Table 3.1: Survey types, specifications, equipment, and durations for the proposed survey works

Vessel type/s	Survey specifications	Sound equipment	Estimated duration
An offshore survey vessel, approximately 30- 80 m in length for deeper waters.	*Primary Survey of DA:* Transect surveys across the DA (line spacing of 125 m) and complimented by crosslines spaced at approximately 1,000 m intervals). An additional data coverage of approximately 2 km around the DA may also be applied. *Primary Survey of ECC:* An estimated area of 1,500 m in width will be surveyed (may vary depending on cable route assessment). Preliminary arrangement of transect lines are shown in **Figure 3.2** and **Figure 3.3**.	• Multibeam echosounder (MBES) • Side Scan Sonar (SSS) • Parametric Sub-Bottom Profiler (SBP) • Ultra High Resolution Seismic (UHRS) sparker	Approximately 15 days for offshore survey vessel (subject to weather conditions and operational factors);
A nearshore survey vessel, approximately 15 m in length for shallower waters.			Approximately 3 days for the nearshore smaller vessel.

3.1.1 Survey Vessels

All vessels will be operated in accordance with international regulations and follow industry best practices ensuring the safety of the crew, equipment, and environment. Crew members will hold the required certifications and undergo regular training and drills to maintain their skills and knowledge. All equipment and personnel will be mobilised as per standard procedures and manufacturer's instructions.

Vessels will be equipped with the necessary safety and communication equipment, including personal protective equipment (PPE), life rafts, life jackets, Emergency Position-Indicating Radiobeacons (EPIRBs,), and Global Maritime Distress and Safety System (GMDSS) equipment.

Regular maintenance and inspections will be performed on all vessels and equipment to ensure optimal performance and safety. Vessel operations will adhere to company policies and procedures, including environmental and safety management systems. Regular communication with local authorities, marinas, and other vessels operating in the vicinity will be maintained.

Vessels operating in nearshore environments will follow guidelines and precautions to minimise environmental impact and ensure safe navigation. Tidal and weather conditions will also be considered, and operations may be temporarily suspended in case of unfavourable conditions for safe navigation to ensure the safety of the crew and equipment.

Further detail of the sound sources, including noise-producing survey equipment and the survey vessels, can be found below.

3.2 Geophysical Surveys

3.2.1 Objective

The proposed geophysical survey aims to comprehensively investigate the site using a combination of techniques, including multibeam echosounder (MBES), side scan sonar, magnetometer, and seismic surveys. The objective of the proposed geophysical survey is to:

- Map the seabed and sub-surface to optimise positioning of moorage/anchoring and cable routing within the application area and to enable assessment of cable burial depth;
- Plan the scope and positioning of the geotechnical sampling programme in the application area;
- Identify sensitive marine habitats that may need to be avoided during geotechnical and environmental sampling, and infrastructure installation; and
- Provide the geophysical data from which a marine archaeological assessment can be undertaken as part of the consenting process.

3.2.2 Method Statement

This method statement outlines the general procedures and operations to be followed for the planned geophysical survey of the NCW 1 DA and ECC AoS.

All survey activities will be carried out using specialised equipment and vessels, following industry best practices, and adhering to relevant safety and environmental guidelines. The collected data will be processed and interpreted by experienced professionals to provide a comprehensive understanding of the site's characteristics.

3.2.3 Survey Design

The geophysical survey will be conducted using a systematic approach to ensure 100% data coverage of the site. A survey vessel, approximately 30-80 metres in length, will be utilised to perform transects across the DA , with line spacing between 125 and 250 metres. These primary survey lines will be complemented by crosslines spaced at approximately 500 - 1,000-metre intervals, providing additional data and quality control (line plan is dependent on local characteristics and the final equipment set up).

For the ECC AoS, an estimated area of approximately 1,500 metres in width will be surveyed to ensure the identification of the optimal route and the detection of any potential hazards. More than one potential cable corridor may be surveyed. This corridor (or corridors) will lie within the ECC AoS. The final corridor route (or routes) is currently being determined as part of a cable route assessment, and route dimensions quoted above may vary depending on several factors (e.g. seabed hazards, depth of sediment, landfall location).

There will be a 2 kilometre buffer for vessels transiting and potential surveying.

Preliminary arrangement of transect lines are shown in **Figure 3.2** and **Figure 3.3**, to be finalised in advance of survey.

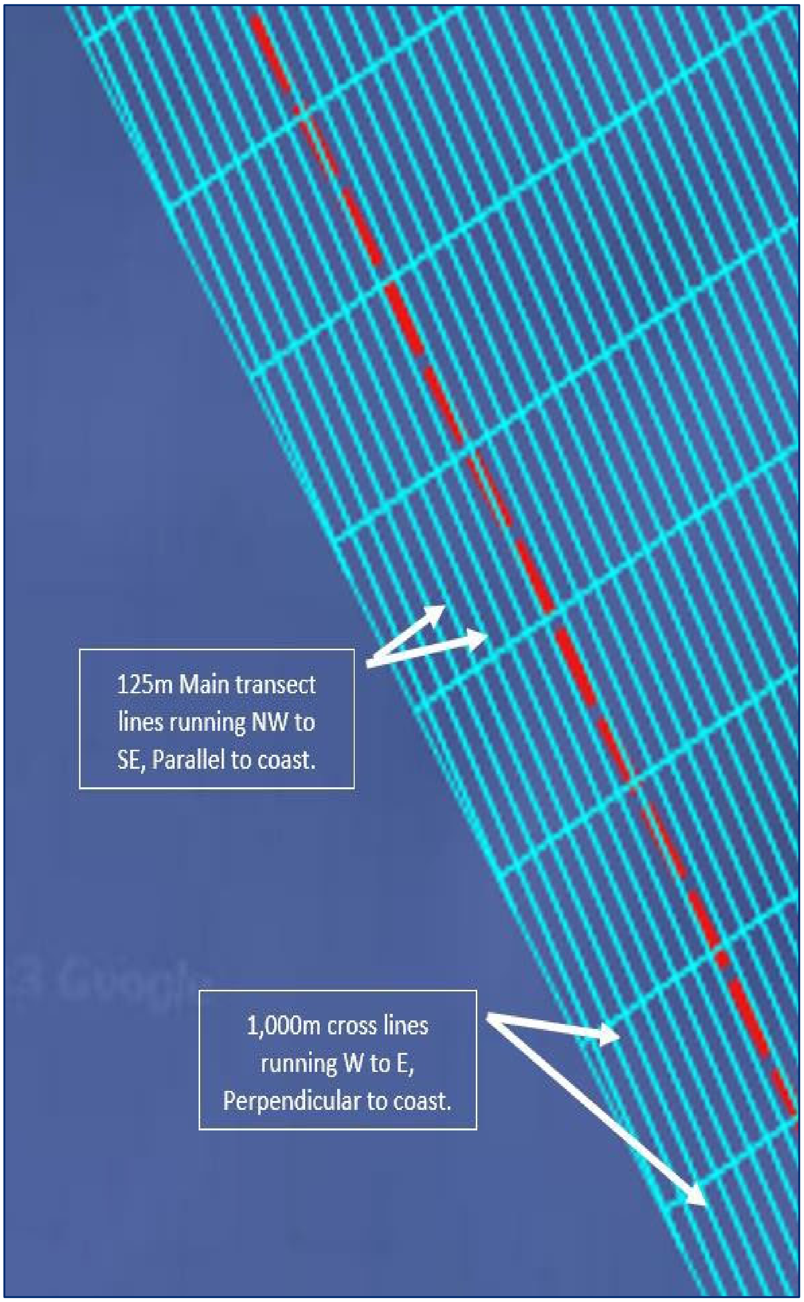


Figure 3.2: NCW1 Development Area example transects

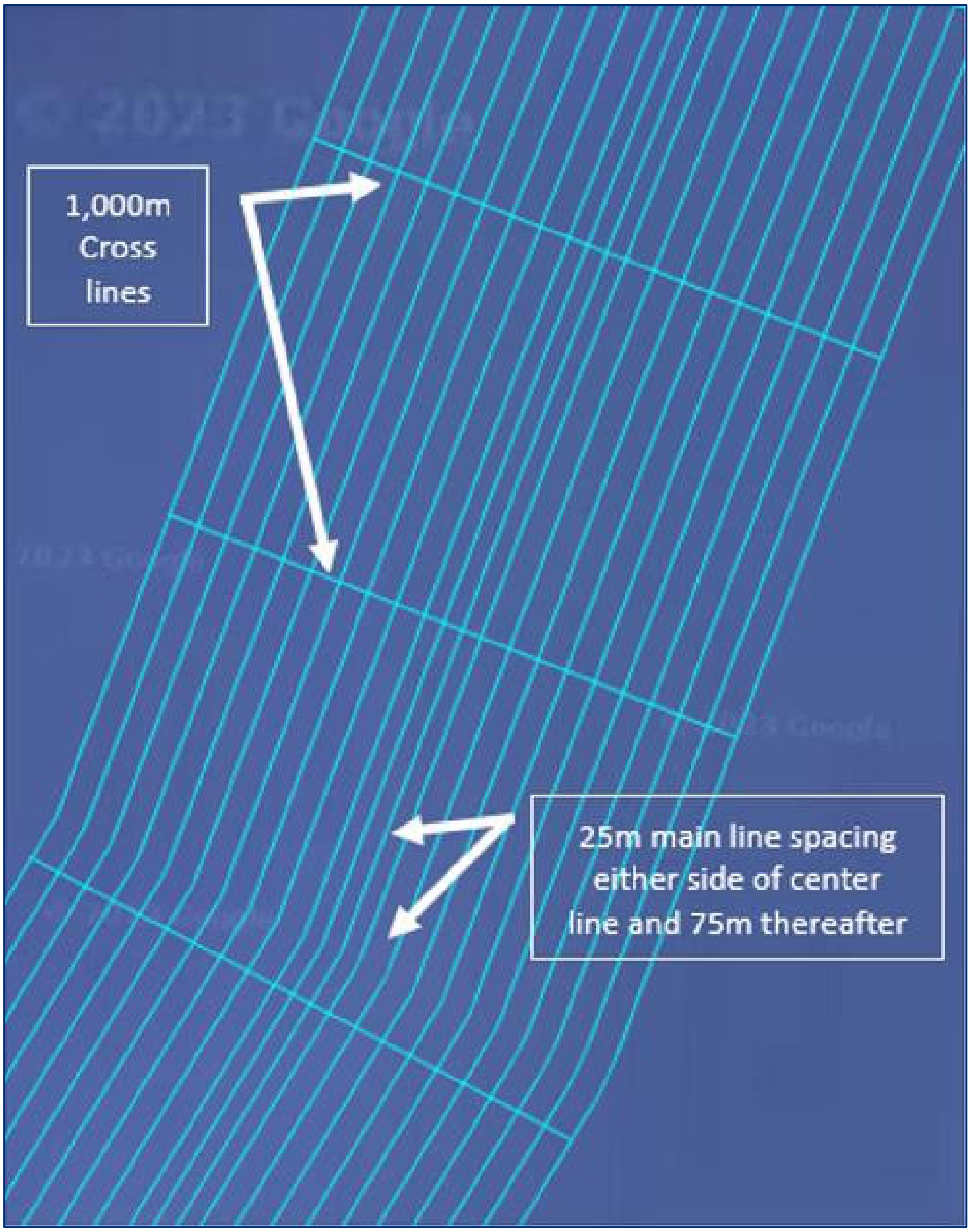


Figure 3.3: NCW1 Export Cable Corridor example transects

In nearshore areas, a smaller vessel of approximately 15 meters in length will be used. This smaller vessel will allow for greater manoeuvrability and access to shallow waters, ensuring complete data coverage.

A support/guard vessel may also be utilised during the survey to assist with operations, provide logistical support, and ensure the safety and security of the primary survey vessels and their crew. This vessel will help to maintain efficient operations and provide a rapid response in the event of any incidents or issues during the survey.

Unmanned vessels of approximately 4-metre length may also be used for some data collection activities, which will be monitored and controlled by onshore operators.

3.2.4 Mobilisation

Equipment and personnel will be mobilised as per standard procedures and manufacturer's instructions. The chosen port for mobilisation, crew changes, and demobilisation will be confirmed after survey contractor has been appointed.

Calibrations and verifications of the survey equipment will take place during mobilisation and before the commencement of operations.

Mobilisation is considered complete when all systems, tests, trials, calibrations, equipment, personnel, documentation, permits, and consents are in place and functioning correctly.

3.2.5 Data Acquisition Equipment

It is intended that the following equipment is used for surveys:

- **Surface Positioning:** Differential GPS (DGPS) systems will be used for high-accuracy positioning;
- **Subsea Positioning:** Ultra-Short Baseline (USBL) systems will be employed for subsea positioning;
- **Multibeam Echosounder (MBES):** A system for collecting detailed topographical data of the seabed. Determines depth and nature of the seabed by transmitting sound pulses;
- **Side Scan Sonar (SSS):** Uses sound pulses to generate images of the seabed. Hull mounted or towed at specific depth to optimise output;
- **Magnetometer:** Towed magnetometers will be used for magnetic data collection, ensuring proper altitude and navigational accuracy;
- **Sub-Bottom Profiling (SBP):** Hull mounted parametric device to identify and measure sediment layers below the seabed; and
- **Ultra High Resolution Seismic (UHRS):** Towed seismic source (e.g. sparker) identifies and characterises the deeper layers of sediment/bedrock underneath the seafloor.

The surveyor will be responsible for real-time quality control of all data gathered. Data processing and analysis will be conducted by the geophysicist onboard, using appropriate software tools.

3.2.6 Transect Execution

The survey vessel will navigate along each transect line according to the pre-determined plan, maintaining a constant speed and heading.

Survey equipment, such as MBES, SSS, and SBP, will be deployed and operated in accordance with manufacturer guidelines and project requirements. Real-time monitoring of equipment performance, data quality, and vessel position will be conducted throughout the transect.

Any deviations from the planned transect line or adjustments to the survey equipment settings will be documented and communicated to the project team.

3.2.7 Towed Equipment

For towed equipment (magnetometers, SSS and UHRS), the tow line will be made from high strength materials, with length to be determined based on the desired depth or position, as well as the survey objectives and local environmental conditions. A combination of floats and weights will be used to maintain the desired depth and position, with the risk of snagging or entanglement carefully considered. NCW will work to minimise the potential for snagging and entanglement on static fishing gear. We will be identifying and engaging with potentially affected fishermen through our Fisheries Liaison Officer (FLO) in the months in advance of the surveys taking place.

Deployment and recovery of towed equipment will be performed using winches, launch and recovery systems, and handling equipment designed for safe and efficient operation. Personnel involved in handling towed equipment will be trained and experienced in the proper procedures and safety measures.

The sparker system uses a high-voltage electrical discharge to generate a brief acoustic pulse in the water. The energy source settings, such as voltage and pulse rate, will be selected based on equipment specifications, survey objectives, and local environmental conditions. The settings will be adjusted as necessary during the survey to optimize data quality and penetration.

3.3 Acoustic Doppler Current Profilers (ADCP) Survey

3.3.1 Objective

The proposed Acoustic Doppler Current Profilers (ADCP) survey aims to investigate the offshore wind site by deploying ADCPs in seabed frames to measure waves, water levels, and currents. The acquired data will be essential for understanding the site's hydrodynamic conditions and informing the design and positioning of the offshore wind farm infrastructure and to investigate their potential impact on sediment transport and coastal processes. This may be augmented by a transect survey, where a vessel mounted, downward facing ADCP records current profiles while the vessel transects the area of interest in a repeated pattern over the course of a flood/ebb cycle (approximately 12 hours). This can be completed both during spring and neap tides to provide greater spatial coverage (at lower temporal resolution than seabed mounted ADCPs).

3.3.2 Method Statement

This method statement outlines the general procedures and operations to be followed for the planned ADCP deployment within the DA. This document will be reviewed and updated once the survey contractor has been appointed and submitted to DAERA for approval at least 8 weeks prior to the survey.

All survey activities will be carried out using specialised equipment and vessels, following industry best practices, and adhering to relevant safety and environmental guidelines. The collected data will be processed and interpreted by experienced professionals to provide a comprehensive understanding of the site's hydrodynamic conditions.

3.3.3 Survey Design

The ADCP survey will be designed to ensure optimal data coverage. A survey vessel, approximately 20-60 metres in length, will be utilised to transport and deploy the ADCP seabed frames at two predetermined locations within the DA. The locations will be selected based on factors such as water depth, seabed characteristics, and distance from existing or planned infrastructure. The proposed deployment locations described in **Table 3.2** and illustrated in **Figure 3.4** below are indicative.

Table 3.2: Proposed Coordinates of ADCP and Wabe Buoy

Instrument	Lat	Long
ADCP 1	55° 6.0'	-5° 50.4'
ADCP 2	54° 58.6'	-5° 38.6'
Wave Buoy	55° 1.6'	-5° 46.6'

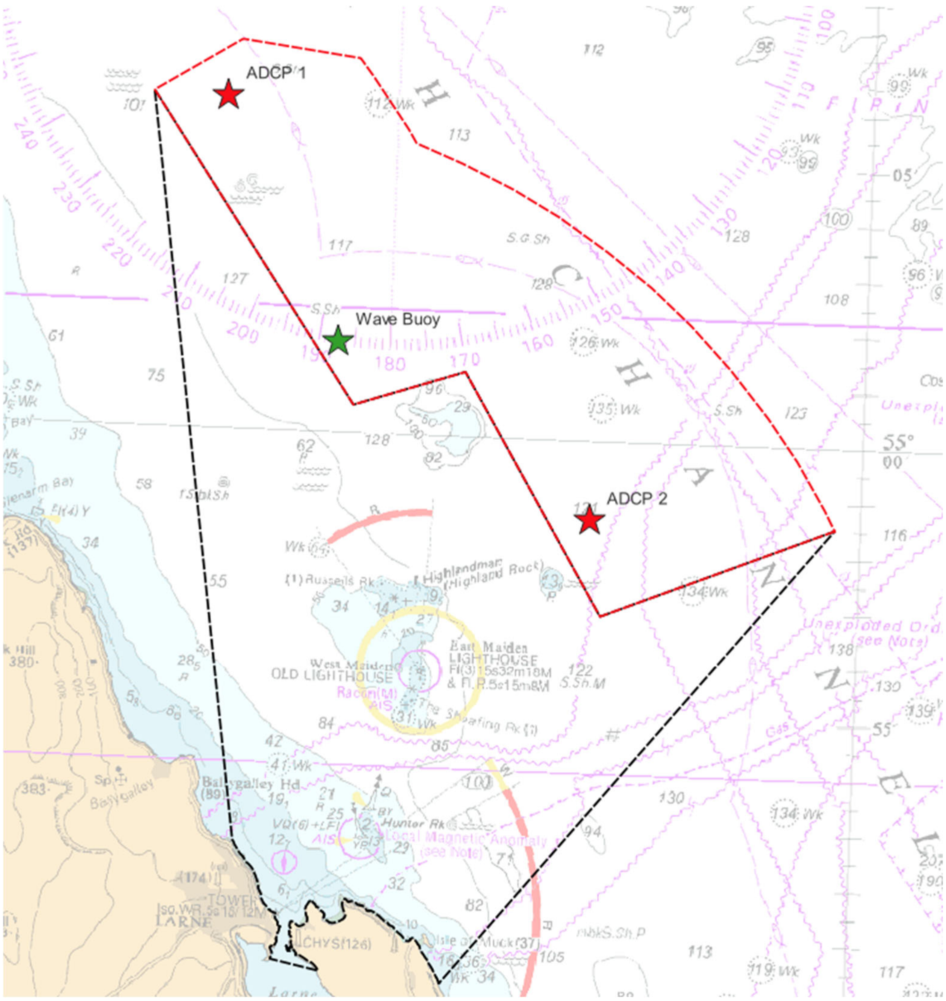


Figure 3.4: Indicative ADCP and Wave Buoy Locations

The ADCPs will be deployed in shrouded seabed frames, or low-drag submerged buoys, designed to securely anchor the instruments to the seafloor and protect them from damage or displacement. The frames will also ensure proper orientation and positioning of the ADCPs to achieve accurate and reliable measurements.

The total estimated duration of the survey, including mobilization, deployment, recovery, and demobilization is 12 Months. Actual timeline may be affected by weather conditions and other operational factors.

For the transect survey, the ADCP will be securely mounted on a survey vessel and calibrated as per the manufacturer's guidelines to ensure accurate measurements. The vessel will then navigate along the predetermined transects at a controlled speed, with the ADCP transmitting and receiving sound signals to measure the velocity of water currents at various depths. The transect route will be repeated several times over a 12-hour period to deliver multiple data points per position. Data collected will be logged in real-time and will include current velocity and direction through the water column.

3.3.4 Mobilisation

Equipment and personnel will be mobilised as per standard procedures and manufacturer's instructions. The chosen port for mobilisation, crew changes, and demobilisation will be confirmed after the survey contractor has been appointed.

Calibrations and verifications of the survey equipment will take place during mobilisation and before the commencement of operations.

Mobilisation is considered complete when all systems, tests, trials, calibrations, equipment, personnel, documentation, permits, and consents are in place and functioning correctly.

3.3.5 Data Acquisition Equipment

It is intended that the following equipment is used for surveys:

- **Surface Positioning:** Differential GPS (DGPS) systems will be used for high-accuracy positioning;
- **Subsea Positioning:** Ultra-Short Baseline (USBL) systems will be employed for subsea positioning;
- **Acoustic Doppler Current Profilers (ADCPs):** Deployed in seabed frames for measuring waves, water levels, and currents; and
- **CTD Sensors:** a device for determining Conductivity, Temperature, and Depth.

3.3.6 Frame Design

3.3.6.1 Option 1

The ADCP will be mounted in a trawl resistant seabed frame on a double axis gimble for self-levelling. The frame will be manufactured from marine grade stainless steel and will measure approximately 1.5 m wide and 0.5 m high (refer

Figure 3.5). The frame will weigh approximately 400 kg , with final quantity of ballast to be determined prior to the survey following consideration of maximum currents and wave induced orbital velocities at the final deployment depths.

An acoustic release mechanism will be attached to each frame to provide principal recovery mechanism. The frame will be attached to a ~500 kg clump weight (1 m wide), via 200 m of ground line to provide a redundant recovery option via trawl capture in the event of acoustic release failure (**Figure 3.6**).

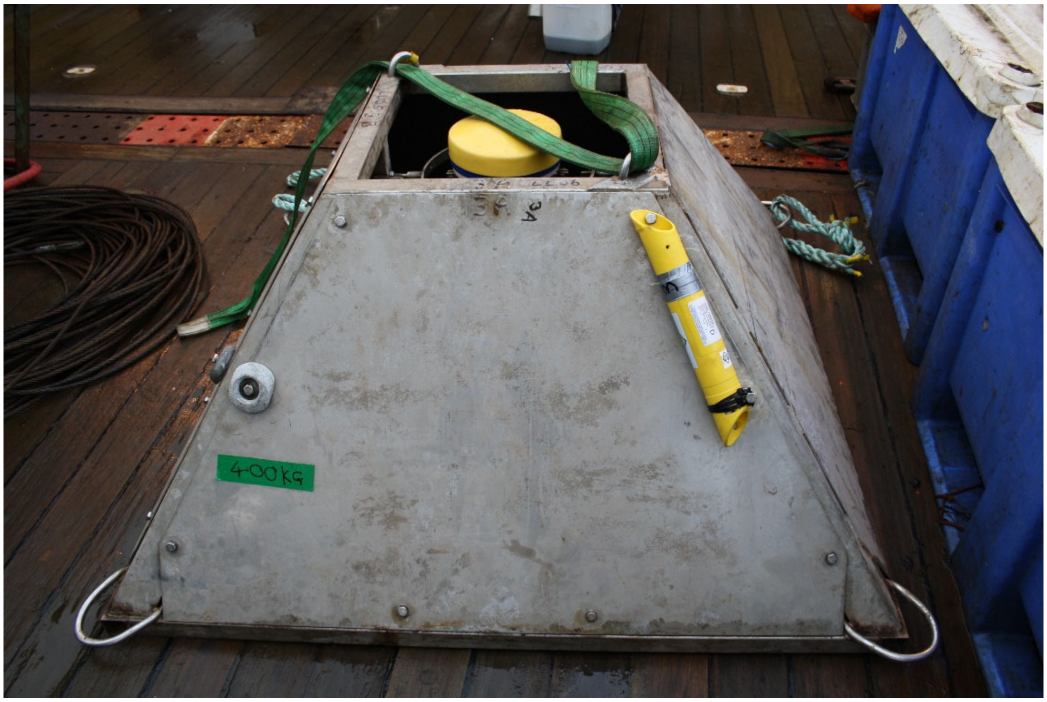


Figure 3.5: Example ADCP seabed frame

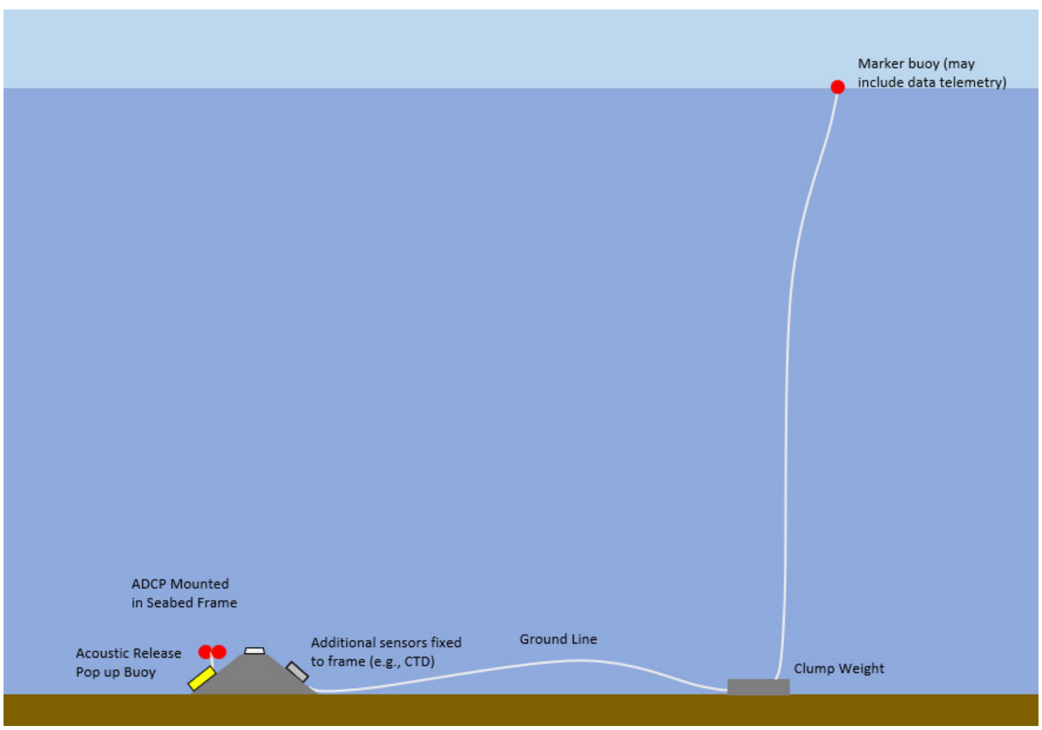


Figure 3.6: Example ADCP Seabed Frame Arrangement

Transponders will be attached to frames and clump weights to enable accurate final confirmation of frame and clump weight locations.

3.3.6.2 Option 2

To mitigate potential difficulties in landing a seabed frame upright in the water depths at the site, an alternative arrangement would be to house the ADCP in a low drag submerged buoy, held in position with ground weight (1 m wide), with 200 m ground line and clump weight (1 m wide). A potential arrangement is shown in **Figure 3.7**.

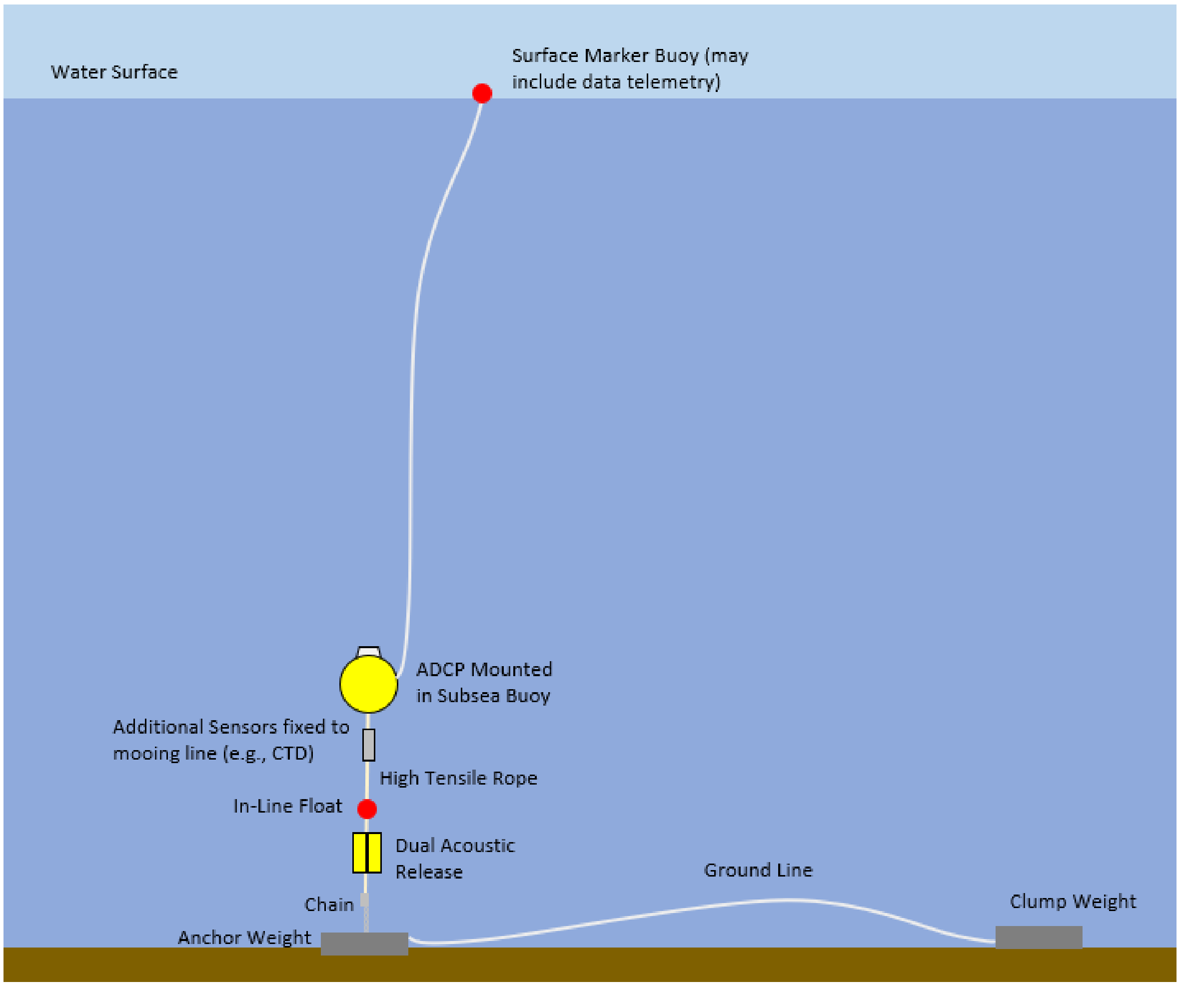


Figure 3.7: Example ADCP submerged mooring arrangement

3.3.6.3 Marker Buoys

A surface marker buoy may be used with either arrangement as principal recovery option. The buoy will be attached to the frame, clump weight or mooring. There will typically be a swivel on the underside, with a lifting eye, and/or light-emitting diode (LED) light on top. The maximum diameter is approximately 500 millimetres.

Example marker buoys are illustrated in **Figure 3.8**.

Figure 3.8: Example Marker Buoys

3.3.7 ADCP Deployment and Recovery

The survey vessel will navigate to the predetermined ADCP deployment locations, ensuring accurate positioning using the DGPS and USBL systems. The ADCP seabed frames or moorings will be carefully lowered to the seafloor using a winch and handling equipment designed for safe and efficient operation. Personnel involved in the deployment will be trained and experienced in the proper procedures and safety measures.

After the seabed frame has been successfully lowered to the seabed, the ground line is paid out as the vessel manoeuvres to a predetermined location where the clump weight is lowered to the seabed.

An overhead vessel transect will then be completed to the confirm precise frame and clump weight locations using the USBL tracking system.

Once the ADCPs have completed their measurement period, the survey vessel will return to the deployment locations to recover the seabed frames or moorings. If a marker buoy is not utilised, the USBL system will be used to locate and track the ADCPs on the seafloor. A signal will be sent to the acoustic pop-up buoy, and once visually located the winch and handling equipment will be used to carefully lift the ADCP seabed frames or moorings from the seafloor and onto the survey vessel. A grapnel will be used to recover the frames in the event of pop-up buoy failure. This will involve lowering the hook to the seabed and trawling between the seabed frame and clump weight.

Once the ADCPs are safely onboard, the collected data will be downloaded and transferred to the data processing team for further analysis.

3.3.8 Data Processing and Reporting

Following the completion of the ADCP survey and the recovery of the instruments, the collected data will be processed and analysed by a team of experienced hydrodynamic specialists using appropriate software tools. The analysis will focus on the accurate determination of wave, water level, and current characteristics within the survey area.

A comprehensive report will be prepared, detailing the results of the ADCP survey, including data plots, tables, and graphs to illustrate the findings. The report will also include a discussion of the data quality, uncertainties, and any limitations or anomalies observed during the survey.

The final report will provide essential information to support the planning, design, and construction of the offshore wind farm infrastructure.

3.4 Wave Buoy

3.4.1 Objective

The survey aims to characterise the wave climate at the proposed North Channel Wind 1 (NCW1) floating offshore wind site. A wave buoy will be anchored to the seafloor using a mooring system designed to withstand the local wave and current conditions. The acquired data will be used to develop further understanding the site's wave regime, inform the design and positioning of the wind farm infrastructure and to investigate their potential impact on sediment transport and coastal processes.

3.4.2 Method Statement

This method statement outlines the general procedures and operations to be followed for the planned wave buoy deployment within the DA.

All survey activities will be carried out using specialised equipment and vessels, following industry best practices, and adhering to relevant safety and environmental guidelines. The collected data will be processed and interpreted by experienced professionals to provide a comprehensive understanding of the site's wave regime.

3.4.3 Survey Design

The wave buoy is planned for deployment within the offshore wind farm DA for a duration of 12 months . The location for this deployment is shown in **Figure 3.4** and has been selected to capture representative data for the area.

The wave buoy will be equipped with an array of sensors configured to capture specific types of data including wave heights, periods, and direction. A downward-looking ADCP, may also be integrated for the purpose of measuring subsurface ocean currents.

The buoy will operate continuously throughout the period of deployment, gathering data in real-time. This data will be transmitted via satellite or Global System for Mobile Communications (GSM), to enable remote observation and data acquisition. Scheduled maintenance activities will be conducted in accordance with the O&M plan (see section 3.4.7) to ensure the integrity of the moorings and reliability and accuracy of the data collected.

3.4.4 Mobilisation

Equipment and personnel will be mobilised as per standard procedures and manufacturer's instructions. The chosen port for mobilisation, crew changes, and demobilisation will be confirmed after the survey contractor has been appointed.

Calibrations and verification of the survey equipment will take place during mobilisation and before the commencement of operations.

Mobilisation is considered complete when all systems, tests, trials, calibrations, equipment, personnel, documentation, permits, and consents are in place and functioning correctly.

3.4.5 Data Acquisition Equipment

It is intended that the following equipment is used for surveys:

- **Surface Positioning:** Differential GPS (DGPS) systems will be used for high-accuracy positioning;
- **Subsea Positioning:** Ultra-Short Baseline (USBL) systems will be employed for subsea positioning if required;
- **Wave Buoy:** Directional buoy weighing from 70 – 100kg, with diameter of up to 1.2m, with flashing obstruction light; and
- **Downward looking ADCP:** Mounted on buoy below water line to measure ocean currents
- **CTD Sensors:** a device for determining Conductivity, Temperature, and Depth.

3.4.6 Mooring Design

The mooring system is engineered with a focus on durability and stability. It features a length of rubber (bungee) cord, terminated with stainless steel fittings, to allow the buoy to absorb shocks and adapt to the dynamic marine environment. This bungee section is directly connected to a swivel affixed to the underside of the buoy. At the opposite end, the bungee is coupled with a high tensile mooring line or chain, supplemented with inline floats and weights. These components are ultimately connected to a sinker weight, which has a minimum mass of approximately 650 kg, and approximate seabed dimensions of 1 m x 1 m (subject to supplier design).

The surface buoy will have a diameter of up to 1.2 m and will feature a flashing obstruction light, with lighting and marking to be agreed with Commissioner of Irish Lights. It is likely that the buoy will be marked as follows at all times:

- Coloured yellow from at least the water-line to the top of the buoy.
- Have a yellow, flashing light character that is visible through 360 degrees with a 5 nm range
- Surmounted by a yellow ‘x’ shape topmark

An indicative mooring arrangement is illustrated in **Figure 3.9**.

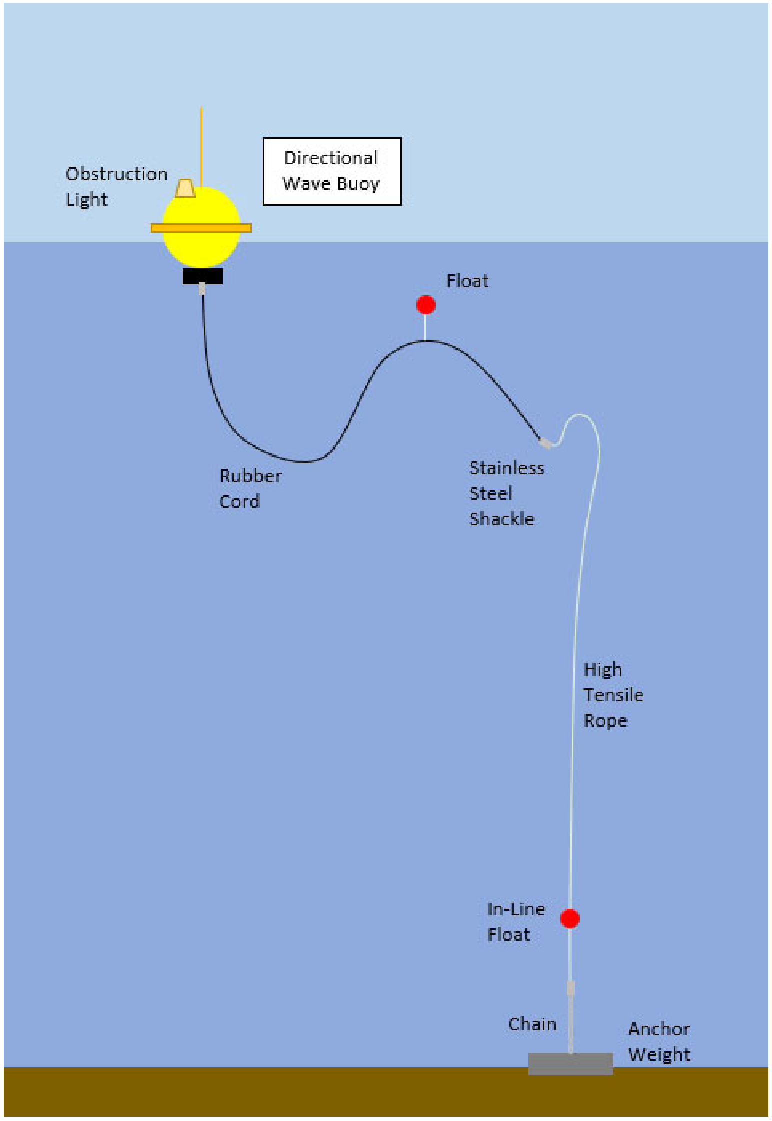


Figure 3.9: Example Wave Buoy Mooring Arrangement

The buoy may also be required to meet the following International Association of Marine Aids to Navigation and Lighthouse Authorities availability standards:

- Position – category 2 (not less than 99%).
- Light – Category 2 (not less than 99%)
- Daymark – Category 2 (not less than 99%)
- Topmark – Category 2 (not less than 99%).

Requirements to notify the Commissioner of Irish Lights on the availability of aids to navigation may also be required prior to works commencing.

Final mooring arrangement will be determined based on supplier recommendations and will be tailored to the specific water depths at the selected deployment location. Additional factors, such as tidal range and anticipated wave and meteorological conditions are also incorporated into the final design of the mooring system.

3.4.7 Operations and Maintenance

Regular maintenance and inspections will be undertaken to ensure data integrity and the ongoing functionality of the wave buoy and mooring system. During maintenance operations, the buoy will be attached to a winch and lifted onboard by either a crane or an A-frame. These activities will be conducted on a suitably equipped working vessel.

Buoys will be cleaned, and integrity of the mooring system assessed. A change out of the mooring systems may be required, depending on condition and any observed evidence of damage or wear and tear. Some elements will only require replacement if inspection reveals structural damage, such as propeller damage or other forms of excessive wear. During each service visit, a complete set of spare mooring components will be available on the survey vessel.

Specific activities during each service visit will encompass:

- Thorough inspection of the mooring systems and replacement of components such as bungee cord, shackles etc as needed;
- Examination and replacement of anodes as needed;
- Provision of a spare ground weight to account for the possibility of total loss during recovery;
- Inspection of the outer housing for any form of damage;
- Testing of the LED light's functionality;
- Review and replacement of O-rings as required;
- Confirmation of the battery status;
- Downloading of data and examination of the memory card's storage capacity; and
- Verification of the satellite and data transmission systems.

Upon completion of these maintenance activities, the wave buoy will be redeployed at the original location to continue data acquisition as planned.

3.4.8 Deployment and Recovery

The survey vessel will navigate to the predetermined buoy deployment location, ensuring accurate positioning using the DGPS and USBL systems.

After inspection and safety checks are complete, the anchor and mooring system will be prepared ensuring all components, including the buoy are properly aligned and secured. After the anchor is positioned for deployment, the wave buoy slowly lowered into the water using the A-frame or crane. The Anchor can then be lowered to the seabed.

Once the buoy is in position and the anchor is secured, onboard technicians will remotely verify the operational status of the buoys systems.

Once the wave buoy has completed its measurement period, the survey vessel will return to the deployment location to recover buoy, mooring and anchor system. Initially the buoy will be lifted out of the water, detached from the mooring system and secured on the deck. Following on the winch will be used to recover the anchor and mooring system.

Once the wave buoy is safely onboard, the collected data will be downloaded and transferred to the data processing team for further analysis.

3.4.9 Data Processing and Reporting

Following the completion of the wave survey and the recovery of the instruments, the collected data will be processed and analysed by a team of experienced metocean specialists using appropriate software tools. The analysis will focus on the accurate determination of wave height, direction and period characteristics within the survey area.

A comprehensive report will be prepared, detailing the results of the survey, including data plots, tables, and graphs to illustrate the findings. The report will also include a discussion of the data quality, uncertainties, and any limitations or anomalies observed during the survey.

The final report will be submitted to the client and relevant stakeholders, providing essential information to support the planning, design, and construction of the offshore wind farm infrastructure.

3.5 Offshore Benthic Survey

3.5.1 Objective

The aim of the survey is to gather a comprehensive dataset which describes the benthic ecology (habitats and infaunal/epifaunal communities) within the survey area to characterise the habitats present and their associated biological communities and form the first point in a monitoring timeseries. The survey will identify and determine the extent and distribution of Annex I habitats present in the survey area. Water samples will also be taken to form a marine water quality baseline for the area.

The desired outcomes of this investigation are:

- To characterise habitats and biological communities and their variability, for instance with depth and lateral distribution, across the site;
- To gather quantitative and semi-quantitative benthic and epibenthic biological community data which can be used to monitoring change in the communities over time;
- To identify and determine the extent and distribution of Annex I habitats present across the site;
- To produce a European nature information system (EUNIS) level 5 and Annex I habitat maps for the survey area; and
- To quantify water quality parameters and their variability, for instance with depth and lateral distribution across the site.

This survey will provide baseline data for the Environmental Statement (ES) for the development consent application.

3.5.2 Method Statement

All survey activities will be carried out using specialised equipment and vessels, following industry best practices, and adhering to relevant safety and environmental guidelines. The collected data will be processed and interpreted by experienced professionals to provide a comprehensive understanding of the site's characteristics.

3.5.3 Survey Design

Seabed imagery (High Definition (HD) video and stills) will be collected from up to 80 stations within the survey areas (40 nr within the DA and 40 nr within the ECC AoS) and, where suitable, samples by grab sampler. Water samples and Conductivity, Temperature and Depth (CTD) profiles will be collected with a CTD Profiler and Rosette Sampler from every third station visited. **Figure 3.10** represents an indicative survey plan of the 80 stations all outside a maximum depth of 0.5 m to allow for the vessel draught (under keel clearance).

3.5.4 Data Acquisition Equipment

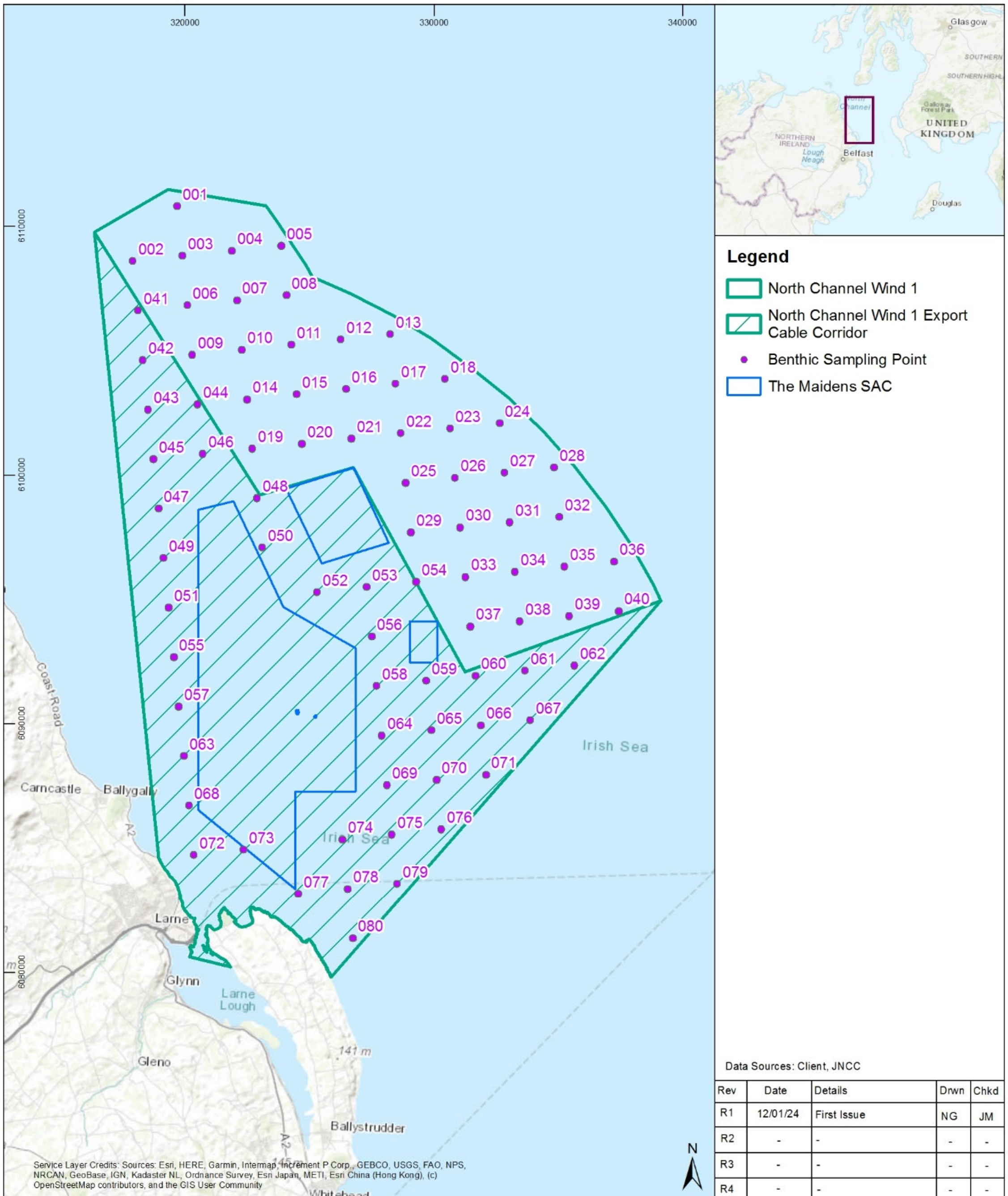
3.5.4.1 Grab Sampling

A grab sampler will be used to retrieve a soil sample of the seabed by the lowering of a mechanical grab. The grab will be launched from a vessel crane or A-frame.

Four grab samples will be collected at each station suitable for grab sampling using a 0.1 m^2 Day (for mud/fine sand habitats) or 0.1 m^2 'mini' Hamon (for coarse sediments) grab as appropriate. Grab sampling will be undertaken as described below. An example illustration of a Day Grab is shown in **Figure 3.11**.

Three samples collected from each grab sampling station will be sieved for macrofauna using 1 millimetre mesh diameter sieves. Macrofauna samples will be stored in clearly labelled (internally and externally) plastic containers and preserved in 10 percent formaldehyde buffered with borax.

One sample from each grab sampling station will be subsampled for Particle Size (350 millilitres) and Organic Carbon (100 millilitres). Particle Size and Organic Carbon subsamples will be stored in clearly labelled (internally and externally) plastic containers and frozen as soon as is practicable after collection .



Rev	Date	Details	Drwn	Chkd
R1	12/01/24	First Issue	NG	JM
R2	-	-	-	-
R3	-	-	-	-
R4	-	-	-	-

Project Name NORTH CHANNEL WIND	Scale 1:250,000 Plot Size 217mm (h) x 163mm (w)	Datum ETRS 1989 Projection ETRS 1989 UTM Zone 30N	Drawing Number EOR0814-BENS-001-01
Drawing Title NORTH CHANNEL WIND 1 BENTHIC SAMPLING POINTS	0 0.5 1 2 3 4 5 nm 0 1 2 4 6 8 10 km		North Channel Wind in partnership with rps

Figure 3.10: Proposed North Channel Wind 1 Benthic Sampling Points

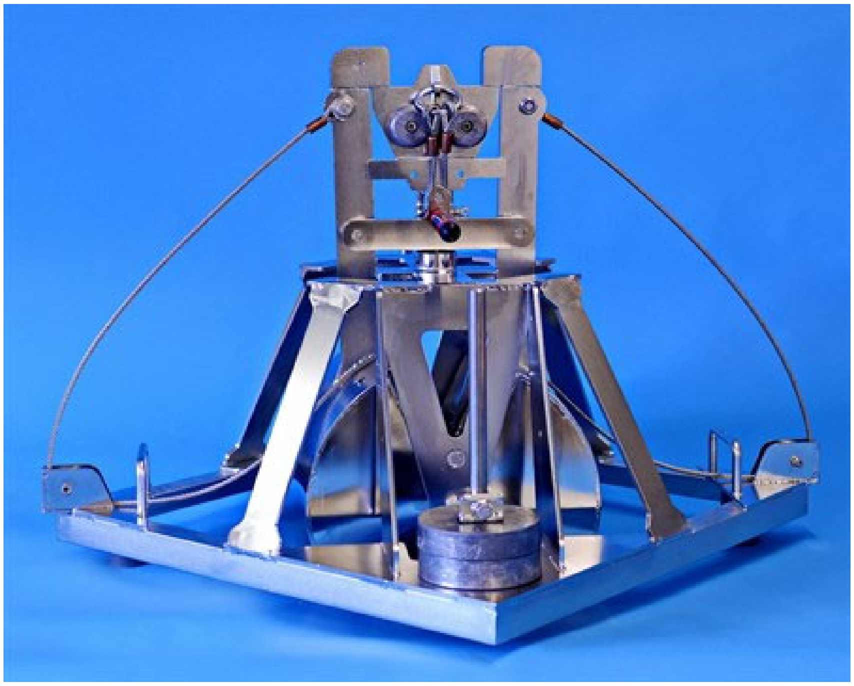


Figure 3.11: Example of Day Grab

3.5.4.2 Water Sampling

Water sampling will be conducted at every third station sampled following the methodology described below and in O'Brien et al. (2018) .

The Contractor shall be responsible for the handling, storage and transport of the samples to the onshore laboratory (and subsequent transport between laboratories), their storage and eventual disposal. Samples shall be handled and stored in a manner that minimises the risk of disturbance. All samples shall be appropriately labelled, stored upright, in a dry area, away from excessive moisture adhering to the storage criteria given in ISO19901-8 and its reference to ISO 22475-1.

The Contractor shall populate a Sample List and utilise a Chain Of Custody form to document and determine accountabilities for the samples during transit.

All samples, sub-samples and sample containers shall be labelled with a unique identifying number immediately after being removed from the sample. Sample labels should, where applicable, be printed or scanned labels rather than handwritten. The label shall include as a minimum:

- The Employer and the project name
- ID of sample.
- Date of sampling.
- Initials of a sampler

All tapes, labels, adhesives and markings shall be water resistant.

Photography of all samples shall be using an appropriate and sufficient photography setup to consistent high quality sample photography. This shall include:

- High Resolution (16MP or better) Digital SLR camera, in a fixed position.

- A fixed strong and consistent light source to ensure consistent sample colour.
- A photographic board, which as a minimum, shall be labelled with:
  - ID of sample
  - Date of sampling

3.5.4.3 Seabed Imagery

At each sampling station/location a 50 m DC/ remotely operated vehicle (ROV) transect will be completed at c. 0.3 – 0.4 knots and max of 0.5 knots, with video collected continuously and still images collected when the DC is at a standard altitude (e.g., 0.5 m from seabed), to ensure consisted field of view, and at as high a frequency as is possible with at least one image collected every 20 seconds).

Ideally a minimum of four still photographs will be acquired at each environmental sampling station. Additional photographs or video footage will be acquired along transects to characterise sensitive habitats or features. This technique involves no intrusive seabed sampling.

Indicative equipment to be used is a SeaSpyder using Canon EOS 100D Digital Still Camera with dedicated strobe and an integrated video system capable of performing full HD recordings.

3.6 Marine Mammal Acoustic Monitoring

Continuous Porpoise Detector (C-POD) and/or AMAR Autonomous Multichannel Acoustic Recorder (AMAR) devices will be deployed in the application area to monitor the presence of cetaceans. They are fully automated passive acoustic monitoring instruments that detect porpoises, dolphins and other toothed whales (except sperm whales) by recognising the trains of echo-location sounds they produce to detect their prey, orientate and interact. A C-POD is a self-contained computer and hydrophone and can log the times and duration of click trains which resemble the echo-location clicks produced by porpoises and dolphins. Click trains are stored into different frequency bins, which can be used in some cases to identify individual animals (e.g., adult and calf). F-PODs use new electronics and software to capture more information. Static acoustic monitoring is independent of weather conditions once deployed and thus ensures high quality data is collected but only at a small spatial scale (typically around 5-700 metre radius from the C-POD). Both C-PODs and F-PODs monitor the presence and activity of toothed cetaceans by the detection of the trains of echolocation clicks that they make. Whilst it is expected that C-PODs will eventually be superseded by the new F-POD, if F-PODs are unavailable at the time of monitoring, C-PODs have the ability to record echolocations in order to robustly determine required data.

Up to two C-PODs/F-PODs may be deployed at any one time across the site. A sound trap may be deployed alongside one of the C-PODs/F-PODs for various durations throughout the monitoring campaign to obtain background noise measurements. The C-PODs/F-PODs will be recovered every three months to download data and change batteries. Upon each three-month recovery they may be relocated so that over the 12-month monitoring period C-PODs/F-PODs will be deployed at locations across the site.

The exact locations of the C-PODs/F-PODs has not being determined yet. Either two permanent sites will be selected, or the two sites will be relocated every three months (during battery change) based on a 4 x 4 km survey grid across the site .

A schematic of the mooring design is presented in **Figure 3.12**.

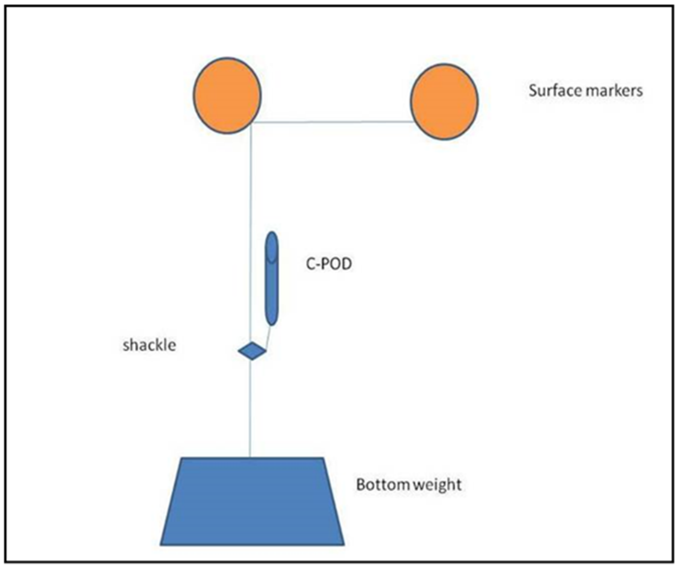


Figure 3.12: C-POD anchoring solution example (Source: IWDG)

Heavy weight moorings using dyneema rope and clumped chain as mooring blocks are used. A single line runs from the mooring blocks to two surface buoys, with a single loop made on the main line towards bottom where all monitoring units are shackled into a loop which is lined with a metal thimble to protect the rope from fraying with a swivel located above weights and below buoys to account for tides. A second safety line is threaded through the lid of the C-POD and also shackled onto the main line. This heavy weight mooring design is used, as it has proved successful at a number of other sites around the country, even during adverse weather conditions (O'Brien *et al*., 2013).

Recovery is through lifting the entire mooring and exchanging the C-PODs before redeployment, habitat loss is therefore temporary.

3.7 Interaction with Other Users of the Sea

Prior to commencing the surveys, contact will be established with other users of the sea in the survey area, including commercial fishing vessels, recreational boaters, and offshore installations. Relevant authorities and maritime agencies will also be informed of the survey operations.

Survey plans, schedules, and contact details will be shared in advance to ensure awareness and to minimise potential conflicts. Regular updates on the progress of the survey will be provided to relevant stakeholders, as required.

The survey vessels will be equipped with an Automatic Identification System (AIS) to monitor and track nearby vessel traffic in real-time. The AIS will be used to identify potential conflicts and facilitate communication with other vessels to ensure safe and efficient operations.

A guard vessel may be used as an additional safety and communication measure during geophysical survey operations. Its primary function would be to assist the survey vessel and its equipment, ensure safe operations, oversee agreed temporary exclusion zones and minimise potential conflicts with other maritime activities.

NCW will work to minimise potential impacts on the fishing industry. We will be identifying and engaging with potentially affected fishermen through our Fisheries Liaison Officer in the months in advance of the surveys taking place.

3.8 Noise Levels of the Survey Equipment

The survey equipment to be used for surveys of the DA and ECC was reviewed by the underwater acoustics team in RPS, to estimate the levels of underwater noise to be produced by the equipment during their operation, and of the survey vessels themselves, so as to predict the likely range of onset for potential physiological and behavioural effects on marine mammals due to increased anthropogenic noise as a result of the proposed surveys.. Source levels for the active equipment were combined to produce a "combined" source that represents the survey vessel's sound signature while actively surveying during the survey, as outlined in **Table 3.3**.

Table 3.3: Summary of Noise Sources and Activities of the Marine Surveys

Equipment	Source Pressure level [SPL]	Primary frequencies (-20 dB width)	Source model details	Impulsive/ non-impulsive
Survey vessels based on max of: • ILV Granuaile, (80m) • Roman Rebel (28m)	173 dB SPL	10-2,000 Hz	(Wittekind, 2014; Simard, *et al*., 2016; Heitmeyer, 2001)	Non-impulsive
Side scan sonar: (Edgetech FS4205 or equivalent)	Not included	230,000 Hz & 850,000 Hz	Not included in assessment due to minimal frequency being well outside the hearing range of any marine mammal species. (VHF group max: ~125 kHz)	n/a
Multibeam echosounder: (Reson Seabat T50R or equivalent)	168-175 dB SPL (ping rate dependent, spherical level)	190,000 – 420,000 Hz	Manufacturer.Source level based on source power (200-300 Watts). Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth.	Impulsive
Sub-bottom profiler 1 (Parametric pinger/chirper, e.g. Innomar Standard)	201-207 dB SPL (ping rate dependent) 222* dB LP (240 dB L_P on-axis)	4,000 – 15,000 Hz and 85,000 – 115,000 Hz	Manufacturer. Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth.	Impulsive
Sub-bottom profiler 2 (UHRS Sparker at max 800J per shot)	193 dB SPL 224 dB L_P (ping rate dependent)	630 – 5,000 Hz	Manufacturer. Ping rate determined by local depth.	Impulsive

* *Level at 20 degree off vertical axis*

It is important to note that source levels varied depending on the location of the survey due to the two factors listed below.

- The ping rate, and therefore the Sound Pressure Level (SPL) of the source, varies with the local depth.

- During the survey of the DA an additional sub-bottom profiler is active to achieve deeper sediment penetration (an Ultra High Resolution Seismic (UHRS) sparker type).

Therefore, modelling was based on selected locations within the DA and the ECC. These locations were chosen to ensure a conservative assessment that covers the variation in the site. These locations were:

- ECC-Coast: Location in the ECC near the coast to assess impacts on shallow slope (**Figure 3.13**).
- ECC-Reef: Location on rocky reef north-west of "East Maiden" lighthouse and west of "Highlandman" marker (**Figure 3.14**).
- ECC-Mid: Location at ~120 m depth on flat seabed, representing the middle section of the ECC likely to form a significant part of the final corridor (**Figure 3.15**).
- DA-SE: Location in the DA towards the centre of the north Irish Sea and south-east end of the DA. Surrounding waters uniformly deep (**Figure 3.16**).
- DA-NW: Location in the DA towards the coastal slope and north-west end of the DA. Surrounding waters slope up to land (Antrim) to the west, flat to the east (**Figure 3.16**).

Figure 3.13, **Figure 3.14**, **Figure 3.15** and **Figure 3.16** also display the surveys vessels sound signature while actively surveying in these different locations within the survey area.

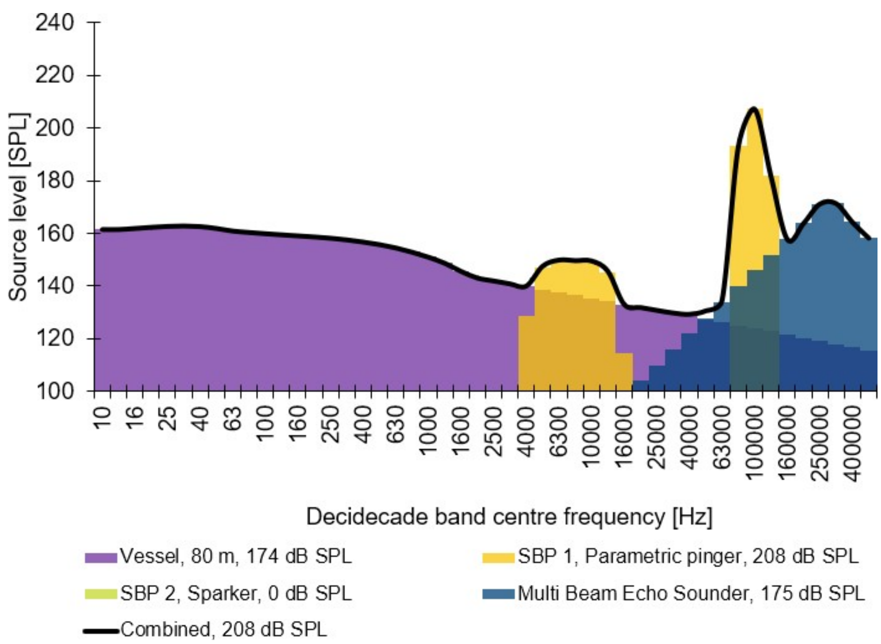


Figure 3.13: ECC-Coast: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in shallow areas of the ECC

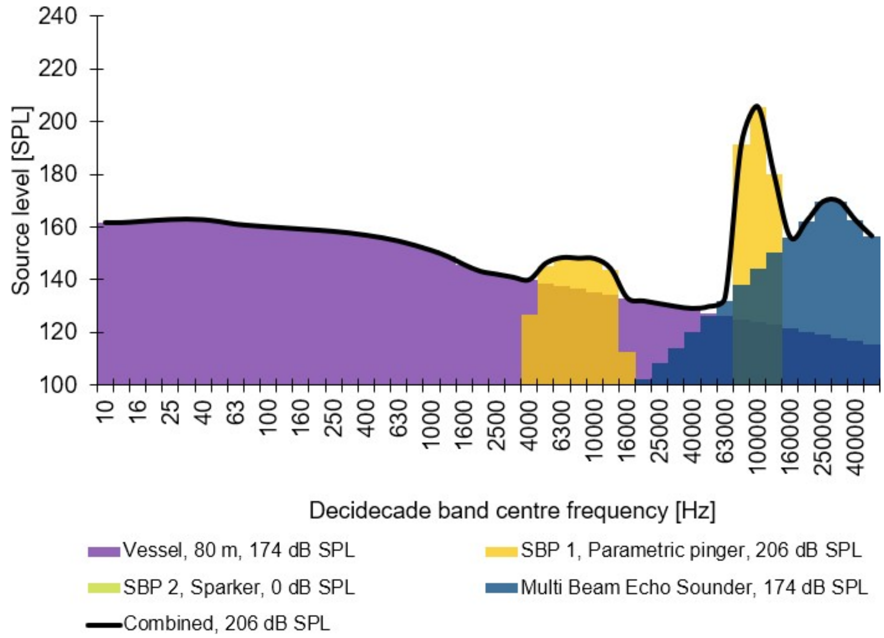


Figure 3.14: ECC-Reef: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in shallow areas with hard sediment of the ECC

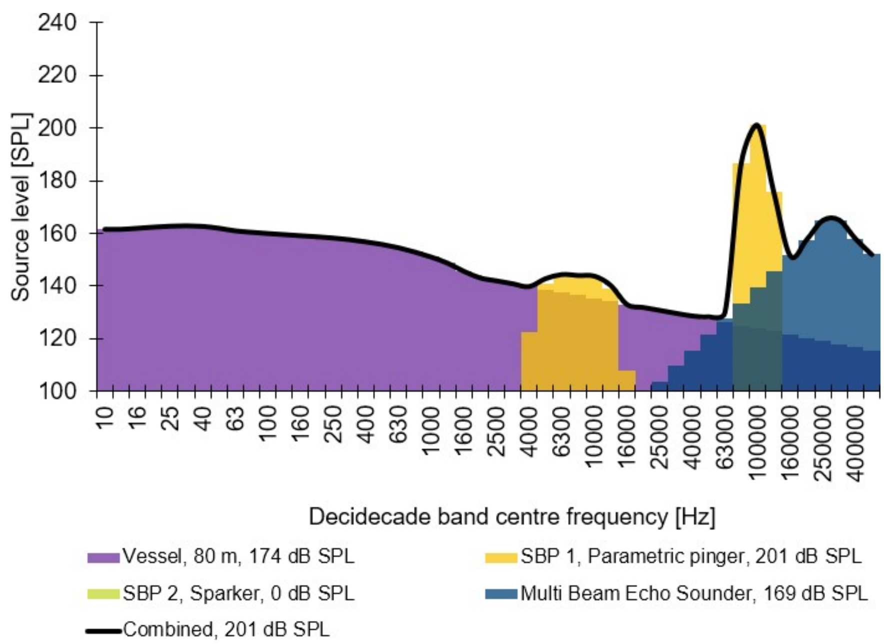


Figure 3.15: ECC-Mid: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in deep areas of the ECC

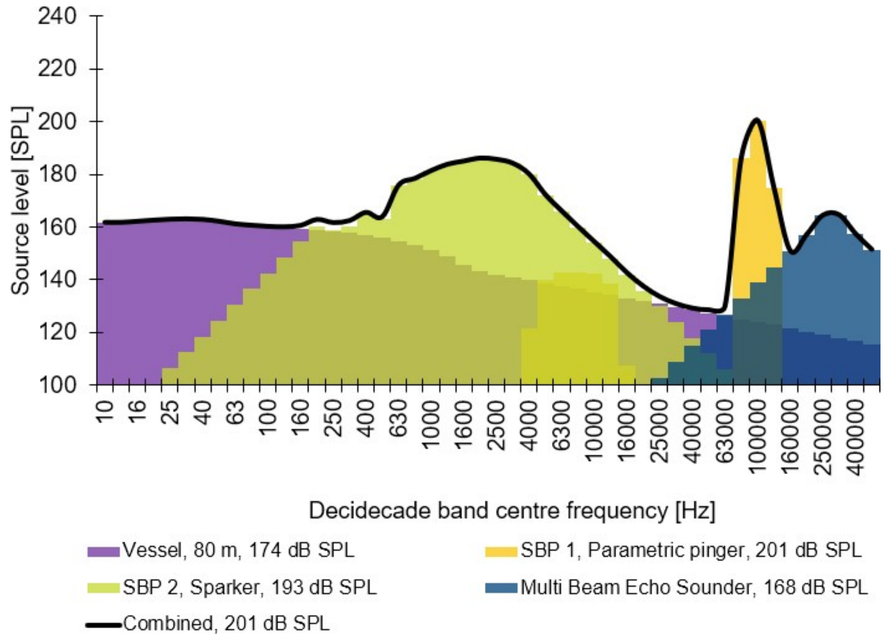


Figure 3.16: DA (DA-SE and DA-NW): Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in the DA

The SSS has not been included in the assessment as its minimal frequency (230 kHz) is far higher than the maximal frequency audible to the Very High Frequency (VHF) hearing group (~125 kHz) of marine mammals. Even allowing for spectral leakage (energy "leakage" into other frequencies due to the acoustic properties of the transducer) it is unfeasible that there will be significant energy below 150 kHz to be relevant.

The multibeam echosounder is likewise well above the upper limit of hearing for the VHF group but has been included as the spectral leakage might mean that enough energy makes it into the hearing range of the VHF group.

The parametric SBP ("Sub-bottom profiler 1" in **Table 3.3**) has a very narrow beam directed vertically down, with levels attenuating rapidly as the angle away from vertical increases. A source level at an angle of 20 degrees from vertical has been used for the assessment. This means that for the deeper sites (130 m) there will be an approximately 50 m radius around the vessel where we will underpredict the impact for animals at the sediment depth (130 m), reducing to 20 m at 50 m depth (i.e., a cone under the SBP with a width of 40 degrees). For the soft-starts (minimum 15 minutes) the ping rate of the parametric SBP reduces to 1 ping per second, effectively reducing the exposure level (LE) of the source. The assessment assumes this source is limited to a maximal LP of 240 dB and maximal 1 second LE of 208 dB, with a similar beam pattern to the Innomar SBPs.

The sound sources assessed were separated into two distinct types:

- **Impulsive** sounds which are typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI, 1986; NIOSH, 1998; ANSI, 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions.

- **Non-impulsive** (continuous) sounds which 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 (ANSI, 1995; NIOSH, 1998). This category includes sound sources such as continuous vibro-piling, running machinery, some sonar and vessels.

The combined source was modelled in the assessment as omnidirectional, and this was a conservative estimate as all sources, apart from the vessel, are highly directional in nature and angled towards the sediment, giving rise to increased transmission losses when compared to an omnidirectional source. The vessel is assumed to move at 2 knots during the surveying, this is a conservative measure to increase the survey time as the vessel will likely move at ~4 knots (limited by the temporal resolution of the survey equipment).

4 STAGE 1 SCREENING APPRAISAL

A Stage 1 screening exercise must be undertaken by the competent authority to determine whether, firstly, the proposed development is directly connected with or necessary to the management of the site, and secondly, to assess, in view of best scientific knowledge, if the proposed development, individually or in combination with another plan or project is likely to have a significant effect on any European site.

4.1 Directly connected with or necessary to the management of the site

The Proposed Development is a suite of Geophysical, Environmental and Metocean Marine Surveys to help inform preliminary design of a future offshore wind farm intended to connect to the Northern Ireland Electricity grid and generate renewable electricity.

The Proposed Development is therefore not directly connected with or necessary to the management of any European site and is subject to the provisions of Regulation 43 of the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended).

4.2 European Sites

This screening exercise considers European sites designated under European Council Directives 92/43/EEC and 2009/147/EC and protected under the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended). The proposed development must be screened against those European sites for which a pathway of effect can be reasonably established between a receptor and the source of an effect.

The proposed development is partially located within four European sites:

- The ECC AoS for NCW 1 includes a small portion of Larne Lough SPA between MHWM and MLWM southeast of Ballylumford Power Station;
- The ECC AoS for NCW 1 passes through the northern portion of the East Coast (Northern Ireland) Marine SPA seaward of MLWM and between Drains Bay on the East Antrim coast and Mullaghboy on the Islandmagee peninsula, and also passes through two subsites of this SPA where shallower waters occur in the otherwise deeper marine areas north and east of Highland Rock near the West Maiden and East Maiden lighthouses. These subsites of the East Coast (Northern Ireland) Marine SPA also abut the south-eastern edges of the NCW 1 array DA;
- The ECC AoS for NCW 1 passes through the northern portion of the North Channel SAC seaward of MLWM and between Brown's Bay and Mullaghboy on the Islandmagee peninsula; and
- The Maidens SAC is entirely contained within the ECC AoS for NCW 1 and abuts the south-eastern edges of the NCW 1 array DA.

4.2.1 Establishing an Impact Pathway

The possibility of significant effects is considered in this report using the source-pathway-receptor model.

- '**Source**' is defined as the individual elements of the proposed works that have the potential to affect the identified ecological feature (or receptor).
- '**Pathway**' is defined as the means or route by which a source can affect the ecological feature.
- An '**Ecological feature**' is defined as qualifying features the SPA or SAC for which conservation objectives have been set for the European sites under consideration (refer to **Table 4.1**).

Each element can exist independently however an effect is created when there is a linkage between the source, pathway and receptor.

Given the nature of the proposed development, which comprises Geophysical, Metocean, Benthic sampling and Marine Mammal surveys over a period of twelve months, there will be no permanent infrastructure installed in the marine environment. As such, there will be no potential to give rise to any permanent habitat loss within or outside of the European sites outlined above; nor will there be physical barriers to dispersal, or interruption of movement or migration (in the case of either migratory birds or marine mammals) within the North Channel. The proposed development will entail the movement of one or two sea going vessels of up to 80 m in length as described in section 3, deploying moored equipment on a short term basis within the DA and ECC AoS and moving across the DA and ECC AoS as described in section 3 utilising equipment that produces subsea noise as described in section 3.8.

As the proposed activities are to occur in areas that overlap with four European sites as outlined above, the possibility of Annex I habitat disturbance, disturbance and displacement of qualifying feature species by the survey vessels, accidental pollution causing diminution of water quality of the marine environment and the possibility of injury or disturbance as a result of the survey equipment must be considered.

Based on the above preliminary analysis, East Coast (Northern Ireland) Marine SPA and Larne Lough SPA have been scoped into the screening appraisal. The East Coast (Northern Ireland) Marine SPA is functionally linked to a number of other SPA sites by providing marine areas that their seabird populations rely on. As such, the following SPAs have been scoped into the screening appraisal:

- East Coast (Northern Ireland) Marine SPA
- Larne Lough SPA
- Belfast Lough SPA
- Outer Ards SPA
- Copeland Islands SPA
- Strangford Lough SPA

Based on the above preliminary analysis, the following SACs have been scoped into the screening appraisal:

- Inner Hebrides and the Minches (Scotland)
- South-East Islay Skerries (Scotland)
- Skerries and Causeway SAC (NI)
- The Maidens SAC (NI)
- North Channel SAC (NI)
- Strangford Lough SAC (NI)
- Murlough SAC (NI)

The SPAs scoped into the screening appraisal are illustrated in **Figure 4.1**. Their qualifying features and conservation objectives are described in **Table 4.1**. The SACs scoped into the screening appraisal are illustrated in **Figure 4.2**. Their qualifying features and conservation objectives are described in **Table 4.2**. The European sites in proximity to the proposed development are illustrated in **Figure 4.3**.

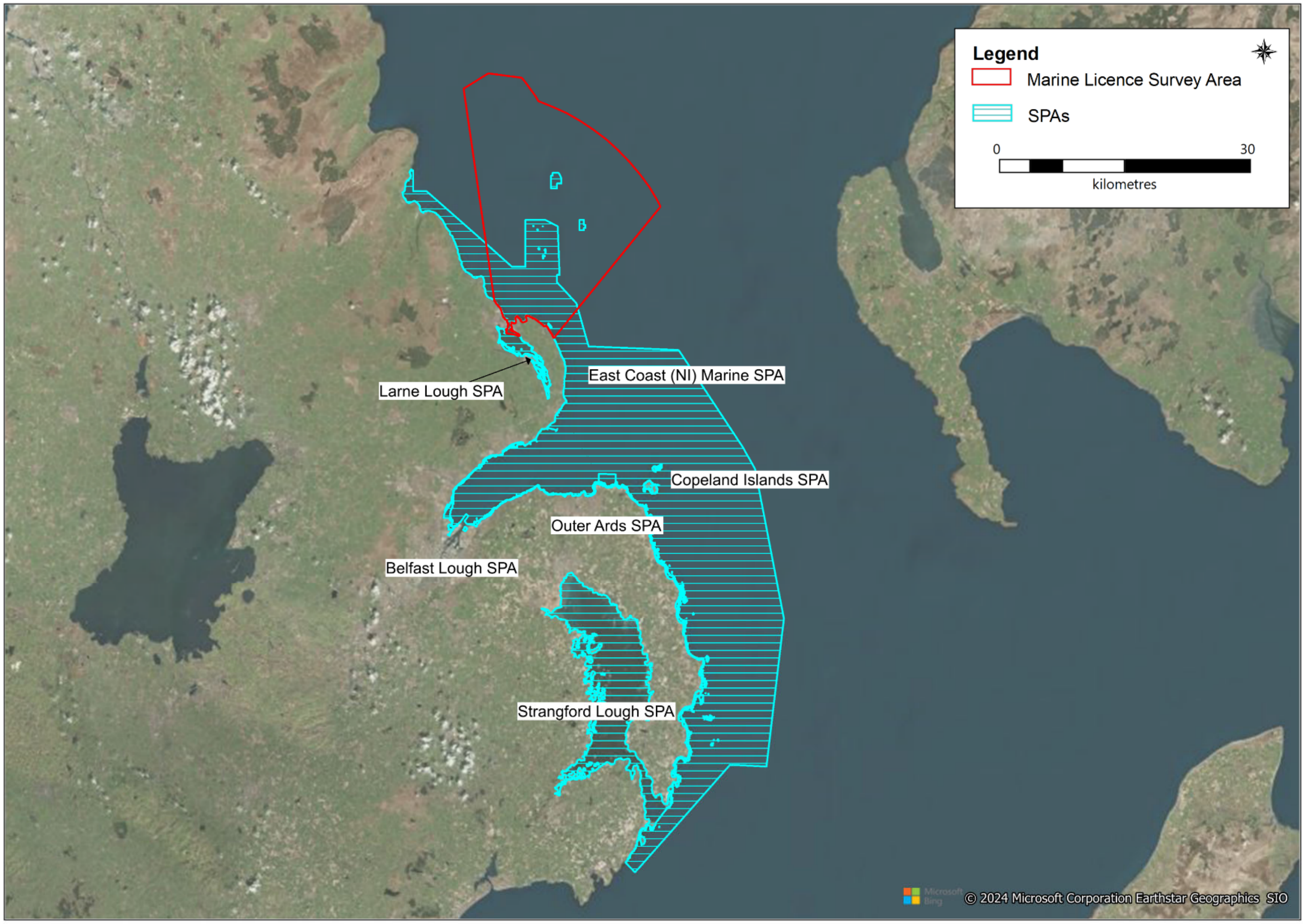


Figure 4.1: SPAs Scoped into Stage 1 Screening Appraisal

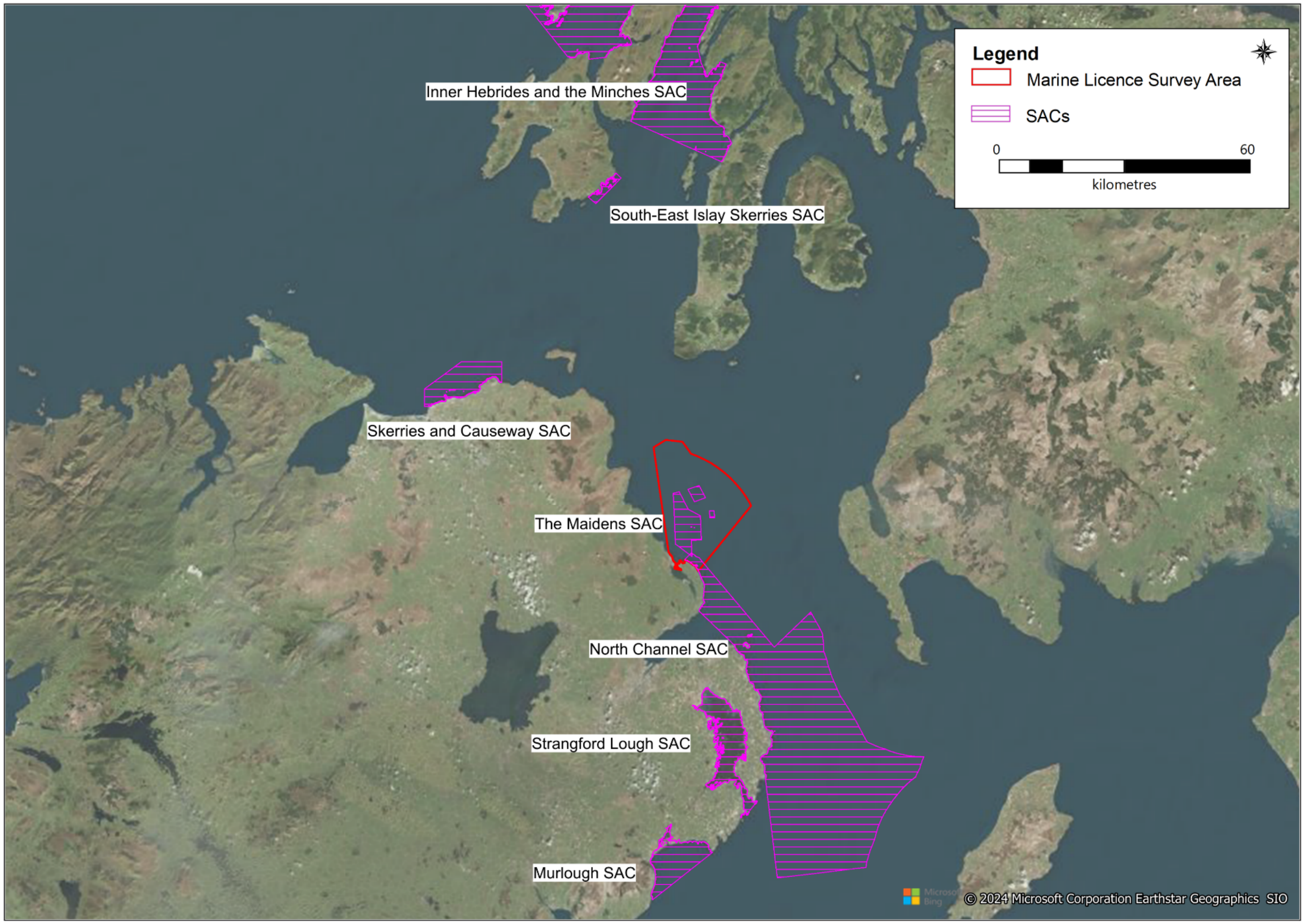


Figure 4.2:SACs Scoped into Stage 1 Screening Appraisal

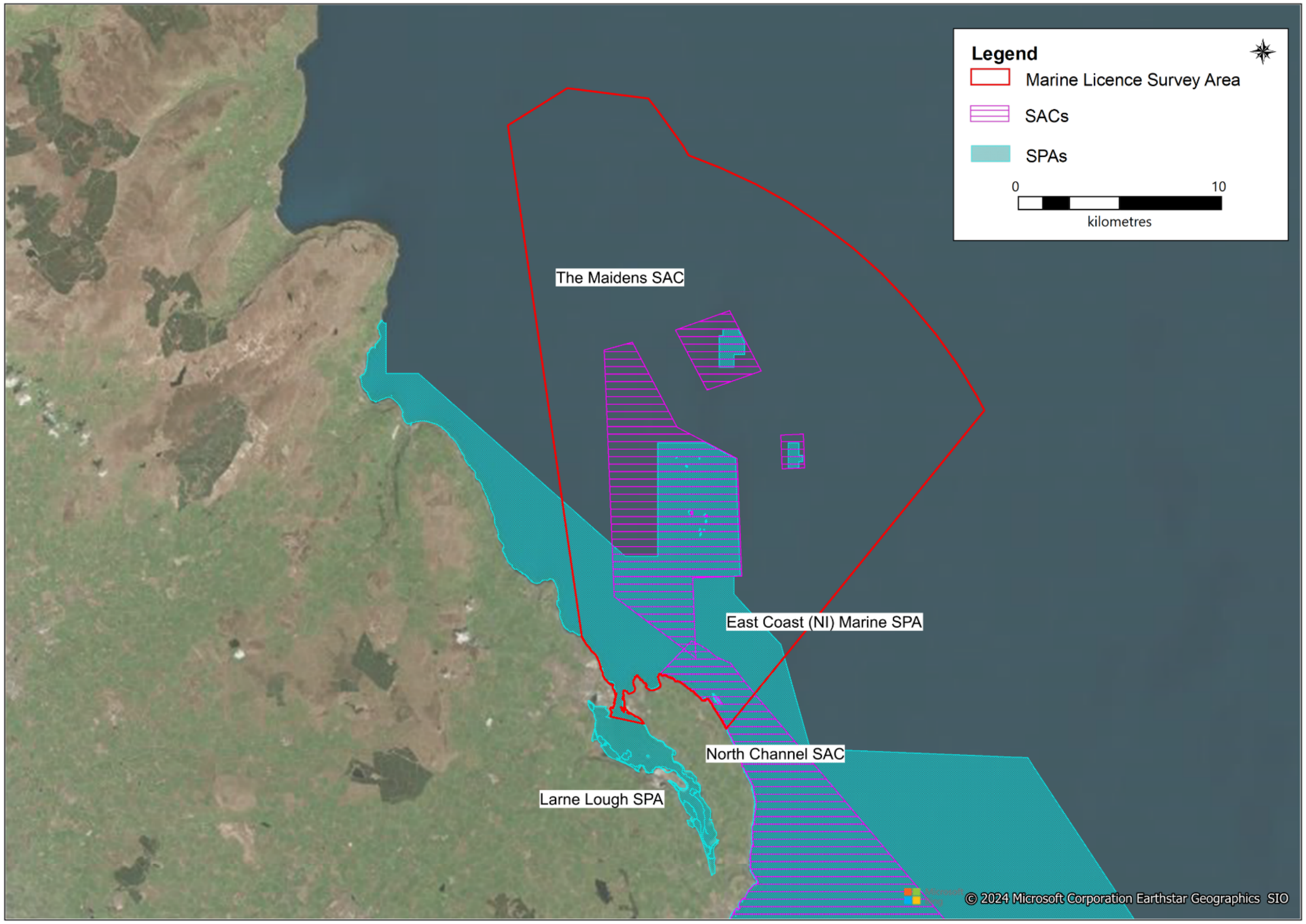


Figure 4.3: All types of European sites in proximity to the Proposed Development scoped into the Screening Appraisal

Table 4.1: Conservation Objectives and Qualifying Features of SPAs in the zone of influence of the Proposed Development

European site	Distance / direction	Selection feature(s)	Conservation objectives
Proposed East Coast (NI) Marine SPA) [UK9020320] (including subsumed Belfast Lough Open Water SPA)	Overlaps with ECC AoS; Abuts DA (see section 4.2 and Figure 4.3 above)	• Non-breeding population of Great Crested Grebe • Non-breeding population of Red-throated Diver • Non-breeding population of Eider • Rafting Manx Shearwater in the breeding season originating from an adjoining colony • Foraging Sandwich, Common and Arctic Tern in the breeding season originating from adjoining tern colonies • Habitat extent • Roosting/loafing sites	Component objective for species as follows – • To maintain or enhance the population of the qualifying species • To maintain or enhance the range of habitats utilised by the qualifying species • To ensure that the integrity of the site is maintained; • To ensure there is no significant disturbance of the species and • To ensure that the following are maintained in the long term: o Population of the species as a viable component of the site o Distribution of the species within site o Distribution and extent of habitats supporting the species o Structure, function and supporting processes of habitats supporting the species Component objective for habitat extent as follows – • Maintain the extent of main habitat components subject to natural processes Component objective for roosting/loafing sites as follows – • Maintain all locations of sites
Larne Lough SPA [UK9020042] (including subsumed Swan Island SPA)	Overlaps with ECC AoS (see section 4.2 and Figure 4.3 above)	• Sandwich Tern • Roseate Tern • Common Tern • Light-bellied Brent Goose • Habitat Extent • Roost site locations	Component objective for species as follows – • To maintain or enhance the population of the qualifying species • Fledging success sufficient to maintain or enhance population • To maintain or enhance the range of habitats utilised by the qualifying species • To ensure that the integrity of the site is maintained; • To ensure there is no significant disturbance of the species and • To ensure that the following are maintained in the long term: o Population of the species as a viable component of the site o Distribution of the species within site o Distribution and extent of habitats supporting the species o Structure, function and supporting processes of habitats supporting the species Component objectives for habitat extent as follows – • To maintain or enhance the area of natural and semi-natural habitats used or potentially usable by the feature bird species, subject to natural processes • Maintain the extent of main habitat components subject to natural processes Component objective for roost sites as follows – • Maintain or enhance sites utilised as roosts
Belfast Lough SPA [UK9020101]	15.8 km S of ECC AoS (see section 4.2 and Figure 4.1 above)	• Redshank • Great Crested Grebe • Habitat extent • Roost site locations	Component objective for species as follows - • To maintain or enhance the population of the qualifying species • Fledging success sufficient to maintain or enhance population • To maintain or enhance the range of habitats utilised by the qualifying species • To ensure that the integrity of the site is maintained;

European site	Distance / direction	Selection feature(s)	Conservation objectives

			• To ensure there is no significant disturbance of the species and
			• To ensure that the following are maintained in the long term:
			  ○ Population of the species as a viable component of the site
			  ○ Distribution of the species within site
			  ○ Distribution and extent of habitats supporting the species
			  ○ Structure, function and supporting processes of habitats supporting the species
			Component objectives for habitat extent as follows -
			• To maintain or enhance the area of natural and semi-natural habitats used or potentially usable by the feature bird species, subject to natural processes
			• Maintain the extent of main habitat components subject to natural processes
			Component objective for roost sites as follows -
			• Maintain or enhance sites utilised as roosts

Outer Ards SPA [UK9020271]	16.9 km S of ECC AoS (see section 4.2 and Figure 4.3 above)	• Arctic Tern
		• Light-bellied Brent Goose
		• Golden Plover
		• Ringed Plover
		• Turnstone
		• Habitat Extent
		• Roost site locations
			Component objective for species as follows -
			• To maintain or enhance the population of the qualifying species
			• Fledging success sufficient to maintain or enhance population
			• To maintain or enhance the range of habitats utilised by the qualifying species
			• To ensure that the integrity of the site is maintained;
			• To ensure there is no significant disturbance of the species and
			• To ensure that the following are maintained in the long term:
			  ○ Population of the species as a viable component of the site
			  ○ Distribution of the species within site
			  ○ Distribution and extent of habitats supporting the species
			  ○ Structure, function and supporting processes of habitats supporting the species
			Component objectives for habitat extent as follows -
			• To maintain or enhance the area of natural and semi-natural habitats used or potentially usable by the feature bird species, subject to natural processes
			• Maintain the extent of main habitat components subject to natural processes
			Component objective for roost sites as follows -
			• Maintain or enhance sites utilised as roosts

The Copeland Islands SPA [UK9020291]	19.4 km SE of ECC AoS	• Manx shearwater
		• Arctic tern
		• Habitat extent
			Component objective for species as follows -
			• To maintain or enhance the population of the qualifying species
			• Fledging success sufficient to maintain or enhance population
			• To maintain or enhance the range of habitats utilised by the qualifying species
			• To ensure that the integrity of the site is maintained;
			• To ensure there is no significant disturbance of the species and
			• To ensure that the following are maintained in the long term:
			  ○ Population of the species as a viable component of the site
			  ○ Distribution of the species within site
			  ○ Distribution and extent of habitats supporting the species
			  ○ Structure, function and supporting processes of habitats supporting the species

European site	Distance / direction	Selection feature(s)	Conservation objectives
			Component objectives for habitat extent as follows - • To maintain or enhance the area of natural and semi-natural habitats used or potentially usable by the feature bird species, subject to natural processes • Maintain the extent of main habitat components subject to natural processes

Strangford Lough SPA [UK9020111]	28.0 km S of ECC AoS (straight line distance)
	
	62.0 km S of ECC AoS (hydrological pathway)
		• Sandwich Tern
		• Common Tern
		• Arctic Tern
		• Golden Plover
		• Bar-tailed Godwit
		• Species Light-bellied Brent Goose
		• Shelduck
		• Knot
		• Redshank
		• Great Crested Grebe
		• Cormorant
		• Greylag Goose
		• Wigeon
		• Gadwall
		• Teal
		• Mallard
		• Pintail
		• Shoveler
		• Goldeneye
		• Red-breasted Merganser
		• Coot
		• Oystercatcher
		• Ringed Plover
		• Grey Plover
		• Lapwing
		• Dunlin
		• Curlew
		• Turnstone
		• Waterfowl assemblage
		• Habitat extent
		• Roost site locations
			Component objectives for species as follows -
			• To maintain or enhance the population of the qualifying species
			• Fledging success sufficient to maintain or enhance population
			• To maintain or enhance the range of habitats utilised by the qualifying species
			• To ensure that the integrity of the site is maintained;
			• To ensure there is no significant disturbance of the species and
			• To ensure that the following are maintained in the long term:
			  ○ Population of the species as a viable component of the site
			  ○ Distribution of the species within site
			  ○ Distribution and extent of habitats supporting the species
			  ○ Structure, function and supporting processes of habitats supporting the species
			Component objectives for waterfowl assemblage as follows -
			• No significant decrease in population against national trends
			• Maintain species diversity contributing to the wintering waterfowl assemblage population
			Component objectives for habitat extent as follows -
			• To maintain or enhance the area of natural and semi-natural habitats used or potentially usable by the feature bird species, subject to natural processes
			• Maintain the extent of main habitat components subject to natural processes
			Component objective for roost sites as follows -
			• Maintain or enhance sites utilised as roosts

Table 4.2: Conservation Objectives and Qualifying Features of SACs in the zone of influence of the Proposed Development

European site	Distance / direction	Selection feature(s)	Conservation objectives
North Channel SAC [UK0030399]	Overlaps ECC AoS (see section 4.2 and Figure 4.3 above)	• Harbour porpoise	To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained in the long term: • The Harbour porpoise is a viable component of the site; • There is no significant disturbance of the species; and • The condition of supporting habitats and processes, and the availability of prey is maintained.
The Maidens SAC [UK0030384]	Overlaps ECC AoS; Abuts DA (see section 4.2 and Figure 4.3 above)	• Grey seal • *Harbour (Common) seal (ASSI feature)*	• Maintain (and if feasible enhance) population numbers and distribution of Grey Seal. • Maintain and enhance, as appropriate, physical features used by Grey Seals within the site. • *No significant decrease in population of common seal against national trends, caused by on-site factors*
Strangford Lough SAC [UK0016618]	62.0 km S of ECC AoS (hydrological pathway)	Harbour (Common) seal	• Maintain and enhance, as appropriate, the Harbour (Common) Seal population • Maintain and enhance, as appropriate, physical features used by Harbour (Common) Seals within the site
Skerries and Causeway SAC [UK0030383]	41.8 km NW (hydrological pathway)	• Harbour porpoise	• Ensure the species is a viable component of the site. • Ensure there is no significant disturbance of the species. • Ensure the supporting habitats and processes relevant to harbour porpoises and their prey are maintained.
Murlough SAC [UK0016612]	77.5 km S (hydrological pathway) (see 4.2 above)	• Harbour (Common) seal	• Maintain (and if feasible enhance) population numbers and distribution of Harbour (Common) Seal. • Maintain and enhance, as appropriate, physical features used by Harbour (Common) Seals within the site
Inner Hebrides and Minches SAC [UK0030393]	68.0 km N (hydrological pathway) (see 4.2 above)	• Harbour porpoise	• To ensure that the Inner Hebrides and the Minches SAC continues to make an appropriate contribution to harbour porpoise remaining at favourable conservation status. • To ensure for harbour porpoise within the context of environmental changes, that the integrity of the Inner Hebrides and the Minches SAC is maintained as follows: o Harbour porpoise within the Inner Hebrides and the Minches are not at significant risk from injury or killing. o The distribution of harbour porpoise throughout the site is maintained by avoiding significant disturbance. o The condition of supporting habitats and the availability of prey for harbour porpoise are maintained.
South-East Islay Skerries SAC [UK0030067]	62.0 km N via open water (see 4.2 above)	• Harbour (Common) seal	• To ensure for the Harbour seal that the following are maintained in the long term: • Population of the species as a viable component of the site; • Distribution of the species within site; • Distribution and extent of habitats supporting the species; • Structure, function and supporting processes of habitats supporting the species; and • No significant disturbance of the species.

** Note: Other SAC qualifying interests not susceptible to underwater noise or disturbance effects are not listed.*

4.3 Likely Significant Effects on European Sites

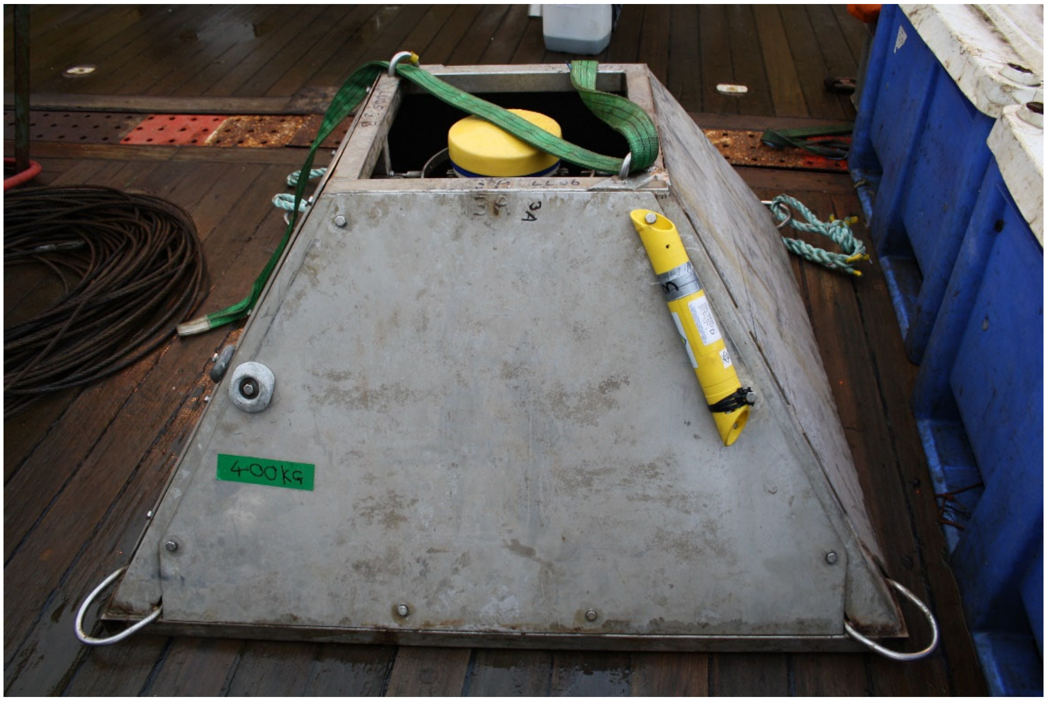
4.3.1 Disturbance to Annex I Habitats

As can be seen from **Figure 3.10**, the benthic sampling plan includes for Seabed imagery (HD video and images) collection and grab sampling from up to 80 stations within the survey areas (40 nr within the DA and 40 nr within the ECC AoS). None of these proposed sampling locations are located within The Maidens SAC.

Where grab samples are to be taken, 4 nr grab samples will be collected at each suitable station using a 0.1 m^2 Day Grab (for mud/fine sand habitats) or 0.1 m^2 'mini' Hamon grab (for coarse sediments) as appropriate.

As can be seen from **Figure 3.4**, ADCP devices and a wave buoy device shall be deployed and moored in locations outside of The Maidens SAC. The ADCPs will be deployed in shrouded seabed frames, or submerged low drag buoys, designed to securely anchor the instruments to the seafloor and protect them from damage or displacement. A clump weight will also be located on the seabed floor along with the seabed frame, approximately 200 m from the device (refer

Figure 3.5, **Figure 3.6** and **Figure 3.7**). The dimensions of the ADCP devices and the anchor blocks to be placed on the seabed are 1 m^2.



The wave buoy device is to be anchored in a similar fashion to the ADCP devices, as can be seen in **Figure 3.9**, with an anchor block of the same dimensions (1 m^2) to also be placed on the seabed. The 2 nr C-PODs/F-POD devices will also be moored to the seabed in a similar fashion to the ADCP devices, as can be seen in **Figure 3.12**, with an anchor block of the same dimensions (1 m^2) to also be placed on the seabed.

The setting of ADCP seabed frames, anchor blocks and clump weights, and the action of Day and Hamon grab sampling equipment on the seabed may result in the suspension and subsequent deposition of seabed sediments on the seabed in the area immediately surrounding the activity causing sediment to enter suspension. This has the potential to result in temporary increases in suspended sediment concentrations (SSCs). However, effects on Annex I sandbank and reef habitats arising from these activities will not occur as any suspended sediments arising around the immediate vicinity of the grab sampling or mooring blocks shall be short term, of very limited spatial extent and highly reversible. The activities will occur in limited, discrete locations within the survey areas, and any increases in SSCs will be very low, very short-lived and inconsequential in the context of the natural variability of SSCs in the region. The survey area is located within a highly dynamic environment and small, transient increases in SSC would return to background levels within minutes to a small number of hours following activities associated with setting of ADCP seabed frames, anchor blocks and clump weights on the seabed, and the action of Day and Hamon grab sampling.

There is no potential for likely significant effects on sandbanks covered by seawater all the time and reef features of The Maidens SAC.

4.3.2 Disturbance as a result of the Survey Vessels or Mooring Systems

These activities are to occur in an area that has been analysed for its vessel movements in the NCW offshore EIA Scoping Report (RPS, 2024) using datasets from 2019 to show representative pre-COVID vessel numbers (**Figure 4.4**). That analysis estimates approximately 2,610 commercial vessel transits per year that intersected the footprint of the DA. The main navigational feature for the area is a Maritime and Coastguard Agency (MCA) regulated Traffic Separation Scheme (TSS) in the North Channel located 9 nm north-west of the array study area. This provides a set of rules for shipping traffic turning around the North Channel entrance between Rathlin Island, Torr Head and the Mull of Kintyre.

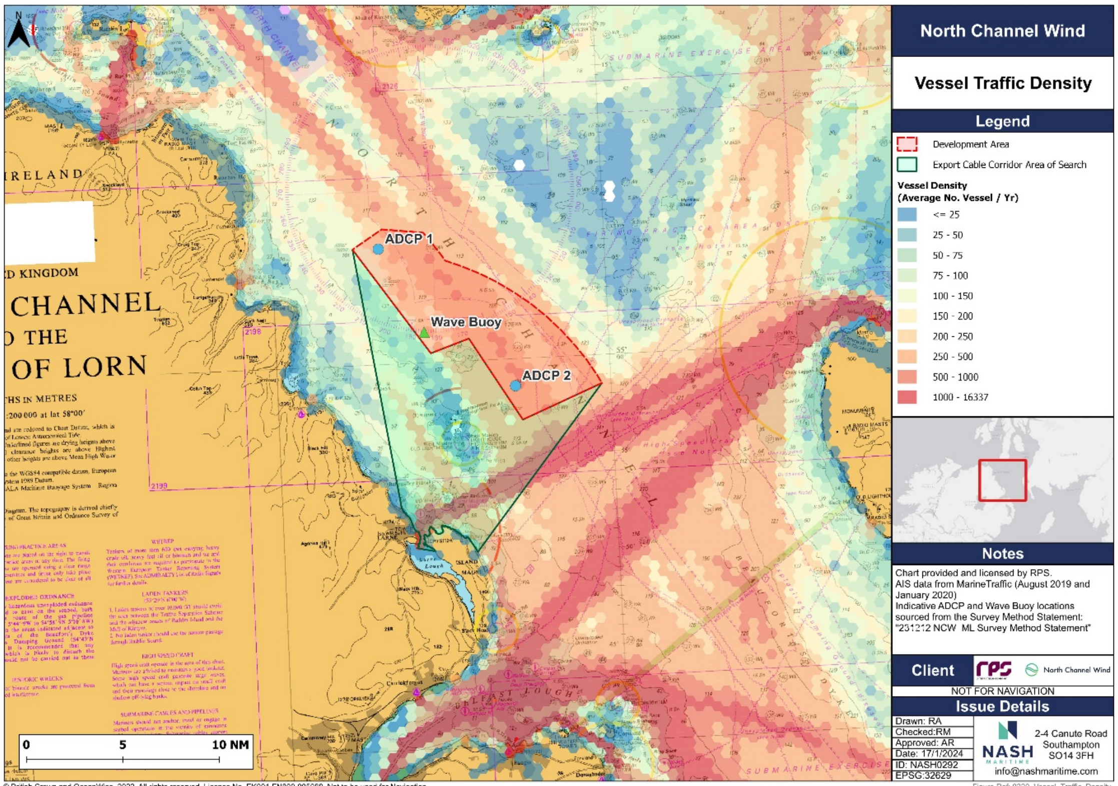


Figure Ref: 0220_Vessel_Traffic_Density

Figure 4.4: Vessel Traffic Density in proximity to the NCW Marine Survey Area

Larne Port is located at the south of the DA study area. The port is primarily used for the P&O Ferries routes that operate in this area with limited other general cargo use on an ad-hoc basis. Larne Port has a fishing and recreational community with several clubs making use of Larne Lough and the wider area. Two ferry routes are evident to the south-east of the site of proposed development - the Larne to Cairnryan route operated by P&O Ferries with six crossings per day; and the Belfast to Loch Ryan route operated by Stenaline conducting five crossings per day (**Figure 4.5**). In addition, routes from Heysham, Liverpool and Douglas intersect the ECC AoS on passage to Belfast. Fishing activity is shown to the east inshore along the Scottish coast between Loch Ryan and the entrance to the Firth of Clyde, with several fishing vessel transits passing through the DA between Larne or Belfast and the north-eastern traffic lane of the TSS in the North Channel. Analysis also shows evidence of fishing activity along the ECC AoS, particularly near to landfall around Larne and the approaches to Belfast.

Offshore cruising routes through the site include routes between Belfast Lough and Campbeltown, Glenarm and the Firth of Clyde, and Belfast Lough and the Sound of Jura.

The tracks of the various types of vessels analysed in the NCW Offshore Scoping Report RPS (2024) pass through the area to be surveyed as part of the proposed development, and it is instructive to illustrate the movements of these types of vessels to understand the baseline conditions with respect to vessel movements in order to evaluate whether or not the addition of one or two sea going vessels of up to 80 m in length might present the possibility of disturbance to qualifying features of European sites.

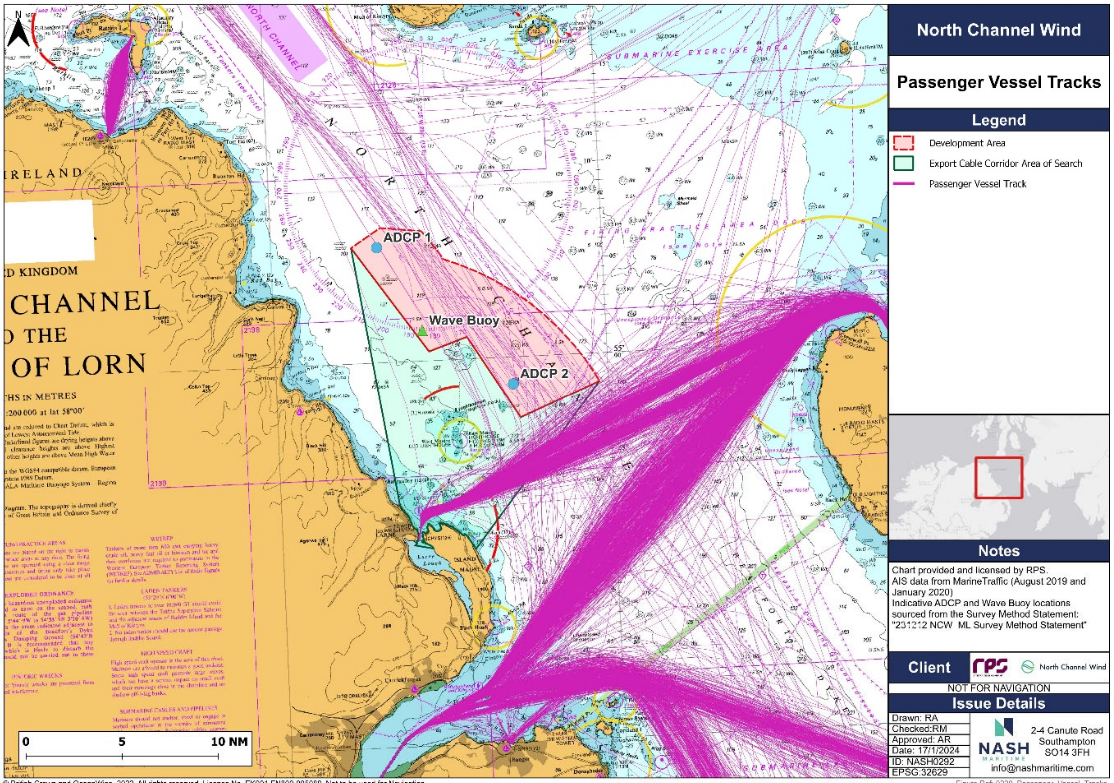


Figure 4.5: Passenger Vessel Traffic Activity in proximity to the NCW Marine Survey Area

Illustrating these vessel movements (**Figure 4.4**) shows clearly that there is a significant amount of vessel traffic passing through the DA and ECC AoS areas and by a wide variety of vessel types, from cargo ships and tankers (refer **Figure 4.6**), to commercial ferries, fishing trawlers and recreational vessels (**Figure 4.7**).

Adding another vessel or two (an inshore and an offshore vessel) will not change the characteristics of the area in terms of how frequently or how often anthropogenic activities in marine vessels occurs. A significant number of marine vessels pass through this area, and the addition of the two survey vessels is not likely to represent a new 'source' of effect or an intensification of an existing source of effect for injury or disturbance to or displacement of qualifying features of the European sites considered.

In relation to the addition of new mooring systems for 2 nr ADCP devices, a wave buoy and 2 nr C-POD/F-POD devices as described in section 3 above, the addition of up to five additional sets of mooring lines or chain, supplemented with inline floats and weights in an area that is currently subject to significant amounts of inshore fishing (refer **Figure 4.7**) and where significant amounts of existing mooring systems are already in place, is not likely to represent a new 'source' of effect or an intensification of an existing source of effect for injury or disturbance to or displacement of qualifying features of the European sites considered.

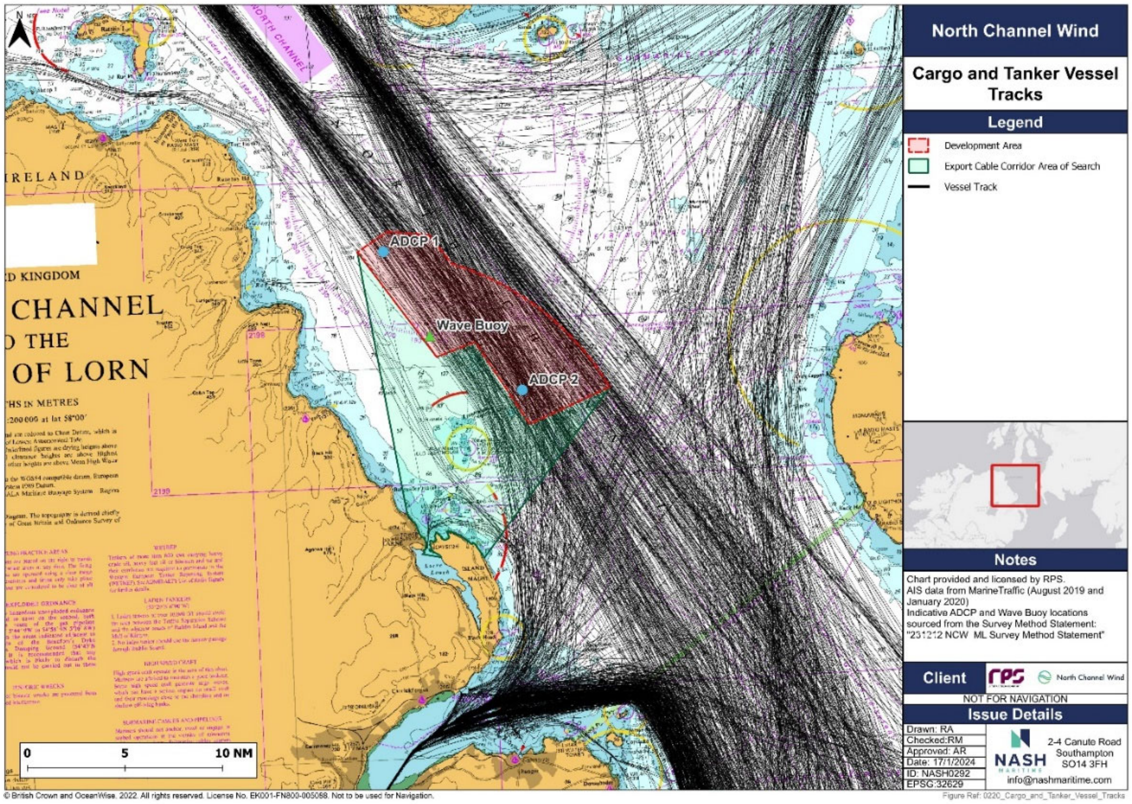


Figure 4.6: Cargo and Tanker Vessel Traffic Activity in proximity to the NCW Marine Survey Area

The conservation objectives of the proposed East Coast (Northern Ireland) Marine SPA seek to *inter alia* maintain or enhance the range of habitats utilised by the qualifying species; ensure there is no significant disturbance of the species; maintain the distribution and extent of habitats supporting the species; and maintain all roosting/loafing sites within the SPA. The presence of two additional vessels and up to five additional mooring systems will not threaten these component objectives.

The conservation objectives of the North Channel SAC seek to ensure that harbour porpoise remains a viable component of the SAC; that there is no significant disturbance of the species; and that the condition of supporting habitats and processes, and the availability of prey is maintained. The presence of two additional vessels and up to five additional mooring systems will not threaten these component objectives.

The conservation objectives of The Maidens SAC seek to maintain (and if feasible enhance) population numbers and distribution of Grey Seal, and maintain and enhance if appropriate, physical features used by Grey Seals within the SAC.

The presence of two additional vessels and up to five additional mooring systems will not threaten these component objectives.

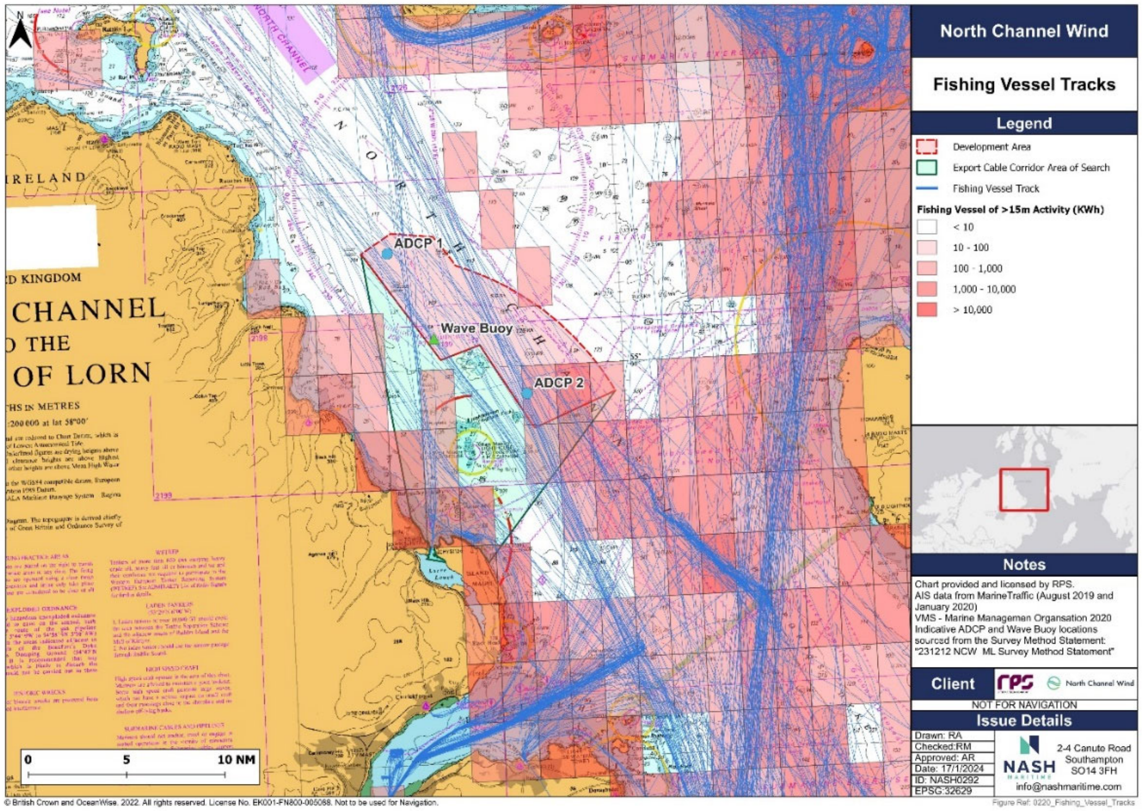


Figure 4.7: Fishing Vessel Activity in proximity to the NCW Marine Survey Area

Additional component objectives for Larne Lough SPA, Belfast Lough SPA, Outer Ards SPA, the Copelands Islands SPA and Strangford Lough SPA seek to maintain or enhance sites used as nesting or roosting sites. The presence of two additional vessels and up to five additional mooring systems will not threaten these component objectives.

Conservation objectives for The Maidens SAC, Strangford Lough SAC, Murlough SAC seek to maintain and enhance, as appropriate, physical features used by Grey Seals or Common seals as the case may be, within the site. Conservation objectives for the North Channel SAC, Skerries and Causeway SAC, Inner Hebrides and the Minches SAC and South-East Islay Skerries SAC seek to ensure no significant disturbance of harbour porpoise. The presence of two additional vessels and up to five additional mooring systems will not threaten these component objectives.

In addition to the presence of vessels for the surveys for which a marine licence application has been submitted, the applicant also intends to undertake a Marine Vessel Traffic Survey, although this is not an activity for which a Marine Licence has been sought. This survey will include:

- Surveys of marine vessel traffic to inform a Navigational Risk Assessment at EIA phase.
- Survey duration shall be approximately 2x 14 day campaigns.

A Maritime Guidance Note 654 compliant vessel-based vessel traffic survey (AIS, Radar and Visual) of 2x 14-day survey campaigns with one vessel roaming in the vicinity of the red line development area plus a suitable buffer is a third vessel that will potentially be present in the marine survey application area at the same time as thew two previous vessels described in section 3.

The presence of an additional vessel to undertake a Marine Vessel Traffic Survey will not threaten the conservation objectives of the proposed East Coast (Northern Ireland) Marine SPA, The Maidens SAC, the North Channel SAC, Larne Lough SPA, Belfast Lough SPA, Outer Ards SPA, the Copelands Islands SPA, Strangford Lough SPA, Strangford Lough SAC, Murlough SAC, Skerries and Causeway SAC, Inner Hebrides and the Minches SAC or South-East Islay Skerries SAC.

4.3.3 Diminution of Marine Water Quality as a result of Accidental Pollution

As the surveys involve equipment being towed or deployed to undertake a range of geophysical investigations and metocean, benthic and marine mammal surveys, and do not involve significant physical drilling or excavation by mechanical means, apart for the fuels and oils present on the survey vessels and used for their engines, cranes and winches, there will be no drilling fluids or other lubricants introduced into in the marine environment as a result of the surveys. All seagoing commercial vessels in UK waters comply with the International Convention for the Prevention of Pollution from Ships (MARPOL 3F) Regulations including those addressing potential invasive marine species and the use of ballast water treatment systems as a matter of standard shipping industry compliance. Adding up to three more vessels to the marine traffic of the area does not increase the likelihood of point pollution from a ship at sea. The addition of the survey vessels will not represent a new 'source' of effect or an intensification of an existing source of effect for pollution.

Conservation objectives for East Coast (Northern Ireland) Marine SPA, Larne Lough SPA, Belfast Lough SPA, Outer Ards SPA, Copeland Islands SPA and Strangford Lough SPA seek to maintain or enhance the area of natural and semi-natural habitats used or potentially usable by the feature bird species, subject to natural processes; and maintain the extent of main habitat components subject to natural processes. The presence of two additional vessels complying with the MARPOL Regulations will not threaten these component objectives.

Conservation objectives for the North Channel SAC, Skerries and Causeway SAC, Inner Hebrides and the Minches SAC and South-East Islay Skerries SAC seek to maintain the condition of supporting habitats and processes, and the availability of prey species. The presence of two additional vessels complying with the MARPOL Regulations will not threaten these component objectives.

4.3.4 Disturbance and Auditory Injury as a result of Survey Equipment

The surveys will be utilising equipment as set out in section 3.2.5**Error! Reference source not found.**, and this equipment will produce underwater noise. This is a source of potential effect, as the noise produced during surveys could potentially cause disturbance, displacement and auditory injury or harm. This possibility must be investigated for those qualifying features that are susceptible to ensonification in the marine environment, or the prey items of qualifying species that rely on the survey area.

The surveys have potential to impact on qualifying feature marine mammals from sound produced during the geophysical surveys. The introduction of additional man-made sound has the potential to result in disturbance or injury, by affecting a mammals' ability to feed, avoid predators, communicate, and navigate the marine environment (Nieukirk et al, 2004; Richardson, et al., 2013). The impacts on these mammals include short-term behavioural changes; temporary or permanent auditory damage; and mortality (Southall et al., 2019). However, if the frequency resulting from the underwater sound source does not exceed the hearing thresholds of the marine species, they may not experience any effect from this exposure (Carroll et al. 2017). An underwater noise assessment has been prepared to support a marine wildlife risk assessment and this HRA appraisal (refer **Appendix I**).

The noise modelling assessment predicted the ranges for potential injury and disturbance for marine mammals and fish based on the recommended criteria for the different hearing groups. The assessment criteria used in this assessment were developed based on a review of available evidence including national and international guidance and scientific literature.

Injury to marine mammals in the form of Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS) and behavioural thresholds for sound sources were based on the latest international guidance (based on the best available scientific information), that are widely accepted for assessments in the UK, Europe and worldwide (Southall, et al., 2019.; Popper, et al., 2014).

4.3.4.1 Hearing Sensitivity

Hearing sensitivity varies between marine mammals, and therefore they have varying sensitivities to noise and susceptibility to noise-induced impacts (NOAA, 2018). Moreover, their reactions to sound have been shown to depend on sound source level, propagation conditions, ambient noise and individual differences (such as age, sex, habitat and previous habituation to noise) (Richardson *et al*., 1995).

In order to assess the impacts of underwater noise on these species, they are classed into functional hearing groups (Southall *et al.,* 2007; Southall *et al*., 2019). National Oceanic and Atmospheric Administration (NOAA) Fisheries have produced marine mammal acoustic technical guidance, which provides thresholds for the onset of PTS and TTS in marine mammal hearing for all underwater sound sources. These are based on the assumption that, outside of their hearing ranges, it is unlikely that a species will experience an auditory impact. The hearing weighting function is designed to represent the sensitivity for each group within which acoustic exposures can have auditory effects. The categories includes:

- **High Frequency (HF) cetaceans**: Marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales (e.g. bottlenose dolphin)
- **Very High Frequency (VHF) cetaceans**: Marine mammal species such as true porpoises, river dolphins and pygmy/dwarf sperm whales and some oceanic dolphins, generally with auditory centre frequencies above 100 kHz) (e.g. harbour porpoise)
- **Phocid Carnivores in Water (PCW)**: True seals, earless seals (e.g. harbour seal and grey seal)

The classification of each species according to these criteria is displayed below in **Table 4.3**. The most sensitive species likely to be present in the survey area is harbour porpoise, which has an estimated auditory band width of 275 Hz to 160 kHz. Grey seals are also likely to present in the area and have an estimated auditory band width of 50 Hz to 86 kHz, which is the same auditory band width as the harbour seal, which may also be present in the survey area. Bottlenose dolphin may also be present in the area and are classed as 'high-frequency cetaceans'; these species can produce sounds in a lower band frequency, for social interaction, as well as in intermediate to high frequencies, which are used for echolocation. Therefore, they have a large hearing range, but have peaks in hearing sensitivity where echolocation signals are strongest (Southall *et al*., 2019).

Table 4.3: Functional marine hearing groups for marine mammals and basking shark potentially present in the survey areas. Hearing group classification and estimated auditory band width taken from NOAA Marine Mammal Acoustic Technical Guidance (NOAA, 2018) and from Southall, *et al* (2019) Marine Mammal Noise Exposure Criteria.

Species	Hearing Group	Estimated auditory band width

Harbour porpoise	VHF	275 Hz to 160 kHz
Harbour seal	PCW	50 Hz to 86 kHz
Grey seal	PCW	50 Hz to 86 kHz
Bottlenose dolphin	HF	150 Hz to 160 kHz

4.3.4.2 Potential For Injury

The zone of injury in this appraisal is classified as the distance over which a marine mammal can suffer Permanent Threshold Shift (PTS) leading to non-reversible auditory injury. Injury thresholds are based on a dual criteria approach using both un-weighted LP (maximal instantaneous SPL) and marine mammal hearing weighted LE. The hearing weighting function is designed to represent the sensitivity for each group within which acoustic exposures can have auditory effects. To determine the potential spatial range of injury and behavioural change, a review has been undertaken of available evidence, including international guidance and scientific literature.

Both the criteria for impulsive and non-impulsive sound are relevant for this study given the nature of the sound sources used during the survey. The relevant PTS and TTS criteria proposed by Southall et al. (2019) are summarised in **Table 4.4**.

Table 4.4: PTS and TTS onset acoustic thresholds (Southall et al., 2019)

Hearing Group	Parameter	Impulsive [dB]		Non-impulsive [dB]	
		PTS	TTS	PTS	TTS
High frequency (HF) cetaceans	L_P, (unweighted)	230	224	-	-
	L_E, (MF weighted)	185	170	198	178
Very high frequency (VHF) cetaceans	L_P, (unweighted)	202	196	-	-
	L_E, (HF weighted)	155	140	173	153
Phocid carnivores in water (PCW)	L_P, (unweighted)	218	212	-	-
	L_E, (PW weighted)	185	170	201	181

4.3.4.3 Potential for Disturbance

Scientific literature shows that responses to disturbance vary between and within species' and depend on the individual characteristics (body size, condition, sex and personality) and extrinsic factors (environmental context, repeated exposure, prior experience and acclimatisation) (Harding, *et al.,* 2019). These factors will affect whether an individual exhibits an aversive response to sound, particularly in an area with high sound levels related to human activities.

Typically, a 'strong disturbance' is one which has the potential to disturb a marine mammal (or fish) or marine stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (NMFS, 2005; JNCC, 2010). The United States (US) National Marine Fisheries Service (NMFS) (NMFS, 2005) define strong disturbance in all marine mammals as Level B harassment and for impulsive sound suggests a threshold of 160 dB re 1 μPa (root mean square (rms)).

This threshold meets the criteria defined by JNCC (2010a) as a 'non-trivial' (i.e., significant) disturbance and is equivalent to the Southall *et al.,* (2007) severity score of five or more on the behavioural response scale. Outside of this threshold, behavioural responses are considered trivial, and unlikely to significantly impact the marine animal, or its population status in the wild.

For example, these responses often include minor changes in swimming speed, direction and/or dive profile, modification of vocal behaviour and minor changes to respiratory rate (Southall, *et al.,* 2007). For mild disturbance, a precautionary level of 140 dB re 1 μPa (rms) is used to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound.

For vessel noise (continuous sound), NMFS (2005) guidance sets the marine mammal level B harassment threshold for continuous noise at 120 dB re 1 μPa (rms), which sits approximately mid-way between the range of values identified in Southall *et al*. (2007).

Based upon NMFS criteria, disturbance thresholds in this assessment for marine mammals were 120 dB SPL and 160 dB $L_{E\ single\ impulse}$ or 1-second L_E for non-impulsive and impulsive sound, respectively. Criteria for the onset of behavioural effects for fish were 150 dB SPL for fish with no swim bladder (basking sharks) for both impulsive and non-impulsive sound sources, and up to 189 dB SPL for other fish species. For fish species these behavioural changes could include the elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury but may indirectly affect the individual fish (such as by impairing predator detection) (Hastings, 2002; Worcester, 2006; WSDOT, 2011) It is also noted that non- impulsive thresholds can often be lower than ambient noise for coastal waters with some human activity, meaning that ranges determined using this limit will tend to be higher than actual ranges.

4.3.4.4 Potential Impacts of the Marine Surveys

It is to be recalled, as set out in section 3.8 that the survey area is not of uniform depth. Modelling was based on selected locations within the DA and the ECC AoS, chosen to ensure a conservative assessment that covers the variation in the site. These locations were:

- ECC-Coast: Location in the ECC near the coast to assess impacts on shallow slope
- ECC-Reef: Location on rocky reef north-west of "East Maiden" lighthouse and west of "Highlandman" marker
- ECC-Mid: Location at ~120 m depth on flat seabed, representing the middle section of the ECC likely to form a significant part of the final corridor
- DA-SE: Location in the DA towards the centre of the north Irish Sea and south-east end of the DA. Surrounding waters uniformly deep
- DA-NW: Location in the DA towards the coastal slope and north-west end of the DA. Surrounding waters slope up to land (Antrim) to the west, flat to the east

4.3.4.4.1 Development Area

During the survey in the DA both the sparker-type SBP and the parametric SBP are used, with the sparker dominating the noise relevant to the LF group and the parametric SBP most relevant to the HF and VHF groups. The deeper water in the DA means the SBP will run with lower ping rates, leading to lower exposure levels compared to the generally shallower ECC AoS. Impact ranges for the VHF group are generally high, and due to the noise at lower frequencies the combined noise from the vessel will be audible over much larger distances for all groups.

Risk ranges for peak pressure was under 10 meters for all mammal groups for PTS and TTS limits, with fish TTS limits exceeded to approximately 50 meters. The greatest risk ranges of the DA survey site occur in the NW of the site and are summarised for each group in **Table 4.5**. Starting ranges for fleeing animals of the VHF group extend to approximately 350 m, with the remaining groups having ranges below 10 m. Behavioural response ranges of 1 km and 4.5 km for marine mammals and fishes respectively.

Table 4.5: Summary of Risk Ranges for the DA

Condition	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	80	520	30	0
1 second exposure PTS risk [m]	0	150	0	0
0.5 hours' exposure TTS risk [m]	810	9200	4060	150
0.5 hours' exposure PTS risk [m]	240	890	210	30
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft-start)	221	13401	5582	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft-start)	8	338	3	0
Behavioural response range [m]	1070	1070	1070	4550

The VHF group (harbour porpoise) has a minimal starting range (to avoid PTS, for fleeing animal) of between 323 and 338 m, for the DA survey. The risk ranges for PTS for the remaining mammals and fishes assessed were all found to be below 10 m and therefore it was determined that given the standardly prescribed JNCC (2017) 500 m exclusion zone, there is little to no risk of PTS injury for these groups. For example, any of these species (with the exception of harbour porpoise) would have to be within 10 m of the vessel to experience a threshold shift in hearing.

The behavioural response ranges for fishes are very high (4-4.5 km), meaning potential disturbance for fishes over large parts of the surveyed area. For example, at 2 knots (1 m/s) a location under the survey line will be above the behavioural response range for up to 2.5 hours (or half that time for a survey moving at 4 knots). The equivalent disturbance time for mammals is just under 0.5 hours (approximately 1 km). Therefore, the behavioural response limits for harbour porpoises, seals and fishes are likely to be exceeded during surveying, due to the sparker-type SBP overlapping the frequency regions of greatest hearing sensitivity for these groups as well as the ability for the lower frequencies to travel further with less attenuation. This means TTS for the LF, VHF and PCW groups is likely to occur while surveying the DA. The TTS risk ranges calculated were up to 12, 13 and 5 km for the LF, VHF and PCW groups respectively, while surveying the development area.

The range of effects suggest that behavioural effects on harbour porpoise, grey seal and harbour seal are likely to occur during the DA surveys if animals are within 1,070 m of the surveys. For some fish species, this range increases to 4.55 km.

4.3.4.4.2 Export Cable Corridor Area of Search

During the survey in the ECC AoS the sparker-type SBP is not used as deep sediment penetration is not needed. This means that the parametric SBP, with most energy at 85-115 kHz dominates the noise emitted from the vessel. The shallower waters in the ECC means the SBP will run with higher ping rates, leading to higher exposure levels compared to the deeper DA. Impact ranges for the VHF group are generally high, but due to high attenuation at the main frequencies the behavioural response ranges are shorter than in the DA survey area.

Risk ranges for peak pressure were under 10 m for all mammal groups for PTS and TTS limits, with the fishes TTS limits exceeded to approximately 50 meters. The greatest risk ranges of the ECC AoS survey site occur in the 'reef' areas and are summarised for each group in **Table 4.6**.

Table 4.6: Summary of Risk Ranges for the ECC AoS

Condition	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	190	730	20	0
1 second exposure PTS risk [m]	20	300	0	0
0.5 hours' exposure TTS risk [m]	870	1600	420	260
0.5 hours' exposure PTS risk [m]	410	1040	100	90
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft-start)	264	926	18	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft-start)	18	401	3	0
Behavioural response range [m]	620	620	620	860

The harbour porpoise (VHF group) has a minimal starting range to avoid PTS for a fleeing animal (soft-start assumed) of between 321 m and 401 m for the ECC survey. Similar to the DA survey, these values fall below the 500 m exclusion zone (pre-survey watch) described in the standard JNCC mitigation guidelines for geophysical survey works (JNCC, 2017). Therefore, there is a very little acute risk of exceeding sound exposure levels for a member of the VHF group.

The remaining mammals and fishes likely to be present in the survey area had a risk range for PTS for fleeing animals of less than 18 meters. Therefore, given the standardly prescribed 500 m exclusion zone, there is little to no risk of injury for these groups, as these species would have to be within 18 m of the vessel to experience a threshold shift in hearing.

The ranges of effect suggest that behavioural effects on harbour porpoise, grey seal and harbour seal are likely to occur during the ECC surveys if animals are within 620 m of the surveys. For some fish species, this range increases to 860 m.

4.3.4.5 Conservation Objectives of the European sites

For the North Channel, conservation objectives seek to ensure no significant disturbance to harbour porpoise and that prey availability is maintained. Section 4.3.4.4.1 above outlines that for DA surveys, TTS may occur at 9,200 m for 0.5 hours' exposure and PTS may occur at 890 m for 0.5 hours' exposure. Harbour porpoises within 1,070 m of the survey locations may exhibit behavioural responses. For some of their prey species, this range increases to 4.55 km. For ECC AoS surveys, TTS may occur at 1,600 m for 0.5 hours' exposure and PTS may occur at 1,040 m for 0.5 hours' exposure. Harbour porpoises within 620 m of the survey locations may exhibit behavioural responses. For some of their prey species, this range increases to 860 m. This analysis makes clear that individuals of the population of harbour porpoise within the North Channel SAC may be subject to auditory injury and/or disturbed and likely significant effects cannot be excluded in the absence of mitigation measures.

For The Maidens SAC, conservation objectives seek to maintain the distribution of Grey seal. The DAERA conservation objective document states that disturbance of species may occur through the use of "powerful sonar required for surveys or construction phases as these may directly harm marine mammals or act as a barrier to marine mammals using the area". For DA surveys, TTS may occur at 4,060 m for 0.5 hours' exposure and PTS may occur at 210 m for 0.5 hours' exposure. Harbour porpoises within 1,070 m of the survey locations may exhibit behavioural responses. For some of their prey species, this range increases to 4.55 km. For ECC AoS surveys, TTS may occur at 420 m for 0.5 hours' exposure and PTS may occur at 100 m for 0.5 hours' exposure. This analysis makes clear that individuals of the population of Grey seal in The Maidens SAC may be subject to auditory injury and/or disturbed and likely significant effects cannot be excluded in the absence of mitigation measures.

Skerries and Causeway SAC is 42 km away from the survey area via open water. Strangford Lough SAC is 47 km away from the survey area via open water. South-East Islay Skerries SAC is 62 km away from the survey area via open water. Murlough SAC is 63 km away from the survey area via open water. Inner Hebrides and Minches SAC is 68 km away from the survey area via open water. The analysis in section 4.3.4.4 above shows that no individuals of the populations of Harbour porpoise, Grey seal of Common seal in these SACs will be subject to auditory injury and/or disturbed at these distances. Likely significant effects can be excluded at the screening stage and in the absence of mitigation measures.

Conservation objectives for East Coast (Northern Ireland) Marine SPA, Larne Lough SPA, Belfast Lough SPA and Outer Ards SPA seek to ensure that the structure, function and supporting processes of habitats supporting the species are maintained. This includes the availability of prey species.

For DA surveys, TTS may occur at 150 m for 0.5 hours' exposure and PTS may occur at 30 m for 0.5 hours' exposure. Fish species within 4,550 m of the survey locations may exhibit behavioural responses. For ECC AoS surveys, TTS may occur at 260 m for 0.5 hours' exposure and PTS may occur at 90 m for 0.5 hours' exposure. Fish species within 860 m of the survey locations may exhibit behavioural responses. Outer Ards SPA includes a marine area of approximately 2.5 km^2 overlapping with the East Coast (Northern Ireland) Marine SPA, and this is 2.3 km away from the southeastern tip of the ECC AoS. The East Coast (Northern Ireland) Marine SPA is a very large site, extending over 960 km^2. The seabirds that use this site and for which it is designated forage widely, feeding on fish opportunistically. Two survey vessels deploying survey equipment that may induce a behavioural response in prey species out to 4.5 km would not amount to a reduction in the availability of prey, as that prey would simply move to another part of the marine environment, and the feature species of the East Coast (Northern Ireland) Marine SPA would follow their prey, as they always do. Likely significant effects can be excluded at the screening stage and in the absence of mitigation measures.

For Larne Lough SPA, Belfast Lough SPA and the Copeland Islands SPA, the sites do not contain subtidal marine waters in which seabirds dive and surface feed. This potential impact pathway is not relevant to those sites. Likely significant effects can be excluded at the screening stage and in the absence of mitigation measures.

Strangford Lough SPA does contain subtidal marine waters in which their seabird populations dive and surface feed, but it is located too far away from the proposed surveys and this potential impact pathway is not relevant to those sites. Likely significant effects can be excluded at the screening stage and in the absence of mitigation measures.

Skerries and Causeway SAC is 42 km away from the survey area via open water. Strangford Lough SAC is 47 km away from the survey area via open water. South-East Islay Skerries SAC is 62 km away from the survey area via open water. Murlough SAC is 63 km away from the survey area via open water. Inner Hebrides and Minches SAC is 68 km away from the survey area via open water. Just in the same way that no individuals of the populations of Harbour porpoise, Grey seal of Common seal in these SACs will be subject to auditory injury and/or disturbed at these distances, then likewise their prey species of fish shall not be affected either. Likely significant effects can be excluded at the screening stage and in the absence of mitigation measures.

4.4 In-combination with other Plans or projects

The Habitats Regulations requires that in-combination effects with other plans or projects are considered. On this basis, a range of other projects as listed in **Table 4.7** below were considered in terms of their potential to result in in-combination effects with the proposed development.

Projects considered relevant to the in-combination assessment are those which will occur within the marine environment with potential to act on the same European sites identified as being subject to likely significant effects arising as a result of the proposed development. As such, terrestrial projects subject to typical planning applications are not generally relevant with a focus on projects requiring assessment as part of a marine area consent application.

The author and reviewer of this HRA report have significant experience of assessing the likely significant effects of proposed development in the marine environment on European sites. Their experience in this regard is set out in **Table 4.8**, setting out the range of marine projects where the author and reviewer of this report have assessed potential effects of marine activities, suspended sediments and pollution on Annex I habitats and disturbance and displacement of, and injury to of Annex II species and Birds Directive species. As such, they are well placed to consider the possibility of in-combination effects as a result of the other projects listed in **Table 4.7**.

For project references in **Table 4.8**, ML relates to a Marine licence issued by DAERA. FS relates to a Foreshore Licence issued by the Department of Housing, Local Government and Heritage. DAS relates to a Dumping at Sea permit issued by the EPA. LIC relates to a Maritime Area licence issued by MARA.

Table 4.7: Projects considered for In-combination Effects

Project	Location	Description
Marine Licence ML 28_12 Islandmagee Gas Storage Project	East Antrim coast, off Islandmagee Within NCW1 ML survey area boundary	*Licence issued 05.11.2021.* The Islandmagee Gas Storage Project; comprises the construction by solution mining of seven underground caverns in the Permian salt strata approximately 1,700m below Larne Lough, off Islandmagee, County Antrim. (discharge end D 4507 0347, intake end D 4464 0327). The project includes the design and construction of a surface brine pumping facility, a gas compression facility, associated gas pipelines, a brine and seawater pipeline and associated infrastructure. The components of the Project which are subject of this application are limited to (i) the boreholes and subsurface caverns to be leached (ii) the seawater intake structure and (iii) the brine discharge pipeline.
Marine Licence ML2021017 WwTW Outfall	15 Coast Road, Larne Within NCW1 ML survey area boundary	*Licence issued 21.01.2022.* Construction of a new outfall to service a new waste water treatment plant to service the new development of 9 properties at 15 Coast Road, Larne Outfall Termination Point / Outlet E340752, N404170. Limits of Works NE Vertex: 340760, 404200 SW Vertex: 340680, 404140
Marine Licence ML2022001 Maintenance Dredging	Cushendun Harbour 10 km west from NCW 1 survey area boundary	*Licence issued 02.08.2022.* Maintenance dredge of Cushendun Harbour. The sediment will be dredged and relocated to Cushendun beach using a mechanical digger, tractor and trailer. The material will be deposited to ensure it remains within the same sediment cell.

Project	Location	Description
Marine Licence ML2022009 Pier remedial works	Red Bay Pier 12 km west from NCW 1 survey area boundary	*Licence issued 13.06.2023.* The proposed project involves remedial works to Red Bay Pier that are essential for its preservation. The proposed Works comprises installation of a new sheet pile wall around the head of the pier. The new wall will be 93m in length and installed approximately 1m seaward of the existing sheet pile wall. The area in between the existing and proposed sheet pile walls will be filled with concrete. The wall will be anchored at the top by raking ground anchors. A reinforced concrete capping beam will be constructed to connect the heads of the piles and transfer the horizontal anchor loads. It is anticipated that a small section of rock armour revetment at the seaward outer corner of the pier will be removed and temporarily relocated onsite for reinstatement following driving of the piles. Minor remedial woks to the existing masonry quay wall, in the form of re-pointing with lime mortar, will also be undertaken.
Marine Licence ML2023020 Maintenance dredging	Sea disposal of Belfast Harbour dredge material 17 km SE of NCW 1 survey area boundary	*Licence issued 27.07.2023* It is assumed that the dredging works will be carried out by a trailer suction dredger, assisted by a plough vessel and that the dredged material will be transported to the DAERA approved offshore disposal site where it will be deposited via either bottom doors or split hopper. A log will be kept of each disposal action including the co-ordinates of where the dredged material was disposed of. Coordinates of Belfast Dredgings C-site: 54º 45.300' N 05º 29.600'W

Table 4.8: NIS Author and Reviewer Experience in Assessing Marine Projects

Ref.	Client	Project
ML 28_12	Private Client	Islandmagee Gas Storage Project
ML 122_15	Belfast Harbour Commissioners	Construction of new berthing facilities at D3, Belfast Harbour
ML 124_15	Private Client	Repairs to pier and rock armouring, Portballintrae
ML 150_16	Belfast Harbour Commissioners	Disposal of dredged material from D3, Belfast Harbour
ML 21_17	Causeway Coast & Glens Borough Council	Dredge of Red Bay Harbour, Co. Antrim
ML 3_18	Causeway Coast & Glens Borough Council	Dredging of slipway at Cushendun
ML 18_18	Causeway Coast & Glens Borough Council	Disposal of dredged material Church Bay Harbour, Rathlin Island
ML 2_19	Private client	Diffuser Head Replacement, Bushmills, Co. Antrim
ML 7_19	Private client	Installation of floating pontoons for pleasure craft use, Abercorn Basin, Belfast Harbour
ML 15_19	Private client	Belfast Flood Allevation Scheme - Revetment Works on River Lagan
ML2020017	Private client	Replacement of a pontoon system, River Bann, Coleraine
ML2021001	Belfast Harbour Commissioners	Phase 1 - Scour Protection Repairs, VT4 Ferry Terminal, Belfast Harbour

Ref.	Client	Project
ML2021002	Belfast Harbour Commissioners	Phase 2 - Scour Protection Repairs, VT4 Ferry Terminal, Belfast Harbour
ML2021022	Private client	Floating pontoons for the sea trials & testing of electric powered boats, Musgrave Channel, Belfast Harbour
ML2022020	Private client	Localised removal and relocation of material, Seaport Jetty, Portballintrae
ML2023023	Newry, Mourne & Down District Council	Carlingford Lough Greenway Section 3 (between NI/ROI border and Victoria Lock)
FS005699 DAS S0024-01	Dublin Port Company	Alexandra Basin Redevelopment
FS005705	Private client	Carlingford Lough Ferry
FS006281 DAS S0021-01 DAS S0021-02	Port of Cork Company	Ringaskiddy Port Redevelopment
FS006292	Uisce Éireann	Marine Site Investigations
FS006495 DAS S0004-02	Dublin Port Company	Maintenance Dredging
FS006497	Dublin Port Company	Marine Site Investigations
FS006837	Shannon Foynes Port Company	Foynes Port Capacity Expansion Project
FS006843	Uisce Éireann	Greater Dublin Drainage Project
FS006893 DAS S0024-02	Dublin Port Company	MP2 Project
FS006975 DAS S0009-03	Shannon Foynes Port Company	Maintenance Dredging 2021-26
FS006980	Dublin Port Company	Maintenance Dredging 2020-21
FS007049	Private client	OWF Marine Site Investigations
FS007126 DAS S0004-03	Port of Cork Company	Maintenance Dredging
FS007132 DAS S0013-03	Dublin Port Company	Maintenance Dredging 2022-29
FS007164 DAS S0033-01	Dublin Port Company	Capital Dredging 2022-30
FS007290	DLR County Council	Fender replacement at Carlisle Pier
FS007339	Private client	OWF Marine Site Investigations
FS007552	RNLI	Site Investigation Works Courtmacsherry
FS007555	Private client	OWF Marine Site Investigations
Planning Reg. Ref. 23/22 LIC230008	ESB	Land based and marine site investigations at Moneypoint Generating Station to aid the design of increased port facilities in support of the ORE industry
LIC230014	Shannon Foynes Port Company	Site investigation in the maritime area including reclaimed dockland and surrounding nearshore to aid the design of increased port facilities in support of the ORE industry

The proposed development has potential to act in-combination with the projects listed in **Table 4.7** if the surveys are being carried out at the same time as those other projects are also active, producing noise in the marine environment in an area already ensonified as a result of the proposed development alone.

4.4.1 Islandmagee Gas Storage Project

The HRA and appropriate assessment of the licensing authority proposed mitigation in relation to protection of marine mammals during marine activities capable of producing noise capable of disturbance or injury, and it is a condition of the licence issued that construction of the seawater intake and the brine outfall shall occur only under environmental controls set out in a Construction Environmental Management Plan (CEMP) to *inter alia* prevent disturbance and under measures specified in a Marine Mammal Protocol supervised by an experienced Marine Mammal Observer (MMO). The activities permitted under ML 28_12 could occur at the same time as activities proposed for the NCW 1 marine surveys. Likely significant underwater noise effects cannot be excluded at the screening stage for the proposed NCW marine surveys alone, and they also cannot be excluded for those activities occurring in combination with permitted activities under ML 28_12. Mitigation is required, as set out in section 5.1.

4.4.2 WwTW Outfall

The activities permitted under ML 2021017 could occur at the same time as activities proposed for the NCW 1 marine surveys. The licence issued requires construction of a new outfall to service a new waste water treatment plant to service the new development of 9 properties at 15 Coast Road, Larne to occur under environmental controls set out in a CEMP to prevent pollution of the marine environment. No conditions are attached to the licence to prevent adverse underwater noise effects on marine mammals. As there are no significant underwater noise effects as a result of activities under ML 2021017 alone, there will be no significant in-combination effects between the proposed NCW marine surveys occurring in combination with permitted activities under ML 2021017.

4.4.3 Dredging Campaigns

The activities permitted under ML 2022001 at Cushendun could occur at the same time as activities proposed for the NCW 1 marine surveys. The licence issued is not available to view on the DAERA Marine Licensing Public Register. As part of the permitted dredging campaign, dredged sediment will be relocated to Cushendun beach using a mechanical digger, tractor and trailer. The material will be deposited to ensure it remains within the same sediment cell. Without access to the HRA or marine licence and conditions attached, RPS can only apply its own judgment as to whether or not in-combination effects. As outlined in **Table 4.8**, the authors and reviewers have significant experience of assessing effects of dredging projects. It is our view that dredging and beach renourishment activities located 10 km away by sea from the NCW 1 marine survey application area will not result in significant in-combination underwater noise effects if those activities were to be undertaken at the same time as the proposed NCW marine surveys.

The activities permitted under ML 2023020 allow the disposal at sea of dredged material from Belfast Harbour. The licensed disposal site is located 17 km from the NCW 1 marine survey area. The activities permitted under ML 2023020 could occur at the same time as activities proposed for the NCW 1 marine surveys. No conditions are attached to the licence to prevent adverse underwater noise effects on marine mammals. As there are no significant underwater noise effects as a result of activities under ML 2023020 alone, there will be no significant in-combination effects between the proposed NCW marine surveys occurring in combination with permitted activities under ML 2023020.

4.4.4 Red Bay Pier

The activities permitted under ML 2022009 at Red Bay Pier could occur at the same time as activities proposed for the NCW 1 marine surveys. The permitted works comprise installation of a new sheet pile wall around the head of the pier, with the area between the existing and proposed sheet pile walls to be filled with concrete. A small section of rock armour revetment at the seaward outer corner of the pier will be removed and temporarily relocated onsite for reinstatement following driving of the piles.

It is a condition of the licence issued that activities generating loud, low to medium frequency impulsive noise shall be registered with the JNCC Marine Noise Registry and that rock breaking (or similar) works occur only under controls specified in a Marine Mammal Protocol as part of a CEMP to prevent disturbance to marine mammals and supervised by an experienced Marine Mammal Observer (MMO).

Likely significant underwater noise effects cannot be excluded at the screening stage for the proposed NCW marine surveys alone, and they also cannot be excluded for those activities occurring in combination with permitted activities under ML 2022009, given that the range to avoid TTS for fleeing harbour porpopise is 13.4 km (refer **Table 4.5**) and Red Bay pier is 12 km away. Mitigation is required, as set out in section 5.1.

4.5 Summary of the Screening Assessment

Having considered the possibility of likely significant effects on European sites resulting from a proposed suite of Geophysical, Metocean, Benthic and Marine Mammal Surveys for the North Channel Wind 1 Offshore Wind Farm, some features of some sites were screened in:

- the possibility of injury and or disturbance to Harbour porpoise or a reduction in their prey species in the North Channel SAC; and
- the possibility of injury and or disturbance to Grey seal or a reduction in their prey species in The Maidens SAC.

5 STAGE TWO APPRAISAL

Having already considered the conservation objectives for Harbour porpoise in the North Channel SAC, and Grey seal in The Maidens SAC in **Table 4.2** and section 4.3.4 above, and taking into account the mitigation measures applied in the European Protected Species (EPS) and Marine Wildlife Risk Assessment incorporating a Geophysical Survey Subsea Noise Technical Report at **Appendix I** of this HRA report, it follows that adverse effects on the integrity of the North Channel SAC and The Maidens SAC can be avoided through the application of mitigation measures to prevent the possibility of injury and or disturbance to Harbour porpoise in the North Channel SAC or Grey seal in The Maidens SAC, or a reduction in their prey species in the survey area.

5.1 Mitigation Measures

Mitigation measures must be applied to prevent the possibility of injury and or disturbance to Harbour porpoise in the North Channel SAC or Grey seal in The Maidens SAC, or a reduction in their prey species in the survey area as a result of the proposed NCW 1 marine surveys alone and also in combination with other projects as described in section 4.4.

The relevant measures are industry standard measures which are incorporated as part of the consenting regimes for geophysical activities within the United Kingdom Continental Shelf (UKCS) region. Whilst these measures may have some limitations, they are based on reasonably conservative assumptions, and shall reduce the risk of injury to marine mammals to negligible levels (JNCC, 2017). The mitigation measures which have been discussed in the above risk assessment are detailed in **Table 5.1**, with the detailed procedures being laid out in JNCC's "guidelines for minimising the risk of injury to marine mammals from geophysical surveys" (JNCC, 2017).

Table 5.1: Mitigation measures for the proposed survey operations. Details of mitigation taken from JNCC (2017)

Measure	Assumed in Subsea Noise Model	Description	Procedure upon marine mammal detection (JNCC, 2017)
Soft-Start	Y	A soft-start of 15 minutes consists of having a maximum of 1 ping or pulse per second for the sub-bottom profilers for this duration. This will give animals more time to flee while the noise emissions are relatively lower.	If marine mammals are detected in the mitigation zone during survey activities, either during soft-start or at full power, there is no requirement to stop the survey activities.
Exclusion Zone – Marine Mammal Observer	N	A 30-minute search by a certified MMO prior to survey start to establish likely absence of marine mammals within 500 m of the vessel prior to commencing soft-start. Given the risk ranges of the VHF group extend to 400m this is recommended to mitigate likely hearing injury.	If marine mammals are detected, the soft-start should be delayed until their passage and the soft-start should be commenced again once 20 mins have elapsed since the last sighting in the mitigation zone
Equipment Limitations	N	This is not a described mitigation; however, assumes that any SBP used similar to the Innomar model	The procedures are the same for unplanned, and for planned breaks:

Measure	Assumed in Subsea Noise Model	Description	Procedure upon marine mammal detection (JNCC, 2017)
		will have peak pressure levels below 240 dB LP and 1-second exposure levels below 208 dB LE in the frequency range 85-115 kHz (final equipment configuration will not be louder than the presented equipment).	• For breaks of <10 minutes there is no requirement for soft- start and the survey will recommence at the same level provided no marine mammals/basking shark have been detected in the mitigation zones during the break; and • For breaks of >10 minutes the full mitigation procedure (as described above) will be adopted including pre-survey monitoring and soft-start.
MMO Monitoring	N	Use of a certified MMO on board to undertake exclusion zone search and to monitor the mitigation zones during any unplanned breaks during operations. For planned breaks, mitigation zone monitoring should commence prior to the break, so that 20 minutes of monitoring can be achieved.	
Noise Reduction	N	Where possible, the amount of anthropogenic noise entering the marine environment will be minimised through the operations using the lowest practicable power levels. The use of noise emitting survey equipment will also be minimised, so that it is only fired when necessary.	n/a

The qualifying feature most at risk of injury from the underwater sound produced by the proposed geophysical surveys was the harbour porpoise. This appraisal and the Marine Wildlife Risk Assessment at **Appendix I** shows that the risk ranges of injury (PTS) to a moving animal of this species during these surveys was between 321 m and 401 m, which falls within the 500 m mitigation range which would be monitored by MMOs prior to the start of surveys (the exclusion zone – see **Table 5.1** above). As such, there is no residual acute risk of injury for any individuals of this species from either the DA or ECC AoS surveys. In addition, given the slow start procedures in place, it is expected that the animals and prey species should have sufficient time to flee from the environs of a survey vessel and effectively vacate the 500 m exclusion zone prior to surveys.

All other marine mammals and fishes assessed had risk ranges which were under 18 m, and therefore the risk to these hearing groups is considered of little to no risk, especially when considering the mitigation measures applied.

Therefore, under the assumptions laid out for the survey method, the sources used, and the mitigation applied, the noise arising from surveys of the ECC, and the DA is unlikely to cause permanent injury to any marine mammals. Population level effects shall not occur. Adverse effects upon the integrity of the European sites concerned shall not occur and no reasonable scientific doubt remains as to the absence of such effects.

Accordingly, the competent authorities may conclude, beyond reasonable scientific doubt, that the proposed surveys will not adversely affect the integrity of any European site.

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Appendix I

European Protected Species (EPS) and Marine Wildlife Risk Assessment incorporating a Geophysical Survey Subsea Noise Technical Report

North Channel Wind in partnership with rps MAKING COMPLEX EASY

NORTH CHANNEL WIND
NORTH CHANNEL WIND 1 EUROPEAN PROTECTED SPECIES (EPS) AND MARINE WILDLIFE RISK ASSESSMENT

Approval for issue			
For and on behalf of North Channel Wind	*Rev04*	James McCrory	06/02/2024
For and on behalf of North Channel Wind	*Rev03a*	James McCrory	05/09/2023
For and on behalf of North Channel Wind	*Rev03*	Sarah Heaton / Tessa McGarry	30/08/2023
For and on behalf of North Channel Wind	*Rev02*	Sarah Heaton / Claire Ludgate	04/08/2023
For and on behalf of North Channel Wind	*Rev01*	Sarah Heaton / Claire Ludgate	07/07/2023
For and on behalf of RPS	*Rev 0 (issued to authors)*	Sarah Heaton / Claire Ludgate	06/07/2023

Prepared by	Prepared for
RPS	North Channel Wind Ltd.

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GLOSSARY

Term	Definition
Baseline Environment	The existing conditions as represented by the latest available survey and desktop data which is used as a benchmark to assess the impacts of the proposed surveys.
Cetaceans	Aquatic mammals constituting the infraorder Cetacea (whales, dolphins, porpoises).
Continuous Sound	As defined in the National Physical Laboratory (NPL) 2014 guidelines (NPL, 2014), continuous sounds are sounds where the acoustic energy is spread over a significant time, typically many seconds, minutes or even hours. The amplitude of the sound may vary throughout the duration, but the amplitude does not fall to zero for any significant time. The sound may contain broadband noise and tonal (narrowband) noise at specific frequencies. Examples of continuous sound include ship noise, operational noise from machinery including marine renewable energy devices, and noise from drilling.
Decibel (dB)	Expression of the ratio of one value of a power quantity to another (reference value) on a logarithmic scale. The reference value should be stated.
Impulsive Sound	Typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI 1986; NIOSH 1998; ANSI 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions.
Marine Mammal Management Unit	Marine mammal Management Unit (MUs) for marine mammals in UK waters, which provide an indication of the spatial scales at which impacts of plans and projects alone, cumulatively and in combination, need to be assessed for the key cetacean species in UK waters. For cetaceans, these management units are defined by the Inter-Agency Marine Mammal Working Group. For seal species (harbour and grey seal), the Special Committee on Seals (SCOS) provided advice on seal MUs
Non-impulsive (Sound Source)	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 (ANSI 1995; NIOSH 1998). This category includes sound sources such as continuous vibro-piling, running machinery, some sonar and vessels
Permanent Threshold Shift	An irreversible loss of hearing sensitivity.
Pinnipeds	Infraorder of marine mammals including true and eared seals, sealions and walrus.
Root-Mean-square Sound Pressure	Square root of the integral over a specified time interval of squared sound pressure, divided by the duration of the time interval, for a specified frequency range.
Sound Exposure Level	Ten times the logarithm to the base 10 of the ratio of sound exposure to the specified reference value in decibels. The reference value in underwater acoustics is 1 $\mu Pa^2 s$.

ABBRIEVIATIONS

Acronym	Description
ADCP	Acoustic Doppler Current Profiler
AoS	Area of Search
CGNS	Celtic and Greater North Seas
CIS	Celtic and Irish Sea
CMACS	Centre for Marine and Coastal Studies Ltd
DA	Development Area
DA-SE	Development Area Southeast
DA-SW	Development Area Southwest
DECC	Department of Energy and Climate Change
DGPS	Differential Global Positioning System
DAERA	Department of Agriculture, Environment and Rural Affairs
ECC	Export Cable Corridor
EPS	European Protected Species
ESDP	European Spatial Development Perspectives
HF	High Frequency
IAMMWG	Inter-Agency Marine Mammal Working Group
IBSG	Irish Basking Shark Group
IMA	Irish Marine Atlas
IS	Irish Sea
IWDG	Irish Whale and Dolphin Group
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
MBES	Multibeam echosounder
MCZ	Marine Conservation Zone
MMO	Marine Mammal Observer
MNR	Marine Nature Reserve

Acronym	Description
MPA	Marine Protected Area
MU	Management Unit
NBN	National Biodiversity Network
NCW1	North Channel Wind 1
NI	Northern Ireland
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRW	Natural Resources Wales
OCA	Other Marine Carnivores in Air
OCW	Other Marine Carnivores in Water
OWF	Offshore Wind Farm
PCW	Phocid Carnivores in Water
PTS	Permanent Threshold Shift
RMS	Root Mean Squared
SAC	Special Area of Conservation
SBP	Sub-Bottom Profiling
SI	Sirenians
SPL	Sound Pressure Level
SSS	Side Scan Sonar
TTS	Temporary Threshold Shift
UHRS	Ultra High Resolution Seismic
UK	United Kingdom
US	United States
UKCS	United Kingdom Continental Shelf
VHF	Very High Frequency
WS	West Scotland

UNITS

Unit	Description
dB	Decibel
Hz	hertz
J	Joules
kHz	Kilo-hertz
km	Kilo-metre
Km2	Kilo-metre squared
LP	Sound pressure level
m	Metres
m/s	Metres per second
Pa	Pascal - Acoustic pressure
μPa	Micro-pascal

1. INTRODUCTION

1.1. PURPOSE OF THIS DOCUMENT

North Channel Wind is owned by SBM Offshore, a leading global contractor in offshore energy installations. They have partnered with an Irish-based developer, NMK Renewables to carry out the front-end development work for North Channel Wind 1 (NCW1), a prospective floating offshore wind farm (OWF) in the North Channel of the Irish Sea (hereafter referred to as the 'North Channel'). NCW intends to undertake marine surveys at the proposed site in order to inform the location and design of the proposed OWF and cable route to shore. Proposed survey areas are shown in Figure 1:1, noting that an export cable route assessment is currently underway which aims to narrow down the area of search for the Export Cable Corridor (ECC). The proposed marine surveys in this area will include geophysical, environmental and met ocean marine surveys. This European Protected Species (EPS) and Marine Wildlife Risk Assessment covers the geophysical surveys for this project only. Further detail on these methods is presented in the survey design section of this report (Section 1.2).

Under part 4 of the Marine and Coastal Access Act (see Section 2), a Marine Construction Licence must be applied for to complete the proposed marine surveys. Therefore, the proposed survey works will be carried out following award of the Marine Construction Licence.

These surveys are due to take place in one contiguous area, approximately 15 km off the north-eastern Northern Ireland coast, with water depths up to 200 m. For the purposes of the noise modelling assessment, and because the survey designs differ between two sites within the contiguous survey area, this area has been separated into two survey sites:

- The NCW1 Development Area (DA; Figure 1:1; red polygon), which covers approximately 176 km² with depths from 110-160 m covering a relatively flat sediment surface mostly characterised by gravelly sand.
- The Export Cable Corridor (ECC; Figure 1:1; red dashed polygon), which covers approximately 260 km² with depths from 0-210 m covering undulating bathymetry. The sediment is a combination rocks, gravel & sand.

Some marine species in the UK are protected under law as European Protected Species (EPS) and as such it must be demonstrated, prior to survey works, that there are no risks of injury or disturbance to EPS within the vicinity of the survey areas. In addition, since the survey areas lie within Northern Ireland (NI) territorial waters, some species are afforded protection through wildlife licensing under the Wildlife (Northern Ireland) Order 1985, and so risks to these species must also be assessed to demonstrate that the activities will not be detrimental to the maintenance of the relevant populations (See Section 2 for the relevant legislation). Therefore, this EPS and Marine Wildlife Risk Assessment is used to describe the species which may be at risk in the survey areas from survey activities, how they are at risk, and how this risk can be reduced to adhere with relevant legislation.

The purpose of the following document is to set out the relevant species baseline in the survey areas; describe the survey activities and noise levels produced by the proposed activities; undertake subsea noise modelling in the survey areas; and following this modelling, assess the risk of injury or disturbance (following mitigation) to marine protected species.

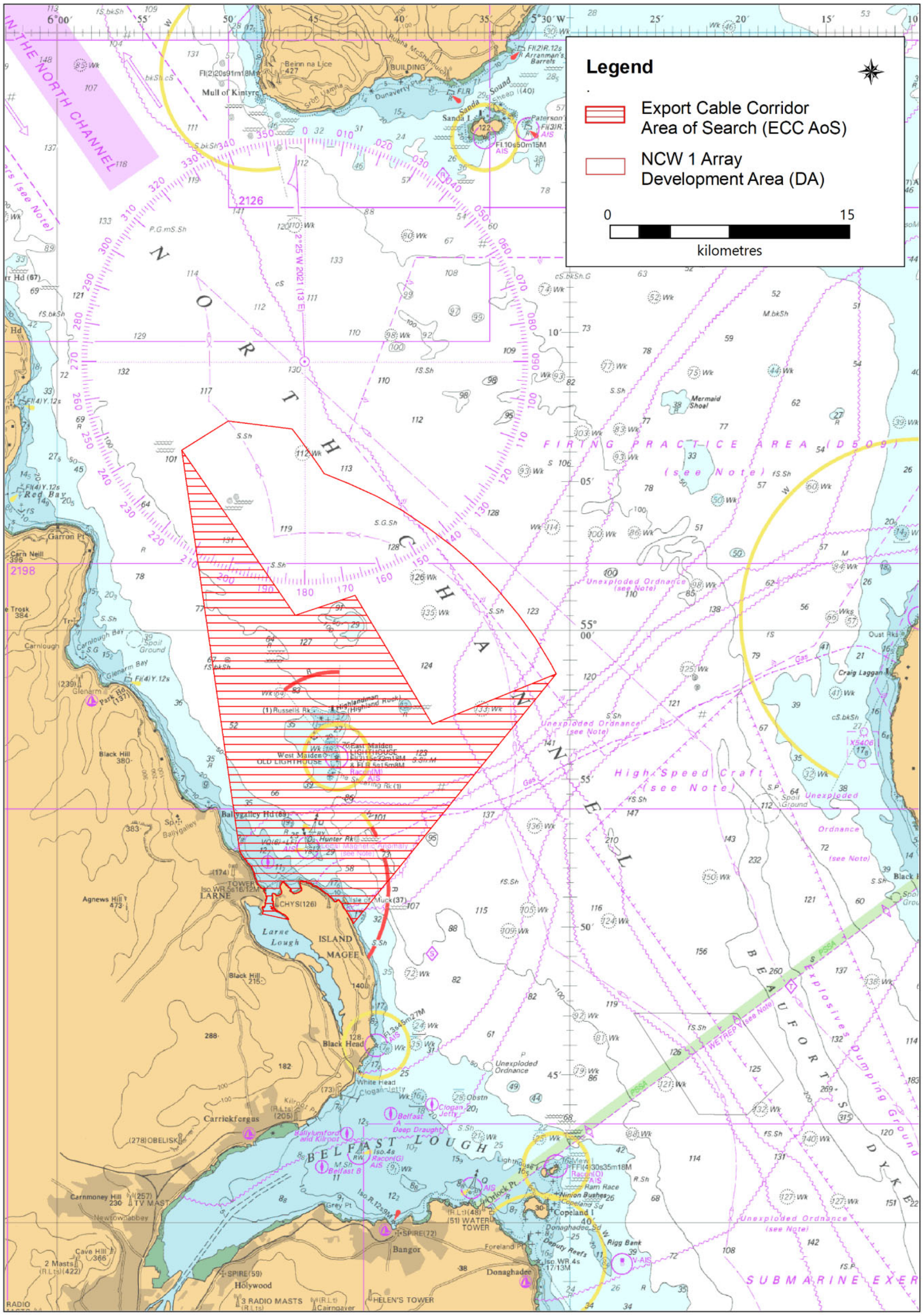

Figure 1:1. North Channel Wind 1 Development Area (red polygon) and Export Cable Corridor Area of Search (dashed red polygon)

1.2. SURVEY DESIGN

The proposed surveys will be carried out following award of the Marine Construction License, ideally during the 24 months between Autumn 2024 to Autumn 2026 and subject to weather conditions. The geophysical (including Archaeology) survey works, following award of the Marine Construction Licence, will ideally be carried Spring 2025.

The objectives of the survey are to:

- Map the seabed and sub-surface to optimise positioning of moorage/anchoring and cable routing within the application area and to enable assessment of cable burial depth;
- Plan the scope and positioning of the geotechnical sampling programme in the application area;
- Identify marine habitat areas from which the benthic survey can be undertaken;
- Identify sensitive marine habitats that may need to be avoided during geotechnical and environmental sampling and infrastructure installation; and
- Provide the geophysical data from which a marine archaeological assessment can be undertaken as part of the consenting process.

The proposed survey operations will be undertaken by offshore survey vessels, inshore survey vessels and potentially support/guard vessels to assist with operations, provide logistical support and ensure the safety and security of the other vessels. The exact specification of the survey vessels to be used in these surveys has yet to be decided, however, the proposed vessels and survey specifications are indicative and detailed below in Table 1:1. These vessels are assumed to move at 2 knots during surveying (1 m/s). This speed affects the time an individual animal is exposed to the sound generated by a survey, and thus a slower speed is precautionary. The actual speed will likely be 3-4 knots (1.5-2.1 m/s).

Both the DA and the ECC will be surveyed using similar geophysical survey equipment (details of survey equipment are provided in the Risk Assessment in Section 4). The survey lines layout differs between the surveys, as shown in Figure 1:2 and Figure 1:3, and described further in Sections 1.2.1 and 1.2.2. These layouts are preliminary but changes to the survey line layout are unlikely to change the conclusion of this assessment as the whole survey area would still be covered.

The exact equipment to be used will be confirmed following the appointment of a survey contractor.

Table 1:1 Survey types, specifications, equipment, and durations for the proposed survey works.

Survey type	Vessel type/s	Survey specifications	Sound equipment	Estimated duration
Geophysical surveys	An offshore survey vessel, approximately 30-80 m in length for deeper waters.	*Primary Survey of DA:* Transect surveys across the DA (line spacing of 125 m) and complimented by crosslines spaced at approximately 1,000 m intervals). An additional data coverage of approximately 2 km around the DA may also be applied.	• Multibeam echosounder (MBES) • Side Scan Sonar (SSS) • Parametric Sub-Bottom Profiler (SBP) • Ultra High Resolution Seismic (UHRS) sparker	15 days for offshore survey vessel (subject to weather conditions and operational factors); and 3 days for the nearshore smaller vessel.

	A nearshore survey vessel, approximately 15 m in length for shallower waters.	*Primary Survey of ECC:* An estimated area of 1,500 m in width will be surveyed (may vary depending on cable route assessment). Preliminary arrangement of transect lines are shown in **Figure 1:2** and **Figure 1:3.**		

1.2.1. DEVELOPMENT AREA

The DA will be surveyed by transect lines with line spacing of 125 m, depending on local characteristics and final equipment set up. These will run in NW-SE direction, with additional perpendicular lines running at 1,000 m centres to cross-check the acquired data and allow the area to be fully characterised (Figure 1:2). This means that the main survey lines are 10-20 km long with the perpendicular lines being 6-10 km in length.

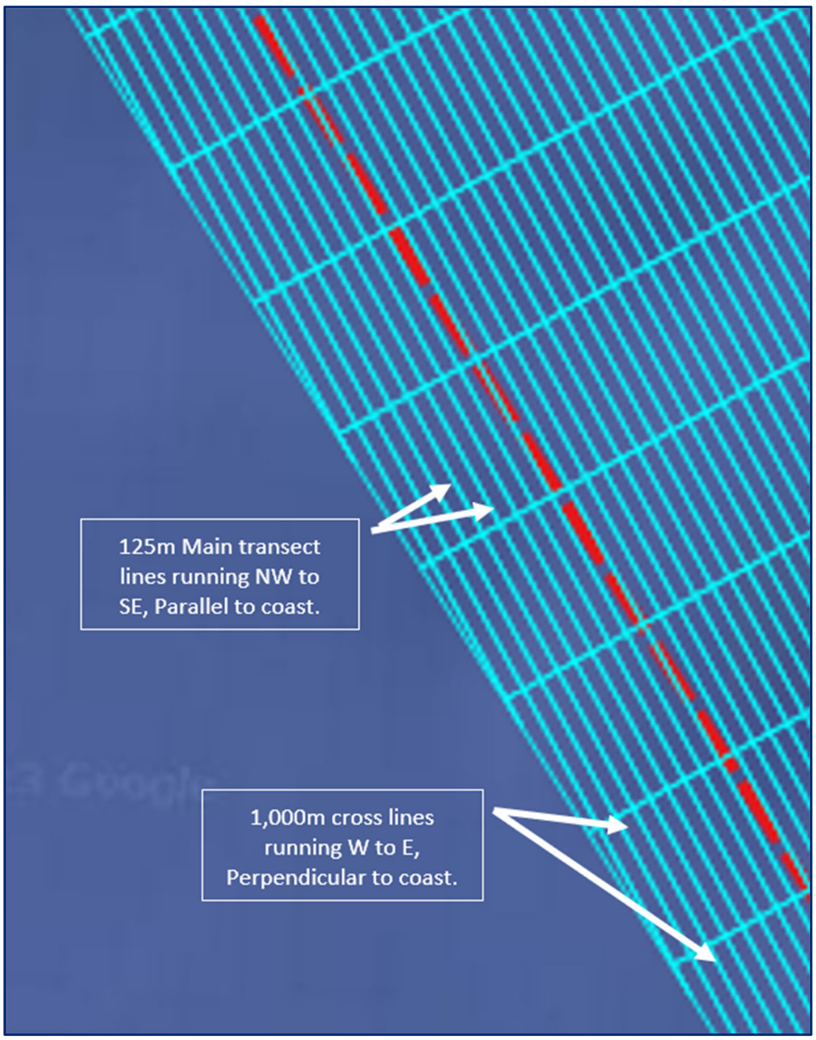

Figure 1:2. NCW1 Development area example transects.

1.2.2. EXPORT CABLE CORRIDOR

The ECC does not require full characterisation, only the route identified as suitable will be surveyed. The final route is not currently known but will be 12-30 km (anticipated ~20 km) long and the surveyed area will be approximately 1500 m wide (750 m either side of the route). Survey line spacing will be 25 m at the centre of the proposed corridor and 75 m further away (Figure 1:3).

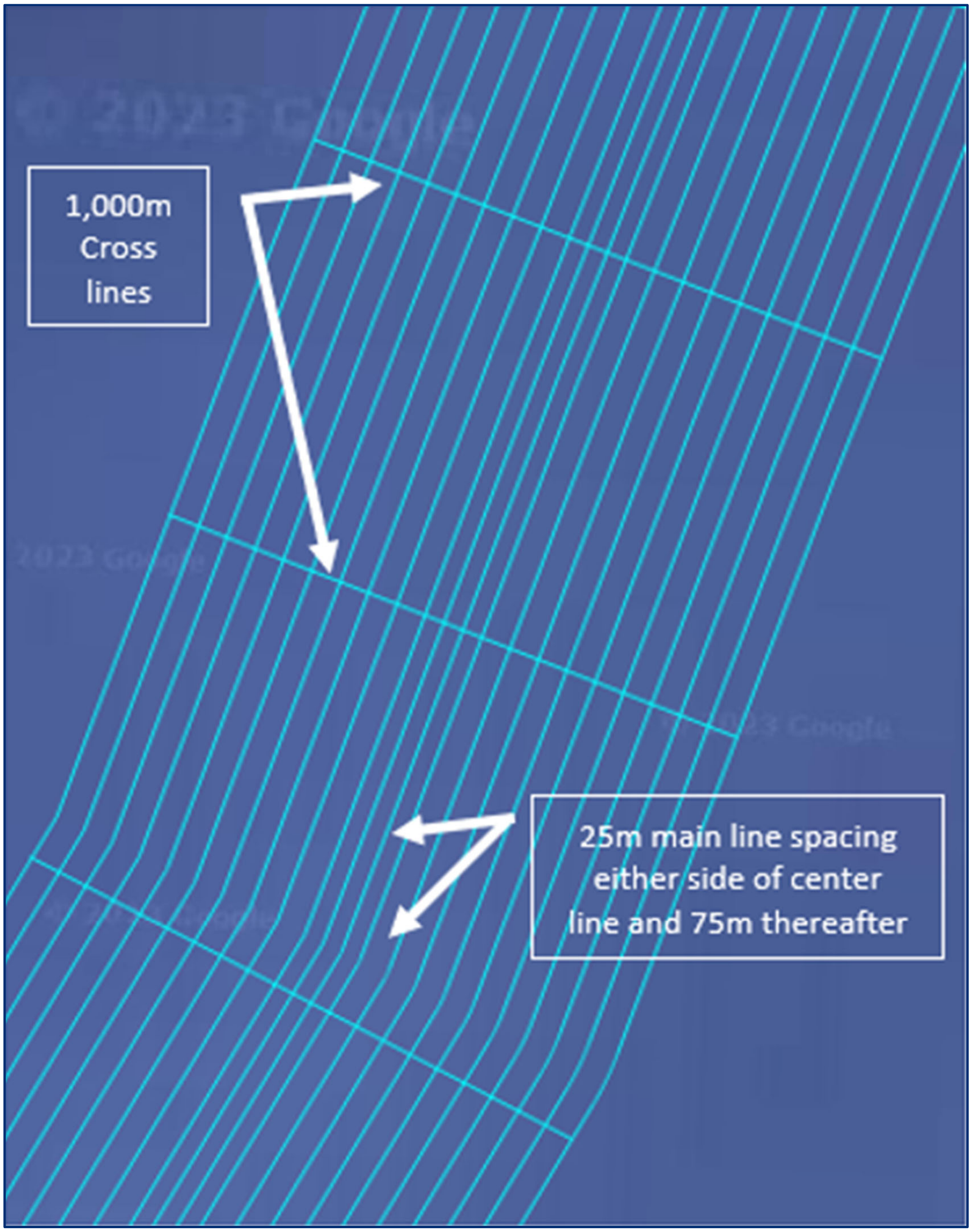

Figure 1:3. Export cable corridor example transects.

1.2.3. SURVEY VESSELS

All vessels will be operated in accordance with international regulations and follow industry best practices ensuring the safety of the crew, equipment, and environment. Crew members will hold the required certifications and undergo regular training and drills to maintain their skills and knowledge. All equipment and personnel will be mobilised as per standard procedures and manufacturer's instructions.

Vessels operating in nearshore environments will follow guidelines and precautions to minimise environmental impact and ensure safe navigation.

Tidal and weather conditions will also be considered, and operations may be temporarily suspended in case of unfavourable conditions for safe navigation to ensure the safety of the crew and equipment.

Further detail of the sound sources, including noise-producing survey equipment and the survey vessels, can be found in Section 4.1.1.

1.3. SURVEY EQUIPMENT

The surveys will utilise three main types of noise emitting geophysical survey equipment, listed below, as well as the survey vessels, which emit non-impulsive, continuous sound. These sound sources are described in detail in Section 4.1.1.

- **Side Scan Sonar (SSS),** an impulsive sound source used to generate an accurate image of the seabed; this uses an acoustic beam to obtain a sonic image of a narrow area of seabed to either side of the instrument by measuring the amplitude of back-scattered return signals.
- **Multibeam Echosounder (MBES),** an impulsive sound source used to record the two-way travel time of a high frequency pulse emitted by a transducer to obtain detailed maps of the seafloor showing water depths.
- A **parametric Sub-bottom Profiler (SBP)**, an impulsive sound source used to characterize layers of sediment or rock under the seafloor; they use a transducer which emits a sound pulse vertically downwards towards the seafloor, and a receiver which records the return of the pulse once it has been reflected off the seafloor.
- **Ultra High Resolution Seismic (UHRS)**: Towed sparker identifies and characterises the deeper layers of sediment/bedrock underneath the seafloor.

1.4. PROTECTED AREAS

Several protected areas have been identified in the vicinity of the survey area including Special Areas of Conservation (SACs), Marine Protected Areas (MPAs), Marine Conservation Zones (MCZs) and Marine Nature Reserves (MNRs) (Figure 1:4; Table 1:2). One of these sites, The Maidens SAC overlaps directly with the survey site, and is designated for grey seal *Halichoerus grypus*. The other nearby sites (SACs and MNRs) are designated for the following species (See Table 1:2 for further detail):

- Harbour porpoise *Phocoena phocoena*;
- Harbour seal *Phoca vitulina*;
- Grey seal;
- Risso's dolphin *Grampus griseus*; and
- Minke whale *Balaenoptera acutorostrata*.

Figure 1:4 Map of the Marine Mammal Protected Areas near to the survey areas.

Table 1:2. Summary of Marine Mammal Protected Areas in the vicinity of NCW 1 with distances (km) to the NCW1 DA, at the nearest point.

Site	Type	Species	Distance to NCW 1 (km)
Special Areas of Conservation			
The Maidens	SAC	Grey seal	0
North Channel	SAC	Harbour porpoise	12.38
Skerries and Causeway	SAC	Harbour porpoise	39.53
Strangford Lough	SAC	Harbour seal	40.6
South-East Islay Skerries	SAC	Harbour seal	58.29
Inner Hebrides and the Minches	SAC	Harbour porpoise	66.84
Murlough	SAC	Harbour seal	74.43
Marine Protected Areas			
Loch Sween	MPA	Basking shark	86.32
Isle of Man Marine Nature Reserves			
West Coast	MNR	Harbour porpoise	86.85
		Grey seal	
		Harbour seal	
Ramsey	MNR	Grey seal	92.95
		Harbour seal	
Niarbyl Bay	MNR	Harbour porpoise	103.29
		Grey seal	
Port Erin Bay	MNR	Harbour porpoise	108.5
		Basking shark	
Calf and Wart Bank	MNR	Harbour porpoise	110.17
		Harbour seal	

Site	Type	Species	Distance to NCW 1 (km)
		Grey seal	
		Risso's dolphin	
		Basking shark	
Laxey Bay	MNR	Minke whale	110.45
		Harbour porpoise	
		Bottlenose dolphin	
Baie ny Carrickey	MNR	Harbour porpoise	111.52
		Bottlenose dolphin	
		Risso's dolphin	
Douglas Bay	MNR	Risso's dolphin	112.78
		Bottlenose dolphin	
Langness	MNR	Risso's dolphin	114.46
		Harbour seal	
		Grey seal	
		Harbour porpoise	

2. LEGISLATION

This section will provide a high-level overview of the legislative background and details of relevant licences,

NCW 1 and the relevant surveys areas lie wholly within Northern Ireland (NI) territorial waters and as such, a Wildlife Licence may be issued where the Department of Agriculture, Environment and Rural Affairs (DAERA) Marine and Fisheries Division is satisfied that there is no satisfactory alternative to the activity and that the activity will not be detrimental to the maintenance of the population of the species concerned.

The species which are afforded protection through wildlife licensing are listed in the schedules to the following nature conservation legislation (Table 2:1).

Table 2:1. Marine species and relevant legislation (adapted from Marine wildlife licensing | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk).

Species Group	Marine Species	Legislation	Offences
European Protected Species	All whales, dolphins and porpoises All marine turtles	Habitats Regulations - Schedule 2	Kill, injure, disturb, take, transport, trade
Seals	Harbour and grey seals	Habitats Regulations - Schedule 3 Wildlife Order - Schedules 5, 6 & 7	Kill or take by specific methods Kill, injure, disturb, take, transport, trade
Sharks	Basking shark (*Cetorhinus maximus)*	Wildlife Order - Schedules 5, 6 & 7	Kill, injure, disturb, take, transport, trade

2.1. THE CONSERVATION (NATURAL HABITATS, ETC) REGULATIONS (NORTHERN IRELAND) 1995 (AS AMENDED) (THE HABITATS REGULATIONS)

The Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (as amended) enacts Annex IV of the Habitats Directive (92/43/EEC). This protects all cetacean species listed as EPS throughout their range by making it an offence under these regulations to:

- Deliberately capture, injure or kill any EPS;
- Deliberately disturb them; or
- Deliberately damage or destroy a breeding site or resting place.

The Joint Nature Conservation Committee (JNCC), Natural England (NE) and the Countryside Council for Wales (CCW) (now Natural Resources Wales (NRW)) have produced draft guidance concerning the Habitat Regulations and protection of marine EPS from injury and disturbance (JNCC, 2010). Additional guidance also provides an interpretation of the regulations in greater detail for seismic surveys (JNCC, 2017). The 2010 guidance defines disturbance as significant when "it is likely to be detrimental to the animals of an EPS or significantly affect their local abundance or distribution". It also highlights that "trivial disturbance" should not be considered as a disturbance offence under Article 12.

An EPS license is required under the Habitats Regulations if the risk of injury or disturbance to cetacean species, from any potential effect (i.e., underwater noise) is assessed as likely, following the application of mitigation.

Marine turtles were added to Schedule 2 through an amendment to the legislation in 2004. They now appear in The Conservation (Natural Habitats, etc.) (Amendment) Regulations (Northern Ireland) 2004 under provision 17 and are therefore afforded protection and should be considered in assessments.

2.2. THE WILDLIFE (NORTHERN IRELAND) ORDER 1985 (AS AMENDED) (THE WILDLIFE ORDER)

Under Article 10 of the Wildlife (Northern Ireland) Order 1985 (as amended), it is an offence to intentionally or recklessly kill, injure take or disturb a harbour seal, grey seal or basking shark *Cetorhinus maximus*.

It is also an offence to intentionally or recklessly:

- Damage or destroy, or obstruct access to, any structure or place which any such animal uses for shelter or protection,
- Damage or destroy anything which conceals or protects any such structure,
- Disturb any such animal while it is occupying a structure or place which it uses for shelter or protection; or
- To have in possession or control any live or dead wild animal included in Schedule 5 or any part of, or anything derived from, such an animal.

Where impact cannot be avoided or mitigated, a licence may be required for operations.

3. SPECIES BASELINE INFORMATION

3.1. INTRODUCTION

A summary of the distribution and abundance for each of the key species likely to be found within the survey area is provided below. This information has been used to inform the assessment of risk of injury or disturbance based on the results from the subsea noise modelling (Section 4). A summary of the key data sources is provided in Table 3:1. For the purpose of this section, the most recent baseline survey data identified has been used to report the protected species densities.

The most recent baseline survey data has been collected during marine mammal and ornithology site-specific surveys undertaken between September 2022 and January 2023 (Table 3:4; APEM, 2022). These surveys counted protected species in the survey area of the NCW1 project area as part of an ongoing two-year project-specific survey, which are being used to inform future environmental impact assessment work at the NCW1 site.

Table 3:1. Key data sources used to provide a baseline of protected marine species within the survey areas (DA and ECC).

Data Source	Date	Description	Reference
APEM Digital aerial survey works of the NCW1&2 OWF project area (data from the first 5 months of recordings)	Surveys conducted between September 2022 and January 2023 (ongoing)	The data from the first five months of aerial survey works undertaken by APEM to assess the abundance and distributions of marine mammals (and birds) present in the survey area.	(APEM, 2022; 2023)
SCANS III distribution maps for cetaceans	Surveys conducted during July 2016 (Published 2021)	Estimates of distributions of cetaceans given for spatial blocks around the UK from aerial and sighting surveys. The survey area for the survey works overlaps with blocks E and G.	(Hammond, *et al.,* 2013; 2017) (Hammond, *et al.*, 2021-Revised)
ObSERVE surveys	Surveys conducted in the summer and winter of 2015 and 2016. (Published 2018)	Aerial surveys of cetaceans (and seabirds) in Irish waters: records of occurrence, distribution and abundance in 2015-2017.	(Rogan *et al.,* 2018)
Waggitt distribution maps for cetaceans	Collated survey data from between 1980 and 2018 (Published 2020)	Distribution data for cetacean species in the North-East Atlantic.	(Waggitt, *et al.,* 2020)
Carter, *et al.* (2020) distribution maps for grey and harbour seals.	Survey data used was predominantly collected (94.4%) from 2013-2018 (Published 2020)	Distribution data for grey and harbour seal in the British Isles. This source includes maps of at-sea distribution for both seal species.	(Carter, *et al.,* 2020)

Data Source	Date	Description	Reference
Inter-Agency Marine Mammal Working Group (IAMMWG) cetacean abundance estimates in the UK	Published 2021 (from collated survey data, notably SCANS III and ObSERVE)	Updated abundance estimates of cetacean species for relevant MUs, derived from observation surveys including SCANS III, and ObSERVE.	(IAMMWG, 2023)
Irish Marine Atlas (IMA)	Various	Distribution, range and abundance information for marine species in Irish waters. Includes records of observations from various sources.	(IMA, -date-)
National Biodiversity Network (NBN) Atlas	Various	Sightings data compiled into one network for a number of species. Used in this report for sightings of leatherback turtles (*Dermochelys coriacea*).	(NBN, 2023)
Manx Marine Mammal Environmental Assessment	Recent survey works from 2005-2016 for pinnipeds, cetaceans, basking sharks and turtles. (Published 2018)	A compilation of information on marine mammals in Manx Territorial waters. Covers cetaceans, basking sharks, leatherback turtles and seals.	(Howe, 2018)

The marine mammal species and other protected marine species most commonly documented in the eastern Irish Sea are listed below. It should be noted that not all of these species are distributed in the North Channel, at the survey sites.

- Harbour porpoise;
- Bottlenose dolphin *Tursiops truncates;*
- Common dolphin *Delphinus delphis;*
- Risso’s dolphin;
- Minke whale;
- Grey seal;
- Harbour seal;
- Basking shark; and
- Leatherback sea turtle.

3.2. KEY PROTECTED SPECIES

The following section will outline the marine mammal protected species in the area, reported as the species most commonly documented in the North Channel, the surrounding areas, including the Irish Sea, West Coast of Scotland and the Celtic Sea. A description of each species and their estimated densities in the survey area is provided in Table 3:2 (cetacean species) and

Table 3:3 (other protected species) and further detail on their distributions and ecology is provided in 3.2.1 (cetaceans), 3.2.2 (pinnipeds), 3.2.3 (basking shark) and 3.2.4 (sea turtles).

The latest 2020 abundance estimates for management units (MU) are also reported by the IAMMWG for harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin and minke whale. These estimates are derived from projects including SCANS-II and SCANS-III (Hammond *et al*. 2013; 2017) and ObSERVE (Rogan *et al.,* 2018). These abundance estimates are presented in Table 3:5, for the species listed above.

Collection of site-specific survey data for marine mammals is ongoing at NCW 1 and data collected between the months of September 2022 and January 2023 has also been included in this assessment to provide the most up to date data. These surveys aim to provide baseline information on the distribution and abundance of marine mammals within the NCW1&2 Offshore Wind Farm Proposed DA and ECC, including a 10 km buffer surrounding this area and therefore covers the DA survey site. The counts of marine mammal sightings are summarised, by month, in Table 3:4.

Table 3:2. Key protected cetacean species which may be in the survey area and estimated densities from Waggitt, *et al.* (2020) data and SCANS III data (relevant densities are those for Block E which overlaps with 35.605 km^2 of the Development Area survey area and 378.235 km^2 of the Export Cable Corridor survey area, and from Block G, which overlaps with 133.997 km^2 of the Development Area survey area and 49.334 km^2 of the Export Cable Corridor survey area (Hammond, *et al.,* 2017). General distribution and abundance information is taken from the NCW 1&2 Scoping Report (NCW, 2023).

Species	Distribution and Abundance in the Northern Channel and Irish Sea (North Channel Wind, 2023)	Mean annual densities of animals per km^2 in the survey area Waggitt *et al.* (2020)	Greatest density of animals/km^2 SCANS III Data Block E	Greatest density of animals/km^2 SCANS III Data Block G
Harbour porpoise	This species is abundant and widespread throughout the Irish Sea and West Coast of Scotland, with locally high densities of porpoises in areas including the west coast of Scotland. Sightings tend to be higher in coastal areas than offshore, however they inhabit depths range from -5 to 150 m. The harbour porpoise is a citation species for SAC designation in the Irish Sea due to areas of consistently high densities (Heinanen and Skov, 2015). It is also a desginated feature for the North Channel SAC, Inner Hebrides and the Minches SAC and Skerries and Causeway SAC. Harbour porpoise is also designated in several Isle of Man Marine Nature Reserves on the northern coast of the Isle of Man: West Coast, Calf and Wart Bank, Port Erin Bay.	0.276	0.239	0.336
Bottlenose dolphin	Occurs commonly in the eastern and western Irish Sea near the coast. There is a semi-resident population at Cardigan Bay (south of the survey area), where a high concentration of sightings occurs.	0.016	0.0082	0.1206
Common dolphin	Found off the western coasts of Britain and Ireland in continental shelf waters, notably in the Celtic Sea at the southern end of the Irish Sea. The species occurs at low densities mainly offshore in the Irish Sea, in a	0.101	No sightings recorded in block E or block G.	

Species	Distribution and Abundance in the Northern Channel and Irish Sea (North Channel Wind, 2023)	Mean annual densities of animals per km^2 in the survey area Waggitt *et al.* (2020)	Greatest density of animals/km^2 SCANS III Data Block E	Greatest density of animals/km^2 SCANS III Data Block G
	central band that extends northwards towards the Isle of Man. They are commonly found in the region.			
Risso's dolphin	This species has a worldwide distribution and is commonly sighted in clusters in the Irish Sea, generally preferring deeper offshore waters, near to the continental shelf edge. Risso's dolphin are commonly recorded in the Irish Sea and western Scotland Coastal Areas.	0.001	0.0082	No sightings recorded in block G.
Minke whale	Minke whales have a wide distribution in both coastal/inshore waters and oceanic/offshore areas in the Irish Sea. They are the most frequently sighted baleen whale in Irish waters, occurring seasonally (spring/summer) in the Irish Sea. In Manx waters, they are typically seen off the west and south between May and August, moving round to the east between September and November.	0.010	0.0173	0.0271

Table 3:3. Key protected pinniped and turtle species which may occur in the survey area, including estimated densities for the North Channel and Irish Sea which have been described from scientific literature. Key literature includes Carter, *et al.*, 2020 and Southall, *et al.*, (2005).

Species	Distribution and Abundance in the northern Irish Sea	The mean at-sea distribution of animals (per 5x5 km grid cell)
Pinnipeds		

Species	Distribution and Abundance in the northern Irish Sea	The mean at-sea distribution of animals (per 5x5 km grid cell)
Grey seal	Grey seals are widespread in cold and temperate northwest European shelf waters and abundant throughout the Irish Sea both in winter and summer (Waggitt *et al.,* 2020). The main grey seal breeding colonies which are close to the proposed survey area are those in the Inner Hebrides, though smaller breeding colonies exist off the coast of Northern Ireland, the Isle of Man, and north Wales. The Maidens SAC also overlaps directly with the survey area, and includes grey seal as a designated feature; furthermore, numerous MNRs on the Isle of Man have grey seal documented as a key species including: West Coast, Calf and Wart Bank, and Port Erin Bay.	2.912
Harbour seal	Harbour seal is the most widely distributed pinniped species in the world and is known to inhabit North Atlantic and North Pacific seas (CMACS, 2005; Thompson *et al.,* 2019). The largest concentrations of haul-out sites are found in Scotland, primarily on the west coast, Inner and Outer Hebrides, Orkney and Shetland, but other important haul out sites are found on the east coast of Northern Ireland. Nearby SACs including Strangford Lough, Murlough, and the South-East Islay Skerries include this species as a designated feature; furthermore, it is designated in several Isle of Man MNRs on the northern coast of the Isle of Man, including the West Coast, Calf and Wart Bank, and Port Erin Bay.	0.426
Turtle Species		
Leatherback turtle	The occurrence of marine turtles in NI waters is rare (with the majority of its population occurring in the North-east Atlantic), and usually a result of a current taking them off their usual route (King and Berrow, 2009). Sightings which do occur in the Irish Sea tend to occur between July and September, and further north between August and October (Pierpoint, 2000).	There are not enough recorded sightings to generate a density estimate for this species.
Basking shark		
Basking shark	Basking sharks are commonly seen at the surface in the summer months, and have been evidenced migrating through the Irish Sea, predominantly near the Isle of Man (Dolton *et al.,* 2020, Doherty *et al*., 2017a; 2017b). This species often undergoes large migrations, of which their strategies vary widely between regions (IBSG, 2023).	Basking shark have been sighted in a density of 11-50 individuals sighted per 0.5 by 0.5° (degrees) (50 by 50km) to the north of the Isle of Man (Southall *et al*., 2005).

Table 3:4. Total counts of protected species in the survey area of the NCW1 project area from marine mammal and ornithology site-specific surveys undertaken between September 2022 and January 2023 (APEM, 2022).

Month	Species	Total counts (n)
September	Common dolphin	140
	Harbour porpoise	16
	Dolphin / Porpoise	10
	Seal species	1
	Basking shark	1
October	Harbour porpoise	18
	Seal species	3
	Grey seal	2
November	Harbour porpoise	17
	Seal species	2
	Grey seal	1
December	Grey seal	36
	Harbour porpoise	10
	Dolphin / Porpoise	2
January	Harbour porpoise	7
	Grey seal	9

Table 3:5. Abundance estimates for protected cetacean species for relevant management units from IAMMWG (2023).

Species	MU	Abundance of animals in MU (CV)	95% confidence interval	Abundance of animals in the UK portion of MU (CV)	95% Confidence interval for UK portion of MU
Harbour porpoise	West Scotland (WS)	28,936 (0.16)	21,140 – 39,608	24,305 (0.18)	17,121 –34,505
	Celtic and Irish Sea (CIS)	62,517 (0.13)	48,324 – 80,877	16,777 (0.2)	11,216 – 25,096
Bottlenose dolphin	Coastal West Scotland and the Hebrides (CWSH)	-	-	45*	33-66
	Irish Sea (IS)	293 (0.54)	108 - 793	186 (0.52)	70 - 492
Common dolphin	Celtic and Greater North Seas (CGNS)	102,656 (0.29)	58,932 – 178,822	57,417 (0.32)	30,850 – 106,863
Risso's dolphin		12,262 (0.46)	5,227 – 28,764	8,687 (0.63)	2,810 – 26,852
Minke whale		20,118 (0.18)	14,061 – 28,786	10,288 (0.26)	6,210 – 17,042

3.2.1. CETACEANS

Harbour porpoise

Harbour porpoise is the most commonly observed cetacean species in UK waters, with high densities in the Irish Sea and its Northern and Southern channels (Wall *et al.,* 2013). Sightings occur year-round throughout the Irish Sea (Baines and Evans, 2009). This species prefers habitats where depths range from 5-150 m in highly sloped regions (Booth *et al*., 2013; Buttifant, 2021). In addition, water depth and hydrodynamic variables have been found to have the greatest influence on the distribution of the species within the Irish Sea (Heinänen and Skov, 2015).

Harbour porpoise also appear in the IMA observation data, which shows the species has been identified in the North Channel, close to the survey sites between 2005 and 2011 (IMA, 2005;2011). Furthermore, most recent survey data from APEM found that harbour porpoise were present in all five months (September to January) in the survey area. Therefore, this data and scientific studies suggest that harbour porpoise is likely to occur within the proposed survey sites all year-round.

Specific desktop sources predict the densities of the species within the survey areas. Harbour porpoises were found to have a density of 0.239 animals per km^2 in the SCANS III survey in block E and 0.336 animals per km^2 in block G, which both overlap with the survey areas (Hammond, *et a*l., 2021-Revised). Distribution maps of cetacean species within the North-east Atlantic by Waggitt *et al*. (2020) also indicate that Harbour porpoise are present in the area. There is a predicted mean annual density of 0.276 animals per km^2 for the survey area (Waggitt*, et al.*, 2020).

Bottlenose dolphin

Bottlenose dolphin are relatively common in the Irish Sea. High concentrations of sightings occur in Cardigan Bay, to the south of the survey area (CMACS, 2005; Baines and Evans, 2009), due to semi-resident populations here. Seasonally, higher sightings occur in coastal regions during summer and autumn (Baines and Evans, 2009), mostly between July and September, with a secondary peak in April (Reid *et al.,* 2003). This species is mostly found in coastal regions, with low densities often recorded offshore (Baines and Evans, 2012). Generally, studies have found that they prefer estuarine areas with the steepest slopes and depths (Ingram and Rogan, 2002). These studies suggest that this species is likely to occur within the survey site (Reid *et al*., 2003; Baines and Evans, 2012; Wall *et al.,* 2013; Waggitt *et al*., 2020), however, lack of observations of this species in the most recent APEM surveys could suggest they are more likely to occur in the months with no survey data (February to August; APEM 2022).

In regard to densities reported for the survey area, the bottlenose dolphin were found from the SCANS III survey to have a density of 0.0082 animals per km^2 in survey block E, and a density of 0.1206 animals per km^2 in survey block G (Hammond, *et al.*, 2021-Revised). This species also appears in the Waggitt *et al*. (2020) distribution maps in the area, with a mean annual density of 0.016 animals per km^2 for the survey area (Waggitt*, et al.*, 2020).

Common dolphin

Common dolphin are sighted occasionally in the Irish Sea, and their presence is considered to be rare. They tend to favour coastal, shelf, slope and deep-water habitats, rarely being observed near to the shore (JNCC, 2003; Mackney and Gimenez, 2006). However, they have been sighted in the North Channel by the Irish Whale and Dolphin Group in November 2015, demonstrating that they may be present in the survey area (IMA, 2015). Moreover, the site-specific aerial surveys conducted by APEM during 2022 found that common dolphin were present in the DA and ECC during September, with a total count of 140 animals in the DA, ECC and a 10 km buffer surrounding this area (APEM, 2022). There were no sightings of the common dolphin in the remaining four months of APEM survey data. There were also no sightings recorded for common dolphin in either SCANS III survey block E or block G. However, this species does appear in the Waggitt *et al.* (2020) maps, overlapping with the survey area, with a mean annual density of 0.101 animals per km^2 (Waggitt*, et al.*, 2020).

Risso's dolphin

Risso's dolphin are one of the five species found by the Department of Energy and Climate Change (DECC) to be encountered in the Irish Sea, especially in the Northern Irish Sea (DECC, 2016). They tend to prefer shelf-edge offshore waters in depth ranging from 400 – 1,000m (NOAA, 2022). There are two recorded observations in the IMA of Risso's dolphins in the North Channel between 2005 and 2011, suggesting they may be present in the area (IMA, 2005; 2011). However, no Risso's dolphin were observed in the first five months of Aerial surveys by APEM (2022).

In regard to densities reported for the survey area, Risso's dolphin were found from the SCANS III survey to have a density of 0.0082 animals per km^2 in survey block E, and no density estimates for block G (Hammond, *et a*l., 2021-Revised). This species also appears in the Waggitt *et al.* (2020) distribution maps in the area, with a mean annual density of 0.001 animals per km^2 for the survey area (Waggitt*, et al.*, 2020).

Minke whale

This species predominantly occurs in the Irish Sea seasonally, during summer months and most sightings are from the northern Irish Sea (DECC, 2016; NatureScot, 2019). They are typically found in deep water areas over 50 m in depth, often associated with densities of their prey species (RSPB, 2014). Minke whales have been sighted by the Irish Whale and Dolphin Group navigating the North Channel, so may occur in the survey area (IMA, 2005; 2011). However, this species was not sighted during the first five months of site-specific survey data (APEM, 2022).

Specific to the survey area, Minke whale were recorded in SCANS III to have a density of 0.0173 animals per km^2 in survey block E, and a density of 0.0271 animals per km^2 in survey block G (Hammond, *et al.*, 2021-Revised). This species also appears in the Waggitt *et al*. (2020) distribution maps in the area, with a mean annual density of 0.010 animals per km^2 for the survey area, also suggesting the species may be present in the survey area (Waggitt*, et al.*, 2020).

3.2.2. PINNIPEDS

Harbour seal

Harbour seals are known to inhabit North Atlantic and North Pacific seas (CMACS, 2005; Thompson *et al.,* 2019). Their densities are found to be substantially higher near to haul-out areas and sites of approximately 30 m water depth (Aarts, *et al.,* 2016). There are known haul out sites near to the survey site, which are coupled with studies which show the presence of harbour seals in the area. Thompson, *et al.,* (2019) estimated the population sizes of harbour seals at haul-out locations in the UK during their annual moult and found clear evidence of their presence in the North Channel; the count estimated for the zone covering the survey site (Northern Ireland) was 948 seals (Thompson *et al.,* 2019)

Specific to the survey site, Carter, *et al*. (2019) estimated that there were on average 0.426 harbour seals per 5x5 km grid cell. Therefore, it is likely this species will be present during the survey works. This species was not positively identified during the APEM site-specific surveys (APEM, 2022). However, it is possible they were present, as there were sightings of seal species during three of the surveys, which could not be definitively identified as grey or harbour seal.

Grey Seal

Grey seals are known to inhabit the coasts of Northern Ireland and North Wales, as well as in other parts of the Irish Sea. Their numbers are found to vary considerably from day to day in Northern Island during summer months. Morris and Duck (2018) used aerial thermal imaging to count grey seal populations in Northern Ireland and concluded a population of 505 grey seals in Northern Ireland. There were high concentrations of this species found in Strangford Lough SAC and Murlough SAC (40.6 km and 74.43 km from the survey site, respectively) and smaller numbers in the Maidens SAC (Morris and Duck, 2018).

Specific to the survey site, Carter, *et al.* (2019) estimated that that there were, on average, 2.912 grey seals per 5x5 km grid cell. Therefore, it is extremely likely this species will be present during the survey works. In addition, grey seal sightings were recorded during the APEM site-specific surveys in four out of five months (APEM, 2022). Seal species were also recorded in the fifth month; however, it was not determined whether this individual was a grey seal or a harbour seal.

3.2.3. BASKING SHARK

Basking sharks are known to inhabit the Irish Sea and have been observed on the surface in summer and spring months near to the Isle of Man and further North, with the species typically undergoing a north-south migration through the Irish Sea (Sims *et al*., 2008; Wilson *et al*., 2020).

The Irish Basking Shark Group (IBSG) is a dedicated group which studies the distribution of the species in Irish Seas; they have an abundance of ongoing projects, including the Malin Head Survey and tag deployment surveys which aim to better understand the distributions of Basking sharks in Irish Waters. Results suggest that the species could be present in the survey area. Furthermore, data from individual sighting reported by Sharrock*, et al.* (2023), which took place between 1987 and 2006, shows that basking sharks have been sighted abundantly in the North Channel, with some sightings directly overlapping with the survey site. These sightings were linked to social interaction and to courtship and feeding behaviour (Sharrock, *et al.,* 2023). Southall, *et al.* (2005) presented density information for basking shark to the north of the Isle of Man in densities of 11-50 individuals per 50 km by 50 km grid square. More recently, one individual was sighted during the September site-specific survey, demonstrating they have been present in the area during the most recent summer (APEM, 2022).

3.2.4. LEATHERBACK TURTLE

Leatherback turtles have been sighted in the Irish Sea between July and September, and further north between August and October (Pierpoint, 2000), however their occurrence is considered rare. Sightings data in 2000 reported 26 individuals in August in the Irish Sea and suggested that the species passes through the channel during these months (Pierpoint, 2000). More recently, Hanley *et al.* (2013) also recorded 16 leatherback turtles in Manx waters between 2001 and 2011. There are also visual observation records of leatherback turtles in the North Channel, recorded through citizen science and compiled in the NBN atlas (NBN, 2023). This shows some recordings of the species in the North Channel between 1995 and 2017, the majority of which take place between the summer months; there is also one recording which overlaps with the survey site, however this was recorded in summer 2000 (NBN, 2023).

Generally, their occurrence in NI is considered rare (King, 2009), usually being a result of a current taking them off their usually route. It also seems unlikely, since the proposed surveys are taking place between Winter 2023 and Spring 2024, that this species will be encountered.

Due to their rare occurrence, marine turtles will not be considered further in this risk assessment. However, should any marine turtles by encountered during the survey works, best practice will be followed including:

- An immediate notification to DAERA of the marine turtle sighting; and
- Following the UK Turtle Code, which gives guidance on how to report approach, handle and rescue individuals (Marine Conservation Society, 2023).

4. RISK ASSESSMENT

Anthropogenic underwater noise is readily transmitted into the underwater environment and has the potential to adversely affect marine mammals and fish (Richardson, *et al.,* 2013) In particular, cetaceans are capable of generating and detecting sound, and depend on sound for feeding, predator avoidance, communication and navigation (Bailey *et al.,* 2010). Four zones of noise influence have been described by Richardson and Würsig, (1997), and these vary with the distance from the source, including: audibility (sound is detected); masking (interfere with detection of sounds and communication); responsiveness (behavioural or physiological response) and injury/hearing loss (tissue damage in the ear).

At close range to a high-level noise source, permanent or temporary hearing damage may occur to marine species, while at very close range gross physical trauma and even death is possible. At long ranges (several kms) the introduction of any additional noise could, for the duration of the activity, potentially cause behavioural changes, for example to the ability of species to communicate and to determine the presence of predators, food, underwater features, and obstructions.

This assessment considers the zones of auditory injury and disturbance with the relevant thresholds for the onset of effects, compared to the modelled noise level produced by the geophysical surveys. Sound generated by geophysical surveys can be a major contributor to low frequency sound within the hearing ranges of some marine mammals, and therefore, has the potential to impact some species (Nieukirk *et al*, 2004; *Richardson, et al.,* 2013). The species at risk from the noise generated by the geophysical surveys described above are discussed in the following section. These are based on the Southall *et al.* 2019 and Popper *et al.* 2014 framework for assessing impact from noise on marine mammals and fishes.

Consequently, the primary purpose of the underwater noise risk assessment is to predict the likely range of onset for potential physiological and behavioural effects due to increased anthropogenic noise as a result of the survey works.

4.1. UNDERWATER SOUND MODELLING

4.1.1. SOUND SOURCES

For the DA and ECC, geophysical surveys will be undertaken; the details of these surveys are presented in Section 1.2 and 1.3. A subsea noise assessment was carried out to predict the ranges of effect from the different noise-producing survey equipment, which are summarised in Table 4:1, including the vessel itself. Source levels for the active equipment were combined to produce a “combined” source that represents the survey vessel’s sound signature while actively surveying during the survey.

Table 4:1 Summary of Noise Sources and Activities Included in the Subsea Noise Assessment.

Equipment	Source Pressure level [SPL]	Primary frequencies (-20 dB width)	Source model details	Impulsive/non-impulsive
Survey vessels (based on max of: ILV Granuaile, 80m & Roman Rebel, 28 m)	173 dB SPL	10-2,000 Hz	(Wittekind, 2014; Simard, et al., 2016; Heitmeyer, 2001)	Non-impulsive
Side scan sonar (Edgetech FS4205 or equivalent)	Not included	230,000 Hz & 850,000 Hz	Not included in assessment due to minimal frequency being well outside the hearing range of any species. (VHF group max: ~125 kHz)	Not applicable

Equipment	Source Pressure level [SPL]	Primary frequencies (-20 dB width)	Source model details	Impulsive/non-impulsive
Multibeam echosounder (Reson Seabat T50R or equivalent)	168-175 dB SPL (ping rate dependent, spherical level)	190,000 – 420,000 Hz	Manufacturer, source level based on source power (200-300 Watts). Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth.	Impulsive
Sub-bottom profiler 1 (Parametric pinger/chirper, e.g. Innomar Standard)	201-207 dB SPL (ping rate dependent) 2221 dB LP (240 dB LP on-axis)	4,000 – 15,000 Hz & 85,000 – 115,000 Hz	Manufacturer. Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth.	Impulsive
Sub-bottom profiler 1 (Sparker at max 800J per shot)	193 dB SPL 224 dB LP (ping rate dependent)	630 – 5,000 Hz	Manufacturer. Ping rate determined by local depth.	Impulsive

It is important to note that source levels varied depending on the location of the survey due to the two factors listed below.

- The ping rate, and therefore the Sound Pressure Level (SPL) of the source, varies with the local depth.
- During the survey of the DA an additional sub-bottom profiler is active to achieve deeper sediment penetration (a sparker type).

Therefore, modelling was based on selected locations within the DA and the ECC. These locations were chosen to ensure a conservative assessment that covers the variation in the site. These locations were:

- DA-SE: Location in the DA towards the centre of the north Irish Sea and south-east end of the DA. Surrounding waters uniformly deep.
- DA-NW: Location in the DA towards the coastal slope and north-west end of the DA. Surrounding waters slope up to land (Antrim) to the west, flat to the east.
- ECC-Coast: Location in the ECC near the coast to assess impacts on shallow slope.
- ECC-Mid: Location at ~120 m depth on flat seabed, representing the middle section of the ECC likely to form a significant part of the final corridor.

ECC-Reef: Location on rocky reef north-west of “East Maiden” lighthouse and west of “Highlandman” marker.Figure 4:1, Figure **4**:**2**, Figure 4:3 and Figure 4:4 display the surveys vessel’s sound signature while actively surveying in these different locations within the survey area.

[1] Level at 20 degree off vertical axis

Figure 4:1: ECC-Coast: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in shallow areas of the ECC.

Figure 4:2: **ECC-Reef: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in shallow areas with hard sediment of the ECC.**

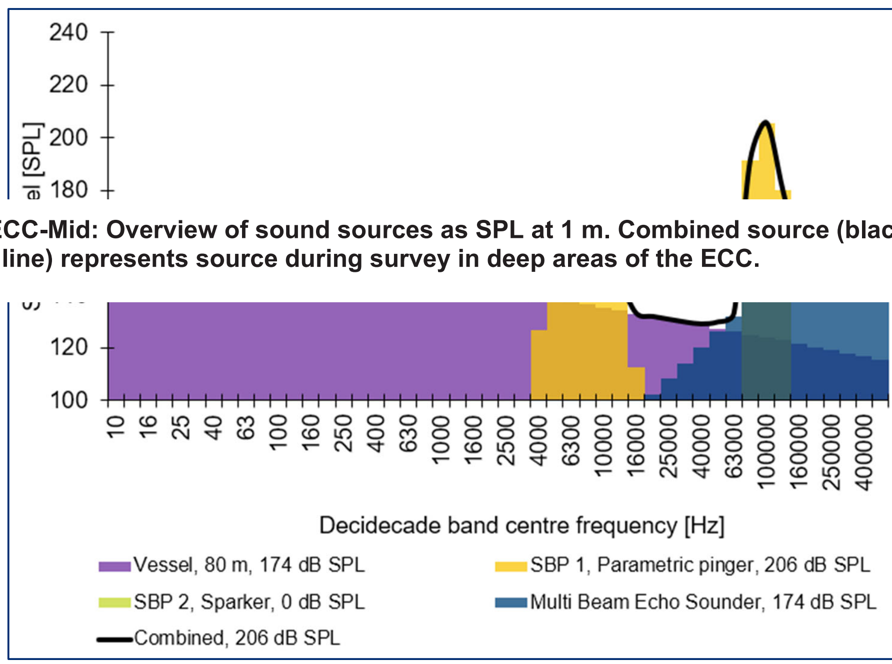

Figure 4:3. ECC-Mid: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in deep areas of the ECC.

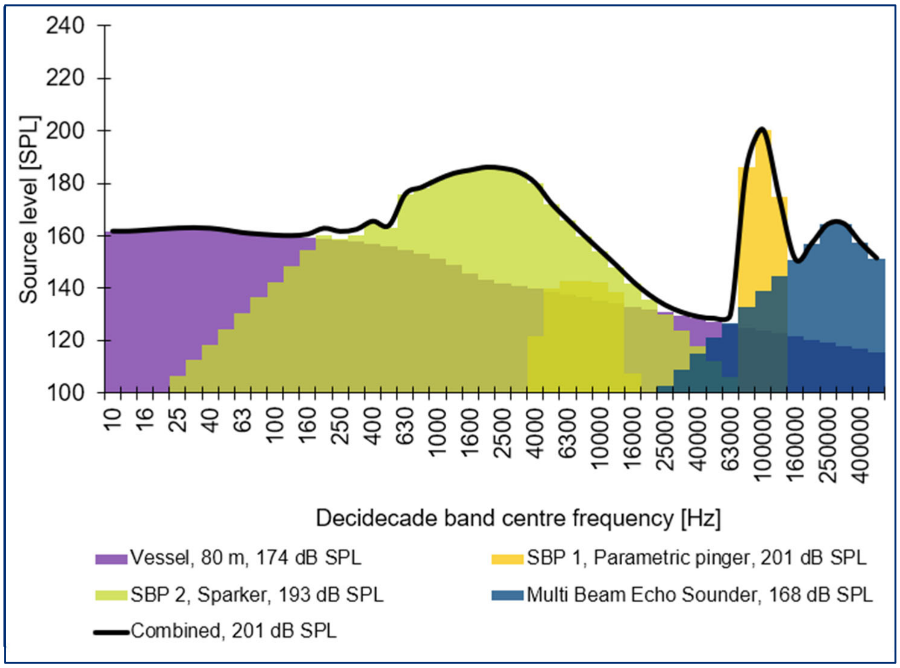

Figure 4:4. DA (DA-SE and DA-NW): Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in the DA.

The SSS has not been included in the assessment as it's minimal frequency (230 kHz) is far higher than the maximal frequency audible to the Very High Frequency (VHF) hearing group (~125 kHz). Even allowing for spectral leakage (energy "leakage" into other frequencies due to the acoustic properties of the transducer) it's unfeasible that there will be significant energy below 150 kHz to be relevant.

The multibeam echosounder is likewise well above the upper limit of hearing for the VHF group but has been included as the spectral leakage might mean that enough energy makes it into the hearing range of the VHF group.

The parametric SBP ("Sub-bottom profiler 1" in Table 4:1) has a very narrow beam directed vertically down, with levels attenuating rapidly as the angle away from vertical increases. We have used the source level at an angle of 20 degrees from vertical for the assessment. This means that for the deeper sites (130 m) there will be an approximately 50 m radius around the vessel where we will underpredict the impact for animals at the sediment depth (130 m), reducing to 20 m at 50 m depth (i.e., a cone under the SBP with a width of 40 degrees). For the soft-starts (minimum 15 minutes) the ping rate of the parametric SBP reduces to 1 ping per second, effectively reducing the exposure level (L_E) of the source. The results assume this source is limited to a maximal L_P of 240 dB and maximal 1 second L_E of 208 dB, with a similar beam pattern to the Innomar SBPs.

The sound sources assessed were separated into two distinct types:

- Impulsive sounds which are typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI, 1986; NIOSH, 1998; ANSI, 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions.
- Non-impulsive (continuous) sounds which 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 (ANSI, 1995; NIOSH, 1998). This category includes sound sources such as continuous vibro-piling, running machinery, some sonar and vessels.

The combined source was modelled as omnidirectional, and this was a conservative estimate as all sources, apart from the vessel, are highly directional in nature and angled towards the sediment, giving rise to increased transmission losses when compared to an omnidirectional source. The vessel is assumed to move at 2 knots during the surveying, this is a conservative measure to increase the survey time as the vessel will likely move at ~4 knots (limited by the temporal resolution of the survey equipment).

4.1.2. NOISE MODELLING APPROACH

The noise modelling assessment predicted the ranges for potential injury and disturbance for marine mammals and fish based on the recommended criteria for the different hearing groups. The assessment criteria used in this assessment were developed based on a review of available evidence including national and international guidance and scientific literature.

Injury to marine mammals in the form of Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS) and behavioural thresholds for sound sources were based on the latest international guidance (based on the best available scientific information), that are widely accepted for assessments in the UK, Europe and worldwide (Southall, *et al.,* 2019*.;* Popper, *et al*., 2014).

As a marine mammal swims away from the sound source, the noise it experiences will become progressively more attenuated. Sound exposure calculations (Presented in Section 7.1, Appendix 1 to this report) were used in this assessment to estimate the approximate minimum start distance for a marine mammal in order for it to be exposed to sufficient sound energy to result in the onset of potential injury or to estimate if a set exclusion zone is sufficient for an activity (e.g., will an exclusion zone of 500 m be sufficient to prevent exceeding a limit). It should be noted that the sound exposure calculations are based on the simplistic assumption that the animal will continue to swim away at a fairly constant relative speed. The real-world situation is more complex, and the animal is likely to move in a more complex manner.

For this assessment, a swim speed of 1.5 m/s was used for all marine mammals (cetaceans and pinnipeds) and basking sharks. These were based on reported swim speeds from the literature for the relevant species.

The main assumptions for the validity of the results presented were:

- A soft-start of minimum 15 minutes, where the SBPs are firing maximally once per second;
- Any SBP or UHRS sparker used similar to the Innomar model will have peak pressure levels below 240 dB L_P and 1-second exposure levels below 208 dB L_E in the frequency range 85-115 kHz; and
- Final equipment configuration is not louder than the presented equipment.

Five types of results are presented to inform this assessment:

1. **“1-second exposure risk range”:**

This is the range of acute risk of impact from the activity (a one second exposure) and is presented to indicate short term risk and for comparison with other studies. This assumes a stationary animal (during the 1-seond exposure) with all equipment operating at full power and does not include a soft-start.

2. **“0.5 hours exposure risk range”:**

This is the risk range for a stationary animal with all equipment operating at full power and does not include a soft-start.

3. **“Minimal starting range for a fleeing animal”:**

The minimal range a fleeing animal needs to start fleeing from to avoid being exposed to noise exceeding its TTS/PTS threshold. All these assume an animal moving in a straight line away from the source at a constant speed of 1.5 m/s. Soft-start is assumed. This metric forms the main basis of the assessment.

4. **“Peak level risk range”:**

The range of acute risk of impact from peak pressure levels associated with the impulsive sources. This measure is not included in tables as the range to the lowest TTS limit (fish 186 dB LP) was ~50 m (all other groups are shorter).

5. **"Behavioural response range":**

The range at which the behavioural limit for the marine mammals (160 dB SPL) or the fishes (150 dB SPL) behavioural limits for impulsive noise is exceeded.

4.2. IMPACTS OF UNDERWATER SOUND

The following section assesses the potential impacts on the relevant marine mammals and fishes (including basking sharks) from sound produced during the geophysical surveys (see Section 4.1.1). The introduction of additional man-made sound has the potential to result in disturbance or injury, by affecting a mammals' ability to feed, avoid predators, communicate, and navigate the marine environment (Nieukirk *et al*, 2004; Richardson, *et al*., 2013). The impacts on these mammals include short-term behavioural changes; temporary or permanent auditory damage; and mortality (Southall *et al.,* 2019). However, if the frequency resulting from the underwater sound source does not exceed the hearing thresholds of the marine species, they may not experience any effect from this exposure (Carroll *et al.* 2017).

4.2.1. HEARING SENSITIVITY

4.2.1.1. Marine Mammals

Hearing sensitivity varies between marine mammals and fishes, and therefore they have varying sensitivities to noise and susceptibility to noise-induced impacts (NOAA, 2018). Moreover, their reactions to sound have been shown to depend on sound source level, propagation conditions, ambient noise and individual differences (such as age, sex, habitat and previous habituation to noise) (Richardson *et al*., 1995).

In order to assess the impacts of underwater noise on these species, they are classed into functional hearing groups (Southall *et al.,* 2007; Southall *et al*., 2019). National Oceanic and Atmospheric Administration (NOAA) Fisheries have produced marine mammal acoustic technical guidance, which provides thresholds for the onset of PTS and TTS in marine mammal hearing for all underwater sound sources. These are based on the assumption that, outside of their hearing ranges, it is unlikely that a species will experience an auditory impact.

The hearing weighting function is designed to represent the sensitivity for each group within which acoustic exposures can have auditory effects. The categories include:

- Low Frequency (LF) cetaceans: Marine mammal species such as baleen whales (e.g. minke whale).
- High Frequency (HF) cetaceans: Marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales (e.g. bottlenose dolphin).
- Very High Frequency (VHF) cetaceans: Marine mammal species such as true porpoises, river dolphins and pygmy/dwarf sperm whales and some oceanic dolphins, generally with auditory centre frequencies above 100 kHz) (e.g. harbour porpoise).
- Phocid Carnivores in Water (PCW): True seals, earless seals (e.g. harbour seal and grey seal); hearing in air is considered separately in the group PCA.
- Other Marine Carnivores in Water (OCW): Including otariid pinnipeds (e.g. sea lions and fur seals), sea otters and polar bears; air hearing considered separately in the group Other Marine Carnivores in Air (OCA).
- Sirenians (SI): Manatees and dugongs. This group is only represented in the NOAA guidelines.

The classification of each species according to these criteria is displayed below in Table 4:2.

Table 4:2. Functional marine hearing groups for marine mammals and basking shark potentially present in the survey areas. Hearing group classification and estimated auditory band width taken from NOAA Marine Mammal Acoustic Technical Guidance (NOAA, 2018) and from Southall, *et al* (2019) Marine Mammal Noise Exposure Criteria.

Species	Hearing Group	Estimated auditory band width
Harbour porpoise	VHF	275 Hz to 160 kHz
Harbour seal	PCW	50 Hz to 86 kHz
Grey seal	PCW	50 Hz to 86 kHz
Minke whale	LF	7 Hz to 35 kHz
Bottlenose dolphin	HF	150 Hz to 160 kHz
Common dolphin	HF	150 Hz to 160 kHz
Basking shark	Group 1 fish	20 Hz to 1500 Hz (Peak between 200 and 600 Hz)

The most sensitive species likely to be present in the survey area is the harbour porpoise, which has an estimated auditory band width of 275 Hz to 160 kHz. Grey seals are also likely to present in the area and have an estimated auditory band width of 50 Hz to 86 kHz, which is the same auditory band width as the harbour seal, which may also be present on site. Minke whale may also be present at the site and are classed as 'low-frequency cetaceans' with an estimated auditory band width of 7 Hz to 35 kHz.

The remaining cetaceans which may be present in the area (identified in the baseline; Section 3) are classed as 'high-frequency cetaceans'; these species can produce sounds in a lower band frequency, for social interaction, as well as in intermediate to high frequencies, which are used for echolocation. Therefore, they have a large hearing range, but have peaks in hearing sensitivity where echolocation signals are strongest (Southall *et al*., 2019).

4.2.1.2 Basking shark

Basking sharks are a protected marine species which are also considered in this Risk Assessment. The species are classified by Popper, *et al.,* 2014 as group 1 fish (fish with no swim bladder). Basking sharks have only an inner ear and no swim bladder, meaning that they are only sensitive to particle motion (Chapuis *et al.,* 2019). Therefore, they are sensitive to low frequency sounds only (between 20 Hz and 1500 Hz) with their hearing sensitivity peaking between 200 and 600 Hz, depending on the species (Carroll, *et al.,* 2017). The aforementioned estimated hearing bandwidth of elasmobranchs is well below that of the geophysical survey equipment proposed for use in the survey operations.

4.2.2. ASSESSMENT OF POTENTIAL INJURY

This section summarises the potential for injury impacts to species of marine mammal and fishes in the survey area. For this study, it is the zones of injury (PTS) that are of primary interest, along with estimates of behavioural impact ranges. The zone of injury in this study is classified as the distance over which a marine mammal can suffer PTS leading to non-reversible auditory injury. Injury thresholds are based on a dual criteria approach using both un-weighted L_P (maximal instantaneous SPL) and marine mammal hearing weighted L_E. The hearing weighting function is designed to represent the sensitivity for each group within which acoustic exposures can have auditory effects. To determine the potential spatial range of injury and behavioural change, a review has been undertaken of available evidence, including international guidance and scientific literature.

Both the criteria for impulsive and non-impulsive sound are relevant for this study given the nature of the sound sources used during the survey. The relevant PTS and TTS criteria proposed by Southall *et al.* (2019) are summarised in Table 4:3

Table 4:3. PTS and TTS onset acoustic thresholds (Southall *et al.,* 2019).

Hearing Group	Parameter	Impulsive [dB]		Non-impulsive [dB]	
		PTS	TTS	PTS	TTS
Low frequency (LF) cetaceans	L_P, (unweighted)	219	213	-	-
	L_E, (LF weighted)	183	168	199	179
High frequency (HF) cetaceans	L_P, (unweighted)	230	224	-	-
	L_E, (MF weighted)	185	170	198	178
Very high frequency (VHF) cetaceans	L_P, (unweighted)	202	196	-	-
	L_E, (HF weighted)	155	140	173	153
Phocid carnivores in water (PCW)	L_P, (unweighted)	218	212	-	-
	L_E, (PW weighted)	185	170	201	181
Other marine carnivores in water (OCW)	L_P, (unweighted)	232	226	-	-
	L_E, (OW weighted)	203	188	219	199
Sirenians (SI) (NOAA only)	L_P, (unweighted)	226	220	-	-
	L_E, (OW weighted)	190	175	206	186

4.2.3. ASSESSMENT OF POTENTIAL DISTURBANCE

Scientific literature shows that responses to disturbance vary between and within species' and depend on the individual characteristics (body size, condition, sex and personality) and extrinsic factors (environmental context, repeated exposure, prior experience and acclimatisation) (Harding, *et al.,* 2019). These factors will affect whether an individual exhibits an aversive response to sound, particularly in an area with high sound levels related to human activities.

Typically, a 'strong disturbance' is one which has the potential to disturb a marine mammal (or fish) or marine stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (NMFS, 2005; JNCC, 2010). The United States (US) National Marine Fisheries Service (NMFS) (NMFS, 2005) define strong disturbance in all marine mammals as Level B harassment and for impulsive sound suggests a threshold of 160 dB re 1 µPa (root mean square (rms)). This threshold meets the criteria defined by JNCC (2010a) as a 'non-trivial' (i.e., significant) disturbance and is equivalent to the Southall *et al.,* (2007) severity score of five or more on the behavioural response scale. Outside of this threshold, behavioural responses are considered trivial, and unlikely to significantly impact the marine animal, or its population status in the wild. For example, these responses often include minor changes in swimming speed, direction and/or dive profile, modification of vocal behaviour and minor changes to respiratory rate (Southall, *et al.,* 2007). For mild disturbance, a precautionary level of 140 dB re 1 µPa (rms) is used to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound.

For vessel noise (continuous sound), NMFS (2005) guidance sets the marine mammal level B harassment threshold for continuous noise at 120 dB re 1 µPa (rms), which sits approximately mid-way between the range of values identified in Southall *et al*. (2007).

Based upon NMFS criteria, disturbance thresholds in this assessment for marine mammals were 120 dB SPL and 160 dB $L_{E\ single\ impulse}$ or 1-second L_E for non-impulsive and impulsive sound, respectively. Criteria for the onset of behavioural effects for fish were 150 dB SPL for fish with no swim bladder (basking sharks) for both impulsive and non-impulsive sound sources, and up to 189 dB SPL for other fish species.

For fish species these behavioural changes could include the elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury but may indirectly affect the individual fish (such as by impairing predator detection) (Hastings, 2002; Worcester, 2006; WSDOT, 2011) It is also noted that non-impulsive thresholds can often be lower than ambient noise for coastal waters with some human activity, meaning that ranges determined using this limit will tend to be higher than actual ranges.

4.2.4. POTENTIAL IMPACTS FOR THE DA SURVEY

During the survey in the DA both the sparker-type SBP and the parametric SBP are used, with the sparker dominating the noise relevant to the LF group and the parametric SBP most relevant to the HF and VHF groups. The deeper water in the DA means the SBP will run with lower ping rates, leading to lower exposure levels compared to the generally shallower ECC. Impact ranges for the VHF group are generally high, and due to the noise at lower frequencies the combined noise from the vessel will be audible over much larger distances for all groups.

Risk ranges for peak pressure was under 10 meters for all mammal groups for PTS and TTS limits, with the fishes TTS limits exceeded to approximately 50 meters. These risk ranges are presented for each sub-location within of the survey site (DA-SE; DA-SW) in the following sections, and summarised for each group in Table 4:4 and Table 4:5.

4.2.3.1 DA-SE

Starting ranges for fleeing animals of the VHF group extend to approximately 350 m, with the remaining groups having ranges below 10 m. Behavioural response ranges of 1 km and 4.2 km for marine mammals and fishes respectively (see Table 4:4).

Table 4:4. DA-SE, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	50	70	510	20	0	0
1 second exposure PTS risk [m]	0	0	140	0	0	0
0.5 hours' exposure TTS risk [m]	6720	770	8570	3730	280	140
0.5 hours' exposure PTS risk [m]	360	230	870	190	10	30
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft-start)	10893	204	12690	4989	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft-start)	3	6	323	3	3	0

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
Behavioural response range [m]	970	970	970	970	970	4185

4.2.3.2 DA-SW

Starting ranges for fleeing animals of the VHF group extend to approximately 350 m, with the remaining groups having ranges below 10 m. Behavioural response ranges of 1 km and 4.5 km for marine mammals and fishes respectively (see Table 4:5).

Table 4:5. DA-NW, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	50	80	520	30	0	0
1 second exposure PTS risk [m]	0	0	150	0	0	0
0.5 hours' exposure TTS risk [m]	7240	810	9200	4060	310	150
0.5 hours' exposure PTS risk [m]	390	240	890	210	10	30
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft-start)	11699	221	13401	5582	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft-start)	5	8	338	3	3	0
Behavioural response range [m]	1070	1070	1070	1070	1070	4550

Potential Injury Impacts

The VHF group (harbour porpoise) is the main concern in this assessment with a minimal starting range (to avoid PTS, for fleeing animal) of between 323 and 338 m, for the DA survey (assuming a soft-start of at least 15 minutes). Therefore, given the 30 minutes pre-survey watch to give a 500 m minimal range recommended by procedures laid out in the JNCC's guidelines (See Section 4.3 for further detail), there is little acute risk for a member of the VHF group to exceed its auditory limits. In addition, harbour porpoise is very sensitive to noise, including the presence of vessels and displays avoidance movements in response to impulsive noise sources, such as seismic surveys and pile-driving around offshore wind farms (Thompson, *et al.,* 2013). Therefore, it is considered unlikely that an animal would remain in the vicinity of survey vessel during the noise-producing activities; therefore, injury is unlikely.

The risk ranges for PTS for the remaining mammals and fishes assessed were all found to be below 10 m and therefore it was determined that given the 500 m exclusion zone, there is little to no risk of injury for these groups. For example, any of these species (with the exception of harbour porpoise) would have to be within 10 m of the vessel to experience a threshold shift in hearing.

Potential Disturbance Impacts

The behavioural response ranges for fishes are very high (4-4.5 km), meaning potential disturbance for fishes over large parts of the surveyed area. For example, at 2 knots (1 m/s) a location under the survey line will be above the behavioural response range for up to 2.5 hours (or half that time for a survey moving at 4 knots). The equivalent disturbance time for mammals is just under 0.5 hours (approximately 1 km). Therefore, the behavioural response limits for harbour porpoises, seals and fishes are likely to be exceeded during surveying, due to the sparker-type SBP overlapping the frequency regions of greatest hearing sensitivity for these groups as well as the ability for the lower frequencies to travel further with less attenuation. This means TTS for the LF, VHF and PCW groups is likely to occur while surveying the DA. The TTS risk ranges calculated were up to 12, 13 and 5 km for the LF, VHF and PCW groups respectively, while surveying the development area.

Therefore, the ranges of effect suggest that behavioural effects on protected mammals, including minke whale, harbour porpoise, grey seal and harbour seal are likely to occur during the DA surveys. There are limited studies directly investigating the temporary disturbance impacts from impulsive noise sources from geophysical surveys. However, there are an abundance of studies on the effects of multi-array seismic surveys on marine mammals which can be useful in supporting predictions of behavioural responses of marine mammals to geophysical survey sources in general, given the overlap of parameters that typically characterise sound sources (i.e. transmission frequency; source level; pulse duration); these findings are summarised below. The impacts of disturbance effects on basking sharks are discussed in Section 4.2.8.

Temporary disturbance may have implications on survival and fitness and population-level consequences, particularly for species such as harbour porpoise, which have been shown to forage almost constantly (24 hours a day) to meet their high energy and metabolic requirements, and therefore may be more vulnerable to anthropogenic disturbance (Wisniewska *et al*., 2016). However, several studies suggest that to some extent, marine mammals would be able to adapt their behaviour to reduce impacts on survival and reproduction rates and tolerate elevated levels of underwater sound during site investigation surveys. Marine mammals are also deemed to have a high tolerance to behavioural disturbance, and studies suggest that disturbance is unlikely to be ecologically significant for marine mammals.

For example, harbour porpoise behavioural responses were investigated in response to a commercial two-dimensional seismic airgun survey in the North Sea, conducted over 10 days and using an airgun array (impulsive sound source). The results demonstrated that prolonged survey noise did not lead to broad scale displacement of harbour porpoise (Thompson, *et al.,* 2013). Furthermore, Nabe-Nielsen *et al.,* (2014) found that in response to noise from wind turbines and ships, the impacts were minor, and sound was found to have no effect on the survival or resilience of the population. Furthermore, a study by Sarnocińska *et al.* (2020) indicated that although there was temporary displacement and change in harbour porpoise echolocation behaviour in response to a 3D seismic survey, prolonged use of seismic survey sound did not lead to broader-scale displacement into higher-risk habitats. Similar conclusions were also drawn from a ten-month study of overt responses to seismic exploration in humpback whale *Megaptera novaeangliae*, sperm whale *Physeter macrocephalus* and Atlantic spotted dolphin *Stenella frontalis,* which demonstrated no evidence of prolonged or large-scale displacement of these mammal species from the region during the survey (Weir, 2008). A study by Kates Varghese *et al*. (2020) also on behavioural responses specifically to MBES surveys found that the only marine mammal metric that changed was vocalisation rate and concluded that these changes in behaviour were unlikely to be biologically significant.

In addition, the marine mammal species assessed are mobile species, and likely to move away from loud sources of sound. Therefore, these survey works are considered of trivial disturbance (unlikely to result in population-level effects). Furthermore, the mitigation applied in the survey to reduce the impacts of sound, although not dealing with disturbance directly, will also assist in reducing the potential for disturbance effects.

4.2.5. SUMMARY OF RISK OF INJURY AND DISTURBANCE FOR THE DA SURVEY

Since the risk of injury can be mitigated effectively through the adoption of the standard JNCC measures (i.e., MMOs monitoring a 500 m mitigation zone and the assumed 15-minute soft-start), there is considered to be no residual risk to cetacean EPS, protected marine mammals, or basking shark.

For disturbance, it is possible that cetacean EPS, protected marine mammals and basking sharks may experience some limited behavioural effects. These effects are unlikely to result in any significant disturbance or displacement for these species. In addition, it is expected that, to some extent, since marine mammals are mobile species, they will be able to adapt their behaviour to reduce any effects, for example through avoidance behaviour. The risk of behavioural effects was therefore considered to be negligible.

4.2.6. POTENTIAL IMPACTS FOR THE ECC SURVEY

During the survey in the export cable corridor the sparker-type SBP is not used as deep sediment penetration is not needed. This means that the parametric SBP, with most energy at 85-115 kHz dominates the noise emitted from the vessel. The shallower waters in the ECC means the SBP will run with higher ping rates, leading to higher exposure levels compared to the deeper DA. Impact ranges for the VHF group are generally high, but due to high attenuation at the main frequencies the behavioural response ranges are shorter.

Risk ranges for peak pressure were under 10 m for all mammal groups for PTS and TTS limits, with the fishes TTS limits exceeded to approximately 50 meters. These risk ranges are presented in the following section, and summarised per group in Table 4:6, Table 4:7 and Table 4:8.

4.2.4.1 ECC-Coast

Starting ranges for fleeing animals of the VHF group extend to approximately 400 m, with the remaining groups having ranges below 20 m. Behavioural response ranges of 620 m and 850 m for marine mammals and fishes respectively (see Table 4:6).

Table 4:6. ECC-Coast, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	0	190	730	20	0	0
1 second exposure PTS risk [m]	0	20	300	0	0	0
0.5 hours' exposure TTS risk [m]	310	870	1600	420	90	260
0.5 hours' exposure PTS risk [m]	50	410	1040	100	0	100
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft-start)	5	234	878	14	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft-start)	3	12	365	3	3	0

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
Behavioural response range [m]	620	620	620	620	620	850

4.2.4.2 ECC-Mid

Starting ranges for fleeing animals of the VHF group extend to approximately 350 m, with the remaining groups having ranges below 10 m. Behavioural response ranges of 430 m and 660 m for marine mammals and fishes respectively (see Table 4:7).

Table 4:7. ECC-Mid, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	0	80	540	0	0	0
1 second exposure PTS risk [m]	0	0	160	0	0	0
0.5 hours' exposure TTS risk [m]	170	670	1360	260	30	130
0.5 hours' exposure PTS risk [m]	10	250	830	30	0	30
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft-start)	3	195	788	8	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft-start)	3	8	321	3	3	0
Behavioural response range [m]	430	430	430	430	430	660

4.2.4.3 ECC-Reef

Starting ranges for fleeing animals of the VHF group extend to approximately 400 m, with the remaining groups having ranges below 20 m. Behavioural response ranges of 620 m and 860 m for marine mammals and fishes respectively (see Table 4:8).

Table 4:8. ECC-Reef, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	0	190	730	20	0	0
1 second exposure PTS risk [m]	0	20	300	0	0	0
0.5 hours' exposure TTS risk [m]	310	870	1600	420	90	260
0.5 hours' exposure PTS risk [m]	50	410	1040	100	0	90
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft-start)	3	264	926	18	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft-start)	3	18	401	3	3	0
Behavioural response range [m]	620	620	620	620	620	860

Potential Injury Impacts

Again, the main species of concern for these surveys is the harbour porpoise (VHF group), which has a minimal starting range to avoid PTS for a fleeing animal (soft-start assumed) of between 321 m and 401 m for the ECC survey. Similar to the DA survey, these values fall below the 500 m exclusion zone (pre-survey watch) described in the standard JNCC mitigation guidelines for geophysical survey works (JNCC, 2017). Therefore, there is a very little acute risk of exceeding sound exposure levels for a member of the VHF group.

The remaining mammals and fishes likely to be present in the survey area had a risk range for PTS for fleeing animals of less than 18 meters. Therefore, given the 500 m exclusion zone, there is little to no risk of injury for these groups, as these species would have to be within 18 m of the vessel to experience a threshold shift in hearing.

Potential Disturbance Impacts

The behavioural response ranges for all species assessed were between 430 m and 850 m, meaning potential disturbance of these species is unlikely, especially when considering that these species are mobile and likely to move out of the vicinity of the survey area. Furthermore, any behavioural effects experienced are unlikely to have long-term ecological consequences (See Section 4.2.4 for further detail).

4.2.7. SUMMARY OF RISK OF INJURY AND DISTURBANCE FOR THE ECC SURVEY

Similarly, to the DA survey, the risk of injury to protected species in the ECC survey area is insignificant, following the adoption of the standard JNCC measures including MMOs monitoring a 500 m mitigation zone and 15-minute soft-start.

The behavioural response ranges for all of the groups assessed were found to be significantly lower than those of the DA survey. Therefore, any disturbance impacts were considered negligible for these surveys, noting the 15-minutie soft-start assumed in these calculations.

4.2.8. IMPACTS ON BASKING SHARKS

This section considers the impacts on basking sharks from the proposed survey activities. Since this species is known to migrate through the North Channel and has been previously sighted in the area, it is important that this species is assessed.

This hearing range of basking sharks is below that of the survey equipment used during these operations. Therefore, it is unlikely this species will be affected by the noise produced during these surveys, especially considering there is no evidence of sound causing morality or stress in this species. Since behavioural ranges for fishes in the DA survey are high, these impacts have been considered; however, since basking sharks are not known to use sound for feeding or communication, it is unlikely to significantly impact this species (Booth, *et al.,* 2013). In addition, these species are highly mobile and so significant adverse impacts to this species are considered unlikely. Despite the unlikelihood of being affected by noise, JNCC guidelines and best practice are still advised to reduce the pressures associated with scientific acoustic surveys, to ensure to the highest degree of confidence that basking sharks are not disrupted (JNCC, 2017).

The use of MMOs and other standard mitigation measures will also reduce the likelihood of impacts to basking sharks, and will reduce any risk of ship strike from the survey vessel/s. There is little data on the frequency of ship strikes on baking sharks (Booth, *et al*., 2013), and given the vessels will be slow-moving, the potential for collision is generally low. However, any existing risk of this occurrence will be mitigated using MMOs before survey operations to detect baking sharks at the surface.

Therefore, given the surveys will adhere to JNCC guidelines and imply associated mitigation, as well as the risk of injury and disturbance from sound being considered negligible, basking sharks are not expected to be at risk of injury or disturbance from these survey operations.

4.2.9. CUMULATIVE IMPACTS

Cumulative impacts are those which can occur from survey operations occurring over a similar area at the same time, at different times and from numerous simultaneous human activities which produce sound in combination with each other. The surveys are due to take place in the North Channel of the Irish Sea over 15 days for the offshore vessel and 3 days for the nearshore survey vessel (subject to weather constraints). The North Channel is one of the principal maritime gateways in the UK, contributing to the European Spatial Development Perspectives (ESDP, 1999), and with several important ports nearby, making it a busy maritime space. However, since there is no residual risk (following application of mitigation measures) of injury to marine protected species from these surveys alone, there is no potential for cumulative injury effects. Therefore, cumulative effects are not considered further in this assessment.

4.3. MITIGATION MEASURES

The following section outlines the mitigation measures which should be applied to reduce the risk of injury to marine mammals and includes the relevant measures which are incorporated as part of the consenting regimes for geophysical activities within the United Kingdom Continental Shelf (UKCS). Whilst these measures may have some limitations, they are based on reasonably conservative assumptions, and should reduce the risk of injury to marine mammals to negligible levels (JNCC, 2017). The mitigation measures which have been discussed in the above risk assessment are detailed in Table 4:9, with the detailed procedures being laid out in JNCC's "guidelines for minimising the risk of injury to marine mammals from geophysical surveys" (JNCC, 2017).

Table 4:9. Mitigation measures for the proposed survey operations. Details of mitigation taken from JNCC (2017).

Mitigation Measure	Assumed in Modelling? (Y/N)	Description	Procedure upon marine mammal detection (JNCC, 2017)
Soft-Start	Y	A soft-start of 15 minutes consists of having a maximum of 1 ping or pulse per second for the sub-bottom profilers for this duration. This will give animals more time to flee while the noise emissions are relatively lower.	If marine mammals are detected in the mitigation zone during survey activities, either during soft-start or at full power, there is no requirement to stop the survey activities.
Exclusion Zone – Marine Mammal Observer	N	A 30-minute search by a certified MMO prior to survey start to establish likely absence of marine mammals within 500 m of the vessel prior to commencing soft-start. Given the risk ranges of the VHF group extend to 400m this is recommended to mitigate likely hearing injury.	If marine mammals are detected, the soft-start should be delayed until their passage and the soft-start should be commenced again once 20 mins have elapsed since the last sighting in the mitigation zone
Equipment Limitations	N	This is not a described mitigation; however, assumes that any SBP used similar to the Innomar model will have peak pressure levels below 240 dB L_P and 1-second exposure levels below 208 dB L_E in the frequency range 85-115 kHz (final equipment configuration will not be louder than the presented equipment).	The procedures are the same for unplanned, and for planned breaks: For breaks of <10 minutes there is no requirement for soft-start and the survey will recommence at the same level provided no marine mammals/basking shark have been detected in the mitigation zones during the break; and For breaks of >10 minutes the full mitigation procedure (as described above) will be adopted including pre-survey monitoring and soft-start.
MMO Monitoring	N	Use of a certified MMO on board to undertake exclusion zone search and to monitor the mitigation zones during any unplanned breaks during operations. For planned breaks, mitigation zone monitoring should commence prior to the break, so that 20 minutes of monitoring can be achieved.	
Noise Reduction	N	Where possible, the amount of anthropogenic noise entering the marine environment will be minimised through the operations using the lowest practicable power levels. The use of noise emitting survey equipment will also be minimised, so that it is only fired when necessary.	n/a

By applying the mitigation measures detailed above, the risk of injury to marine mammals will be reduced to negligible levels.

5. CONCLUSIONS

This EPS and Marine Wildlife Risk Assessment investigated the likelihood of the proposed geophysical surveys in the North Channel Wind 1 Development Area and Export Cable Corridor presenting a risk of injury or disturbance to protected marine species. The noise sources included in the assessment were noise from the vessel, SSS (not included in the risk underwater sound modelling), MBES and SBP, which were assessed in combination using the criteria for impulsive and non-impulsive noise.

The hearing group most at risk of injury from the underwater sound produced by the geophysical surveys was the VHF group, which for this site was namely the harbour porpoise. However, the risk ranges of injury (PTS) to a moving animal of the VHF group during these surveys was between 321 m and 401 m, which falls within the 500 m mitigation range which would be monitored by MMOs prior to the start of surveys (the exclusion zone). As such, there was no residual acute risk of injury for these species from either the DA or ECC surveys. In addition, given the slow start procedures in place, it is expected that the animals should have sufficient time to flee from the vessel and effectively vacate the 500 m exclusion zone prior to surveys. All other marine mammals and fishes assessed had risk ranges which were under 18 m, and therefore the risk to these hearing groups is considered of little to no risk, especially when considering the mitigation measures applied.

Therefore, under the assumptions laid out for the survey method, the sources used, and the mitigation applied, the noise arising from surveys of the ECC, and the DA is unlikely to cause permanent injury to marine mammals and fishes.

While there is little risk of exceedance of the injury limits, we note that the surveys use high-powered sound sources that, while not likely to cause auditory harm, are likely to exceed the behavioural response limits as well as temporary hearing impact limits to 5-10 km for harbour porpoises, seals, and fishes. However, the potential disturbance effects from these surveys on protected marine species are unlikely to qualify as a ‘non-trivial disturbance’ and therefore unlikely to significantly impact the marine animal, or its population status in the wild. This conclusion was sought from previous studies on disturbance from similar surveys and also takes into consideration the standard mitigation measures applied. Therefore, it is concluded that there is a negligible risk of disturbance to the species of concern.

On the basis of this risk assessment, it is concluded that there is no licensing requirement for EPS and protected Marine Wildlife.

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7. APPENDICIES

7.1. APPENDIX 1: NORTH CHANNEL WIND GEOPHYSICAL SURVEY SUBSEA NOISE TECHNICAL REPORT

NORTH CHANNEL WIND, GEOPHYSICAL SURVEY

SUBSEA NOISE TECHNICAL REPORT

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Glossary

Term	Meaning
Decibel (dB)	A customary scale most commonly used (in various ways) for reporting levels of sound. The actual sound measurement is compared to a fixed reference level and the "decibel" value is defined to be $10 \cdot \log_{10}$(actual/reference), where (actual/reference) is a power ratio. The standard reference for underwater sound pressure is 1 micro-Pascal (µPa), and 20 micro-Pascals is the standard for airborne sound. The dB symbol is followed by a second symbol identifying the specific reference value (i.e. re 1 µPa).
Grazing angle	A glancing angle of incidence (the angle between a ray incident on a surface and the line perpendicular to the surface).
Permanent Threshold Shift (PTS)	A total or partial permanent loss of hearing caused by some kind of acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
Temporary Threshold Shift (TTS)	Temporary loss of hearing as a result of exposure to sound over time. Exposure to high levels of sound over relatively short time periods will cause the same amount of TTS as exposure to lower levels of sound over longer time periods. The mechanisms underlying TTS are not well understood, but there may be some temporary damage to the sensory cells. The duration of TTS varies depending on the nature of the stimulus, but there is generally recovery of full hearing over time.
Sound Exposure Level (L_E)	The cumulative sound energy in an event, formally: “ten times the base-ten logarithm of the integral of the squared pressures divided by the reference pressure squared”. Equal to the often seen “SEL” or “dB SEL” quantity. Defined in: ISO 18405:2017, 3.2.1.5
Sound Pressure level (SPL)	The average sound energy over a specified period of time, formally: “ten times the base-ten logarithm of the arithmetic mean of the squared pressures divided by the squared reference pressure”. Equal to the deprecated “RMS level”, “dB_{rms}” and to Leq if the period is equal to the whole duration of an event. Defined in ISO 18405:2017, 3.2.1.1
Peak Level, Peak Pressure Level (L_P)	The maximal sound pressure level of an event, formally: “ten times the base-ten logarithm of the maximal squared pressure divided by the reference pressure squared” or “twenty time the base-ten logarithm of the peak sound pressure divided by the reference pressure, where the peak sound pressure is the maximal deviation from ambient pressure”. Defined in ISO 18405:2017, 3.2.2.1

Acronyms

Term	Meaning
ADD	Acoustic Deterrent Device
LF	Low Frequency (Cetaceans)
HF	High Frequency (Cetaceans)
VHF	Very High Frequency (Cetaceans)
MF	*Mid Frequency (Cetaceans) – DEPRECATED only for reference to NOAA/NMFS 2018 groups*
NMFS	National Marine Fisheries Service
OW/OCW	Otariid pinnipeds/Other Carnivores in water (refers to the same weighting and animal groups)
PTS	Permanent Threshold Shift
PW/PCW	Phocid pinnipeds
RMS	Root Mean Square
L_E	Sound Exposure Level, [dB]
SPL	Sound Pressure Level, [dB]
L_P	Peak Pressure Level, [dB]
TTS	Temporary Threshold Shift
PTS	Permanent Threshold Shift

Units

Unit	Description
dB	Decibel (Sound)
Hz	Hertz (Frequency)
kHz	Kilohertz (Frequency)
kJ	Kilojoule (Energy)
km	Kilometre (Distance)
km^2	Kilometre squared (Area)
m	Metre
ms	Millisecond (10^{-3} seconds) (Time)
ms^{-1} or m/s	Metres per second (Velocity)
µPa	Micro Pascal
Pa	Pascal (Pressure)
psu	Practical Salinity Units (parts per thousand of equivalent salt in seawater)
kg/m^3	Specific density (of water, sediment or air)
Z	Acoustic impedance [$kg/(m^2{\cdot}s)$ or $(Pa{\cdot}s)/m^3$]

Units will generally be enclosed in square brackets e.g.: “[m/s]”

1 INTRODUCTION

This Subsea Noise Technical Report presents the results of a desktop study considering the potential short terms effects of underwater noise on the marine environment from the geophysical survey to map the application area (hereafter referred to as "the Project"). The project is approximately 15 km off the north-eastern Northern Ireland coast, with water depths up to 200 m.

Sound is readily transmitted into the underwater environment and there is potential for the sound emissions from anthropogenic sources to adversely affect marine mammals and fish. At close ranges from a noise source with high noise levels, permanent or temporary hearing damage may occur to marine species, while at a very close range gross physical trauma is possible. At long ranges (several kms) the introduction of any additional noise could, for the duration of the activity, potentially cause behavioural changes, for example to the ability of species to communicate and to determine the presence of predators, food, underwater features, and obstructions

This report provides an overview of the potential effects due to underwater noise from the Project on the surrounding marine environment based on the Southall et al. 2019 and Popper et al. 2014 framework for assessing impact from noise on marine mammals and fishes.

Consequently, the primary purpose of the underwater noise assessment is to predict the likely range of onset for potential physiological and behavioural effects due to increased anthropogenic noise as a result of the Project.

2 ASSESSMENT CRITERIA

2.1 General

To determine the potential spatial range of injury and disturbance, assessment criteria have been developed based on a review of available evidence including national and international guidance and scientific literature. The following sections summarise the relevant assessment criteria and describe the evidence base used to derive them.

Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Assessment criteria generally separate sound into two distinct types, as follows:

- **Impulsive sounds** which are typically transient, brief (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI 1986; NIOSH 1998; ANSI 2005). This category includes sound sources such as seismic surveys, impact piling and underwater explosions.

- **Non-impulsive (continuous) sounds** which 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 (ANSI 1995; NIOSH 1998). This category includes sound sources such as continuous vibro-piling, running machinery, some sonar and vessels.

The acoustic assessment criteria for marine mammals and fish in this report has followed the latest international guidance (based on the best available scientific information), that are widely accepted for assessments in the UK, Europe and worldwide (Southall, et al.; Popper, et al., 2014).

2.2 Injury to Marine mammals

Underwater noise has the potential to affect marine life in different ways depending on its noise level and characteristics. Richardson *et al.* (1995) defined four zones of noise influence which vary with distance from the source and level, to which we have added the “zone of temporary hearing loss”. These are:

- **The zone of audibility**: this is the area within which the animal can detect the sound. Audibility itself does not implicitly mean that the sound will affect the marine mammal.

- **The zone of masking**: this is defined as the area within which noise can interfere with the detection of other sounds such as communication or echolocation clicks. This zone is very hard to estimate due to a paucity of data relating to how marine mammals detect sound in relation to masking levels (for example, humans can hear tones well below the numeric value of the overall noise level).

- **The zone of responsiveness**: this is defined as the area within which the animal responds either behaviourally or physiologically. The zone of responsiveness is usually smaller than the zone of audibility because, as stated previously, audibility does not necessarily evoke a reaction. For most species there is very little data on response, but for species like harbour porpoise there exists several studies showing a relationship between received level and probability of response (Graham IM, 2019; Sarnoci´nska J, 2020; BOOTH, 2017; Benhemma-Le Gall A, 2021).

- **The zone of temporary hearing loss**: The area where the sound level is high enough to cause the auditory system to lose sensitivity temporarily, causing loss of “acoustic” habitat, the volume of water that can be sensed by hearing by the animal.

- **The zone of injury / permanent hearing loss**: this is the area where the sound level is high enough to cause tissue damage in the ear. This is usually classified as permanent threshold shift (PTS). At even closer ranges, and for very high intensity sound sources (e.g. underwater explosions), physical trauma or acute mortal injuries are possible.

For this study, it is the zones of injury (PTS) that are of primary interest, along with estimates of behavioural impact ranges. To determine the potential spatial range of injury and behavioural change, a review has been undertaken of available evidence, including international guidance and scientific literature. The following sections summarise the relevant thresholds for onset of effects and describe the evidence base used to derive them.

The zone of injury in this study is classified as the distance over which a marine mammal can suffer PTS leading to non-reversible auditory injury. Injury thresholds are based on a dual criteria approach using both un-weighted L_P (maximal instantaneous SPL) and marine mammal hearing weighted L_E. The hearing weighting function is designed to represent the sensitivity for each group within which acoustic exposures can have auditory effects. The categories include:

- **Low Frequency (LF) cetaceans**: Marine mammal species such as baleen whales (e.g. minke whale *Balaenoptera acutorostrata*).
- **High Frequency (HF) cetaceans**: Marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales (e.g. bottlenose dolphin *Tursiops truncates* and white-beaked dolphin *Lagenorhynchus albirostris*).
- **Very High Frequency (VHF) cetaceans**: Marine mammal species such as true porpoises, river dolphins and pygmy/dwarf sperm whales and some oceanic dolphins, generally with auditory centre frequencies above 100 kHz) (e.g. harbour porpoise *Phocoena phocoena*).
- **Phocid Carnivores in Water (PCW)**: True seals, earless seals (e.g. harbour seal *Phoca vitulina* and grey seal *Halichoreus grypus*); hearing in air is considered separately in the group PCA.
- **Other Marine Carnivores in Water (OCW)**: Including otariid pinnipeds (e.g. sea lions and fur seals), sea otters and polar bears; air hearing considered separately in the group Other Marine Carnivores in Air (OCA).
- **Sirenians (SI)**: Manatees and dugongs. This group is only represented in the NOAA guidelines.

These weightings have therefore been used in this study and are shown in Figure 2-1. It should be noted that not all of the above categories of marine mammal will be present in the Project area but criteria are presented in this report for completeness.

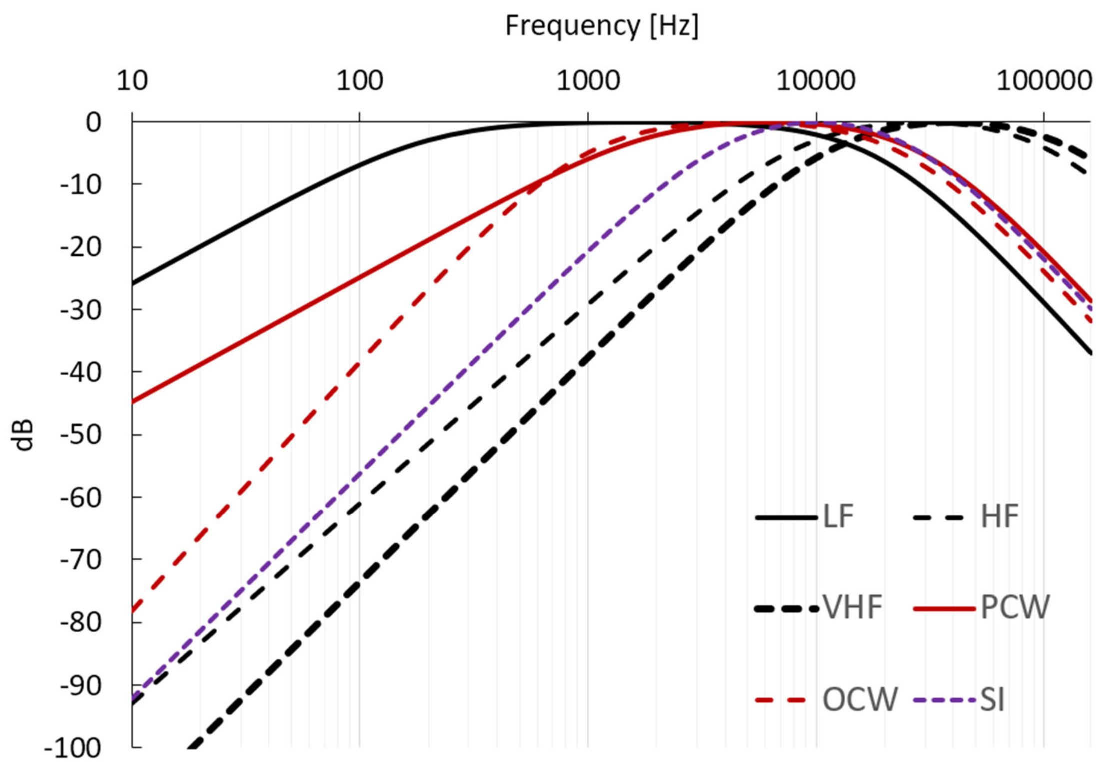

Figure 2-1: Hearing weighting functions for pinnipeds, cetaceans and sirenians (NMFS, 2018; Southall et al. 2019)

Both the criteria for impulsive and non-impulsive sound are relevant for this study given the nature of the sound sources used during the Project. The relevant PTS and TTS criteria proposed by Southall *et al.* (2019) are summarised in Table 2-1.

Table 2-1: PTS and TTS onset acoustic thresholds (Southall *et al., 2019*; Tables 6 and 7)

Hearing Group	Parameter	Impulsive [dB]		Non-impulsive [dB]	
Low frequency (LF) cetaceans	L_P, (unweighted)	219	213	-	-
	L_E, (LF weighted)	183	168	199	179
High frequency (HF) cetaceans	L_P, (unweighted)	230	224	-	-
	L_E, (MF weighted)	185	170	198	178
Very high frequency (VHF) cetaceans	L_P, (unweighted)	202	196	-	-
	L_E, (HF weighted)	155	140	173	153
Phocid carnivores in water (PCW)	L_P, (unweighted)	218	212	-	-
	L_E, (PW weighted)	185	170	201	181
Other marine carnivores in water (OCW)	L_P, (unweighted)	232	226	-	-
	L_E, (OW weighted)	203	188	219	199

Hearing Group	Parameter	Impulsive [dB]		Non-impulsive [dB]	
Sirenians (SI) (NOAA only)	L_P, (unweighted)	226	220	-	-
	L_E, (OW weighted)	190	175	206	186

These updated marine mammal injury criteria were published in March 2019 (Southall, et al.). The paper utilised the same hearing weighting curves and thresholds as presented in the preceding regulations document NMFS (2018) with the main difference being the naming of the hearing groups and introduction of additional thresholds for animals not covered by NMFS (2018). A comparison between the two naming conventions is shown in Table 2-2.

The naming convention used in this report is based upon those set out in Southall *et al*. (2019). Consequently, this assessment utilises criteria which are applicable to both NMFS (2018) and Southall *et al*. (2019).

Table 2-2: Comparison of Hearing Group Names between NMFS (2018) and Southall *et al.* (2019)

NMFS (2018) hearing group name	Southall *et al*. (2019) hearing group name
Low-frequency cetaceans (LF)	LF
Mid-frequency cetaceans (MF)	HF
High-frequency cetaceans (HF)	VHF
Phocid pinnipeds in water (PW)	PCW
Otariid pinnipeds in water (OW)	OCW
Sirenians (SI)	Not included

2.3 Disturbance to Marine Mammals

Disturbance thresholds for marine mammals are summarised in Table 2-3. Note that the non-impulsive threshold can often be lower than ambient noise for coastal waters with some human activity, meaning that ranges determined using this limit will tend to be higher than actual ranges.

Table 2-3: Disturbance Criteria for Marine Mammals Used in this Study based on Level B harassment of NMFS (National Marine Fisheries Service, 2005)

Effect	Non-Impulsive Threshold	Impulsive Threshold
Disturbance (all marine mammals)	120 dB SPL	160 dB $L_{E\ single\ impulse}$ or 1-second L_E

2.4 Injury and Disturbance to Fish and Sea Turtles

The injury criteria used in this noise assessment are given in Table 2-4 and Table 2-5 for impulsive noises and continuous noise respectively. L_P and L_E criteria presented in the tables are unweighted. Physiological effects relating to injury criteria are described below (Popper, et al., 2014):

- **Mortality and potential mortal injury**: either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g. a barotrauma) that death occurs sometime later due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity.

- **Recoverable injury (PTS)**: Tissue and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place. This level of impact is used here as PTS, even though it is not strictly permanent for fish. This is to better reflect the fact that this level of impact is perceived as serious and detrimental to the fish.

- **TTS**: Short term changes in hearing sensitivity may, or may not, reduce fitness and survival. Impairment of hearing may affect the ability of animals to capture prey and avoid predators, and also cause deterioration in communication between individuals, affecting growth, survival, and reproductive success. After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of sound exposure.

Popper et al. 2014 does not set out specific TTS limits for L_P and for disturbance limits for impulsive noise for fishes. Therefore publications: “Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual” (WSDOT, 2011) and “Canadian Department of Fisheries and Ocean Effects of Seismic energy on Fish: A Literature review” (Worcester, 2006) on effects of seismic noise on fish are used to determine limits for these:

1. The criteria presented in the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011). The manual suggests an un-weighted sound pressure level of 150 dB SPL (assumed to be duration of 95 % of energy) as the criterion for onset of behavioural effects, based on work by (Hastings, 2002). Sound pressure levels in excess of 150 dB SPL are expected to cause temporary behavioural changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury but may indirectly affect the individual fish (such as by impairing predator detection). It is important to note that this threshold is for onset of potential effects, and not necessarily an ‘adverse effect’ threshold. Again, the threshold is implemented as either single impulse L_E or 1 second L_E, whichever is greater

2. The report from the Canadian Department of Fisheries and Ocean “Effects of Seismic energy on Fish: A Literature review on fish” (Worcester, 2006) found large differences in response between experiments. Onset of behavioural response varied from 107-246 dB L_P , the 10th percentile level for behavioural response was 158 dB L_P, given the large variations in the data, we have rounded this to 160 dB L_P as the behavioural limit for fishes for impulsive noise.

Table 2-4: Criteria for onset of injury to fish and sea turtles due to impulsive noise

Type of animal	Unit	Mortality and potential mortal injury [dB]	Recoverable injury (PTS) [dB]	TTS [dB]	Behavioural [dB]
Fish: no swim bladder (particle motion detection)	L_E	219[1]	216[1]	186[1]	150[3]
	L_P	213[1]	213[1]	193[2]	189[2]
Fish: where swim bladder is not involved in hearing (particle motion detection)	L_E	210[1]	203[1]	186[1]	150[3]
	L_P	207[1]	207[1]	193[2]	189[2]
Fish: where swim bladder is involved in hearing (primarily pressure detection)	L_E	207[1]	203[1]	186	150[3]
	L_P	207[1]	207[1]	193[2]	189[2]
Sea turtles	L_E	210[1]	(*Near*) High (*Intermediate*) Low (*Far*) Low	-	-
	L_P	207[1]		-	-
Eggs and larvae	L_E	210[1]	(*Near*) Moderate (*Intermediate*) Low (*Far*) Low	-	-
	L_P	207[1]		-	-

[1] (Popper et al. 2014)
[2] (Worcester, 2006)
[3] (WSDOT, 2011)

Where Popper et al. 2014 present limits as “>” 207 or “>>” 186, we have ignored the “greater than” and used the threshold level as given.

Relevant limits for fishes relating to PTS, TTS, and behaviour are given in the table below. Note that for the behaviour limit we have used the impulsive limit as basis for the continuous noise limit, in absence of better evidence.

Table 2-5: Criteria for onset of injury to fish and sea turtles due to continuous noise from Popper et al. 2014 (generalised to all fishes).

Type of animal	Unit	Mortality and potential mortal injury	Recoverable injury (PTS) [dB]	TTS [dB]	Behavioural [dB]
All fishes	L_E	-	222	210	150 [SPL]*

*This is based on the impulsive criteria.

3 METHOD, ENVIRONMENT & SITE

The following section is based on the information given in the document "NCW ML Schedule of works.docx" dated 2023-05-15 as well as written communication with the client.

3.1 Sites

Although the sites form one contiguous area, it is useful to separate them into "development area" (DA) and "export cable corridor" (ECC) as the survey designs differ between the two sites (see **Figure 3-1**).

The DA covers approximately 176 km² with depths from 120-130 m covering a relatively flat sediment surface mostly characterised by gravelly sand.

The ECC covers approximately 260 km² with depths from 0-210 m covering undulating bathymetry. The sediment is a combination rocks, gravelly & sand.

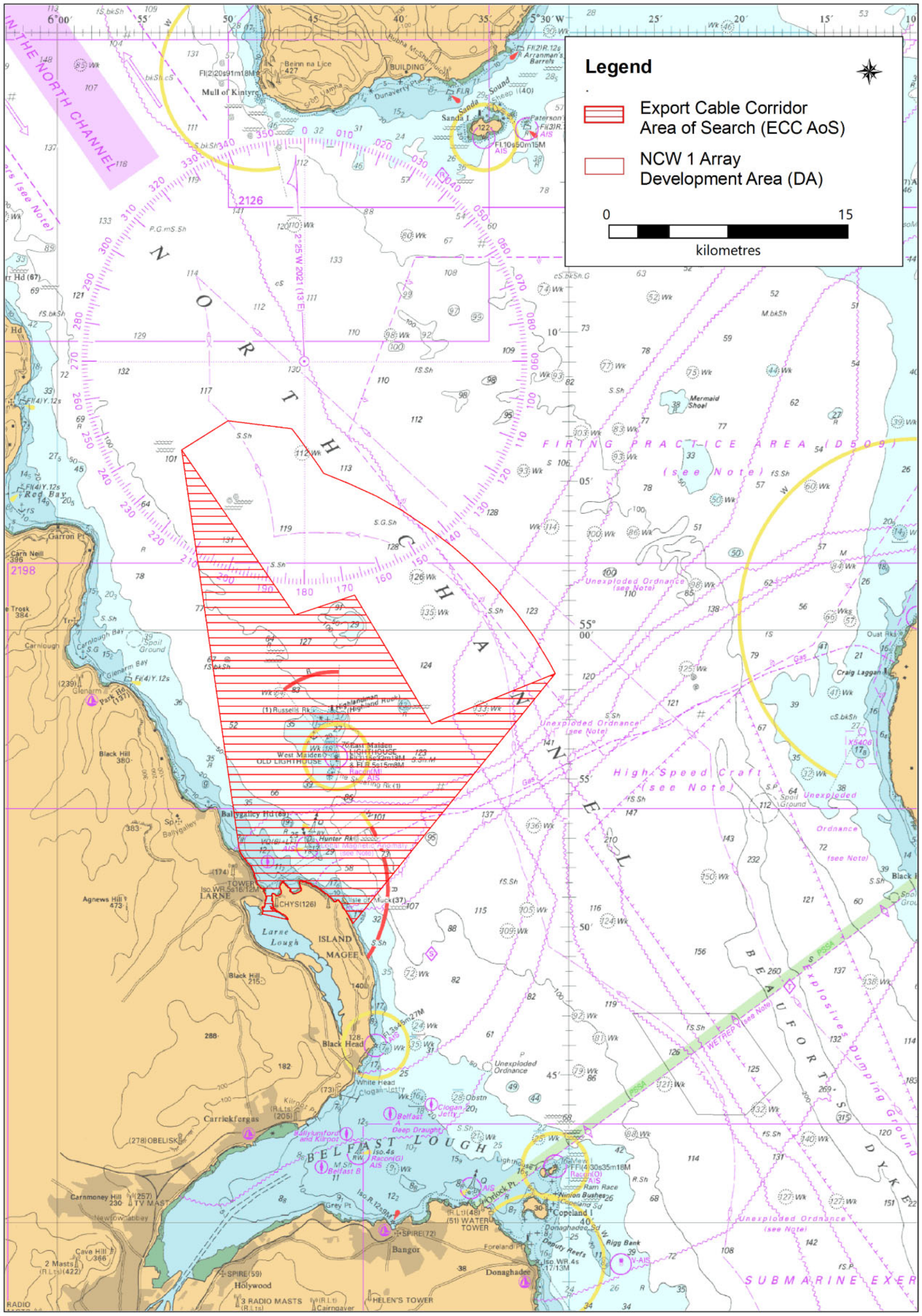

Figure 3-1: Marine Licence Application Area comprising North Channel Wind 1 DA and ECC AoS

3.2 Survey Method

Both sites will be surveyed using similar geophysical survey equipment (see Table 4-1), but the survey lines layout differs corresponding to the respective uses of the sites.

Details on the expected equipment to be used (or representative equipment) can be found in section 4, “Source Noise Levels”.

The vessel is assumed to move at 2 knots during surveying (1 m/s). This speed affects the time a stationary receiver is exposed to the survey, and thus a slower speed is precautionary. The actual speed will likely be 3-4 knots (1.5-2.1 m/s).

Survey line layouts as given in the below are preliminary, but changes to the survey line layout is unlikely to change the conclusion of this assessment given that the whole area needs to be covered regardless.

3.2.1 Development Area

The DA needs to be completely characterised and will be fully covered by transect lines at 125 m centres, running in NW-SE direction, with additional perpendicular lines running at 1 km centres to cross-check the acquired data (Figure 3-2). This means that the main survey lines are 10-20 km long with the perpendicular lines being 6-10 km.

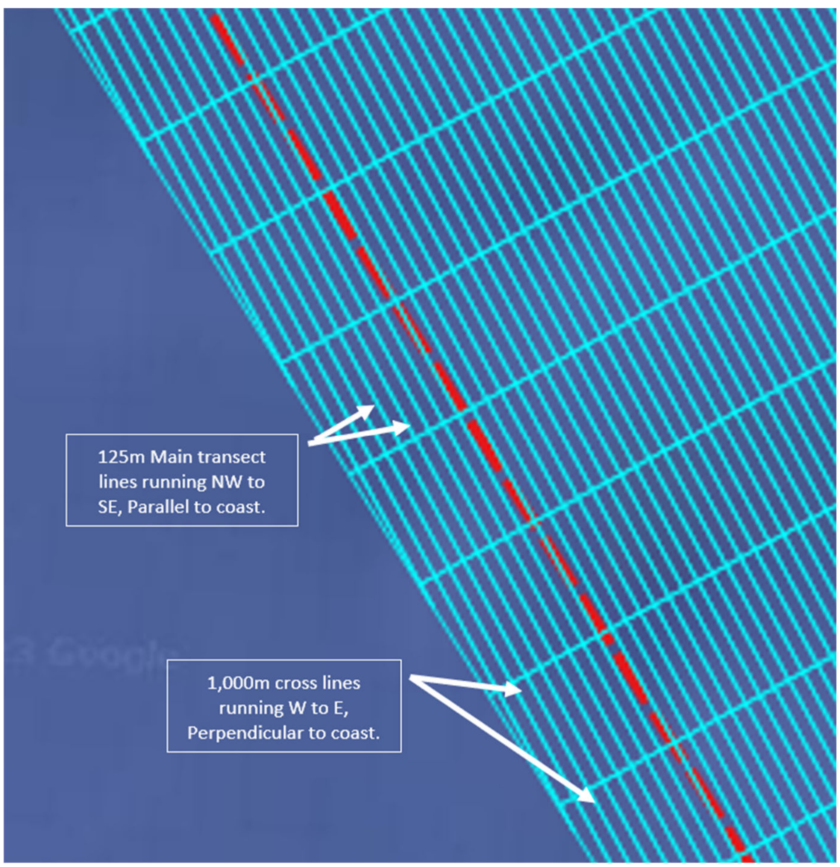

Figure 3-2: Development area example transects

3.2.2 Export Cable Corridor Area

The ECC does not require full characterisation, only the route identified as suitable will be surveyed. The final route is not currently known but will be 12-30 km (probably ~20 km) long and the surveyed area will be approximately 1500 m wide (750 m either side of the route). Survey line spacing will be 25 m at the centre of the proposed corridor and 75 m further away (Figure 3-3).

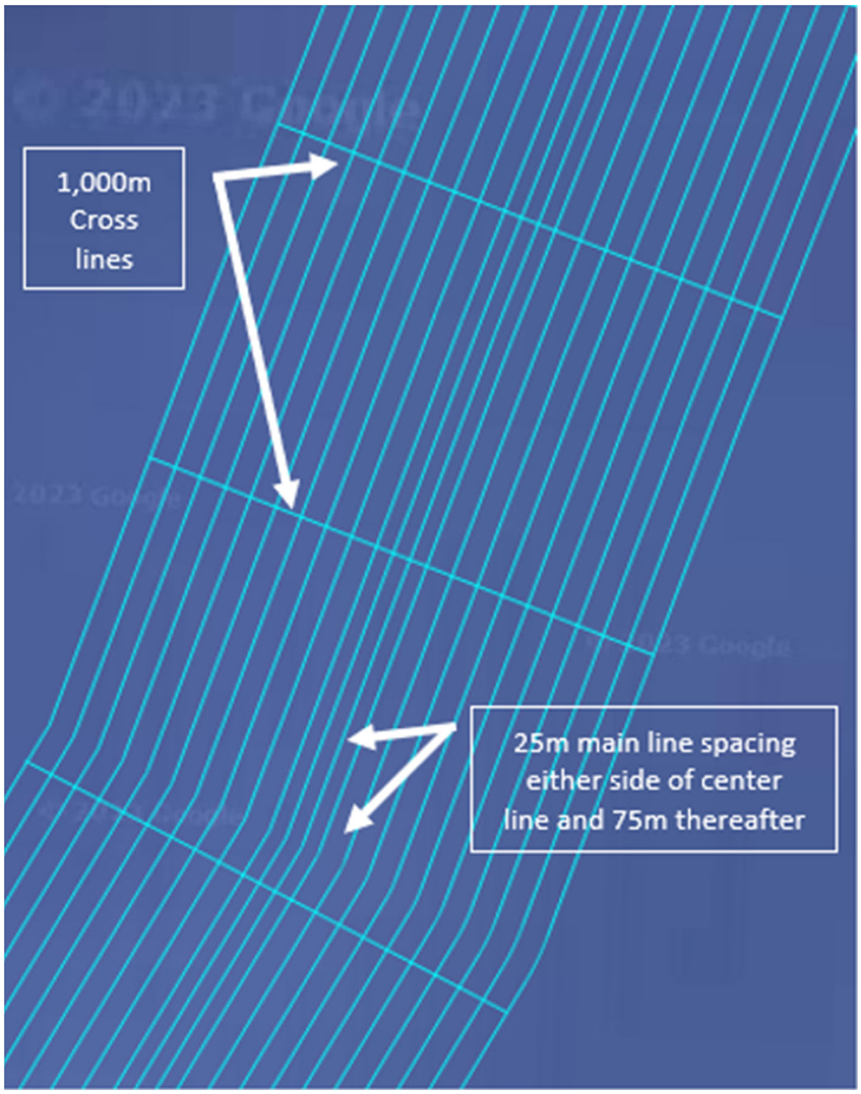

Figure 3-3: Export Cable Corridor transects

3.3 Source locations

Modelling was based on selected locations within the two sites. The locations were chosen to ensure a conservative assessment that covers the variation in the site (Table 3-1 & Figure 3-4) :

1. DA-SE:
   Location in the DA towards the centre of the north Irish Sea and south-east end of the DA. Surrounding waters uniformly deep.

2. DA-NW:
   Location in the DA towards the coastal slope and north-west end of the DA. Surrounding waters slope up to land (Antrim) to the west, flat to the east.

3. ECC-Coast:
   Location in the ECC near the coast to assess impacts on shallow slope.

4. ECC-Mid:
   Location at ~120 m depth on flat seabed, representing the middle section of the ECC likely to form a significant part of the final corridor.

5. ECC-Reef:
   Location on rocky reef north-west of “East Maiden” lighthouse and west of “Highlandman” marker.

Table 3-1: Modelled source locations for the two sites

Site	Source easting (UTM 30N)	Source Northing (UTM 30N)
DA-SE	332961	6097680
DA-NW	322335	6106757
ECC-Coast	321065	6084978
ECC-Mid	329471	6086819
ECC-Reef	322845	6091946

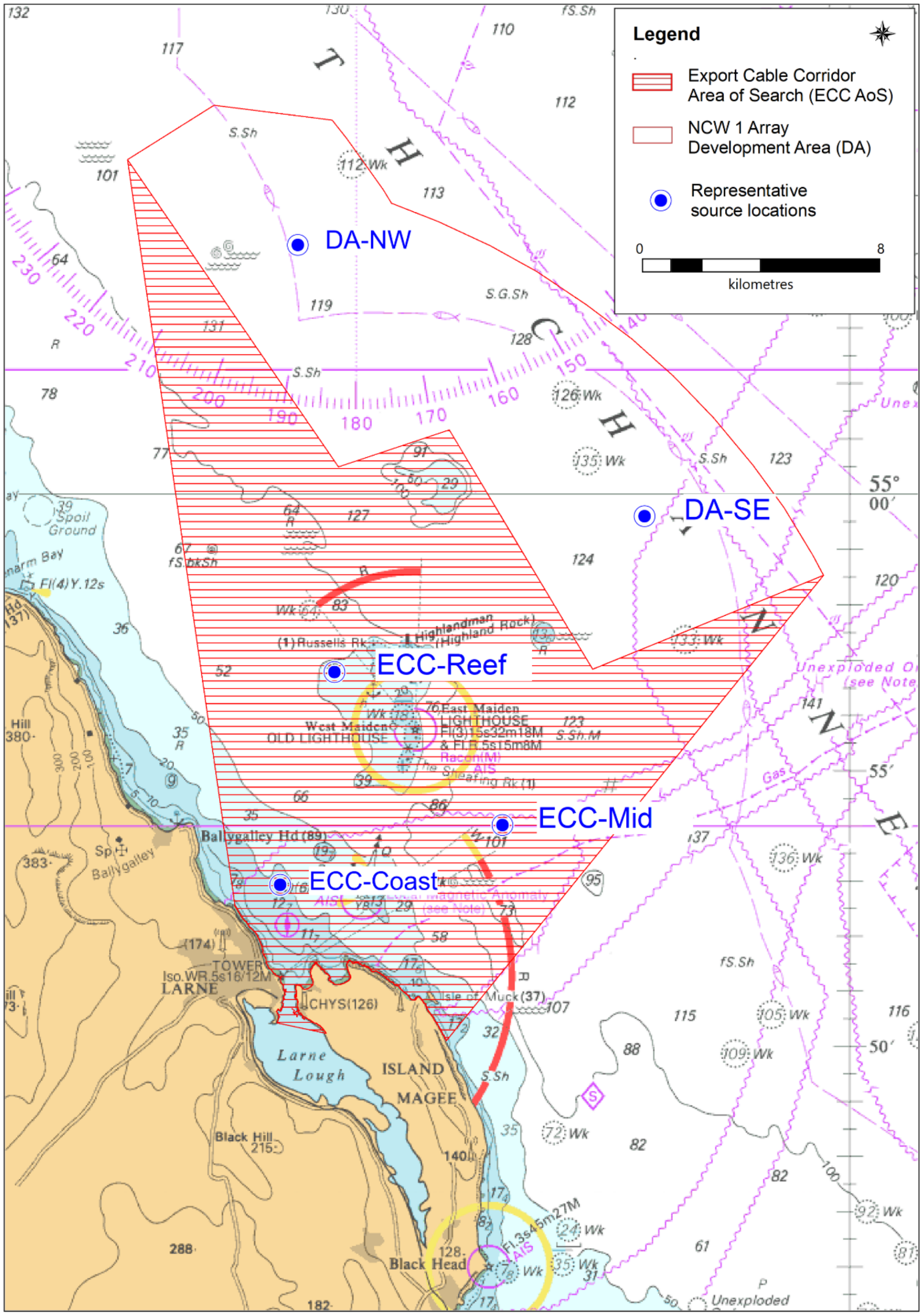

Figure 3-4: Map of selected representative source locations within ECC and DA areas.

3.4 Water Properties

Water properties were determined from historical data for the area. Where a range of values are expected the value leading to less transmission loss was chosen for a more conservative assessment. This thus covers seasonal variation.

- Temperature: 13 degrees – maximal temperature given by Met Eireann for the north Irish Sea[1].
- Salinity: 35 psu
- Soundspeed profile: Assumed uniform given high mixing as a result of tidal flows. A uniform soundspeed profile is conservative compared to the likely downward refracting soundspeed profiles seen during summer months (higher temperature in the surface leads to higher soundspeeds).

3.5 Sediment Properties

Sediment properties are taken from EMODnet[2] "Folk 7-class Classification", nautical charts[3] and British Geological Survey (British Geological Survey, 2023). A sediment model (Ainslie, 2010) was used to derive the acoustic properties of the sediments from the grains size:

Table 3-2: Sediment properties

Site	Sediment type (Folk 7)	Density [kg/m³]	Soundspeed [m/s]	Grain size [mm] (nominal)
DA-SE	Coarse sediment/sand	2428	1950	1.4
DA-NW	Coarse sediment	2597	2035	2.8
ECC-Coast	Mixed sediment/coarse sediment	2273	1874	0.71
ECC-Mid	Coarse sediment	2597	2035	2.8
ECC-Reef	Gravel/Rock & Boulders	2962	2221	11

[1] https://www.met.ie/climate/average-monthly-sea-temperature-at-malin-head/

[2] https://emodnet.ec.europa.eu/ sediment model "Folk 7-class" classification.

[3] https://fishing-app.gpsnauticalcharts.com/i-boating-fishing-web-app/fishing-marine-charts-navigation.html

4 SOURCE NOISE LEVELS

Underwater noise sources are usually quantified in dB scale with values generally referenced to 1 µPa pressure amplitude as if measured at a hypothetical distance of 1 m from the source (called the Source Level). In practice, it is not usually possible to measure at 1 m from a source, but the metric allows comparison and reporting of different source levels on a like-for-like basis. In reality, for a large sound source this imagined point at 1 m from the acoustic centre does not exist. Furthermore, the energy is distributed across the source and does not all emanate from this imagined acoustic centre point. Therefore, the stated sound pressure level at 1 m does not occur for large sources. In the acoustic near field (i.e. close to the source), the sound pressure level will be significantly lower than the value predicted by the back-calculated source level (SL).

4.1 Source models

The noise sources and activities investigated during the subsea noise assessment study are summarised in Table 4-1. Source locations are given in Table 3-1.

Source levels for the active equipment were combined to produce a “combined” source that represents the survey vessel’s sound signature while actively surveying during the survey (see Figure 4-1).

Note that source levels vary depending on the location of the survey due to two factors:

1. The ping rate, and therefore the SPL of the source, varies with the local depth.
2. During the survey of the DA an additional sub-bottom profiler is active to achieve deeper sediment penetration (an Ultra High Resolution Seismic (UHRS) sparker type) .

The side-scan sonar has not been included in the assessment as it’s minimal frequency (230 kHz) is far higher than the maximal frequency audible to the VHF hearing group (~125 kHz). Even allowing for spectral leakage (energy “leakage” into other frequencies due to the acoustic properties of the transducer) it’s unfeasible that there will be significant energy below 150 kHz to be relevant.

The multibeam echosounder is likewise well above the upper limit of hearing for the VHF group, but has been included as the spectral leakage might mean that enough energy makes it into the hearing range of the VHF group (Figure 4-1).

The parametric sub-bottom profiler (“Sub-bottom profiler 1” in Table 4-1) has a very narrow beam directed vertically down, with levels attenuating rapidly as the angle away from vertical increases. We have used the source level at an angle of 20 degrees from vertical for the assessment. This means that for the deeper sites (130 m) there will be an approximately 50 m radius around the vessel where we will underpredict the impact for animals at the sediment depth (130 m), reducing to 20 m at 50 m depth (i.e. a cone under the SBP with a width of 40 degrees). For the soft starts (minimum 15 minutes) the ping rate of the parametric SBP reduces to 1 ping per second, effectively reducing the exposure level (L_E) of the source. The results assume this source is limited to a maximal L_P of 240 dB and maximal 1 second L_E of 208 dB, with a similar beam pattern to the Innomar SBPs. The results also assume that the source of the additional sub-bottom profiler (an UHRS sparker type) (“Sub-bottom profiler 2” in Table 4-1) is also limited to a maximal LP of 240 dB and maximal 1 second LE of 208 dB, with a similar beam pattern to the Innomar SBPs.

Table 4-1: Summary of Noise Sources and Activities Included in the Subsea Noise Assessment

Equipment	Source level [SPL]	Primary frequencies (-20 dB width)	Source model details	Impulsive/non-impulsive
Survey vessels (based on max of: ILV Granuaile, 80m & Roman Rebel, 28 m)	173 dB SPL	10-2,000 Hz	(Wittekind, 2014; Simard, et al., 2016; Heitmeyer, 2001)	Non-impulsive
Side scan sonar (Edgetech FS4205 or equivalent)	Not included	230,000 Hz & 850,000 Hz	Not included in assessment due to minimal frequency being well outside the hearing range of any species. (VHF group max: ~125 kHz)	Not applicable
Multibeam echosounder (Reson Seabat T50R or equivalent)	168-175 dB SPL (ping rate dependent, spherical level)	190,000 – 420,000 Hz	Manufacturer, source level based on source power (200-300 Watts). Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth.	Impulsive
Sub-bottom profiler 1 (Parametric pinger/chirper, e.g. Innomar Standard)	201-207 dB SPL (ping rate dependent) 222[4] dB L_P (240 dB L_P on-axis)	4,000 – 15,000 Hz & 85,000 – 115,000 Hz	Manufacturer. Model based on frequency modulated tone bursts, but representative for constant frequency tone bursts, von Hann window, ping rate determined by local depth.	Impulsive
Sub-bottom profiler 2 (UHRS Sparker at max 800J per shot)	193 dB SPL 224 dB L_P (ping rate dependent)	630 – 5,000 Hz	Manufacturer. Ping rate determined by local depth.	Impulsive

[4] Level at 20 degree off vertical axis

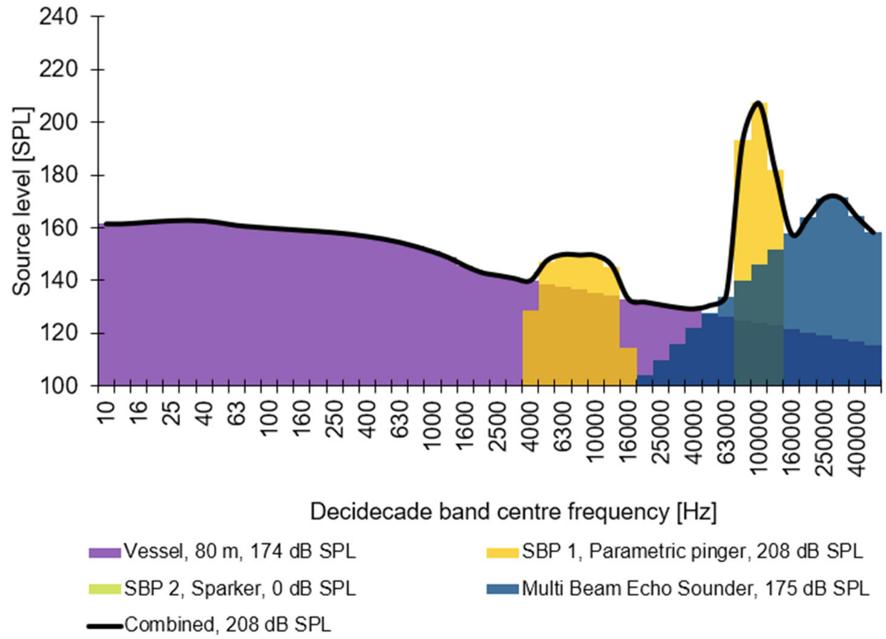

Figure 4-1: ECC-Coast: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in shallow areas of the ECC.

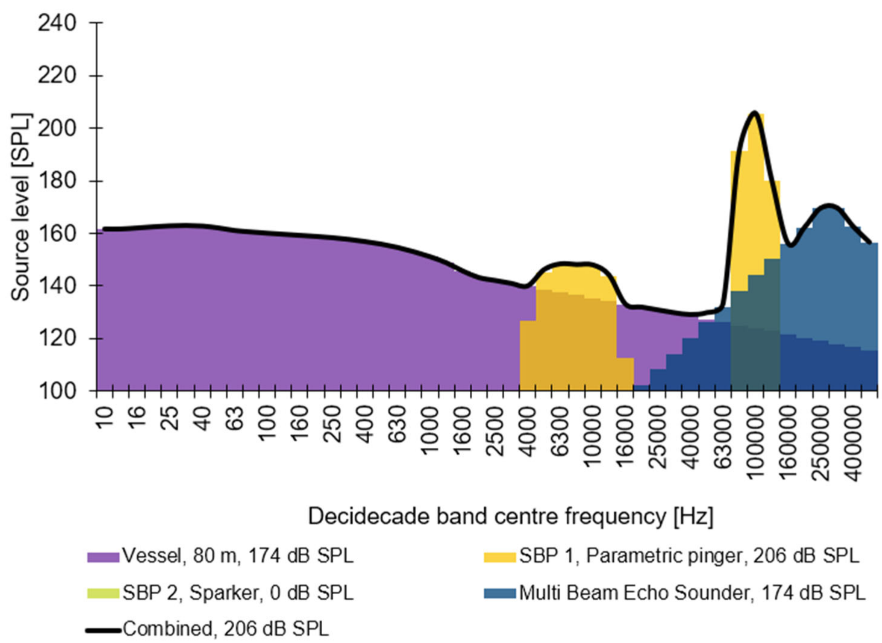

Figure 4-2: ECC-Reef: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in shallow areas with hard sediment of the ECC.

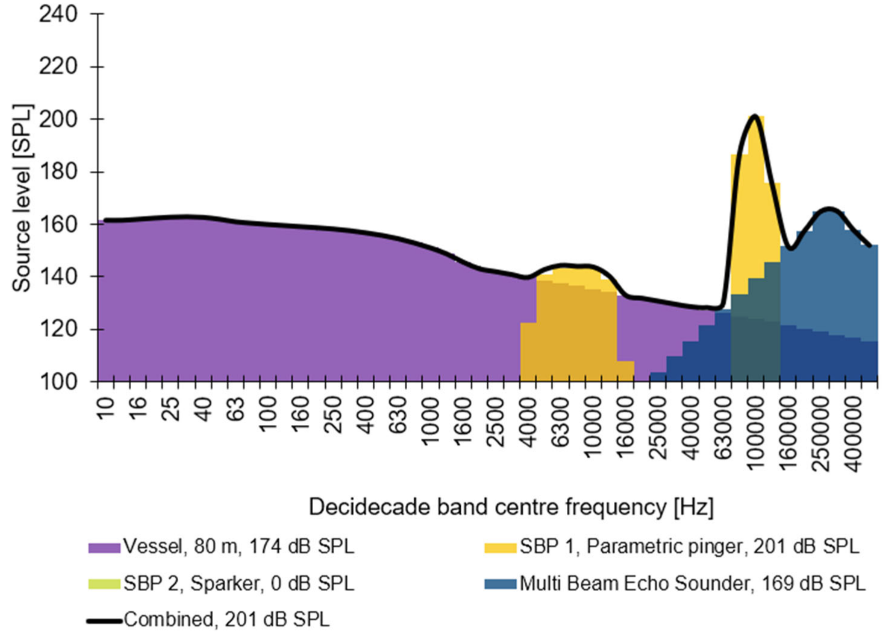

Figure 4-3: ECC-Mid: Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in deep areas of the ECC.

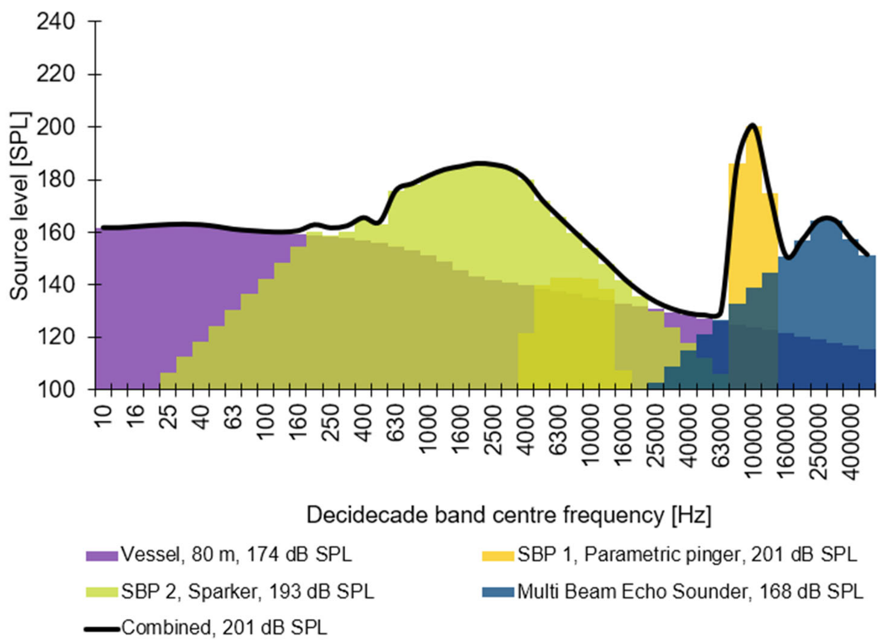

Figure 4-4: DA (both sites): Overview of sound sources as SPL at 1 m. Combined source (black solid line) represents source during survey in the DA.

The source was modelled as omnidirectional, this is a conservative estimate as all sources bar the vessel are highly directional in nature and angled towards the sediment, giving rise to increased transmission losses when compared to an omnidirectional source.

The vessel is assumed to move at 2 knots during the surveying, this is a conservative measure to increase the survey time as the vessel will likely move at ~4 knots (limited by the temporal resolution of the survey equipment).

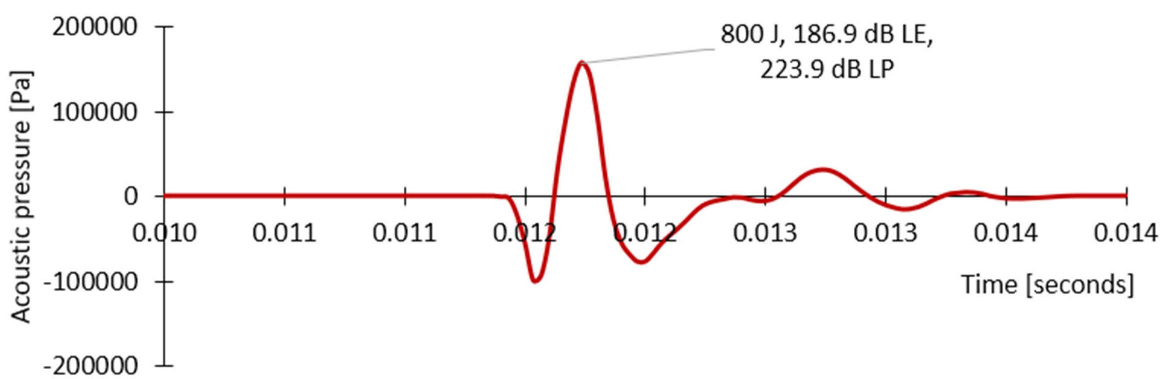

Figure 4-5: Sparker impulse for an 800J sparker.

5 SOUND PROPAGATION MODELLING METHODOLOGY

There are several methods available for modelling the propagation of sound between a source and receiver ranging from very simple models which simply assume spreading according to a $10 \cdot \log_{10}$(range) or $20 \cdot \log_{10}$(range) relationship to full acoustic models (e.g. ray tracing, normal mode, parabolic equation, wavenumber integration and energy flux models). In addition, semi-empirical models are available which lie somewhere in between these two extremes in terms of complexity (e.g. (Rogers, 1981; Weston, 1971)).

5.1 Semi-empirical models

For simpler scenarios where the sediment is relatively uniform and mostly flat or where great detail in modelling is not warranted, due to uncertainty in model input or where the source level is relatively low compared to the receiver sensitivity, the speed of these simpler models is preferred over the higher accuracy of numerical models and are routinely used for these types of assessments. For this assessment we have used the "Roger's" model (Rogers, 1981). This produces very similar output to the also regularly applied "Weston" model (Weston, 1971), but Roger's produces a smoother transition between spherical/cylindrical spreading, mode-stripping and single mode regions of the loss and would normally be preferred unless comparing to earlier work done using the Weston model. Both these models are compared to measurements in the papers describing them and are both capable of accurate modelling in acoustically simpler scenarios[5]. We have presented a comparison between Roger's and Weston's model here for a 30 m deep scenario to show the similarities in the transmission losses they predict. We prefer the Roger's model as it is more conservative for lower frequencies, as it does not have "sharp" steps between different propagation regions.

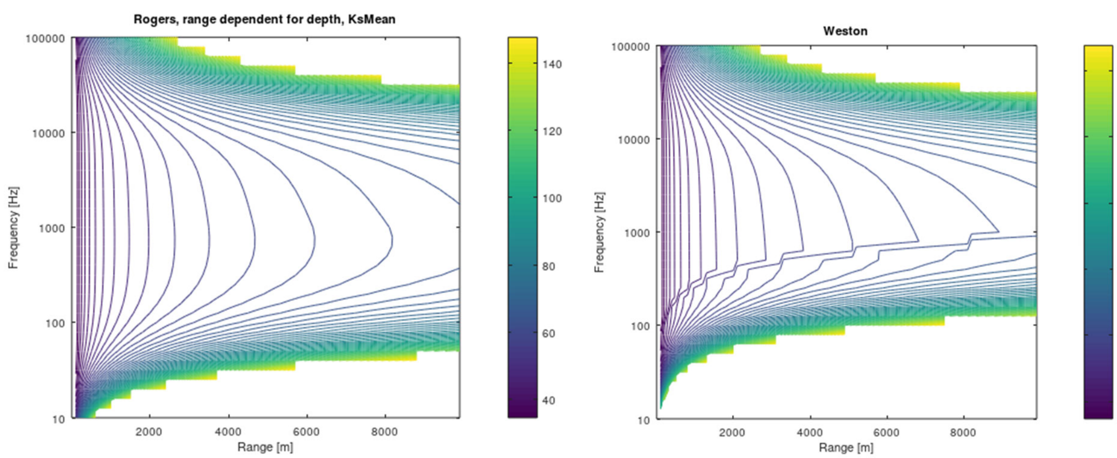

Figure 5-1: Comparison of thwo semi-empirical models over a sandy bottom at 30 m depth. Transmission loss in dB versus range and frequency.

[5] Simpler meaning shallow in relation to the wavelengths and with no significant sound speed gradient in the water column.

These semi-empirical models will tend to underestimate the transmission losses (leading to estimated greater than actual impact) due primarily to the omission of surface roughness, wind effects and shear waves in the sediment.

5.2 Analytical models

For the impulsive sources we have used the dBSea software's ray tracing solver dBSeaRay as this accounts for the full waveform propagation of the impulsive. This means including surface and bottom reflections as well as time-of-arrival in the calculations, as these are important to include to correctly estimate the effects of constructive and destructive interference. dBSea solvers are validated against a range of opensource solvers for so-called "standard scenarios" that have agreed solutions[6].

5.3 Exposure Calculations (dB L_E)

To compare modelled levels with the two impact assessment frameworks (Southall et al. 2019 & Popper et al. 2014) it's necessary to calculate received levels as exposure levels, L_E, weighted for marine mammals, and unweighted for fishes. For ease of implementation sources have generally been converted to an SPL source level, meaning converting to L_E from SPL or from a number of events is relatively easy:

To convert from L_E to SPL the following relation can be used:

$$L_E = \mathrm{SPL} + 10 \cdot Log_{10}(t_2 - t_1) \tag{1}$$

Or where it's inappropriate to convert to SPL by relating to the number of events as:

$$L_{E,n\ events} = L_{E,single\ event} + 10 \cdot Log_{10}(n) \tag{2}$$

As a marine mammal swims away from the sound source, the noise it experiences will become progressively more attenuated; the cumulative, fleeing L_E is derived by logarithmically adding the L_E to which the mammal is exposed as it travels away from the source. This calculation was used to estimate the approximate minimum start distance for a marine mammal in order for it to be exposed to sufficient sound energy to result in the onset of potential injury or if a set exclusion zone is sufficient for an activity (e.g. will an exclusion zone of 500 m be sufficient to prevent exceeding a limit). It should be noted that the sound exposure calculations are based on the simplistic assumption that the animal will continue to swim away at a fairly constant relative speed. The real-world situation is more complex, and the animal is likely to move in a more complex manner.

Reported swim speeds are summarised in Table 5-1 along with the source papers for the assumptions.

For this assessment, we used a swim speed of 1.5 m/s for marine mammals and basking sharks, and 0.5 m/s for fishes other than basking shark.

[6] https://www.dbsea.co.uk/validation/

Table 5-1: Swim speed examples from literature

Species	Hearing Group	Swim Speed (m/s)	Source Reference
Harbour porpoise	VHF	1.5	Otani *et al.,* 2000
Harbour seal	PCW	1.8	Thompson, 2015
Grey seal	PCW	1.8	Thompson, 2015
Minke whale	LF	2.3	Boisseau *et al.,* 2021
Bottlenose dolphin	HF	1.52	Bailey and Thompson, 2010
White-beaked dolphin	HF	1.52	Bailey and Thompson, 2010
Basking shark	Group 1 fish	1.0	Sims, 2000
All other fish groups	All fish groups	0.5	Popper *et al.,* 2014

6 RESULTS AND ASSESSMENT

Tables of various risk measures are presented in this section. The values given represent a “reasonable worst-case scenario” where the upper 90th percentile value from the results is used, meaning 90 % of the results have a smaller risk range than the stated.

Main assumptions for the validity of the results:

- A soft start of minimum 15 minutes, where the SBPs are firing maximally once per second.
- Any SBP used similar to the Innomar model will have peak pressure levels below 240 dB L_P and 1-second exposure levels below 208 dB L_E in the frequency range 85-115 kHz
- Final equipment configuration is not louder than the presented equipment (Table 4-1).

Five types of results are presented to inform this assessment:

1. **“1-second exposure risk range”:**
   This is the range of acute risk of impact from the activity (a one second exposure) and is presented to indicate short term risk and for comparison with other studies.
   This assumes a stationary animal (during the 1-seond exposure) with all equipment operating at full power, and does not include a soft start.

2. **“0.5 hours exposure risk range”:**
   This is the risk range for a stationary animal with all equipment operating at full power and does not include a soft start.

3. **“Minimal starting range for a fleeing animal”:**
   The minimal range a fleeing animal needs to start fleeing from to avoid being exposed to noise exceeding its TTS/PTS limit. All these are for animals moving in a straight line away from the source at a constant speed of 1.5 m/s. Soft start is assumed.
   This metric forms the main basis of the assessment.

4. **“Peak level risk range”:**
   The range of acute risk of impact from peak pressure levels associated with the impulsive sources.
   This measure is not included in tables as the range to the lowest TTS limit (fish 186 dB L_P) was ~50 m (all other groups are shorter).

5. **“Behavioural response range”:**
   The range at which the behavioural limit for the marine mammals (160 dB SPL) or the fishes (150 dB SPL) behavioural limits for impulsive noise is exceeded.

6.1 Export Cable Corridor

During the survey in the export cable corridor the sparker-type SBP is not used as deep sediment penetration is not needed. This means that the parametric SBP, with most energy at 85-115 kHz dominates the noise emitted from the vessel. The shallower waters in the ECC means the SBP will run with higher ping rates, leading to higher exposure levels compared to the deeper DA. Impact ranges for the VHF group are generally high, but due to high attenuation at the main frequencies the behavioural response ranges are shorter.

Risk ranges for peak pressure was under 10 meters for all mammal groups for PTS and TTS limits, with the fishes TTS limits exceeded to approximately 50 meters.

6.1.1 ECC-Coast

Starting ranges for fleeing animals of the VHF group extend to approximately 400 m, with the remaining groups having ranges below 20 m. Behavioural response ranges of 620 m and 850 m for marine mammals and fishes respectively.

Table 6-1: ECC-Coast, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	0	190	730	20	0	0
1 second exposure PTS risk [m]	0	20	300	0	0	0
0.5 hours' exposure TTS risk [m]	310	870	1600	420	90	260
0.5 hours' exposure PTS risk [m]	50	410	1040	100	0	100
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft start)	5	234	878	14	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft start)	3	12	365	3	3	0
Behavioural response range [m]	620	620	620	620	620	850

6.1.2 ECC-Mid

Starting ranges for fleeing animals of the VHF group extend to approximately 350 m, with the remaining groups having ranges below 10 m. Behavioural response ranges of 430 m and 660 m for marine mammals and fishes respectively.

Table 6-2: ECC-Mid, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	0	80	540	0	0	0
1 second exposure PTS risk [m]	0	0	160	0	0	0
0.5 hours' exposure TTS risk [m]	170	670	1360	260	30	130
0.5 hours' exposure PTS risk [m]	10	250	830	30	0	30
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft start)	3	195	788	8	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft start)	3	8	321	3	3	0
Behavioural response range [m]	430	430	430	430	430	660

6.1.3 ECC-Reef

Starting ranges for fleeing animals of the VHF group extend to approximately 400 m, with the remaining groups having ranges below 20 m. Behavioural response ranges of 620 m and 860 m for marine mammals and fishes respectively.

Table 6-3: ECC-Reef, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	0	190	730	20	0	0
1 second exposure PTS risk [m]	0	20	300	0	0	0
0.5 hours' exposure TTS risk [m]	310	870	1600	420	90	260
0.5 hours' exposure PTS risk [m]	50	410	1040	100	0	90
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft start)	3	264	926	18	3	0

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft start)	3	18	401	3	3	0
Behavioural response range [m]	620	620	620	620	620	860

6.2 Development Area

During the survey in the DA both the sparker-type SBP and the parametric SBP are used, with the sparker dominating the noise relevant to the LF group and the parametric SBP most relevant to the HF and VHF groups. The deeper water in the DA means the SBP will run with lower ping rates, leading to lower exposure levels compared to the generally shallower ECC. Impact ranges for the VHF group are generally high, and due to the noise at lower frequencies the combined noise from the vessel will be audible over much larger distances for all groups.

Risk ranges for peak pressure was under 10 meters for all mammal groups for PTS and TTS limits, with the fishes TTS limits exceeded to approximately 50 meters.

6.2.1 DA-SE

Starting ranges for fleeing animals of the VHF group extend to approximately 350 m, with the remaining groups having ranges below 10 m. Behavioural response ranges of 1 km and 4.2 km for marine mammals and fishes respectively.

Table 6-4: DA-SE, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	50	70	510	20	0	0
1 second exposure PTS risk [m]	0	0	140	0	0	0
0.5 hours' exposure TTS risk [m]	6720	770	8570	3730	280	140
0.5 hours' exposure PTS risk [m]	360	230	870	190	10	30
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft start)	10893	204	12690	4989	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft start)	3	6	323	3	3	0
Behavioural response range [m]	970	970	970	970	970	4185

6.2.2 DA-NW

Starting ranges for fleeing animals of the VHF group extend to approximately 350 m, with the remaining groups having ranges below 10 m. Behavioural response ranges of 1 km and 4.5 km for marine mammals and fishes respectively.

Table 6-5: DA-NW, summary of risk ranges.

Condition	LF (TTS / PTS)	HF (TTS / PTS)	VHF (TTS / PTS)	PCW (TTS / PTS)	OCW (TTS / PTS)	Fish (TTS / PTS)
1 second exposure TTS risk [m]	50	80	520	30	0	0
1 second exposure PTS risk [m]	0	0	150	0	0	0
0.5 hours' exposure TTS risk [m]	7240	810	9200	4060	310	150
0.5 hours' exposure PTS risk [m]	390	240	890	210	10	30
Minimal starting range to avoid TTS [m] for fleeing animal (Includes soft start)	11699	221	13401	5582	3	0
Minimal starting range to avoid PTS [m] for fleeing animal (Includes soft start)	5	8	338	3	3	0
Behavioural response range [m]	1070	1070	1070	1070	1070	4550

7 SUMMARY AND CONCLUSIONS

For both survey areas the noise from the parametric sub-bottom profiler drives the hearing injury (PTS) risk ranges for the VHF group (Harbour porpoise). The hearing injury risk range for a moving animal of the VHF group is 300-400 m for all modelled locations, when a soft start procedure is included. This affirms the need for a 500 m exclusion zone established prior to the survey commencing aligning with the JNCC's "guidelines for minimising the risk of injury to marine mammals from geophysical surveys" (JNCC, 2017). Remaining hearing groups had hearing injury risk ranges below 20 meters.

Note that the proposed activities are likely to cause temporary hearing impact (TTS) for the LF (baleen whales), VHF (harbour porpoises) and PCW (seals) groups present within the development area while surveying is ongoing due to the sparker-type sub-bottom profiler overlapping the frequency regions of greatest hearing sensitivity for these groups as well as the ability for the lower frequencies to travel further with less attenuation. This means likely TTS risk ranges up to 12, 13 and 5 km for the LF, VHF and PCW groups respectively, while surveying the development area.

7.1 Export Cable Corridor

During the survey in the export cable corridor the sparker-type SBP is not used as deep sediment penetration is not needed. This means that the parametric SBP, with most energy at 85-115 kHz dominates the noise emitted from the vessel. The shallower waters in the ECC means the SBP will run with higher ping rates, leading to higher exposure levels compared to the deeper DA.

Risk ranges for PTS (hearing injury) for fleeing animals:

- VHF (Harbour porpoises): 321-401 meters.
- Remaining mammals and fishes: <18 meters.

7.2 Development Area

During the survey in the development area both the sparker-type SBP and the parametric SBP are used, with the sparker dominating the noise relevant to the LF group and the parametric SBP most relevant to the HF and VHF groups. The deeper water in the DA means the SBP will run with lower ping rates, leading to lower exposure levels compared to the generally shallower ECC. Impact ranges for the VHF group are generally high, and due to the noise at lower frequencies the combined noise from the vessel will be audible over much larger distances for all groups.

Risk ranges for PTS (hearing injury) for fleeing animals:

- VHF (Harbour porpoises): 323-338 meters.
- Remaining mammals and fishes: <10 meters.

Behavioural response ranges for fishes are very high, 4-4.5 km, meaning potential disturbance for fishes over large parts of the surveyed area. E.g. at 2 knots (1 m/s) a location under the survey line will be above the behavioural response range for up to 2.5 hours (or half that time for a survey moving at 4 knots). The equivalent disturbance time for mammals is just under 0.5 hours (approximately 1 km)

7.3 Mitigation and Limitations

7.3.1 Soft Start

A soft start of minimum 15 minutes was assumed for the modelling. This consists of having a maximum of 1 ping or pulse per second for the sub-bottom profilers for the duration of the soft starts. This will give animals more time to flee while the noise emissions are relatively lower.

7.3.2 Exclusion Zone – Marine Mammal Observer

The modelling did not assume absence of marine mammals within a 500 m range prior to survey start, but given the risk ranges for the VHF group extend to 400 m we recommend adhering to soft start procedures as laid out in JNCC's "guidelines for minimising the risk of injury to marine mammals from geophysical surveys" (JNCC, 2017).

This means a 30-minute search by a certified MMO to establish likely absence of marine mammals within 500 m of the vessel prior to commencing soft start is required to mitigate likely hearing injury.

7.3.3 Equipment limitations

Any SBP used similar to the Innomar model will have peak pressure levels below 240 dB L_P and 1-second exposure levels below 208 dB L_E in the frequency range 85-115 kHz

Final equipment configuration is not louder than the presented equipment (Table 4-1).

7.4 Conclusion

Under the assumptions laid out for the survey method, the sources used and the mitigation applied, the noise arising from surveys of the Export Cable Corridor and the Development Area is unlikely to cause permanent injury to marine mammals and fishes.

While there is little risk of exceedance of the injury limits, we note that the survey uses high-powered sound sources that, while not likely to cause auditory harm, are likely to exceed the behavioural response limits as well as temporary hearing impact limits to 5-10 kms for baleen whales, harbour porpoises, seals and fishes. Note here that the assessment is based on the worst-case estimates for noise sources (most conservative), with the realised impacts likely to be smaller.

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Appendix A – Acoustic Concepts and Terminology

Sound travels through water as vibrations of the fluid particles in a series of pressure waves. The waves comprise a series of alternating compressions (positive pressure variations) and rarefactions (negative pressure fluctuations). Because sound consists of variations in pressure, the unit for measuring sound is usually referenced to a unit of pressure, the Pascal (Pa). The unit usually used to describe sound is the decibel (dB) and, in the case of underwater sound, the reference unit is taken as 1 µPa, one micro-pascal, whereas airborne sound is usually referenced to a pressure of 20 µPa. To convert from a sound pressure level referenced to 20 µPa to one referenced to 1 µPa, a factor of 20 log (20/1) i.e. 26 dB has to be added to the former quantity. Thus, a sound pressure of 60 dB re 20 µPa is the same as 86 dB re 1 µPa, although care also needs to be taken when converting from in air noise to in water noise levels due to the different sound speeds and densities of the two mediums resulting in a conversion factor of approximately 62 dB for comparing intensities (watt/m²), see Table 0-1 , below.

Table 0-1: Comparing sound quantities between air and water

	Constant intensity		Constant pressure	
Properties	**Air**	**Water**	**Air**	**Water**
Soundspeed (C) [m/s]	340	1500	340	1500
Density (ρ) [kg/m³]	1.293	1026	1.293	1026
Acoustic impedance (Z=C·ρ) [kg/(m²·s) or (Pa·s)/m³]	440	1539000	440	1539000
Sound intensity ($I=p^2/Z$) [Watt/m²]	1	1	22.7469	0.0065
Sound pressure ($p=(I*Z)^{½}$) [Pa]	21	1241	100	100
Particle velocity (I/p) [m/s]	0.04769	0.00081	0.22747	0.00006
dB re 1 µPa²	146.4	**181.9**	160.0	**160.0**
dB re 20 µPa²	**120.4**	155.9	**134.0**	134.0
Difference dB re 1 µPa² & dB re 20 µPa²	**61.5**		**26.0**	

All underwater sound pressure levels in this report are described in dB re 1 µPa². In water, the sound source strength is defined by its sound pressure level in dB re 1 µPa², referenced back to a representative distance of 1 m from an assumed (infinitesimally small) point source. This allows calculation of sound levels in the far-field. For large, distributed sources, the actual sound pressure level in the near-field will be lower than predicted.

There are several descriptors used to characterise a sound wave. The difference between the lowest pressure deviation (rarefaction) and the highest pressure deviation (compression) from ambient is the peak to peak (or pk-pk) sound pressure ($L_{P\text{-}P}$ for the level in dB), Note that $L_{P\text{-}P}$ can be hard to measure consistently, as the maximal duration between the lowest and highest pressure deviation is not standardised. The difference between the highest deviation (either positive or negative) and the ambient pressure is called the peak pressure (L_P for the level in dB). Lastly, the average sound pressure is used as a description of the average amplitude of the variations in pressure over a specific time window (SPL for the level in dB). SPL is equal to the L_{eq} when the time window for the SPL is equal to the time window for the total duration of an event. The cumulative sound energy from pressure is the integrated squared pressure over a given period (L_E for the level in dB). L_E is the current ISO standard name for what was previously named “SEL”. These descriptions are shown graphically in Figure 0-1 and reflect the units as given in ISO 18405:2017, “Underwater Acoustics – Terminology”.

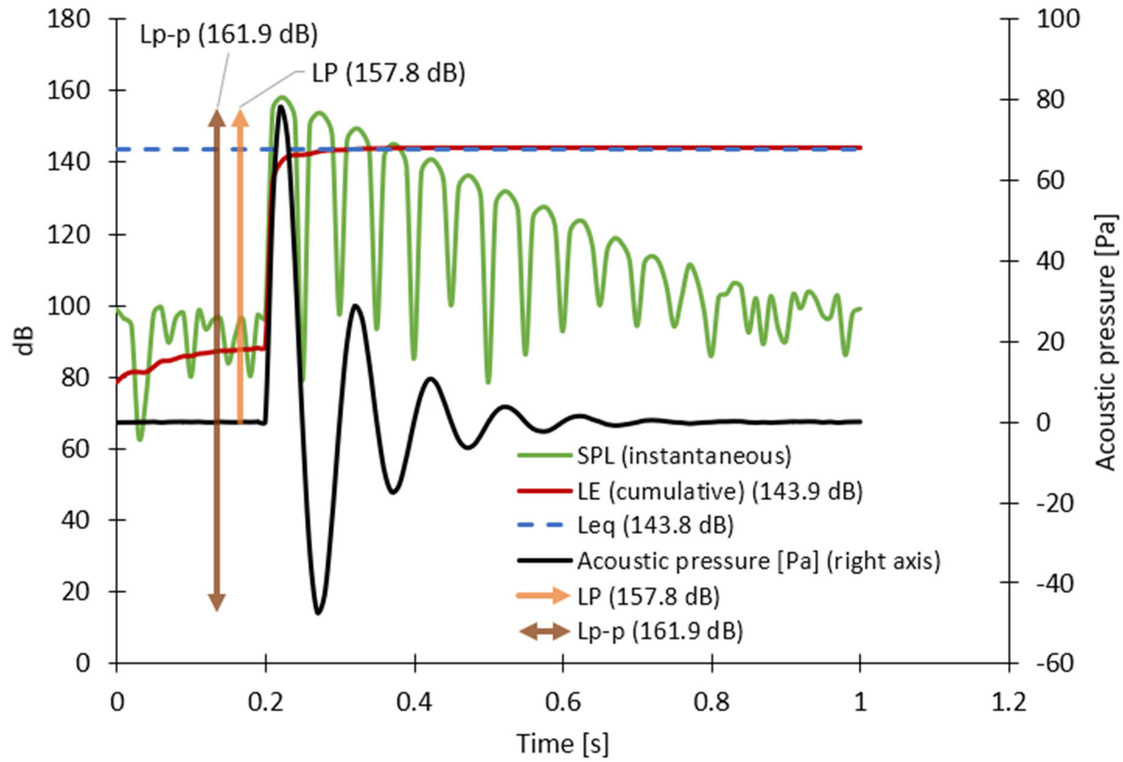

Figure 0-1: Graphical representation of acoustic wave descriptors.

The sound pressure level (SPL[7]) is defined as follows (ISO 18405:2017, 3.2.1.1):

$$SPL = 10 \cdot Log_{10}\left(\frac{\overline{p^2}}{1 \cdot 10^{-12} Pa}\right) \quad (1)$$

Here $\overline{p^2}$ is the arithmetic mean of the squared pressure values. Note that L_P is simply the instantaneous SPL (ISO 18405:2017, 3.2.2.1).

The peak sound pressure level, L_P, is the instantaneous decibel level of the maximal deviation from ambient pressure and is defined in (ISO 18405:2017, 3.2.2.1) and can be calculated as:

$$L_P = 10 \cdot Log_{10}\left(\frac{max(p^2)}{1 \cdot 10^{-12} Pa}\right)$$

Another useful measure of sound used in underwater acoustics is the Exposure Level, or L_E. This descriptor is used as a measure of the total sound energy of a single event or a number of events (e.g. over the course of a day). This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis. Historically, use was primarily made of SPL and L_P metrics for assessing the potential effects of sound on marine life. However, the L_E is increasingly being used as it allows exposure duration and the effect of exposure to multiple events over e.g. a 24-hour period to be taken into account. The L_E is defined as follows (ISO 18405:2017, 3.2.1.5):

[7] Equivalent to the commonly seen "RMS-level"

$$L_E = 10 \cdot Log_{10}\left(\frac{\int_{t_1}^{t_2} p(t)^2 dt}{1 \cdot 10^{-12} Pa}\right) \qquad (2)$$

To convert from L_E to SPL the following relation can be used:

$$L_E = \text{SPL} + 10 \cdot Log_{10}(t_2 - t_1) \qquad (3)$$

Converting from a single event to multiple events for L_E:

$$L_{E,n\ events} = L_{E,single\ event} + 10 \cdot Log_{10}(n) \qquad (4)$$

The frequency, or pitch, of the sound is the rate at which these oscillations occur and is measured in cycles per second, or Hertz (Hz). When sound is measured in a way which approximates to how a human would perceive it using an A-weighting filter on a sound level meter, the resulting level is described in values of dB(A). However, the hearing faculties of marine mammals and fish are not the same as humans, with marine mammals hearing over a wider range of frequencies, fish over a typically smaller range of frequencies and both with different sensitivities. It is therefore important to understand how an animal's hearing varies over the entire frequency range to assess the effects of sound on marine life. Consequently, use can be made of frequency weighting scales to determine the level of the sound in comparison with the auditory response of the animal concerned. A comparison between the typical hearing response curves for fish, humans and marine mammals is shown in Figure 0-2. Note that hearing thresholds are sometimes shown as audiograms with sound level on the y axis rather than sensitivity, resulting in the graph shape being the inverse of the graph shown. It is also worth noting that some fish are sensitive to particle velocity rather than pressure, although paucity of data relating to particle velocity levels for anthropogenic noise sources means that it is often not possible to quantify this effect.

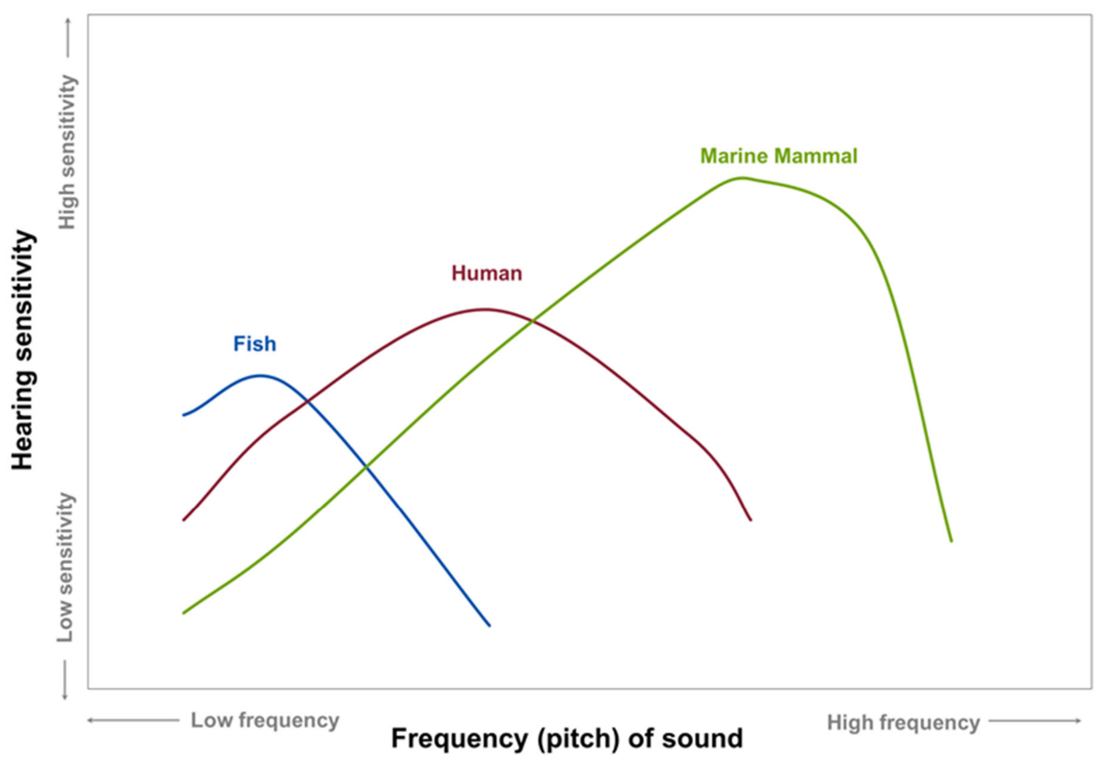

Figure 0-2: **Comparison between hearing thresholds of different marine animals and humans.**

Review of Sound Propagation Concepts

Increasing the distance from the noise source usually results in the level of noise getting lower, due primarily to the spreading of the sound energy with distance, analogous to the way in which the ripples in a pond spread after a stone has been thrown in.

The way that the noise spreads will depend upon several factors such as water column depth, pressure, temperature gradients, salinity, as well as water surface and seabed conditions. Thus, even for a given locality, there are temporal variations to the way that sound will propagate. However, in simple terms, the sound energy may spread out in a spherical pattern (close to the source, with no boundaries) or a cylindrical pattern (much further from the source, bounded by the surface and the sediment), although other factors mean that decay in sound energy may be somewhere between these two simplistic cases.

In acoustically shallow waters[8] in particular, the propagation mechanism is coloured by multiple interactions with the seabed and the water surface (Lurton, 2002; Etter, 2013; Urick, 1983; Brekhovskikh and Lysanov 2003, Kinsler et al., 1999). Whereas in deeper waters, the sound will propagate further without encountering the surface or bottom of the sea, in shallower waters the sound is reflected many times by the surface and sediment.

At the sea surface, the majority of sound is reflected back into the water due to the difference in acoustic impedance (i.e. sound speed and density) between air and water. However, scattering of sound at the surface of the sea is an important factor with respect to the propagation of sound from a source. In an ideal case (i.e. for a perfectly smooth sea surface), the majority of sound wave energy will be reflected back into the sea. However, for rough waters, much of the sound energy is scattered (Eckart, 1953; Fortuin, 1970; Marsh, Schulkin, and Kneale, 1961; Urick and Hoover, 1956). Scattering can also occur due to bubbles near the surface such as those generated by wind or fish or due to suspended solids in the water such as particulates and marine life. Scattering is more pronounced for higher frequencies than for low frequencies and is dependent on the sea state (i.e. wave height). However, the various factors affecting this mechanism are complex. Generally the scattering effect at a particular frequency depends on the physical size of the roughness in relation to the wavelength of the frequency of interest

Because surface scattering results in differences in reflected sound, its effect will be more important at longer ranges from the source sound and in acoustically shallow water (i.e. where there are multiple reflections between the source and receiver). The degree of scattering will depend upon the water surface smoothness/wind speed, water depth, frequency of the sound, temperature gradient, grazing angle and range from source. Depending upon variations in the aforementioned factors, significant scattering could occur at sea state 3 or more for higher frequencies (e.g. 15 kHz or more). It should be noted that variations in propagation due to scattering will vary temporally (primarily due to different sea-states/wind speeds at different times) and that more sheltered areas (which are more likely to experience calmer waters) could experience surface scattering to a lesser extent, and less frequently, than less sheltered areas which are likely to encounter rougher waters. However, over shorter ranges (e.g. within 10-20 times the water depth) the sound will experience fewer reflections and so the effect of scattering should not be significant. Consequently, over the likely distances over which injury will occur, this effect is unlikely to significantly affect the injury ranges presented in this report, and not including this effect will overestimate the impact.

When sound waves encounter the seabed, the amount of sound reflected will depend on the geoacoustic properties of the seabed (e.g. grain size, porosity, density, sound speed, absorption coefficient and roughness) as well as the grazing angle and frequency of the sound (Cole, 1965; Hamilton, 1970; Mackenzie, 1960; McKinney and Anderson, 1964; Etter, 2013; Lurton, 2002; Urick, 1983). Thus, seabeds comprising primarily of mud or other acoustically soft sediment will reflect less sound than acoustically harder seabeds such as rock or sand. This effect also depends on the profile of the seabed (e.g. the depth of the sediment layers and how the geoacoustic properties vary with depth below the sea floor).

[8] Acoustically, shallow water conditions exist whenever the propagation is characterised by multiple reflections with both the sea surface and seabed (Etter, 2013). Consequently, the depth at which water can be classified as acoustically deep or shallow depends upon numerous factors including the sound speed gradient, water depth, sediment type, frequency of the sound and distance between the source and receiver.

The sediment interaction is less pronounced at higher frequencies (a few kHz and above) where interaction is primarily with the top few cm of the sediment (related to the wavelength). A scattering effect (similar to that which occurs at the surface) also occurs at the seabed (Essen, 1994; Greaves and Stephen, 2003; McKinney and Anderson, 1964; Kuo, 1992), particularly on rough substrates (e.g. pebbles).

Another phenomenon is the waveguide effect which means that shallow water columns do not allow the propagation of low frequency sound (Urick, 1983; Etter, 2013). The cut-off frequency of the lowest mode in a channel can be calculated based on the water depth and knowledge of the sediment geoacoustic properties. Any sound below this frequency will not propagate far due to energy losses through multiple reflections. The cut-off frequency as a function of water depth is shown in **Error! Reference source not found.** for a range of seabed types. Thus, for a water depth of 10 m (i.e. shallow waters typical of coastal areas and estuaries) the cut-off frequency would be approximately 70 Hz for sand, 115 Hz for silt, 155 Hz for clay and 10 Hz for bedrock.

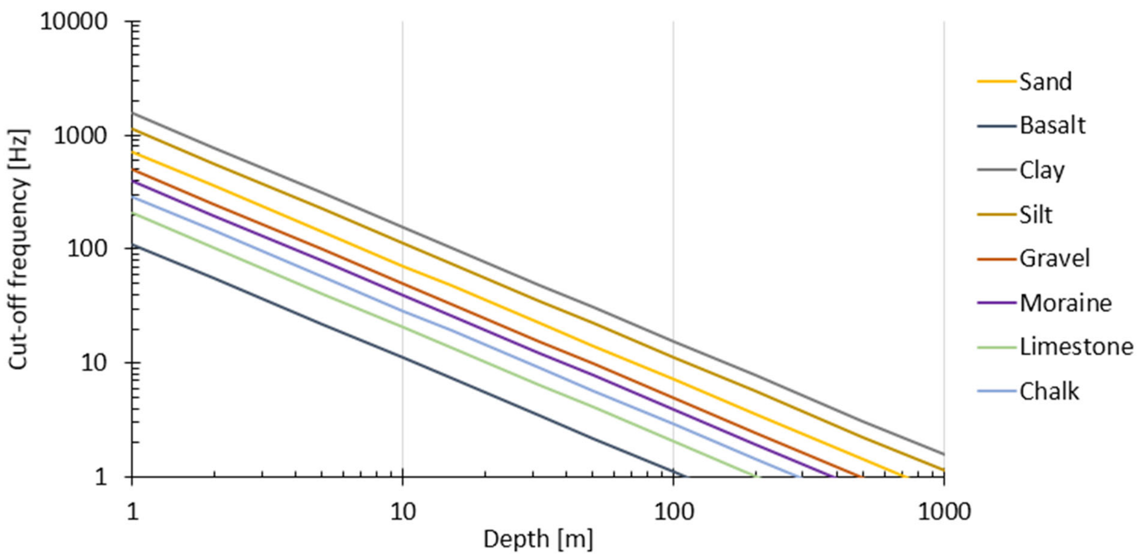

Figure 0-3: Lower cut-off frequency as a function of depth for a range of seabed types.

Changes in the water temperature and the hydrostatic pressure with depth mean that the speed of sound varies throughout the water column. This can lead to significant variations in sound propagation and can also lead to sound channels, particularly for high-frequency sound. Sound can propagate in a duct-like manner within these channels, effectively focussing the sound, and conversely, they can also lead to shadow zones. The frequency at which this occurs depends on the characteristics of the sound channel but, for example, a 25 m thick layer would not act as a duct for frequencies below 1.5 kHz. The temperature gradient can vary throughout the year and thus there will be potential variation in sound propagation depending on the season.

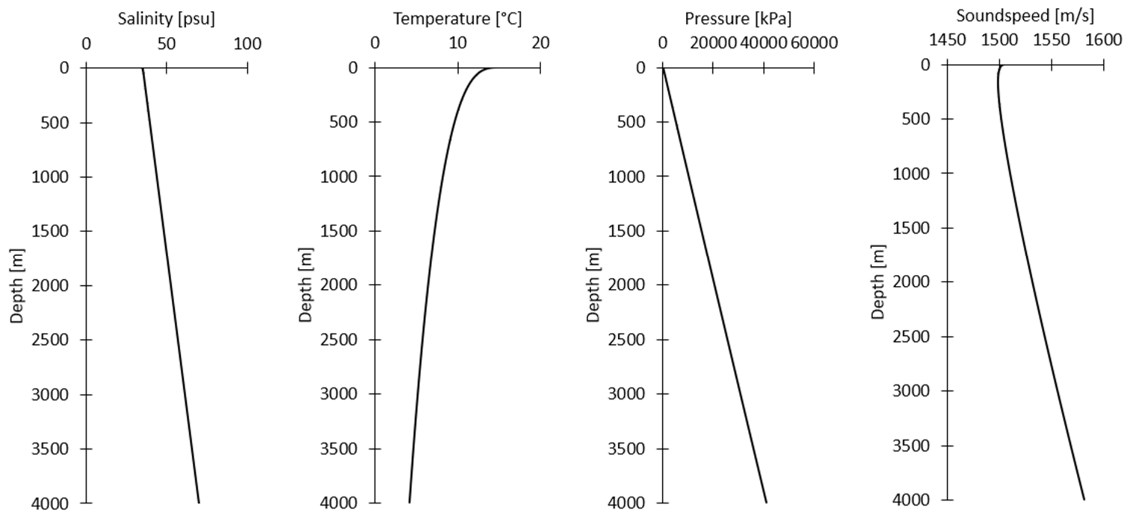

Figure 0-4: Soundspeed profile as a function of salinity, temperature and pressure.

Wind can make a significant difference to the soundspeed in the uppermost layers as the introductions of bubbles decreases the soundspeed and refracts (bends) the sound towards the surface, where the increased roughness and bubbles from the wind will cause increased transmission loss.

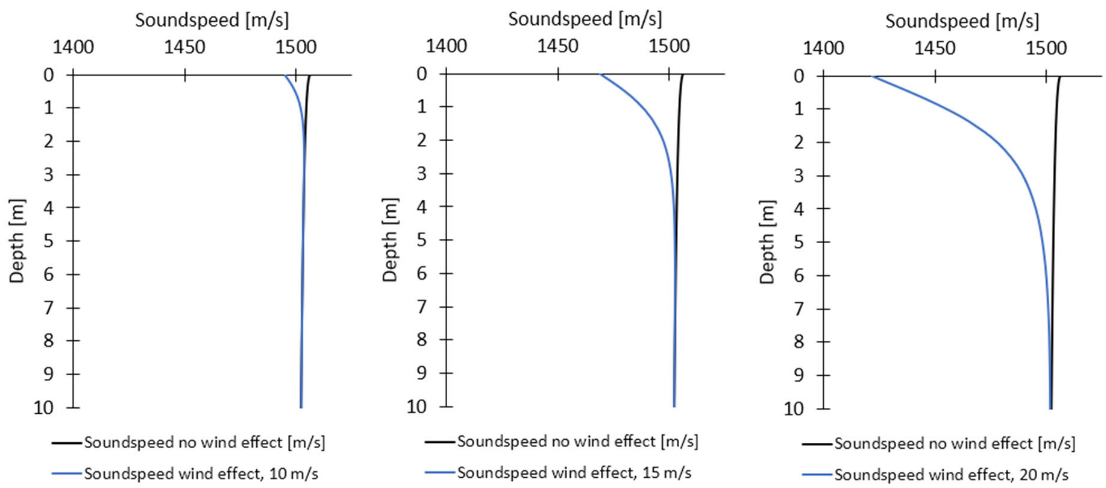

Figure 0-5: Effect of wind (at 10 m height) on upper portion of soundspeed profile.

Sound energy can also be absorbed due to interactions at the molecular level converting the acoustic energy into heat. This is another frequency dependent effect with higher frequencies experiencing much higher losses than lower frequencies. This is shown in **Error! Reference source not found.** where the variation of the absorption (sometimes called volume attenuation) is shown for various salinities and temperatures. As the effect is proportional to the wavelength, colder water, with slower soundspeed/period and being slightly more viscous, will have more absorption. Higher salinity slightly decreases absorption at low frequencies (mostly due to increase in soundspeed and wavelength/period), but much higher absorption at higher frequencies where interaction with pressure sensitive molecules of magnesium sulphite and boric acid increase the conversion acoustic energy to heat.

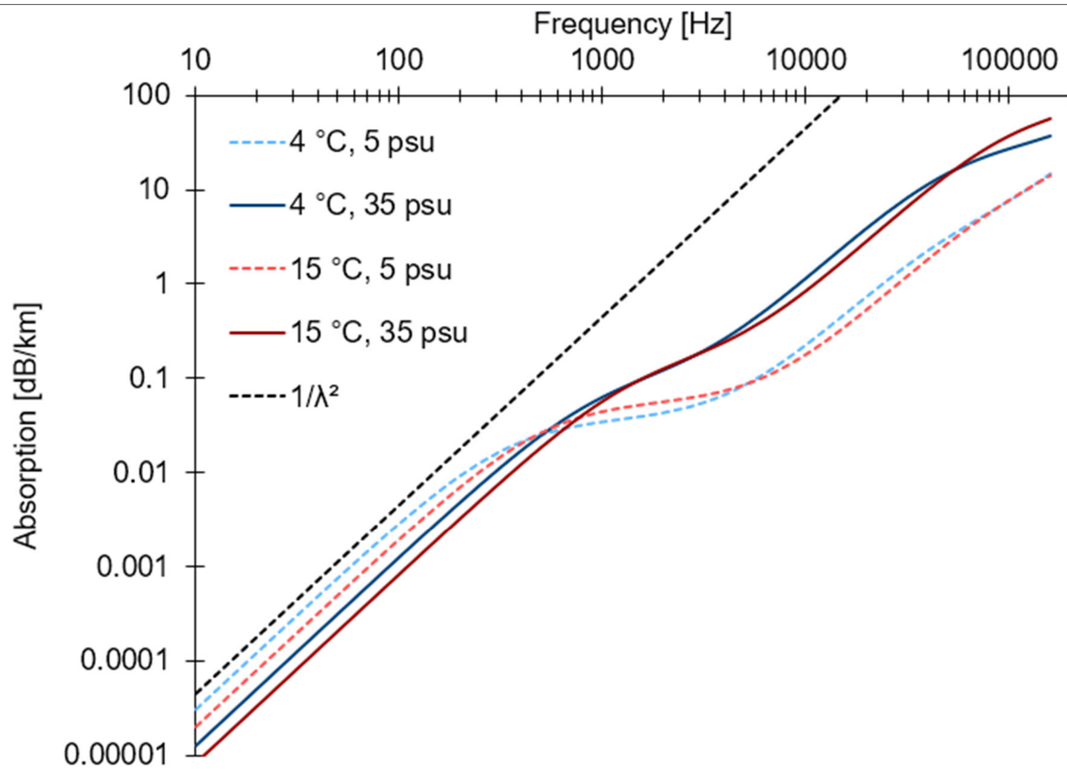

Figure 0-6: Absorption loss coefficient (dB/km) for various salinities and temperature