Chapter 10 Addendum:
Marine Mammals & Megafauna

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ORIEL WIND FARM PROJECT

Environmental Impact Assessment Report - Addendum
Chapter 10 Addendum: Marine Mammals and Megafauna

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10.1 Introduction

This Addendum provides information to supplement the assessment on marine mammals and megafauna included in chapter 10 of the Environmental Impact Assessment Report (EIAR)(RPS, 2024). It has been prepared in response to a Request for Further Information (RFI) from An Coimisiún Pleanála (formerly An Bord Pleanála) (ACP) regarding the planning application (case reference ABP-319799-24) for the Oriel Wind Farm Project (hereafter referred to as "the Project").

Table 10A-1 outlines the information requested according to the referencing used in the 'Schedule-Further Information Request' provided by ACP (e.g. 9.A.i which refers to the 'comprehensive review of relevant mitigation'). Table 10A-1 also indicates where the corresponding information / responses can be found within this Addendum to chapter 10 – Marine Mammals and Megafauna, or in the EIAR, and provides a concluding statement on any resulting updates or changes to the assessment presented in the EIAR (chapter 10: Marine Mammals and Megafauna (EIAR volume 2B). Updated underwater noise modelling was undertaken to inform this assessment and is presented in appendix 10-4: Updated Subsea Noise Modelling Report.

The headings and subheadings in this Addendum correspond to those used in chapter 10 of the EIAR. However, within the 'Assessment of Significance' section (0), one new impact assessment has been added in response to the ACP RFI 9.M. This new assessment covers 'Injury and/or disturbance to marine megafauna from operational underwater noise' (section 10.10.6). Consequently, the numbering of the subsequent subheadings, including 'mitigation and residual effects' and 'future monitoring,' has been adjusted. The reader is directed to review the information presented in this Addendum alongside the assessment presented in the EIAR chapter.

Table 10A-1: Further information requested on Marine Mammals and Megafauna and details on Applicant's response.

Reference	Request for Further Information	Response / Reference where information is presented	Concluding statement
Underwater Noise – Mitigation & Noise Abatement			
9.A	The details that have been submitted in relation to underwater noise arising from the proposed development acknowledges the potential for impacts to arise on marine fauna from both Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) over significant areas. The Wildlife Act 1976, as amended, lists marine mammals, including all dolphin, porpoise, seal and whale species as protected (with subsequent regulations also applying protections to all species of marine turtles and similar protections to basking sharks), stating that it is an offence to hunt, injure, or wilfully interfere with/destroy the resting or breeding place of such species. The January 2014 National Parks and Wildlife Service (NPWS) 'Guidance to Manage the Risk to Marine Mammals from Man-Made Sound Sources' published by the Department of Arts, Heritage and the Gaeltacht (NPWS (2014)), notes that sound sources with the potential to induce TTS in a receiving marine mammal has the potential to cause both disturbance and injury. This guidance has a statutory basis under Regulation 71 of SI No. 477 of 2011, and refers to the "offence to injure" under the Wildlife Act, 1976, noting that TTS "may constitute such an injury". Having regard to the information submitted in the EIAR, the NPWS underwater noise guidelines (NPWS, 2014), the strict protections afforded to marine mammals under the Wildlife Act 1976, as amended, in addition to submissions from prescribed bodies and observers, the Board requires a comprehensive suite of noise abatement measures to be submitted and assessed in addition to the existing mitigation measures referenced in the planning documentation. The applicant is requested to submit:	N/A	The Project had regard to the Guidance to Manage the Risk to Marine Mammals from Man-Made Sound Sources (National Parks and Wildlife Service (NPWS), 2014) (hereafter known as the 'NPWS (2014) guidance') in preparing the assessment for chapter 10: Marine Mammals and Megafauna (EIAR volume 2B). The Project has provided a comprehensive review of noise abatement measures, including the MODIGA with internal air bubble ring, in addition to existing mitigation measures.
	i) A comprehensive review of relevant mitigation, in addition to what is currently contained in the submitted documentation, specifically appropriate noise abatement measures, which could be applied to the proposed development to reduce/restrict the propagation of noise through the marine environment and provide realistic values for the reduction in sound level possible from these technologies. The review must consider the range of suitable abatement measures available, including consideration of, at a minimum, bubble curtains, casings, resonators, and out in detail the suitability of such measures for the construction of the proposed development at this location, including restrictions in relation to their suitability, where relevant.	Appendix 10.8: Comprehensive Review of Relevant Mitigation (Noise Abatement) & Thresholds. The suitability of these measures for the construction of the Project is also outlined. The review includes casing options including MODIGA with internal air bubble ring, which the Applicant proposes to use as its noise abatement system (NAS).	Whilst there are a range of relevant NAS available; these are not required or proportionate for the Project because the assessment of injury and/or disturbance to marine megafauna from underwater noise during pile driving in the EIAR concluded no significant impact. However, in an abundance of caution, the Project is committed to the use of noise abatement measures for the purpose of reducing sound levels from construction piling and will use a MODIGA with internal air bubble ring as its noise abatement system to

Reference		Request for Further Information	Response / Reference where information is presented	Concluding statement
				provide reduction in underwater noise during impact piling. The review of noise mitigation and thresholds has not resulted in changes to the designed-in mitigation or conclusions of the assessment in chapter 10: Marine Mammals and Megafauna (EIAR volume 2B), however MODIGA with internal air bubble ring is included as additional NAS mitigation.
in	ii)	The applicant must also consider and draw on the best available technology and thresholds, including as applied in other EU (European Union) jurisdictions (e.g. Germany; Belgium; Netherlands; Denmark), to identify and provide for suitable noise abatement to reduce the level and extent of potential noise impacts arising from the proposed development. Examples include the German 160 dB re 1 μPa^2s SEL_{ss} and 190 dB re 1 µPa SPL_{peak} thresholds that must not be exceeded at a distance of 750m from a piling site; or the frequency weighted SEL_{cum} PTS thresholds (e.g. harbour porpoise 155 dB re $1\mu Pa^2s$) that must not be exceeded for a fleeing animal with a starting distance of 200m in Denmark.	Appendix 10.8: Comprehensive Review of Relevant Mitigation (Noise Abatement) & Thresholds.	The assessment of noise and noise abatement measures set out in chapter 10: Marine Mammals and Megafauna (EIAR volume 2B) and this Addendum is in line with the best available technology and thresholds and as such has not resulted in changes to the proposed designed-in mitigation or conclusions of the assessment in chapter 10: Marine Mammals and Megafauna (EIAR volume 2B). Whilst the assessment of injury and/or disturbance to marine megafauna from underwater noise during pile driving in the EIAR concluded no significant impact, in an abundance of caution, a review of potential noise abatement systems has been undertaken. The Project is committed to the use of noise abatement measures for the purpose of reducing sound levels from construction piling and will use a casing option known as MODIGA with internal air bubble ring as its noise abatement solution.
	iii)	Revised noise modelling and mapping which provides detailed consideration of the noise abatement strategy selected in response to (ii) above and include: a) The modelled SPL_{peak} and SEL_{cum} PTS and TTS contours for each functional hearing group potentially present, emanating from the existing locations proposed in the application at the periphery of the proposed development to demonstrate the full potential spatial extent of underwater noise propagation. Modelling must	Appendix 10-6: NAS Modelling Report presents the results of noise modelling of noise abatement scenarios including sound levels from piling at 750 m (SPL_{pk}, SEL_{ss}) for scenarios with and without mitigation, with a comparison to German standards.	The outputs of the NAS modelling and mapping clearly demonstrate the potential for measurable reductions in auditory injury (PTS), TTS and disturbance impact ranges/areas. Given the range of reductions demonstrated (see appendix 10-7: NAS Technical Report - Marine Mammals, Megafauna and Fish and Figure 10-A10 in this Addendum) it is

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	also show the noise level (SPL_{peak}, SELss) at 750m from the locations of each of the piling activities selected. b) The modelled SEL_{ss} contours for 120-180 dB re 1µPa2s at 5 dB increments at the locations in (a) above. Mapping provided must show the relevant noise contours in the context of implementing the abatement technologies/ measures identified at (i) above and should be displayed alongside the noise contours in the absence of any such noise abatement measures being implemented. c) Revised details showing the change in total impacted individuals of each species before and after consideration of noise abatement technologies. d) Modelling must be performed for monopiles and pin piles, as both are under consideration within the project design envelope. e) Any additional abatement and/or mitigation measures should also be considered where practicable in terms of their potential for reduction of cumulative effects with other projects in terms of underwater noise.	Appendix 10-7: NAS Comparison Technical Note - Marine Mammals, Megafauna and Fish presents further information in response to items a. to e. An updated Cumulative Impact Assessment is provided in appendix 3-2: Cumulative Impact Assessment Report (EIAR volume 2A Addendum). Section 10.10.1 (Further measures) provides a summary of the results of indicative noise abatement modelling for marine mammals, demonstrating measurable reductions for auditory injury, TTS and disturbance impact ranges/areas. See also appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) (EIAR volume 2A Addendum), which has been updated with revised noise modelling, detailed discussion of ADDs, and includes information on project commitments to reduction in sound levels and the potential application of NAS. It should be noted that pin piles are not proposed for the Project and therefore have not been considered.	expected that application of the NAS available at the time of construction will produce similar results. Furthermore, given that the impact assessment (set out in volume 2B, chapter 10: Marine Mammals and Megafauna and this addendum) and the updated cumulative impact assessment (appendix 3-2: Cumulative Impact Assessment Report (EIAR volume 2A Addendum) has concluded no significant impact on marine mammals, it is considered that any application of NAS would simply further reduce the magnitude of effect on marine mammals for PTS, TTS and disturbance. Appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) has been updated. Despite the assessment of injury and/or disturbance to marine megafauna from underwater noise during pile driving concluding no significant impact, the Project is committed to the use of further noise abatement measures for the purpose of reducing sound levels from construction piling. In an abundance of caution, for the short duration of hammer impact piling of the sacrificial casing (and limited number of days piling), the Project will use the MODIGA with internal air bubble ring as its noise abatement solution (see Appendix 10-8: Comprehensive Review of Relevant Mitigation (Noise Abatement)) to provide reduction in underwater noise during piling. This further contributes to the conclusion of no significant impact on marine mammals from underwater noise during pile-driving.
9.B	The applicant is requested to provide a detailed justification for the 500m (Geophysical acoustic surveys) - 1,000m (pile driving) Marine Mammal Mitigation Zones (as detailed in the Marine Mammal	Section 10.8.2 of this Addendum provides a justification for the mitigation zones.	The Marine Mammal Mitigation Zone focused on the maximum predicted injury ranges. The NPWS (2014) guidance

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	Mitigation Plan (MMMP) (Appendix 5-4 of the EIAR), acknowledging that the results of the underwater noise assessment on marine mammals indicate impacts (TTS) may be experienced beyond mitigation zones for a number of species (Table 1-5 of the MMMP).		details that '*pile driving activity shall not commence if marine mammals are detected within a 1,000 m radial distance of the pile driving sound source'*. In revised noise modelling the maximum PTS range was less than the 1,000 m for SPL_{pk}, and with application of an ADD the SEL_{cum} PTS range would not be exceeded. Therefore, the mitigation range of 1,000 m encompasses the auditory injury (PTS) ranges.
9.C	The EIAR should address the inconsistency in deterrence from different Acoustic Deterrent Device manufacturers and device specifications across studies, and some appear to be misrepresented in the chapter text in terms of their effectiveness. The type of ADD and source level / frequency selected will have direct implications for its effectiveness of impact on different species. Not all species will be equally impacted by a single device, variations in both sound level and frequencies across devices. The applicant is therefore requested to clarify the relevant mitigation measures to be utilised, including their commitment to using specified devices.	The Applicant has updated appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) in response to RFI 9.C to address ADD deterrence and to clarify the relevant mitigation measures to be utilised, including the Applicant's commitment to using specified devices. See also section 10.10.7 of this Addendum.	The updates to appendix 5-4 Addendum: MMMP have not resulted in changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.D	The applicant is requested to address the possibility for temporal mitigation, for example limiting piling to periods that do not overlap with the harbour or grey seal pupping season or the harbour porpoise calving season, to further limit effects on nearby SACs.	Section 10.10.7 of this Addendum provides a response to why the Applicant has not proposed the use of temporal mitigation to avoid seasonal effects.	Consideration of temporal mitigation is unnecessary and would be disproportional to the risk as piling is limited to 26 days total. There are no changes to the conclusions of the assessment in chapter 10: Marine mammals and megafauna.
9.E	The Board notes the applicants' commitment to implement phased piling as part of a Piling Strategy which will be prepared in collaboration with other offshore windfarms in the western Irish Sea to reduce the potential for an in-combination effect. Noting that the Irish Sea Phase 1 ORE projects are independent of one another, the applicant is requested to provide further information regarding the piling strategy outlined in Appendix 05-02: Environmental Management Plan, including an outline of the programming schedules of the other projects to provide a more robust assessment of the potential adverse effects of cumulative noise (airborne and underwater) from concurrent pile driving across the Phase 1 projects in the Irish Sea.	Detail on phased piling was provided in Table 10-12 in chapter 10: Marine Mammals and Megafauna (EIAR volume 2B). Further details on the proposed phased piling are provided in section 10.8.2 of this Addendum. A piling strategy can only be prepared post consent once it is known which projects have the potential to overlap with the Project's programme for piling. The finalised project schedules for each project cannot be determined until each has planning consent. The Applicant can submit a piling schedule if required to comply with conditions of	The Project has committed to a piling strategy to be prepared post consent, prior to commencement of construction. The updated cumulative impact assessment with cumulative population modelling concluded no significant effect for marine mammal and megafauna receptors. Therefore there are no changes to the conclusions of the assessment in chapter 10: Marine mammals and megafauna.

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		planning should the Project receive consent. An updated Cumulative Impact Assessment is provided in appendix 3-2: Cumulative Impact Assessment Report (EIAR volume 2A Addendum), and updated CIA population modelling has been conducted (see section 10.11.2) using indicative piling schedules provided in the applications for other projects (noting these dates are subject to change). Cumulative airborne noise effects from piling were screened out in the EIAR (chapter 25: Airborne noise and vibration) due to distances from the Project.	
9.F	The Board acknowledges the applicant's extensive experience in offshore renewable projects in both the North Sea and Baltic Sea, and other jurisdictions, including the information presented in the EIAR (Appendix 5-11: Supporting Information Demonstrating the Applicant's Experience on Other Offshore Wind Farm Projects). The applicant is invited to submit any details or monitoring/reporting available from previous experience of offshore development in other EU jurisdictions which demonstrates the efficacy of mitigation measures adopted (and proposed in the current application) in relation to underwater noise. In all cases where mitigation is proposed or requested as above, the applicant is requested to comply with all aspects of NPWS (2014) Guidelines including soft start times, delay durations, mitigation zone sites, mandatory ramp-up procedures and defined reporting requirements. Furthermore the use of distance estimation formula should follow the same approach suggested for distance estimation by the Joint Nature Conservation Committee (JNCC) (refer to Marine Mammal Observer Association article on the subject of distance estimation using reticular binoculars for further explanation) and use standard trigonometric equations for calculation.	Appendix 10-5: Underwater Noise Monitoring Experience – Supporting Information, provides details on the measures used on Arcadis Ost 1 project., which includes the use of Big Bubble Curtains. Appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) and section 10.10.7 of this Addendum, confirm that the MMMP has been prepared in accordance with the NPWS (2014) guidance and outlines how this has been achieved. Appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) has been updated to clearly confirm the use of the distance estimation by the JNCC.	There are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna. The design and installation methodology of the Project incorporates the extensive experience the applicant has on other ORE projects. Despite the assessment of injury and/or disturbance to marine megafauna from underwater noise during pile driving concluding no significant impact, the Project is committed to the use of further noise abatement measures for the purpose of reducing sound levels from construction piling. In an abundance of caution, for the short duration of stability piling required for the sacrificial casing, the Project will use the MODIGA with internal air bubble ring as its noise abatement solution. Appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) complies with all aspects of the NPWS (2014) guidance.
	Underwater Noise Modelling		

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9.G	In terms of the underwater noise modelling assessment, a conversion factor (CF) is mentioned in the text of the EIAR but there is no further discussion of this value (e.g., description, justification) in the EIAR or in the Subsea Noise Technical Report (EIAR Appendix 10-02). The applicant is requested to provide a description of the value and how this value was selected.	As outlined in appendix 10-4: Updated Subsea Noise Modelling Report (section 2.1), the source modelling used the equivalent monopile Energy Conversion Factor as outlined in De Jong and Ainslie, 2008, using a value of 1%. Whilst the assessment undertaken as part of the EIAR considered the best available advice at the time, advances have been made in the field of underwater sound modelling since the assessment was carried out, particularly in the field of noise generated by piling activities. Therefore, the modelling was revised to remodel the injury ranges associated with piling to present the most scientifically rigorous and up to date results using the recent research presented by Wood *et al*. (2023).	Updated modelling has been provided in this addendum for injury ranges associated with piling. However, there are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.H	It is noted that recent research (Wood *et al*., 2023) suggests that the modelling method of Weston (1971) used in the application, has been found to be problematic and potentially underestimates the received levels from the noise sources. The 0.5% value used in the Subsea Noise Technical Report is within a reasonable range, however no justification for this value has been provided, therefore it cannot be assumed it has been chosen based on specific aspects of the operations. Options for this value vary, and may reach up to 1.56%, which would give a difference of 4.9dB from the 0.5% used in the assessment. The applicant is requested to address these concerns and, in particular, to provide a justification for the modelling methodology employed.	As outlined above, the modelling was revised applying an updated approach and no longer uses a conversion factor (as recommended by Wood *et al*., 2023). Subsequently the injury ranges associated with piling were remodelled to present the most scientifically rigorous and up to date results to underpin the impact assessment. Refer to appendix 10-4: Updated Subsea Noise Modelling Report (section 3).	Updated modelling has been provided in this Addendum for injury ranges associated with piling There are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.I	The modelling methodology for Acoustic Deterrent Device (ADD) use is not clear in the Subsea Noise Technical Report, for example whether the applicant considers complete exclusion, or if the sound level or frequency of the representative ADD has been considered. It does not appear that the ADD modelling is informed by the dose-response curve. The applicant is requested to clarify this.	See section 10.9 of this Addendum which provides a summary of the ADD modelling.	It is assumed that an animal would react to an ADD by fleeing directly away from the source at a constant velocity in the same way that they would react to piling, assuming no cumulative sound exposure level experienced by the animal. There are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.J	EIAR Chapter 10: Marine Mammals and Megafauna and Appendix 1-21 of the Subsea Noise Technical Report consider underwater noise	At the time of the EIAR, only MBES was expected to be employed however the	The assessment of the potential impact of the use of USBL has been undertaken,

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	impacts associated with each phase of the project. The applicant is requested to clarify whether Ultra-short Baseline (USBL) positioning systems will be used during pre-construction surveys. If so, the applicant is requested to include these systems in the assessment for auditory injury.	Project clarifies USBL positioning systems may be used during routine geophysical surveys. Therefore, see section 10.10.2 of this Addendum which provides an assessment of auditory injury from the use of USBL, which will be used on the Project. Please note that the reference to Appendix 1-21 in RFI 9.J is an error as there are no appendices in appendix 10.2: Subsea Noise Technical Report.	however there are no changes to the overall conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.K	In terms of the species densities values, it is noted that Table 10-6 of the EIAR describes the two values that will be selected for density of each species, to provide a range. In Table 10-30, however, these values are presented as 'Average' and 'Maximum', which is not accurate. The value presented as the 'Average' is the lower of the two values of the range. The maximum density should be used to establish the highest number of animals potentially affected, to ensure a robust conservative assessment. The applicant is requested to review and adjust the document as necessary.	See Table 10A-22 and Table 10A-23 in section 10.10.1 of this Addendum, which replace Table 10.30 in chapter 10: Marine Mammals and Megafauna, splitting Table 10.30 into two tables (SCANS-IV densities and alternative densities, as per RFI request 9L) and clarifies whether each density estimate is the minimum or maximum for each species.	The updates to the data presented in section 10.10.1 do not result in any changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.L	In addition, a number of inconsistencies are noted in terms of the application of densities across sources. For example, the SCANS-IV surveys have been used as the 'Average' density in some cases and the 'Maximum' in others without any commentary on the appropriateness of the choices made. The applicant is requested to provide separate assessment tables for each density source used, (i.e. one table with the consistent use of SCANS-IV for all densities and separate tables where SCANS-III or site-based surveys have been used). All relevant species should be included.	Table 10A-6 and Table 10A-7 (section 10.10.1) replace Table 10.26 in chapter 10: Marine Mammals and Megafauna. Table 10A-8 and Table 10A-9 (section 10.10.1) replace Table 10.27 in chapter 10: Marine Mammals and Megafauna. Table 10A-22 and Table 10A-23 (section 10.10.1) replace Table 10.30 in chapter 10: Marine Mammals and Megafauna Table 10A-25 and Table 10A-26 (section 10.10.1) replace Table 10.34 in chapter 10: Marine Mammals and Megafauna.	The assessment applies dual densities and this has been clarified in 10.10.1, splitting out the tables into SCANS-IV and alternative densities. The updates to the data presented in section 10.10.1 do not result in any changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.

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		Table 10A-34 and Table 10A-35 (section 10.10.3) replace Table 10.41 in chapter 10: Marine Mammals and Megafauna. Each pair of tables splits the original table into SCANS-IV densities and alternative densities and all are updated with revised underwater noise modelling. The assessment applies dual densities (representing a minimum and maximum density) derived from robust baseline characterisation (from both site-specific surveys and other sources of literature (i.e. SCANS-IV), see section 10.6.2) to ensure a precautionary, appropriate and comprehensive evaluation.	
	Behavioural Disturbance		
9.M	The EIAR does not appear to adequately justify the screening out of injury and/or disturbance to marine megafauna from operational underwater noise. While the scientific papers cited in the justification for omission are noted (Norro *et al*., 2011; Hastie *et al*., 2015), the Board is concerned that the scale of the turbines referenced (3MW and 5MW turbines) do not compare with the proposed 25 no. 15MW turbines proposed for the Oriel Project, and that the combined noise effect of the installation may not be 'unlikely to be at a level sufficient to cause injury or behavioural changes to marine mammals, fish or turtles' as indicated in the Subsea Noise Technical Report. It is further noted that the desktop study of operational noise from wind turbines (Table 1-31 of Appendix 10-2: Subsea Noise Technical Report) considers turbines of between 2MW and 5MW. The Board, therefore, requests that disturbance from operational turbines be assessed in the context of the size and the number of turbines proposed, and that the assessment of the combined noise effects of all turbines be examined and relevant disturbance ranges identified.	As detailed in Table 10-13 of the EIAR, it was considered that any impact from operational noise would be highly localised and not at a level which would cause injury or behavioural changes, and therefore not cause a significant impact. However the response to the RFI, see section 10.10.6 of this Addendum, which provides an assessment of injury and/or disturbance to marine megafauna from operational underwater noise. The assessment is based on a wind farm with 25 monopile foundations, each with 15 MW capacity resulting in a cumulative capacity of 375 MW.	This additional impact assessment on injury and/or disturbance to marine megafauna from operational noise has been included in this Addendum, and concludes that impacts will be of slight adverse significance.
9.N	The applicant is requested to more clearly define the methodology for the dose-response assessment. The studies on which the dose-response assessment is based (Graham, 2017; 2019) are explained in detail, however the specific threshold within the dose-response curve that has been used is not stated (Table 10.21 the threshold is listed as "Based on SEL 5 dB contours"). The process of applying the dose-	See section 10.10.1 of this Addendum which explains the dose response calculations and how they were applied to determine the number of animals potentially disturbed, with dose response calculations presented in Table 10A-13 to	The updates to the data presented in section 10.10.1 to explain the methodology for dose response do not change the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.

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	response curve to density maps to determine number of individuals disturbed is not clearly elaborated upon (e.g. description of density calculation within each isopleth and summing). The applicant is requested to address this issue.	Table 10A-21. These are consequently summed across all contour bands to provide a single estimate per species/scenario of the total potential number of animals disturbed during a piling event (as set out in Table 10A-22 and Table 10A-23, which replace Table 10.30 in chapter 10: Marine Mammals and Megafauna).	
9.O	The Board note the use of NOAA Level B Harassment Threshold (National Marine Fisheries Service, USA) rather than more recently defined thresholds in European jurisdictions (e.g. Danish threshold of 143 dB re 1µPa (or 103 dB re 1µPa VHF-weighted) single strike sound exposure level (SELss) (Tougaard, 2021). The Board further note the threshold values recommended by TG Noise (Sigray et al., 2023) and thresholds used in the Ireland's Draft Marine Strategy Part 1, Articles 8, 9 and 10 report 2024 and its Annex III. The applicant is requested to discuss these thresholds and justify why they have not been used in the assessment.	See 10.10.1 for a review of alternative thresholds to the applied NOAA Level B Harassment Threshold and justification for the approach to the assessment of disturbance from piling (using a dose-response approach, with additional application of the strong and mild disturbance thresholds).	Whilst a review of alternative thresholds and justification for the approach to assessment of piling is presented in section 10.10.1, there are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.P	Please address the following comments regarding the presentation of Disturbance data: i) The EIAR requires a discussion of the maximum range of disturbance for NOAA Level B harassment. ii) Table 10-25 of the EIAR appears to be missing a column. The applicant is requested to include SEL_{cum} mitigated injury range for piling at the east modelled location (initiation + soft start + ramp up). iii) The applicant is requested to expand Table 10-30 of the EIAR to display the min, max, and mean range to the selected disturbance threshold. iv) The worst-case number of piling events does not account for contingency of having to move and re-pile if substrate does not accept the pile. The applicant is requested to add in this consideration or justify its exclusion for the worst-case scenario.	See following updates in this Addendum: i) See summary of subsea noise modelling: disturbance in section 10.10.1. ii) See section 10.10.1 and Table 10A-5, which replaces Table 10-25 in chapter 10. iii) See Table 10A-22 and Table 10A-23 in section 10.10.1, which replaces Table 10-30 in chapter 10: Marine Mammals and Megafauna iv) See section 10.8.1.	The presentation of disturbance data has been updated and expanded. There are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
	Survey/Monitoring		
9.Q	With reference to the Guidance on Marine Baseline Ecological Assessments & Monitoring Activities for Offshore Renewable Energy Projects Part 2, April 2018 by the Department of Communications Climate Action and Environment (DCCAE) (DCCAE (2018) Guidance),	See section 10.6.2 for further details on the survey methodology in response to items i and ii. In response to item iii, see also section 10.6.2 and appendix 10-9:	The applicant considers the 4 km buffer is appropriate for a precautionary and comprehensive evaluation of the baseline for assessment. Inclusion of broadband

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	the applicant is requested to provide additional justification/assessment in relation to the following: i) The selection of a 4km buffer area extending around the Array Area. The DCCAE (2018) Guidance recommends a minimum buffer of 10km for cetaceans and seals with monthly haul-out site surveys. ii) The lack of empirical acoustic data, noting the DAU submission which states the omission of acoustic monitoring does not allow the site to be fully characterised for all Annex IV species. iii) The lack of any vantage point surveys or monitoring for pinniped species at the cable landfall location.	Seal Survey Report, which presents the results of seal surveys completed in 2024/2025.	recorder data would not result in a change to the conclusion of assessment. Seal surveys were carried out in 2024/2025, with very few seals recorded at the cable landfall location and no seals were hauled out in any of the surveys. There are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.R	The DAU note that monitoring for pinniped species at the location where the proposed development interacts with the shore was not carried out by the applicant and therefore there is no information on whether harbour and grey seals use this site. The applicant is requested to submit further information by means of specific surveys of the site for pinnipeds and that this should also be set in the context of seasonal changes in distribution of these species. The applicant is requested to refer to the most up-to-date NPWS seal data and DCCAE (2018) Guidance.	See section 10.6.2 of this Addendum and appendix 10-9: Seal Survey Report, which presents the results of seal surveys completed in 2024/2025.	The seal survey data collected in 2024/2025 does not change the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.S	The applicant is requested to confirm whether any on-going or additional surveying has been carried out on the site in relation to mobile species since the application was lodged. If so, the applicant is invited to submit any further survey data results and incorporate these into the assessments within the application documentation as appropriate.	As outlined in section 10.6.2 and appendix 10-9: Seal Survey Report, seal surveys have been completed in 2024/2025. No other surveys were completed for mobile species.	The seal survey data collected in 2024/2025 does not change the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
	Cumulative and Transboundary Impacts		
9.T	The applicant is requested to map maximum masking, and behaviour impacts in the cumulative noise impact assessment on marine mammals and fish and behavioural impacts for shellfish for all phases of the project, including the operational phase. The cumulative assessment should model impacts based on concurrent construction with and without noise abatement with at least one other windfarm in the Irish Sea. Critical periods of breeding and spawning should be identified and if these are associated with any known vocalisations.	See section 10.11 of this Addendum for further information on masking and behaviour impacts in the cumulative noise impact assessment on marine mammals. See section 10.11 provides a justification for not modelling cumulative impacts based on concurrent construction with and without noise abatement with at least one other wind farm in the Irish Sea. See section 10.6.1 for additional discussion on critical periods of breeding	The further information provided on cumulative impacts (masking, projects with and without NAS, critical breeding periods) does not result in any changes to the conclusions of assessment in chapter 10: Marine Mammals and Megafauna.

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Reference	Request for Further Information	Response / Reference where information is presented	Concluding statement
		and spawning and any associations with known vocalisations.	
9.U	The assessment of cumulative impacts appears to deviate from standard practice in that the Cumulative Impact Assessment (CIA) should consider the cumulative percentage of disturbed individuals for each species within the respective Management Unit. The applicant is requested to address this.	See section 10.11.2 of this Addendum.	The cumulative percentage of disturbed individuals for each species within the respective Management Unit is presented under the magnitude of impact section. There are no changes as a result to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.V	Under the current definition of Medium magnitude in the EIAR ("reversible or irreversible in individuals, could result in some population-level effects, but not a level that would alter the relevant population trajectory over a generational scale"), when considering >5% of the reference population that may be impacted for some species, certain evaluations of magnitude could fall within the Medium category. Please provide justification for their assessment as lower magnitude.	See section 10.11.2 of this Addendum	Justification has been provided for the assessment of low magnitude for injury and/or disturbance to marine megafauna from underwater noise during piling-driving / drilling. There are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna
9.W	In addition to the above, the CIA sensitivity appears to be redefined for each of the receptors from the sensitivities used during assessment alone. This is contrary to best practice. While magnitude of the disturbance may change when considering cumulative effects rather than effects from piling alone, the sensitivity should remain constant. The applicant is requested to address this.	See Table 10A-38 and section 10.14 of this Addendum	The Applicant acknowledges errors in the sensitivity conclusions of the CIA section of chapter 10: Marine Mammals and Megafauna (EIAR volume 2B). Whilst the detailed discussion of sensitivity remains valid and the evidence still stands and remains unchanged, the Applicant agrees the final conclusions of sensitivity should align with those for the project alone assessments. Therefore for clarity, the CIA summary table is updated with the corrected sensitivities for clarity. No changes to the significance of effect resulted from these updates and there are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
9.X	The Board notes that the Oriel project took part in consultation across all Irish Sea Phase 1 ORE Projects to assess whether cumulative disturbance resulting from pile driving activities across the five Irish Sea Phase 1 ORE Projects is predicted to result in population level impacts to four marine mammal species (harbour porpoise, bottlenose dolphins, harbour and grey seals). However, there has been no iPCoD	Appendix 10-10: Cumulative iPCoD Modelling Report, which models the other Irish Sea Phase 1 ORE projects and additional projects in the Irish Sea.	Population modelling for other Irish Sea Phase 1 ORE projects and additional projects in the Irish Sea concluded no significant impact on marine mammals. There are no changes to the conclusions

Reference	Request for Further Information	Response / Reference where information is presented	Concluding statement
	modelling performed for the CIA, nor inclusion or consideration of an indicative piling schedule any of the other Phase 1 projects within the EIAR or Appendix 10-03: Marine Mammal Population Modelling Report (iPCoD). The applicant is requested to update the document with iPCoD modelling to be used in the CIA, including indicative piling schedules for the other Irish Sea Phase 1 ORE projects, and to submit to the Board any documentation resulting from the aforementioned consultation.		of the assessment in chapter 10: Marine Mammals and Megafauna.
9.Y	Notwithstanding the rationale provided in relation to the assessment of impacts of operational underwater noise on marine megafauna, and the scoping out of injury and/or disturbance to marine megafauna, including basking sharks and sea turtles, from operational underwater noise (EIAR Chapter 10: Marine Mammals and Megafauna, Table 10-13), the applicant is requested to assess potential impacts from operational underwater noise in terms of the cumulative assessment with other Irish Sea Phase 1 ORE projects.	See section 10.11.2. of this Addendum	Injury and/or disturbance from operational noise was included as an additional impact in the CIA and concluded no significant impact on marine mammals and megafauna.
	Collisions		
9.Z	The DAU state in their submission on this application that when assessing the risk of collisions between marine mammals and vessels, the applicant must include all data relevant to Irish waters and not solely rely on reports from UK monitoring programmes, e.g. those reported in Irish Whale and Dolphin Group Cetacean Stranding Schemes and Irish Whale & Dolphin Group Deep Diving and Rare Species Investigation Programme (both supported by NPWS funding). The applicant is requested to address this issue and incorporate the findings of these data sources in to the submitted documentation.	See section 10.10.3 of this Addendum.	Additional data has been included in the sensitivity section for collision risk. However, there are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.
	Appropriate Assessment		
9.AA	In terms of the NIS submitted in support of the proposed development, it is noted that the Lower River Shannon SAC (Special Area of Conservation) and West Connacht Coast SAC, located on the west coast of Ireland, are two sites with bottlenose dolphin identified as designated features. Given the noted connectivity between the west and east coasts of Ireland, the applicant is requested to justify the omission of these two important sites for this species from the screening process.	The NIS Addendum provides a response on this matter.	This matter is only relevant to the NIS.
NOTE 1	In the interests of minimising the potential for cumulative effects to arise on the environment and marine fauna, and to further inform the Boards consideration of this matter, the applicant is strongly advised to liaise with the other Phase I projects in order to develop a robust suite of appropriate mitigation measures that will reduce the	A piling strategy will be agreed with the other phase 1 developers and is listed as a measure in chapter 10: Marine	There are no changes to the conclusions of the assessment in chapter 10: Marine Mammals and Megafauna.

Reference	Request for Further Information	Response / Reference where information is presented	Concluding statement
	propagation of noise into the Irish Sea and ensure that maximum protection is afforded to all relevant species who inhabit/transit these waters. In all cases where mitigation is proposed or requested as above, the applicant is requested to comply with all aspects of NPWS (2014) Guidelines including soft start times, delay durations, mitigation zone sites, mandatory ramp-up procedures and defined reporting requirements. Furthermore the use of distance estimation formula should follow the same approach suggested for distance estimation by the JNCC (refer to Marine Mammal Observer Association article on the subject of distance estimation using reticular binoculars for further explanation) and use standard trigonometric equations for calculation.	Mammals and Megafauna (EIAR volume 2B). See Appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) and section 10.10.7, which confirm that the MMMP has been prepared in accordance with the NPWS (2014) guidance and outlines how this has been achieved. Section 10.10.7 (and the MMMP Addendum) confirms the use of distance estimation formula will follow the same approach suggested for distance estimation by the Joint Nature Conservation Committee (JNCC) (JNCC, 2017b) (as discussed in Marine Mammal Observer Association (MMOA) (2024)) and will use standard trigonometric equations for calculation.	

10.2 Purpose of this chapter

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.3 Study area

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.4 Policy context

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.5 Consultation

The Table below provides a summary of further consultation undertaken with NPWS in October 2025 (i.e. post application).

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this appendix
October 2025	NPWS – meeting	Requirements for baseline data including for acoustic data to fully characterise the site.	Section 10.6.2 includes detail on acoustic surveys conducted for the Project. Use of echolocation click detectors is considered standard practice and useful supplementary information, but site characterisation is more fully established through visual surveys and desktop survey data. The Applicant is confident that the data presented in the baseline characterisation for cetaceans is sufficient and proportionate to enable a robust assessment of the potential impacts of the Project on cetacean receptors.
		NPWS noted under Irish legislation, TTS constitutes injury and emphasised that the Applicant needs to make it clear that TTS is considered in the MMMP.	TTS is considered in section 10.10 of this Addendum and the MMMP (see appendix 5-4 Addendum: Marine Megafauna Management Plan).
		NPWS noted that the documentation provided no methodology for ADD use.	The Project noted the details of ADD use are not usually provided at this stage and is usually developed further in consultation with NPWS post consent. ADD will be selected to tailor to the correct zone and species trying to deter and noted RPS have worked on the ADD evidence base review for JNCC (Phillips *et al.*, 2025). The MMMP (appendix 5-4 Addendum: MMMP) has been updated with more detailed discussion of ADDs, and confirms the MMMP complies with all aspects of NPWS (2014) guidance, with detail provided in the NIS.

10.6 Methodology to inform the baseline

10.6.1 Desktop study

In response to RFI 9.T additional discussion has been included on critical periods of breeding and spawning and any associations with known vocalisations.

Breeding season information has been identified for marine mammal species whenever this species-specific information is available and is detailed within the species' accounts in volume 2B, appendix 10-1: Marine Mammals and Megafauna Technical Report.

Section 1.6.5 (of volume 2B, appendix 10-1: Marine Mammals and Megafauna Technical Report) summarises breeding for grey seal. Pupping tends to take place between August and November (SCOS 2018) in the UK and Ireland, with pups leaving the breeding site for the sea after approximately one month. In Irish waters grey seal generally breed from September to December (Cronin *et al.*, 2007a, Cronin *et al.*, 2007b) on remote and generally undisturbed areas, (NPWS, 2025). Lambay Island Special Area of Conservation (SAC) supports the principal breeding colony of grey seal on the east coast of Ireland (NPWS, 2014). Additional detail is included throughout the technical report where relevant.

Section 1.6.6 (of volume 2B, appendix 10-1 Marine Mammals and Megafauna Technical Report) summarises breeding for harbour seal. Following the spring/summer breeding and nursing season, the annual moult of harbour seal in Ireland occurs from late July through August, and pups are born in June and July.

Section 1.6.1 (of volume 2B, appendix 10-1 Marine Mammals and Megafauna Technical Report) summarises breeding for harbour porpoise. The age at sexual maturation for the harbour porpoise is approximately three to four years and reproduction is strongly seasonal with mating occurring between June and August (Lockyer, 1995). Gestation is 10 to 11 months and there is a peak in birth rate around the British Isles during the months of June to July (Boyd *et al.*, 1999).

For bottlenose dolphin *Tursiops truncatus*, short-beaked common dolphin *Delphinus delphis* and minke whale *Balaenoptera acutorostrata*, information on breeding seasons is much less clear and there is more uncertainty in defining critical breeding periods. For bottlenose dolphin, mating occurs during the summer months (see Section 1.6.2 1 of volume 2B, appendix 10-1 Marine Mammals and Megafauna Technical Report), and whilst there is no fixed breeding season most births take place between May and November (Harris and Yalden, 2008, National Biodiversity Data Centre, 2025). For short-beaked common dolphin, as described in section 1.6.3 (of volume 2B, appendix 10-1 Marine Mammals and Megafauna Technical Report) the species appears to have two calving peaks (spring and autumn) with a gestation period of 10 to 11 months (Seawatch Foundation, 2012). For minke whale, mating occurs between January and May but there is no evidence of minke whale calving in Irish waters and it is believed they migrate to lower latitudes to breed in the winter months (Irish Whale Dolphin Group (IWDG), 2019).

Therefore the information in volume 2B, appendix 10-1 Marine Mammals and Megafauna Technical Report, in addition to the supplementary information presented above in section 10.6.1, is sufficient to identify critical periods of breeding, summarised in Table 10A-2.

Table 10A-2: Critical periods of breeding for those marine mammal species where data confidence is high.

Species	Critical breeding period
Grey seal	September to December
Harbour seal	July to August
Harbour porpoise	June to August
Bottlenose dolphin	May to November

10.6.2 Site-specific surveys

In response to RFI 9.Q(i) justification has been provided for the selection of a 4 km buffer area extending around the Array Area.

At the time of the first marine mammal vessel surveys undertaken for the Project (April, June and July 2006), the 2018 DCCAE guidance was not released and there was no set standardised guidance for the buffer area for marine mammals (Department of Communications Climate Action and Environment, 2018). The original 2006 survey area applied a 4 km buffer, which has been applied to marine mammal surveys for other consented major wind farms (e.g. East Anglia THREE Offshore Wind Farm (Vattenfall and Scottish

Renewables, 2015); Norfolk Vanguard Offshore Wind Farm (Vattenfall and Scottish Renewables, 2015); East Anglia ONE North Offshore Wind Farm (Scottish Renewables, 2019)) and for the other Phase 1 Projects (Arklow Bank Wind Park 2 (SSE Renewables, 2024), Codling Wind Park (Codling Wind Park Limited, 2024), North Irish Sea Array (NISA Windfarm Ltd., 2024) and Dublin Array (Bray Offshore Wind Limited. and Kish Offshore Wind Limited., 2025)).

Vessel-based surveys carried out in 2018 to 2020 followed the same methodology as for the previous surveys to allow consistency between surveys, therefore a 4 km buffer was applied. Marine Mammal Observers (MMOs) were used after the first three monthly surveys (as for the 2006 surveys), surveying over a 180-degree arc and noted information on species present, group size, age class, adult or calf. The approach to the original vessel-based surveys (2006-2008) with the 4 km buffer was set out for NPWS in June 2020, as part of the Project pre-application consultation. NPWS confirmed they had no further feedback and no further consultation was required. In addition to vessel-based surveys, other surveys were carried out (as highlighted in Table 10-5 of volume 2B, chapter 10: Marine Mammals and Megafauna) which included site-specific aerial surveys in 2020 and static acoustic monitoring in 2019 to 2020.

It is important to note that other sources of literature are used in the baseline characterisation for the Project, which does not solely rely on the vessel-based site-specific surveys. These sources are useful in building a broader and more detailed picture of marine mammal activity in the vicinity of the project.

Furthermore, a 4 km buffer is considered to be proportionate to the zone of influence within which impacts from the Project are likely to occur. Although extending the survey area to 10 km may capture additional sightings, this expansion risks diluting the density estimates in the zone where impacts—such as strong disturbance from piling (see 155 SELss contours in Figure 10-A2 and Figure 10-A3)—are expected to be most pronounced. Specifically, for marine mammals, increasing the survey area often results in a disproportionately larger area relative to the number of additional animals detected, leading to lower overall density estimates. Therefore, it is essential to carefully balance the survey extent with detection capabilities to ensure that density estimates accurately reflect the area most relevant to potential impacts.

It is therefore considered that applying a 10 km buffer would not change conclusions of the assessment in chapter 10: Marine Mammals and Megafauna, because the 4 km buffer appropriately reflects the zone of influence where impacts from the development are most likely, extending to 10 km would dilute density estimates by including a larger area with relatively few additional sightings, and the assessment already applies dual densities to ensure a precautionary and comprehensive evaluation.

In response to RFI 9.Q(ii) clarification has been provided on the acoustic surveys conducted for the Oriel Project.

The Oriel Project conducted Static Acoustic Monitoring (SAM) surveys which were used to supplement site-specific vessel-based and aerial visual surveys, with the primary objectives of (i) describing the long-term presence of harbour porpoise within the Marine Megafauna Study Area, and (ii) to supplement data gaps in visual surveys. To confirm, the site-specific surveys conducted for the Project included vessel-based visual surveys of seabirds and marine mammals conducted monthly between March and August 2006; vessel-based visual surveys from May 2018 to May 2020 (excluding February, March and April 2020 due to COVID restrictions); aerial surveys from April to September 2020; and SAM surveys from November 2019 to November 2020. The SAM surveys conducted, consisted of C-PODs - echolocation click detectors, which are considered effective monitoring tools for (generally) dolphins and porpoises. However, baleen whales (including minke whale) do not echolocate, therefore they cannot be monitored using this tool. As such, a different approach to acoustic monitoring for baleens would be required using broadband recorders (such as autonomous hydrophone arrays).

The Applicant highlights that the use of echolocation click detectors is considered standard practice and useful supplementary information, but site characterisation is more fully established through visual surveys and desktop survey data. Whilst the addition of broadband recorder data would be an interesting addition to the available data, the Applicant is confident that the data presented in the baseline characterisation for cetaceans in volume 2B, chapter 10: Marine Mammals and Megafauna, is sufficient and proportionate to enable a robust assessment of the potential impacts of the Project on cetacean receptors. Finally, the addition of broadband recorder data would not alter the approach to the assessment, as density estimates cannot be established for baleen whales via this tool, and a robust conservative dual-density estimate was

identified from visual site-specific surveys and desktop data. It is therefore considered that the inclusion of broadband recorder data would not result in a change to the conclusion of assessment.

The EIAR has fully and properly characterised the site for Habitats Annex IV cetacean species and it is concluded that there will be no significant adverse impacts on Annex IV cetacean species as a result of the Project.

In response to RFI 9.Q(iii) justification has been provided on the lack of vantage point surveys and/or monitoring for pinniped species at the cable landfall location.

In summary, Vantage Point (VP) surveys were not undertaken for the EIAR, however the lack of VP surveys is not considered to influence the baseline characterisation for seals (as presented in volume 2B, appendix 10-1: Marine Mammals and Megafauna Technical Report), or to affect the adequacy of the impact assessment for seals (as presented in volume 2B, chapter 10: Marine Mammals and Megafauna). However, to supplement the baseline characterisation set out in the Marine Mammals and Megafauna Technical Report, VP seal surveys were conducted from October 2024 to October 2025 at Dunany Bay Beach in Co. Louth for the Project, and an overview of sightings has been presented in Table 10A-3 below.

The Department of Communications (2018) guidance stipulates vantage point surveys are useful for small, coastal sites but states distribution and relative abundance in inshore and offshore waters can be recorded during line transect surveys (both from the air and by boat) with distance sampling. The Applicant considers that for the Project, aerial and vessel-surveys are appropriate to characterise the offshore environment in which most of the impacts for marine mammals will take place (piling, geophysical surveys, vessel noise) for most marine mammal species. Extensive aerial and vessel-based surveys of the offshore wind farm area plus buffer were already conducted (see Table 10-5 in volume 2B, chapter 10: Marine Mammals and Megafauna). The Applicant acknowledges that, whilst seals were sighted in the site-specific surveys, at-sea surveys are not typically used for monitoring of seal populations and therefore volume 2B, appendix 10-1: Marine Mammals and Megafauna Technical Report includes a broad range of other desktop sources for characterising the baseline for grey seal and harbour seal.

In volume 2B, appendix 10-1: Marine Mammals and Megafauna Technical Report, a detailed baseline is characterised drawing upon multiple robust data sources. These include aerial survey data (Duck and Morris, 2013, 2019), telemetry data (Carter *et al.*, 2020, Cronin *et al.*, 2016), biodiversity maps (NBDC, 2024) as well as the most recent Scientific Committee On Seals (SCOS) reports (SCOS, 2020) which includes the latest information on seal haul-out sites in the UK (relevant to the Project given the proximity to Northern Ireland). Information on the closest key haul-out sites for grey seal and harbour seal is presented in volume 2B, appendix 10-1: Marine Mammals and Megafauna Technical Report.

Data from desktop data sources on key haul-out sites was applied to volume 2B, chapter 10: Marine Mammals and Megafauna; - relevant haul-out sites are presented in Figures 10-4, 10-5 and 10-12; and a detailed discussion of key haul-out locations, specifically Wexford Harbour, Clogherhead, Dundalk Bay, and Carlingford Lough are included. The chapter also addresses the sensitivity of these haul-out sites, particularly in relation to potential injury or disturbance to marine megafauna caused by vessel activities (discussed in relevant impact assessment sections).

Additionally, VP seal surveys were conducted from October 2024 to October 2025 for the Project (see appendix 10-9: Seal Survey Report). This appendix summarises the results from a survey of grey seal and harbour seal within 500 m of the cable landfall location at Dunany Bay Beach in Co. Louth. The survey area was determined as a 500 m area of search from an agreed VP onshore, deemed sufficient to cover a sufficiently large area to account for potential hauled-out seals within the cable corridor, as well as any seals utilising the water column upon arrival at the site. The seal survey methodology was based on that described in the DCCAE (2018) guidance and is detailed in appendix 10-9: Seal Survey Report. A summary of sightings is given in Table 10A-3 which shows there were very few seals recorded during VP surveys at the cable landfall location and no seals were hauled out in any of the surveys.

Therefore, there is no change to the conclusions in volume 2B, chapter 10: Marine Mammals and Megafauna, which already includes a detailed robust baseline in appendix 10-1: Marine Mammals and Megafauna Technical Report and includes assessments of haul-out sites where appropriate.

Table 10A-3: Seals recorded during VP surveys of 500 m of the cable landfall location at Dunany Bay Beach in Co. Louth for the Oriel Windfarm Project between October 2024 and October 2025.

Month	Survey 1	Survey 2
October 2024	Survey not carried out due to equipment delays.	No seals hauled out / identified within 500m area of search.
November 2024	No seals hauled out / identified within 500m area of search.	No seals hauled out / identified within 500m area of search.
December 2024	No seals hauled out / identified within 500m area of search. Maximum of two seals commuting offshore (~2km).	Survey not carried out due to weather and tide conditions.
January 2025	Survey not carried out due to weather and tide conditions.	Survey not carried out due to weather and tide conditions. However non-dedicated survey carried out, recorded no seals hauled out / identified within 500m area of search. One seal recorded commuting ~1.5 km offshore.
February 2025	No seals hauled out / identified within 500m area of search. Maximum of three seals commuting offshore (~1.5km).	Outside of breeding season for grey and harbour seals, therefore only one survey required.
March 2025	No seals hauled out / identified within 500m area of search.	Outside of breeding season for grey and harbour seals, therefore only one survey required.
April 2025	No seals hauled out / identified within 500m area of search.	Outside of breeding season for grey and harbour seals, therefore only one survey required.
May 2025	No seals hauled out / identified within 500m area of search.	Outside of breeding season for grey and harbour seals, therefore only one survey required.
June 2025	No seals hauled out / identified within 500 m area of search.	No seals hauled out / identified within 500 m area of search.
July 2025	No seals hauled out / identified within 500 m area of search. One seal commuting offshore (~2 km).	No seals hauled out / identified within 500 m area of search.
August 2025	No seals hauled out / identified within 500 m area of search.	No seals hauled out / identified within 500 m area of search.
September 2025	No seals hauled out / identified within 500 m area of search.	No seals hauled out / identified within 500 m area of search.
October 2025	No seals hauled out / identified within 500 m area of search.	No seals hauled out / identified within 500 m area of search.

10.6.3 Identification of designated sites

No changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.7 Baseline environment

10.7.1 Designated sites

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.7.2 Important Ecological Features

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.7.3 Future baseline scenario

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.7.4 Data validity and limitations

The data presented in EIAR chapter 10: Marine Mammals and Megafauna and appendix 10-1: Marine Mammals and Megafauna Technical Report remains valid in 2026. However, for completeness additional detail and justification for this has been included below. Supplementary VP seal surveys (in response to RFI 9Qiii) were conducted from October 2024 to October 2025 at Dunany Bay Beach in Co. Louth for the Project. An overview of sightings is presented in Table 10A-3 above.

The data assumptions and limitations highlighted in appendix 10-1: Marine Mammals and Megafauna Technical Report (EIAR volume 2B) remain typical of difficulties encountered with undertaking field surveys of marine mammals using boat-based methods. Initially (first three months) the 2018-2020 boat-based surveys were conducted using the same observers as used for recording seabirds; this was subsequently amended by introducing dedicated MMOs to reduce the likelihood that marine mammals are missed during the surveys.

Detection probability is also a limiting factor in recording marine mammals with weather conditions playing a significant role in the ability to detect a marine mammal from the observation platform. Identification to species-level can sometimes be difficult, particularly when distinguishing between grey seal and harbour seal at sea. Since there were a number of sightings recorded as 'seal species', these unidentified seals were allocated to each species (grey seal *Halichoerus grypus* or harbour seal *Phoca vitulina*), based on the relative proportion that each species contributed to the overall number of identified seals present. In this way, all seal sightings could be used in the data analyses, which is important where the number of sightings in general is relatively low. Site-specific aerial surveys were also conducted in 2020, to provide additional data support to the site-specific vessel surveys (2018-2020). Data were analysed appropriately for each survey method and the most precautionary estimate of density was taken forward for assessment (where sightings were sufficient to do so; see appendix 10-1: Marine Mammal and Megafauna Technical Report). It is considered this precautionary approach captures any potential for data variation.

Guidelines on data validity with regards to marine mammal data lifespan is scarce, however data is typically viewed as valid if within five years. Recent Scottish guidance on marine ornithology baseline suggests data should not be more than five years old and there should be at least two years of monthly data (Marine Scotland, 2023). Whilst this advice relates directly to marine ornithology, it is typical for marine ornithology and marine mammal surveys to be conducted from the same survey platform (as per the Project site-specific surveys). In the professional opinion of the author, it is considered that two years of pre-construction surveys to be the minimum requirement for pre-construction surveys, to which the Project site-specific surveys (2018-2020) meet.

In relation to the baseline characterisation that underpins this assessment site-specific data gathered 2018-2020 were corroborated by information collated via the detailed desktop review, including the most recent SCANS-IV data (Giles *et al.*, 2023) for cetaceans and recently published seal data (Carter *et al.,* 2022; SCOS, 2021; SCOS, 2020). Therefore, the baseline characterisation does not rely solely on the field survey data and the baseline characterisation for the Marine Mammal and Megafauna Study Area is considered to be fit for purpose for understanding potential impacts and the precaution built into the assessment will capture any potential for data variation.

10.8 Key parameters for assessment

10.8.1 Project design parameters

No changes have been made to the project design parameters other than further justification provided for the worst-case number of piling events, in response to RFI 9.P(iv) regarding contingency of having to move and re-pile if substrate does not accept the pile.

An average maximum of five hours per pile across all wind turbine generator (WTG) locations has been assumed (with no more than eight hours at selected locations). However, the Applicant has assumed (from a precautionary perspective) installation of one pile per 24 hour period (or one piling day). This precautionary approach allows for generous installation contingency (e.g. the need to move and re-pile if substrate does not accept the pile), as 24 hours far exceeds the average piling time of five hours (and maximum possible piling time of eight hours at selected locations). Up to 26 days of piling has been assumed (25 WTG foundations and 1 Offshore Substation (OSS) foundation), with one monopile installed per day at a maximum

hammer energy of 3,500 kJ. In reality, it is unlikely that 24 hours of piling would ever be required, however the precautionary principle has been applied to the assessment of potential impacts on marine mammals. The 26 piling days is taken forward to the population modelling (see volume 2B, appendix 10-3: Marine Mammal Population Modelling Report (iPCoD), updated population modelling due to revised noise modelling in 10.10.1 and cumulative population modelling in section 10.11) and the piling schedule was developed based on the number of full days of piling over the indicative offshore construction period.

The proposed drive-drill method of installation will result in a very low likelihood of the requirement to move and re-pile at any location. It is proposed that a sacrificial casing will be piled into the unconsolidated deposits only to full resistance. This is a shallow depth penetration of between 5 and 17m (approximately), dependent on the location. Once the sacrificial casing is installed and stabilised further progress will be made with a drill rig. This proposed method will therefore minimise the requirement to re-pile.

10.8.2 Measures included in the Project

In response to RFI 9.B, a detailed justification is provided for the mitigation zones for geophysical acoustic surveys and pile driving.

Construction activities at the Project have the potential to result in elevated levels of subsea noise that could result in injurious (or behavioural effects) on marine mammals. National Marine Fisheries Service (NMFS) (2024) defines auditory injury as damage to the inner ear that can result in the destruction of tissue, which may (or may not) result in a permanent threshold shift (PTS). PTS represents permanent, irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range (NMFS, 2024), which can result in long-term impairment of hearing capabilities critical for communication and navigation. In contrast, Temporary Threshold Shift (TTS) is a temporary, reversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range where recovery from tissue damage is possible (NMFS, 2024). TTS is considered to be temporary impairment (Verfuss and Sparling, 2025) rather than injury, NMFS (2024) produced 'updated criteria for onset of TTS and auditory injury, which includes but is not limited to PTS' because an animal's auditory system can recover.

The NPWS (2014) guidance recommends that TTS is included as a potential injury risk as this could impair the ability of animals to use natural sounds, with potential consequences to fitness and therefore it was included in the impact assessment for underwater noise from piling, geophysical surveys, vessels and other construction activities in volume 2B, chapter 10: Marine Mammals and Megafauna. However, the most likely response of an animal exposed to noise levels that could induce TTS, is to flee the ensonified area. It is therefore considered that there is also a behavioural response (disturbance) that overlaps with potential injury ranges, and animals exposed to noise levels that have the potential to induce TTS are likely to actively avoid hearing damage by moving away from the area.

Therefore, to reduce the risk of injury, the mitigation zones in volume 2A, appendix 5-4 Marine Megafauna Mitigation Plan (MMMP) focused on the maximum predicted injury (PTS) ranges (based on the dual metric approach). The MMMP aligns with the latest available guidance to manage the risk to marine mammals from man-made sound sources in Irish waters, detailed in the NPWS (2014) guidance. The primary goal of mitigation measures is to prevent marine mammals from experiencing PTS, rather than TTS which is reversible and thus considered less severe biologically. As described in Verfuss and Sparling (2025), the level and duration of TTS that cause significant energetic or fitness consequences for individuals (and the proportion of a population affected before population-level impacts occur) are currently unknown. There is currently no set threshold for the onset of a biologically meaningful TTS, but it is likely well above the TTS-onset threshold, likely leading to smaller impact ranges than those obtained directly for the TTS-onset threshold. The TTS-onset thresholds proposed by Southall *et al.* (2007) and Southall *et al*. (2019) were designed to help determine PTS-onset thresholds (as direct determination of PTS-onset thresholds would lead to an injury of the experimental animal and is therefore considered unethical) and represent the smallest measurable TTS above normal variation (Verfuss and Sparling, 2025).

For pile driving, the NPWS (2014) guidance details 'pile driving activity shall not commence if marine mammals are detected within a 1,000 m radial distance of the pile driving sound source, i.e., within the Monitored Zone'. This exceeds the guidance from JNCC (2010) in which the standard mitigation zone for pre start monitoring must have a minimum radius of 500 m from the source of piling sound. ADD will be applied to reduce the potential for injury, and noise modelling was carried out for the SEL_{cum} metric to determine the potential efficacy of using 15 minutes ADD, to deter marine mammals from the injury zone (see volume 2B,

appendix 10-2: Subsea Noise Technical Report). For all marine mammal species, the maximum PTS range was less than the 1 km mitigation zone for both the SPL_{pk} and SEL_{cum} metrics (with the maximum injury range based on the SPL_{pk} metric being 236 m for harbour porpoise, and 394 m based on the SEL_{cum} metric for minke whale). With the use of 15 minutes ADD, this range was reduced further and PTS injury thresholds were not exceeded for all species. Therefore, the mitigation range of 1,000 m well encompasses the auditory injury (PTS) ranges. It is highlighted the 1,000 m mitigation zone will also aid in reducing the potential impact of TTS on marine mammals.

Revised noise modelling (as outlined in appendix 10-4: Updated Subsea Noise Modelling Report) demonstrated updated PTS ranges, both with and without ADD (see section 10.10.1). For peak pressure (SPL_{pk}), revised underwater noise modelling predicted greater PTS ranges than presented in chapter 10: Marine Mammals and Megafauna (EIAR volume 2B) for all species, with differences in PTS ranges ranging from +53.6% (dolphins) to +93.9% (harbour porpoise). In the revised noise modelling the maximum PTS range (based on SPL_{pk}) was 653 m, for harbour porpoise. For SEL_{cum} revised noise modelling showed increased PTS ranges for Very High Frequency (VHF) and Low Frequency (LF) cetaceans, but not for High Frequency (HF) cetaceans (where thresholds were not exceeded). PTS ranges decreased for grey and harbour seals. Minke whale PTS range rose by 97%, harbour porpoise by 132%, while seals decreased by 53%. In the revised noise modelling the maximum PTS range (based on SEL_{cum}) was 1,135 m, for minke whale. As such the maximum injury range for SPL_{pk} is still predicted to be less than the standard 1,000 m mitigation zone for pile-driving proposed by the NPWS (2014) guidance, in line with the EIAR. The 1,135 m for the SEL_{cum} metric falls outside this mitigation zone range, which differs from that presented in chapter 10: Marine Mammals and Megafauna (EIAR volume 2B). However, with the application of an ADD (in addition to measures included in the Project) the threshold for PTS (SEL_{cum}) would not be exceeded for any species and therefore the mitigation range of 1,000 m well encompasses the auditory injury (PTS) ranges.

Furthermore, despite the assessment of injury to marine megafauna from underwater noise during pile driving concluding no significant impact, the Project is committed to the use of noise abatement measures for the purpose of reducing sound levels from construction piling. The Project will use a drive-drill methodology for the monopile installation which minimises the impact piling duration (using sacrificial casing) using a casing-option (MODIGA), which comprises a design-in measure that is part of the project design. However, in an abundance of caution, for the short duration of hammer impact piling of the sacrificial casing (and limited number of days piling) the Project proposes to use the MODIGA with internal air bubble ring as its noise abatement solution, as an additional mitigation (see detail in ‘Further Measures’ under section 10.10.1).

For geophysical surveys (i.e. multibeam echosounders) the NPWS (2014) guidance details ‘acoustic surveying using the above equipment shall not commence if marine mammals are detected within a 500 m radial distance of the sound source intended for use, i.e., within the Monitored Zone’. This aligns with the latest guidance from (JNCC, 2017a) which states the standard radius of the mitigation zone for geophysical surveys is 500 m. volume 2A, appendix 5-4 Marine Megafauna Mitigation Plan details PTS has the potential to occur out to a maximum of 227 m (for harbour porpoise) whilst TTS has the potential to occur out to a maximum of 449 m (in harbour porpoise). Therefore, whilst the mitigation zone should be targeted to focus on PTS, the 500 m radius proposed encompasses the maximum TTS range also.

In response to RFI 9.E, detail on phased piling as part of a Piling Strategy (prepared in collaboration with other offshore windfarms in the western Irish Sea) is provided.

The Phase 1 projects have also committed to implementing phased piling as part of a post-consent Piling Strategy should construction programmes overlap. As detailed in Table 10-12 of EIAR volume 2B, chapter 10: Marine Mammals and Megafauna, the Applicant commits to implementing phased piling alongside other adjacent offshore wind farms in the western Irish Sea as part of a Piling Strategy. This strategy will be prepared post consent in consultation with the compliance authorities and will set out measures for collaboration with other projects to reduce the potential for an in-combination effect. This will include a stepped strategy which follows the mitigation hierarchy - avoid, reduce, mitigate. Consequently, if phased piling is required a collaborative approach will be explored and information presented to demonstrate how a phased piling approach can contribute to the reduction in underwater sound from piling. The aim is to minimise the potential for permanent auditory injury to marine mammals and minimise the area of habitat affected by underwater noise at any one time.

10.8.3 Impacts scoped out of the assessment

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.9 Impact assessment methodology

In response to RFI 9.I, details on the modelling methodology for ADD are outlined below.

Acoustic Deterrent Devices (ADDs) are incorporated into the exposure model prior to simulating the piling schedule. It is assumed that an animal would react to an ADD by fleeing directly away from the source at a constant velocity in the same way that they would react to piling. However, for the duration of an ADD there is no cumulative SEL experienced by the animal. The distance that an animal travels during the duration of ADD use is calculated with the formula $Distance = Swim\_Speed \times ADD\_Duration$, and the resulting value is added to the animal's starting position before the piling schedule is simulated. The swim speed assumed is based on marine mammal group and is chosen to be conservative.

This is considered a reasonable approximation because, while Acoustic Deterrent Devices (ADDs) can cause behavioural disturbance (Boisseau *et al*., 2021; Elmegaard *et al*., 2023), the sound levels they generate are substantially lower than those produced during piling (McGarry *et al*., 2022). In this study, piling source levels exceed 220 dB re 1 µ Pa at 1 m, whereas typical ADDs rarely exceed 200 dB re 1 µPa at 1 m (Gordon *et al.,* 2007; McGarry *et al*., 2022). Given the logarithmic scale of sound measurements, the much higher piling sound levels dominate the total sound energy, meaning that ADD noise makes only a negligible contribution to the cumulative sound exposure level (SEL_{cum}) across the full pile installation period.

In summary, the Applicant has considered the available literature on the impact of ADDs and has assumed complete exclusion based on a conservative marine mammal swim speed.

10.9.1 Overview

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.9.2 Impact assessment criteria

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.9.3 Identification of Designated sites

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.10 Assessment of significance

10.10.1 Injury and/or disturbance to marine megafauna from underwater noise during pile-driving

Summary of Subsea Noise Modelling: Injury

There are no changes or additions in response to RFIs to chapter 10: Marine Mammals and Megafauna.

Whilst the assessment undertaken as part of the EIAR considered the best available advice at the time, advances have been made in the field of underwater sound modelling since the assessment was carried out, particularly in the field of noise generated by piling activities. Therefore (and additionally in response to statutory consultation submissions and the further information requested regarding underwater noise modelling (RFIs 9.G and 9.H)) the source modelling and propagation modelling methodology applied to the subsea noise modelling was updated to present the most scientifically rigorous and up to date results to underpin the impact assessment. See appendix 10-4: Updated Subsea Noise Modelling Report for details of the revised source modelling method (using von Pein *et al*., 2022) and revised 'line source' propagation model. Whilst no changes to the approach for the interpretation of the subsea noise modelling have been

made for marine mammals and megafauna, the results of the revised noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report) and the subsequent updated marine mammal impact assessment are presented in the magnitude of impact section.

Summary of Subsea Noise Modelling: Disturbance

No changes to the information presented in the EIAR have been made, but additional information has been included in response to RFI 9.O (which presents consideration of alternative thresholds to the applied NOAA Level B Harassment Threshold) and to 9P(i) (regarding the maximum range of disturbance for NOAA Level B harassment.

Additionally, in line with 'Summary of Subsea Noise Modelling: Injury' (above), , the source modelling and propagation modelling methodology applied to the subsea noise modelling was updated (see appendix 10-4: Updated Subsea Noise Modelling Report for details of the revised source modelling method (using von Pein *et al.,* 2022) and revised 'line source' propagation model). Whilst no changes to the approach for the interpretation of the subsea noise modelling have been made for marine mammals and megafauna, the results of the revised noise modelling and the subsequent updated marine mammal impact assessment are presented in the magnitude of impact section.

In response to **RFI 9.O and 9.P(i)**, both a dose-response approach and fixed threshold approach were used in the assessment of disturbance from underwater noise during pile driving. For fixed thresholds it is assumed all animals within the threshold area are impacted (with no dose response applied). The assessment applies the NMFS (2005) (part of NOAA) Level B harassment threshold of 160 dB re 1 µPa Sound Pressure Level (root mean squared) (SPL_{rms}) for impulsive sound, defined as "strong disturbance", as well as a 'mild disturbance' threshold of 140 dB re 1 µPa SPL_{rms}. Acknowledging that there are other relevant thresholds available (such as the 143 dB re 1 μPa^2s single pulse SEL for harbour porpoise only, as recommended by NRW (2023)), the approach taken was nonetheless precautionary and based on published thresholds that have been widely applied to offshore wind projects in the UK. Level B harassment is defined by NMFS (2005) as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild. Beyond this threshold the behavioural responses are likely to become less severe (e.g. minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al.*, 2007)). Thus, NMFS (2005) also suggests a precautionary level of 140 dB re 1 µPa SPL_{rms} to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound, although this is not considered likely to lead to a 'significant' disturbance response. In particular, since the EIAR was undertaken only the use of the strong disturbance threshold (160 dB re 1 µPa SPL_{rms}) is recommended for assessment of behavioural disturbance (NMFS, 2025) and therefore consideration of mild disturbance is inherently conservative. Both the strong and mild disturbance thresholds are presented in volume 2B, chapter 10: Marine Mammals and Megafauna and in revised tables in this Addendum (Table 10A-22 to Table 10A-23) and results are discussed per species throughout the magnitude section of volume 2B, chapter 10: Marine Mammals and Megafauna. The numbers of animals calculated for mild and strong disturbance are derived from the noise contours assuming all animals were disturbed above (rather than applying a dose-response methodology).

With revised noise modelling, there is some overlap of mild disturbance with the several SACs (Murlough SAC, North Anglesey Marine SAC, Lambay Island SAC and Rockabill to Dalkey Islands SAC) but no overlap of the strong disturbance contour with any European site with marine mammals listed as a qualifying feature (see Figure 10-A1). Acknowledging the limitations of the single step-threshold approach for strong disturbance and mild disturbance (i.e. does not account for inter-, or intra-specific variance or context-based variance), marine mammals within the area modelled as 'strong disturbance' would be most sensitive to behavioural effects (whilst mild disturbance is not considered likely to lead to a 'significant' disturbance response (NMFS, 2005)). According to the behavioural response severity matrix suggested by Southall *et al.* (2021) such low level disturbance (scoring between 0 to 3 on a 0 to 9 scale) could lead to mild disruptions of normal behaviours, but prolonged or sustained behavioural effects, including displacement are unlikely to occur.

Whilst noise exposure thresholds for auditory injury (such as those from NMFS (2024) and Southall *et al*. (2019) are widely accepted by regulators globally, there is greater uncertainty over thresholds for behavioural responses (Thompson *et al.*, 2025) largely because responses vary in different behavioural

contexts (Booth *et al.*, 2022, Ellison *et al.*, 2018, Southall *et al.*, 2023). As such there is less consistency in regulatory approaches to assessing behavioural responses. EIAs in UK waters have recently moved towards a preferred dose-response approach when assessing the probability of disturbance to cetaceans from different received levels of piling noise (NRW 2023; Sinclair *et al.* 2023). The dose-response curve from Graham *et al.* (2017) has been widely used to represent a conservative disturbance estimate for cetaceans (Thompson *et al.*, 2025). In the Graham *et al.* (2017) dose-response, a 50% probability of disturbance is predicted to occur at a received SEL_{ss} of approximately 145 dB re 1 μPa^2s (comparable to the Tougaard (2021) 143 dB re 1 μPa^2s SEL_{ss} threshold). The Applicant highlights Figures 10-4 and 10-5 in chapter 10: Marine Mammals and Megafauna illustrate the subsea noise contours in 5 dB SEL_{ss} increments.

Recent results from Thompson *et al.* (2025) demonstrate measured behavioural responses of harbour porpoises were much lower than those predicted from the Graham *et al.* (2017) dose-response function (which is applied below to the Project, and has been recommended for assessments in UK waters) and suggested that current assessments of disturbance impacts are overly conservative. It can therefore be concluded that the approach set out in the impact assessment for disturbance to piling is precautionary. Detailed methodology for the dose-response is set out in section 10.10.1 of this Addendum. The associated tables (Table 10A-13 to Table 10A-21)

) demonstrate that totalling the number of animals predicted to be disturbed above the 120 dB re 1 μPa^2s SEL_{ss} contour using a dose-response approach leads to more animals predicted to be disturbed than using the fixed threshold of 143 dB re 1 μPa^2s SEL_{ss}. For example, the numbers of harbour porpoise disturbed for the East monopile WTG location (utilising a SCANS IV density estimate of 0.2803 animals per km^2) using the dose-response approach is up to 497 harbour porpoise, whilst using an indicative threshold approach above 145 dB SEL_{ss} (comparable to 143 dB re 1 μPa^2s) for the same density estimate results in an estimate of up to 155 harbour porpoise (no dose-response applied). Using a more precautionary indicative threshold approach above 140 dB SEL_{ss} for the same density estimate results in an estimate of up to 332 harbour porpoise (no dose-response applied).

Sigray *et al.* (2023) details guidance on the setting of EU threshold values related to anthropogenic impulsive noise in the water. It clearly states, “such guidance is meant to be used by regulators and managers of the EU Member States (MS) aiming to achieve Good Environmental Status of their marine waters, as requested by the Marine Strategy Framework Directive (MSFD)”. The report only focuses on displacement, excluding impacts such as TTS, injury or death. The report sets suggested threshold values to reduce impacts to biodiversity:

- *for short-term exposure (1 day, i.e., daily exposure); the maximum proportion of an assessment/habitat area utilised by a species of interest that is accepted to be exposed to impulsive noise levels higher than Level of Onset of adverse Biological Effects (LOBE), over 1 day, is 20% or lower (≤ 20%).*
- *For long-term exposure (1 year), the average exposure is calculated. The maximum proportion of an assessment/habitat area utilised by a species of interest that is accepted to be exposed to impulsive noise levels higher than LOBE, over 1 year on average, is 10% or lower (≤ 10%).*

Ireland’s Marine Strategy Part 1 (Articles 8, 9 and 10) Report 2024 Government of Ireland (2024a) contains Ireland’s Article 8 Good Environmental Status (GES) assessment for the 11 descriptors of the MSFD which characterise the condition or ‘State’ of the marine environment (Article 8); provides a description of what GES should look like (Article 9); and contains revised environmental targets (Article 10). The report concluded GES has been achieved for impulsive noise in Ireland’s marine environment, based upon an analysis of spatial/temporal patterns of sound sources and noise modelling for impulsive noise. The report concluded the maximum area exceeding the level of adverse effects was never greater than 20%, and the area of average daily exposure never exceeded 10% for the receptor species (thereby following the guidance of EU thresholds in Sigray *et al.* (2023)).

The detailed assessment for this is provided in Annex III (Government of Ireland, 2024b). The approach to assessing the status of impulsive noise uses bottlenose dolphin as an example receptor, with 176 dB re 1 μPa^2s SEL selected as a threshold level for LOBE, and against which to assess GES, taken from the onset of TTS (based on NMFS (2018)). Government of Ireland (2024b) states the exact threshold value is currently being established on a regional basis. The distribution of noise exceeding the 176 dB selected level was modelled and mapped for each year. Noise levels from impulsive noise sources were assumed to be 260 dB

(of unknown metric[1]) (based on the higher end of seismic survey equipment, not piling) and used a simple spherical spreading model to map the distribution of noise exceeding the LOBE.

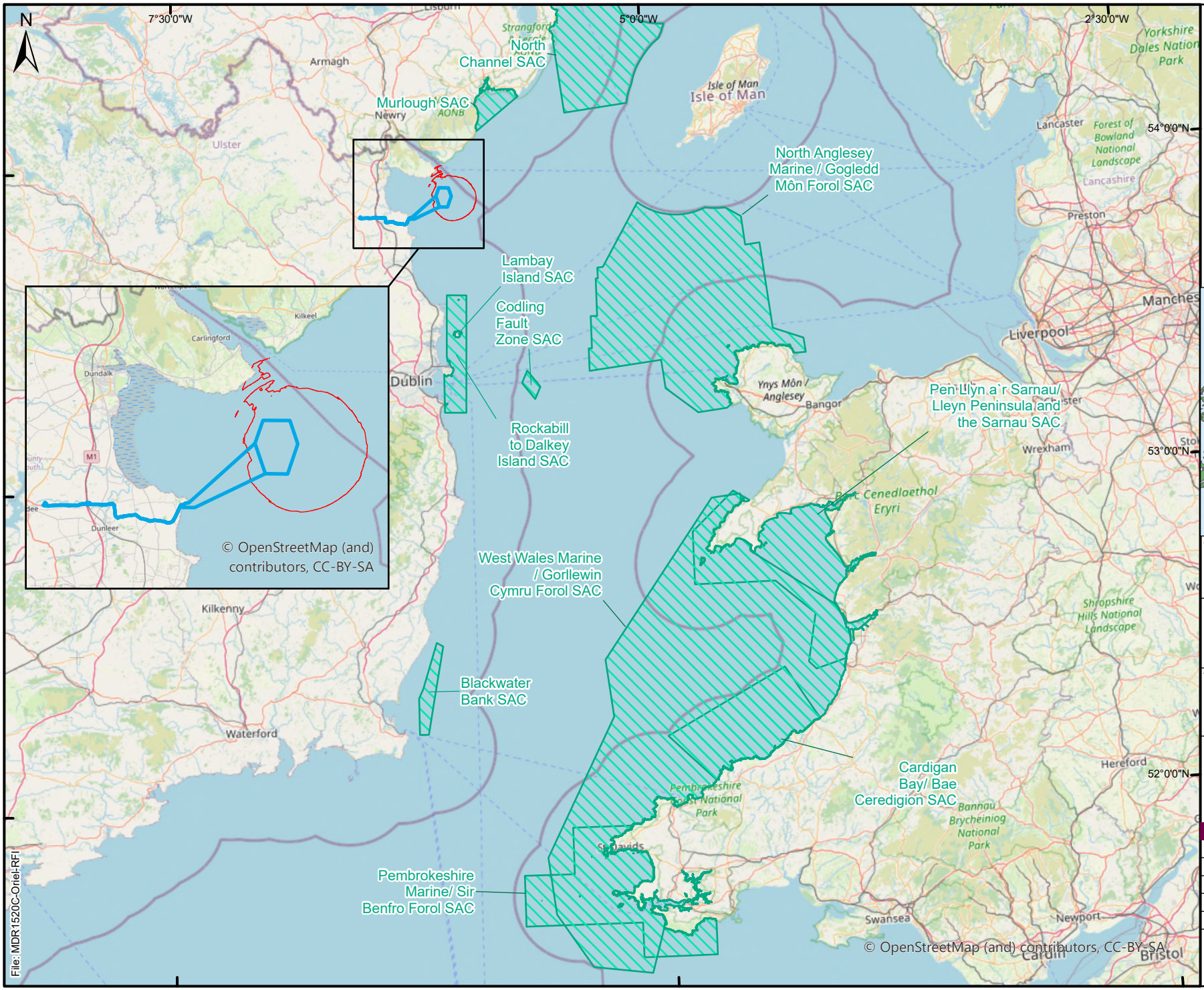
Importantly, revised noise modelling for piling demonstrates there is no overlap of the threshold of 160 dB re 1 µPa (rms) (indicating strong disturbance) with any designated sites (see Figure 10-A1). Therefore, there would be no requirement to calculate daily 20% / seasonal 10% thresholds.

The thresholds discussed in Sigray *et al.* (2023); the Irish Marine Strategy Government of Ireland (2024a), (Government of Ireland, 2024b) are not considered appropriate to apply to a project-level EIA for assessment of piling, for the following key reasons:

- GES is not intended for individual EIA project-level impact assessment, instead to be used at a regional scale assessment at a regulator level.
- There is no set guidance in Ireland to defining the "area" for which an individual project should assess against, nor agreed thresholds for LOBE.
- Daily 20% / seasonal 10% thresholds have been used specifically in guidance to minimise disturbance in harbour porpoise SACs for the purpose of Habitats Regulations Assessments (JNCC, 2020, JNCC, 2024), but not in EIAs.
- The threshold of 160 dB re 1 µPa (rms) used in the EIAR (for strong disturbance) is more precautionary than the selected threshold in Annex III of Ireland's Marine Strategy Part 1 (Government of Ireland (2024b).
- The methodology detailed in Government of Ireland (2024b) is not appropriate for use in the EIAR:
    - The threshold for LOBE in Government of Ireland (2024b) is based on TTS which is a temporary shift in hearing (based on NMFS (2018)) rather than disturbance, and Sigray *et al.* (2023) specifically states TTS is not dealt with in the guidance report as it is covered under EIA/HRA. Use of dose-response is directly related to disturbance.
    - The threshold for LOBE in Government of Ireland (2024b) is derived from temporary shifts in hearing for bottlenose dolphin, but Tougaard (2021) state that insufficient data is available for dolphins to apply a threshold (unlike harbour porpoise).
    - Noise levels were assumed to be 260 dB, derived from seismic survey equipment rather than piling, and a simple spherical spreading model was used to map the distribution of noise exceeding the LOBE. Site-specific bespoke modelling undertaken for the Project is more robust and suitable for the assessment of disturbance from piling.

Therefore, the approach applied to the assessment of disturbance from piling (using a dose-response approach, with additional application of the strong and mild disturbance thresholds) is considered to be robust and precautionary, and whilst alternative thresholds have been reviewed these are not considered appropriate to be applied to an assessment of disturbance for piling, for an EIAR.

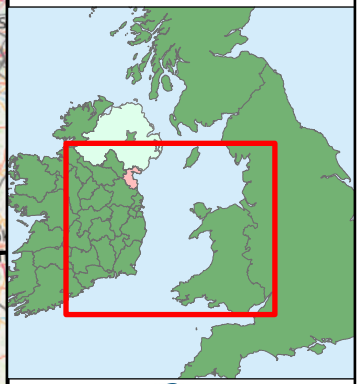
[1] No specific metric of pressure was included in the Annex III report (e.g. did not specify sound pressure level (SPL) peak, peak-peak, Sound Exposure Level (SEL) cumulative (SEL_{cum}), SEL_{24}). Only dB was reported.



Legend

- Application Boundary
- 160dB SPL_{rms}
- Special Area of Conservation (SAC)

Data Sources: Client. Seiche, NPWS



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title Figure 10A-1
NMFS (2005) threshold strong disturbance (160 dB re 1 µPa (rms))) for unmitigated piling of monopiles at the east modelled location and designated sites for marine mammals.

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Issue Details

Drawn By: NG	**Project No.** MDR1520C
Checked By: NG	**File Ref:** MDR1520C-RFI-ADD-UWN-013-02.A1C01
Approved By: BP	**Projection:** ITM (IRENET95)
Scale: 1:1,750,000 @ A4	Geographic Co-ordinates: ETRS89
Date: 11/12/2025	

File: MDR1520C-Oriel-RFI

Summary of thresholds

There are no changes or additions in response to RFIs to EIAR chapter 10: Marine Mammals and Megafauna.

Summary of interim population consequences of disturbance (iPCoD) modelling

There are no changes or additions in the approach to iPCoD modelling in response to RFIs to EIAR chapter 10: Marine Mammals and Megafauna. Updated iPCoD modelling with updated noise modelling for the project alone is presented below under the magnitude of impact section. Updated cumulative population modelling with the updated noise modelling and updated information from CIA projects is discussed in section 10.11 and presented in appendix 10-10: Cumulative iPCoD Modelling Report.

Construction Phase

Magnitude of impact

Injury

No changes to the existing information presented in the EIAR have been made, but additional information has been included in response to RFI 9.L, 9.P(ii) and 9.V and tables have been updated with revised noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report) and a revised marine mammal impact assessment is presented. The magnitude remains unchanged from the EIAR assessment.

Marine mammals

Table 10.24 and Table 10.25 of volume 2B, chapter 10: Marine Mammals and Megafauna have been updated with revised noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report) and updates presented in Table 10A-4 and Table 10A-5.

In response to **RFI 9.P(ii),** cumulative sound exposure levels (SEL) are assessed in terms of two scenarios: 1) a mitigated scenario in which all soft start and low energy phases of piling are applied; and 2) a mitigated plus Acoustic Deterrent Device (ADD) scenario, which includes the same mitigation but with the addition of a 15 minute period of ADD (see volume 2B, EIAR chapter 10: Marine Mammals And Megafauna for discussion on mitigation options). Therefore Table 10A-5 below updates Table 10.25 of the EIAR (with revised noise modelling) to include the fully mitigated scenario which includes soft, start, ramp up and 15 minute ADD, and revises the caption to reflect the scenarios.

Table 10A-4: Table 10-24 Summary of peak pressure injury ranges for marine mammals due to impact piling of 9.6 m diameter monopiles at the east of the offshore wind farm area (N/E = threshold not exceeded), for the revised subsea noise modelling. Note that with engineering mitigation in place (Table 10-12 of volume 2B, chapter 10: Marine Mammals and Megafauna) the ranges of effect are only relevant for the hammer initiation ('Soft Start – First Strike; 525 kJ); Max Energy ranges have been presented for comparison only.

Hearing group (species)	Threshold (Unweighted peak)	Range (m)	
		Soft start - First strike	Max energy
LF	PTS - 219 dB re 1 µPa (pk)	169	425
	TTS - 213 dB re 1 µPa (pk)	273	684
HF	PTS - 230 dB re 1 µPa (pk)	71	177
	TTS - 224 dB re 1 µPa (pk)	114	286
VHF	PTS - 202 dB re 1 µPa (pk)	653	1,638
	TTS - 196 dB re 1 µPa (pk)	1,051	2,638
PCW	PTS - 218 dB re 1 µPa (pk)	183	460
	TTS - 212 dB re 1 µPa (pk)	295	741

Table 10A-5: Table 10-25 Summary of the SEL_{cum} injury ranges for marine mammals due to piling of single monopile at the east of the offshore wind farm area (N/E = threshold not exceeded). Ranges are shown for the mitigated (initiation + soft start + ramp up) and further mitigated (initiation + soft start + ramp up + ADD scenario), for the revised subsea noise modelling.

Species / Group	Threshold (weighted SEL_{cum})	Range (m)	
		No ADD	15 min ADD
LF	PTS – 183 dB re 1 μPa^2s	1,135	N/E
	TTS – 168 dB re 1 μPa^2s	21,500	19,500
HF	PTS – 185 dB re 1 μPa^2s	N/E	N/E
	TTS – 170 dB re 1 μPa^2s	21	N/E
VHF	PTS – 155 dB re 1 μPa^2s	815	N/E
	TTS – 140 dB re 1 μPa^2s	14,500	13,000
PW	PTS – 185 dB re 1 μPa^2s	11	N/E
	TTS – 170 dB re 1 μPa^2s	5,520	3,890

Including soft start and ramp up as a measure included in the Project, the greatest predicted range for PTS (using the SPL_{pk} metric) was for harbour porpoise - a VHF cetacean - with PTS potentially occurring out to 653 m (Table 10A-4). The greatest range for PTS (using the SEL_{cum} metric) was predicted for minke whale - a LF cetacean - with PTS occurring out to 1,135 m (Table 10A-5). The PTS threshold using the SEL_{cum} metric was exceeded at 815 m for harbour porpoise and 11 m for seals but not exceeded for bottlenose dolphin and common dolphin, both HF cetaceans.

The greatest range for TTS, using the SPL_{pk} metric, was predicted for harbour porpoise as a VHF cetacean. TTS in harbour porpoise could occur during piling out to a maximum range of 1,051 m (Table 10A-4). The greatest range for TTS, using the SELcum metric, was predicted for minke whale, as an LF cetacean. TTS in minke whale could occur during piling out to a maximum range of 21,500 m (Table 10A-5). TTS ranges are, however, considered unrealistic due to the thresholds applied and the levels of conservatism built into the model and are therefore an overestimation of the magnitude of the impacts.

The maximum numbers of marine mammals potentially affected within the modelled ranges for PTS and TTS are presented in Table 10A-6/Table 10A-7 (SPL_{pk}) and Table 10A-8 / Table 10A-9 (SEL_{cum}).

In response to **RFI 9.L,** Table 10.26 and Table 10.27 of volume 2B, chapter 10: Marine Mammals and Megafauna has each been split into two tables; 'one for SCANS-IV densities and 'one for alternative density estimates. Alternative density estimates are those based on the Project site-specific surveys (for harbour porpoise, minke whale) or derived from other data sources (SCANS III density surface for bottlenose dolphin, Carter *et al.*2022 for seal species). All are updated with revised noise modelling and each table clarifies whether the density represents the minimum or maximum density estimate for each species.

- Table 10A-6 replaces Table 10.26 (in volume 2B, chapter 10: Marine Mammals and Megafauna) for SPL_{pk} using density estimates SCANS-IV Block CS-D (Gilles *et al.,* 2023).
- Table 10A-7 replaces Table 10.26 (in chapter 10: Marine Mammals and Megafauna) for SPL_{pk} using alternative density estimates.
- Table 10A-8 replaces Table 10.27 (in volume 2B, chapter 10: Marine Mammals and Megafauna) for SEL_{cum} using density estimates SCANS-IV Block CS-D (Gilles *et al.,* 2023).
- Table 10A-9 replaces Table 10.27 (in chapter 10: Marine Mammals and Megafauna) for SEL_{cum} using alternative density estimates.

For all assessed marine mammal IEFs, other than harbour porpoise, less than one individual is predicted to experience PTS or TTS as a result of soft start initiation of impact piling based on the SPL_{pk} thresholds for the species (see Table 10A-6 /Table 10A-7). For harbour porpoise, up to two individuals have the potential to experience PTS, and up to five individuals have the potential to experience TTS, using the SPL_{pk} metric.

The ranges of effect modelled for PTS for the SEL_{cum} metric suggest that up to three harbour porpoise, up to two minke whale, and less than one individual for grey seal and harbour seal respectively have the potential to experience PTS (see Table 10A-8 /Table 10A-9). The threshold for PTS (for the SEL_{cum} metric) for bottlenose dolphin and common dolphin was not exceeded.

The ranges of effect modelled for TTS, using the SEL_{cum} metric suggest up to 378 minke whale have the potential to experience TTS (representing 1.88% of the CGNS MU) (Table 10A-9). For harbour porpoise the predicted value was up to 879 (representing 1.41% of the CIS MU) (Table 10A-9). For bottlenose dolphin and common dolphin less than one individual has the potential to experience TTS (SEL_{cum} metric), representing very small proportions of respective MU populations (Table 10A-8 and Table 10A-9). For grey seal and harbour seal the predicted number of animals was 36 and 27 respectively (Table 10A-9). These numbers represent a small proportion of the relevant reference populations (i.e., 0.61% for grey seal and 1.64% for harbour seal).

To reduce the risk of permanent and temporary auditory injury, measures included in the Project will be implemented as part of a MMMP (see volume 2A, appendix 5-4 Addendum: Marine Megafauna Mitigation Plan). This will include recording of marine mammal activity (visually and using PAM) over a pre-defined mitigation zone. The maximum range over which PTS is predicted to occur was modelled at 653 m (SPL_{pk}) (Table 10A-6) and 1,135 m (SEL_{cum}) (Table 10A-8). Considering the conservative assumptions of the subsea noise modelling that estimated highly precautionary injury ranges, across all species, the maximum range over which injury could occur, using the SPL_{pk} metric, was predicted to be less than the standard 1,000 m mitigation zone for pile-driving proposed by the NPWS (2014) guidance. Conversely, the maximum range over which injury could occur, using the SEL_{cum} metric was predicted to be more than the standard 1,000 m mitigation zone for pile-driving proposed by the NPWS (2014) guidance. It is important to note that SEL_{cum} is not considered a suitable metric to base mitigation zones on, due to the known conservatism and over precautionary estimates predicted for PTS, therefore, to base a mitigation zone on PTS ranges for SEL_{cum} would be disproportionate and unrealistic. For example, in Scotland, the statutory advisor (NatureScot) recommend only SPL_{pk} in defining the mitigation zone. However, in addition to the measures included in the Project, an ADD will be implemented as part of the MMMP, subject to discussion with stakeholders, in order to ensure that any residual ranges of effect (PTS) are mitigated. Table 10A-5 demonstrates that the use of an ADD for 15 minutes can fully mitigate injury due to cumulative exposure. Whilst TTS ranges have been presented based on the current best available information, until such time that there is sufficient information to indicate a level and duration of TTS that may have a significant ecological effect on individuals, the focus of the mitigation proposed is on PTS.

Table 10A-6: Supersedes Table 10.26 - Number of animals potentially affected by PTS (auditory injury) and TTS arising from soft start initiation for piling at a single monopile at the east of the offshore wind farm area based on peak pressure injury ranges (N/E = threshold not exceeded), using density estimates from SCANS-IV Block CS-D (Gilles *et al.,* 2023) and revised underwater noise modelling.

Species	Threshold (Unweighted Peak)	Density estimate (animals/km^2)	Minimum or maximum density estimate	Density Source	MU population	Range (m)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour porpoise	PTS - 202 dB re 1 µPa (pk)	0.28	Minimum	SCANS IV Block CS-D; Gilles *et al.* (2023)	62,517	653	1.34	< 1	0.0006
	TTS - 196 dB re 1 µPa (pk)					1051	3.48	<1	0.0016
Bottlenose dolphin	PTS - 230 dB re 1 µPa (pk)	0.235	Maximum		8,326*	71	0.02	<1	0.000045
	TTS - 224 dB re 1 µPa (pk)					114	0.04	<1	0.0001
Common dolphin	PTS - 230 dB re 1 µPa (pk)	0.027	N/A		102,656	71	0.02	<1	4×10^{-9}
	TTS – 224 dB re 1 µPa (pk)					114	0.04	<1	1×10^{-8}
Minke whale	PTS – 219 dB re 1 µPa (pk)	0.014	Minimum		20,118	169	0.09	<1	0.0001
	TTS - 213 dB re 1 µPa (pk)					273	0.23	<1	0.0002

* Density generated using SCANS-IV data has been compared against a reference population estimated by summing the abundance within the Irish Sea SCANS-IV blocks

Table 10A-7: Supersedes Table 10.26 - Number of animals potentially affected by PTS (auditory injury) and TTS arising from soft start initiation for piling at a single monopile at the east of the offshore wind farm area based on peak pressure injury ranges (N/E = threshold not exceeded), using alternative density estimates and revised underwater noise modelling.

Species	Threshold (Unweighted Peak)	Density estimate (animals/km^2)	Minimum or maximum density estimate	Density Source	MU population	Range (m)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour porpoise	PTS - 202 dB re 1 µPa (pk)	1.33	Maximum	Monthly peak, Oriel site-specific surveys	62,517	653	1.34	2	0.0028
	TTS - 196 dB re 1 µPa (pk)					1051	3.48	5	0.0074
Bottlenose dolphin	PTS - 230 dB re 1 µPa (pk)	0.046	Minimum	SCANS III DSM; Lacey *et al.*, (2022)	293	71	0.02	< 1	0.0013
	TTS - 224 dB re 1 µPa (pk)					114	0.04	< 1	0.0033
Minke whale	PTS – 219 dB re 1 µPa (pk)	0.260	Maximum	Oriel site-specific surveys	20,118	169	0.09	< 1	0.0001
	TTS - 213 dB re 1 µPa (pk)					273	0.23	< 1	0.0003
Grey seal	PTS - 218 dB re 1 µPa (pk)	0.372	N/A	Carter et al. (2022)	5,882	183	0.11	< 1	0.0007
	TTS - 212 dB re 1 µPa (pk)					295	0.27	< 1	0.0017
Harbour seal	PTS - 218 dB re 1 µPa (pk)	0.28	N/A	Carter et al. (2022)	1,635	183	0.11	< 1	0.0018
	TTS - 212 dB re 1 µPa (pk)					295	0.27	< 1	0.0047

Table 10A-8: Supersedes Table 10.27 - Number of animals potentially affected by PTS (auditory injury) and TTS arising from impact piling at a single monopile location at the east of the offshore wind farm area based on SEL injury ranges (including soft start) (N/E = threshold not exceeded), using density estimates from SCANS-IV Block CS-D (Gilles et al., 2023) and revised underwater noise modelling.

Species	Threshold (Unweighted Peak)		Project measure	Density estimate (animals/km^2)	Minimum or maximum density estimate	Density Source	MU population	Range (m)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour porpoise	PTS – 155 dB re 1 µPa2s	Soft start	0.28	Minimum	SCANS IV Block CS-D; Gilles *et al.* (2023)	62,517	815	2.09	<1	0.000009	
	TTS - 140 dB re 1 µPa2s						14,500	660.52	185	0.30	
Bottlenose dolphin	PTS - 185 dB re 1 µPa2s	Soft start	0.235	Maximum		8,326*	N/E	N/A	N/A	N/A	
	TTS - 170 dB re 1 µPa2s						21	0.001	<1	0.000004	
Common dolphin	PTS - 185 dB re 1 µPa2s	Soft start	0.027	N/A		102,656	N/E	N/A	N/A	N/A	
	TTS - 170 dB re 1 µPa2s						21	0.001	<1	3.64 x 10-8	
Minke whale	PTS - 183 dB re 1 µPa2s	Soft start	0.014	Minimum		20,118	1,135	4.05	<1	0.00028	
	TTS - 168 dB re 1 µPa2s						21,500	1,452.2	20	0.10	

* Density generated using SCANS-IV data has been compared against a reference population estimated by summing the abundance within the Irish Sea SCANS-IV blocks

Table 10A-9: Supersedes Table 10.27 - Number of animals potentially affected by PTS (auditory injury) and TTS arising from impact piling at a single monopile location at the east of the offshore wind farm area based on SEL injury ranges (including soft start) (N/E = threshold not exceeded), using alternative density estimates and revised underwater noise modelling.

Species	Threshold (Unweighted Peak)	Project measure	Density estimate (animals/km^2)	Minimum or maximum density estimate	Density Source	MU population	Range (m)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour porpoise	PTS - 202 dB re 1 µPa (pk)	Soft start	1.33	Maximum	Monthly peak, Oriel site-specific surveys	62,517	815	2.09	3	0.0045
	TTS - 196 dB re 1 µPa (pk)						14,500	660.52	879	1.41
Bottlenose dolphin	PTS - 230 dB re 1 µPa (pk)	Soft start	0.046	Minimum	SCANS III DSM; Lacey et al. (2022)	293	N/E	N/A	N/A	N/A
	TTS - 224 dB re 1 µPa (pk)						21	0.001	<1	0.00004
Minke whale	PTS – 219 dB re 1 µPa (pk)	Soft start	0.26	Maximum	Oriel site-specific surveys	20,118	1,135	4.05	2	0.0053
	TTS - 213 dB re 1 µPa (pk)						21,500	1,452.2	378	1.88
Grey seal	PTS - 218 dB re 1 µPa (pk)	Soft start	0.372	N/A	Carter et al. (2022)	5,882	11	0.0038	<1	0.000002
	TTS - 212 dB re 1 µPa (pk)						5,520	95.73	36	0.61
Harbour seal	PTS - 218 dB re 1 µPa (pk)	Soft start	0.28	N/A	Carter et al. (2022)	1,635	11	0.0038	<1	0.000007
	TTS - 212 dB re 1 µPa (pk)						5,520	95.73	27	1.64

The impact of injury on marine mammal receptors is predicted to be of local spatial extent, medium-term duration (i.e. maximum duration of piling phase), intermittent (i.e. elevations in subsea noise occur intermittently over the piling phase) and permanent (PTS)/ temporary (TTS). It is predicted that the impact will affect the receptor directly. The assessment shows that over the ensonified area, only small numbers of animals of all species are likely to occur within the injury zones. These numbers are relatively small in the context of the relevant geographic frames of reference and would not be at a scale that would lead to any measurable population-level effects. In addition, with measures in place including soft start and an MMMP, the magnitude is therefore, still considered to be **low** for PTS as the range of effect falls within the distance which can be managed via the MMMP and **medium** for TTS (as the range of effect may extend beyond the distance which can be managed by the MMMP) (and aligns with the conclusions of the EIAR).

Basking Shark and Leatherback Turtle IEFs

Table 10-28 and Table 10-29 of chapter 10: Marine Mammals and Megafauna have been updated with revised noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report), see Table 10A-10 (SPL_{pk}) and Table 10A-11 (SEL_{cum}).

Table 10A-10: Supersedes Table 10-28 - Summary of the peak pressure injury ranges for fish and sea turtles due to installation of one monopile at the east of the offshore wind farm area (N/E = threshold not exceeded), for revised noise modelling.

Class (relevant species)	Response	Threshold (SPL_{pk}, dB re 1 µPa)	Range (m)	
			First strike	Max
No swim bladder (particle motion detection)	Mortality	213	273	684
	Recoverable Injury	213	273	684
Swim bladder not involved in hearing (particle motion detection)	Mortality	207	439	1,101
	Recoverable Injury	207	439	1,101
Swim bladder involved in hearing (primarily pressure detection)	Mortality	207	439	1,101
	Recoverable Injury	207	439	1,101
Fish eggs and larvae	Mortality	207	439	1,101

Table 10A-11: Supersedes Table 10-29 - Summary of the SEL_{cum} injury ranges for fish and sea turtles due to piling at the east of the offshore wind farm area. Ranges presented are for cumulative exposure for installation of a single monopile, for revised noise modelling. Assessment is based on ranges predicted considering implementation of soft start.

Class (relevant species)	Response	Threshold (SEL_{cum}, dB re 1 µPa^2s)	Range (m)
No swim bladder (particle motion detection)	Mortality	219	N/E
	Recoverable Injury	216	N/E
Swim bladder not involved in hearing (particle motion detection)	Mortality	210	21
	Recoverable Injury	203	147
Swim bladder involved in hearing (primarily pressure detection)	Mortality	207	51
	Recoverable Injury	203	147
Fish eggs and larvae	Mortality	210	935
All fish types	TTS	186	5,520

With implementation of the measures included in the Project (i.e. soft start) based on the SPL_{pk} metric, the impact range for mortality and recoverable injury for basking shark was predicted as 684 m, and the impact range for mortality for leatherback turtle was predicted as 1,101 m (Table 10A-10). The ranges predicted for mortality and recoverable injury using the SEL_{cum} metric were considerably smaller compared to the SPL_{pk} metric. The impact range for mortality for sea turtles was predicted as 21 m, whereas the thresholds for mortality and recoverability for basking shark were not exceeded (Table 10A-11). The criterion for assessing recoverable injury in sea turtles is qualitative rather than quantitative and therefore aligns with that set out for the EIAR: at near distances (tens of metres) the risk of recoverable injury is high, but at both intermediate (hundreds of metres) and far distances (thousands of metres), the risk of recoverable injury was low. The impact range for TTS in basking shark was predicted as occurring out to 5,520 m (Table 10A-11).

Density estimates for sea turtle are very low in the Marine Megafauna Study Area (0.06 animals per km^2). As such, regardless of metric (SPL_{pk} or SEL_{cum}), less than one individual has the potential to be within the ensonified area for injury. Taking a precautionary approach, one individual would represent < 0.05 % of the population. For basking shark, it has not been possible to estimate the number of animals potentially affected by piling activities, given the absence of density and abundance estimates for this species in the Regional Marine Megafauna Study Area. However, based on encounter rates during recent site-specific surveys (maximum 0.006 animals per km^2), it is predicted that the risk of encountering an animal within the ensonified area is very small. With a MMMP in place, piling would be delayed if a basking shark or sea turtle were sighted within the injury zone thereby reducing the risk further.

The impact of injury on basking shark and leatherback turtle is predicted to be of local spatial extent, medium-term duration, intermittent and permanent (mortality or injury)/temporary (TTS). It is predicted that the impact will affect the receptor directly. Measures included in the Project, including soft start and implementation of the MMMP, will reduce the risk of injury occurring on basking shark and leatherback turtle. In addition, the risks are likely to be very small due to the low number of animals passing through the Marine Megafauna Study Area and therefore entering the zones of influence. The magnitude is therefore still considered to be **negligible** for both PTS and TTS (and aligns with the conclusions of the EIAR).

Disturbance

Whilst the assessment undertaken as part of the EIAR considered the best available advice at the time, advances have been made in the field of underwater sound modelling since the assessment was carried out, particularly in the field of noise generated by piling activities. Therefore in response to the further information requested regarding underwater noise modelling (RFI 9.G and 9.H)) the source modelling and propagation modelling methodology applied to the subsea noise modelling was updated (see appendix 10-4: Updated Subsea Noise Modelling Report) for details of the revised source modelling method (using von Pein *et al.,* 2022) and revised 'line source' propagation model). Whilst no changes to the approach to the interpretation of the subsea noise modelling have been made for marine mammals and megafauna, the results of the revised noise modelling and subsequent updated marine mammal impact assessment have been presented.

Furthermore, additional information has been included in response to:

- RFI 9.N – calculation of numbers of animals in the dose response approach;
- RFI 9.K / 9.L – clarification of minimum and maximum density estimate and results using estimates from SCANS-IV and alternative density estimates.
- RFI 9.P(i) maximum range of disturbance for Level B Harassment.

In response to **RFI 9.N**, to obtain the numbers of animals (cetaceans and seals) disturbed during piling, SEL_{ss} contours from subsea noise modelling were plotted by 5 dB isopleths in Geographic Information Systems (GIS) for all modelled locations (monopile wind turbine generator (WTG) in the East and West of the Array) (Table 10A-12). The areas within each isopleth were calculated from the spatial GIS map and a proportional expected response (derived from the dose response curve for each isopleth area) was used to calculate the number of animals potentially disturbed.

Table 10A-12: Area (km^2) per isopleth in noise modelling contours for monopile piling at the East and West location.

Contour Isopleth (dB re 1 μPa^2s SEL_{ss})	Area (km^2)	
	East	West
120 - 125 dB	5854.72	8416.77
125 - 130 dB	7333.30	7097.45
130 – 135 dB	5061.38	1403.49
135 – 140 dB	1200.55	678.14
140 – 145 dB	631.68	396.60
145 – 150 dB	360.18	143.42
150 – 155 dB	120.78	52.44
155 – 160 dB	42.49	17.25
160 - 165 dB	17.66	6.70
165 - 170 dB	7.25	2.80
170 - 175 dB	2.39	1.12
175 - 180 dB	1.05	0.47
> 180 dB	0.72	0.36
Total	**20634.17**	**18216.99**

The dose response calculations are presented in Table 10A-13 to

Table 10A-21 for each species. Each table presents the area (km^2) per 5 dB (SEL_{ss}) contour band (e.g. the total area between the 120 dB re 1 μPa^2s SEL_{ss} contour and the 125 dB re 1 μPa^2s SEL_{ss} contour) and the species-specific density estimate, which are multiplied to give the potential number of animals disturbed per contour band, without a dose-response applied. For pinnipeds, the approach is slightly different and uses a density estimate specific to each contour band from Carter *et al.,* (2022) rather than a single density provided across all contours (which is the approach for cetaceans). Figure 10-A2 and Figure 10-A3 presents disturbance ranges (SEL_{ss}) for monopiles at the east modelled locations overlaid on grey seal at-sea usage and harbour seal at-sea usage respectively, for revised noise modelling. Subsequently, a dose-response factor is applied (per 5 dB contour band) to the calculated potential number of animals disturbed (Graham *et al.* (2017) for cetaceans, Whyte *et al.* (2020) for pinnipeds), to provide the final potential number of animals disturbed per contour band. These are consequently summed across all contour bands to provide a single estimate per species/scenario of the total potential number of animals disturbed during a piling event; this single value is carried forward to the impact assessment (as set out in Table 10A-22 (10.30A) and Table 10A-23 (Table 10.30B) below, in response to **RFI 9.K, 9.L**, and **9.P(iii)**). Additionally, the percentage of the management unit (MU) is then calculated to provide an indication of potential population level impact. Tables are only presented for modelling at the East location, which resulted in the greatest ranges.

Table 10A-13: Calculations of numbers of harbour porpoise disturbed for the East Monopile WTG location, utilising the SCANS IV density estimate (Gilles *et al.*, 2023) (0.2803 animals per km^2).

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose-response applied)	Celtic and Irish Seas (CIS) MU population size	% of the MU population
120 - 125 dB =	5854.72	0.280	1639.32	0.0167801	27.51	62,517	0.04%
125 - 130 dB =	7333.30	0.280	2053.32	0.045674844	93.79	62,517	0.15%
130 – 135 dB =	5061.38	0.280	1417.19	0.105408014	149.38	62,517	0.24%
135 – 140 dB =	1200.55	0.280	336.15	0.207728316	69.83	62,517	0.11%
140 – 145 dB =	631.68	0.280	176.87	0.352963145	62.43	62,517	0.10%
145 – 150 dB =	360.18	0.280	100.85	0.523788037	52.82	62,517	0.08%
150 – 155 dB =	120.78	0.280	33.82	0.690285266	23.34	62,517	0.04%
155 – 160 dB =	42.49	0.280	11.90	0.824759073	9.81	62,517	0.02%
160 - 165 dB =	17.66	0.280	4.95	0.914758114	4.52	62,517	0.01%
165 - 170 dB =	7.25	0.280	2.03	1	2.03	62,517	0.00%
170 - 175 dB =	2.39	0.280	0.67	1	0.67	62,517	0.00%
175 - 180 dB =	1.05	0.280	0.29	1	0.29	62,517	0.00%
> 180 dB =	0.72	0.280	0.20	1	0.20	62,517	0.00%
				Total	**496.6 (rounded up to 497)**		**0.79%**

Table 10A-14: Calculations of numbers of harbour porpoise disturbed for the East Monopile WTG location, utilising the Oriel site-specific survey estimate (1.33 animals per km^2).

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose response applied)	Celtic and Irish Seas (CIS) MU population size	% of the MU population
120 - 125 dB =	5854.72	1.33	7786.78	0.0167801	130.66	62,517	0.21%
125 - 130 dB =	7333.30	1.33	9753.29	0.045674844	445.48	62,517	0.71%
130 – 135 dB =	5061.38	1.33	6731.64	0.105408014	709.57	62,517	1.14%
135 – 140 dB =	1200.55	1.33	1596.73	0.207728316	331.69	62,517	0.53%

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose response applied)	Celtic and Irish Seas (CIS) MU population size	% of the MU population
140 – 145 dB =	631.68	1.33	840.14	0.352963145	296.54	62,517	0.47%
145 – 150 dB =	360.18	1.33	479.05	0.523788037	250.92	62,517	0.40%
150 – 155 dB =	120.78	1.33	160.64	0.690285266	110.89	62,517	0.18%
155 – 160 dB =	42.49	1.33	56.51	0.824759073	46.60	62,517	0.07%
160 - 165 dB =	17.66	1.33	23.49	0.914758114	21.49	62,517	0.03%
165 - 170 dB =	7.25	1.33	9.65	1	9.65	62,517	0.02%
170 - 175 dB =	2.39	1.33	3.18	1	3.18	62,517	0.01%
175 - 180 dB =	1.05	1.33	1.40	1	1.40	62,517	0.00%
> 180 dB =	0.72	1.33	0.96	1	0.96	62,517	0.00%
				Total	**2359.1 (rounded up to 2360)**		**3.77%**

Table 10A-15: Calculations of numbers of bottlenose dolphin disturbed for the East Monopile WTG location, utilising the SCANS IV density estimate (Gilles *et al.*, 2023) (0.235 animals per km^2).

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose response applied)	SCANS IV Irish Sea abundance estimate	% of the MU population (SCANS IV Irish Sea Abundance Estimate)
120 - 125 dB =	5854.72	0.235	1375.86	0.0167801	23.09	8,326	0.28%
125 - 130 dB =	7333.30	0.235	1723.33	0.045674844	78.71	8,326	0.95%
130 – 135 dB =	5061.38	0.235	1189.42	0.105408014	125.37	8,326	1.51%
135 – 140 dB =	1200.55	0.235	282.13	0.207728316	58.61	8,326	0.70%
140 – 145 dB =	631.68	0.235	148.45	0.352963145	52.40	8,326	0.63%
145 – 150 dB =	360.18	0.235	84.64	0.523788037	44.34	8,326	0.53%
150 – 155 dB =	120.78	0.235	28.38	0.690285266	19.59	8,326	0.24%
155 – 160 dB =	42.49	0.235	9.98	0.824759073	8.23	8,326	0.10%
160 - 165 dB =	17.66	0.235	4.15	0.914758114	3.80	8,326	0.05%
165 - 170 dB =	7.25	0.235	1.70	1	1.70	8,326	0.02%

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose response applied)	SCANS IV Irish Sea abundance estimate	% of the MU population (SCANS IV Irish Sea Abundance Estimate)
170 - 175 dB =	2.39	0.235	0.56	1	0.56	8,326	0.01%
175 - 180 dB =	1.05	0.235	0.25	1	0.25	8,326	0.00%
> 180 dB =	0.72	0.235	0.17	1	0.17	8,326	0.00%
				Total	**416.8 (rounded up to 417)**		**5.01%**

Table 10A-16: Calculations of numbers of bottlenose dolphin disturbed for the East Monopile WTG location, utilising the SCANS III density surface estimates for the offshore wind farm area and offshore cable corridor (Lacey *et al.*, 2022) (0.046 animals per km^2).

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose response applied)	IS MU population size	% of the MU population (IS MU)
120 - 125 dB =	5854.72	0.046	269.32	0.0167801	4.52	293	1.54%
125 - 130 dB =	7333.30	0.046	337.33	0.045674844	15.41	293	5.26%
130 – 135 dB =	5061.38	0.046	232.82	0.105408014	24.54	293	8.38%
135 – 140 dB =	1200.55	0.046	55.23	0.207728316	11.47	293	3.92%
140 – 145 dB =	631.68	0.046	29.06	0.352963145	10.26	293	3.50%
145 – 150 dB =	360.18	0.046	16.57	0.523788037	8.68	293	2.96%
150 – 155 dB =	120.78	0.046	5.56	0.690285266	3.84	293	1.31%
155 – 160 dB =	42.49	0.046	1.95	0.824759073	1.61	293	0.55%
160 - 165 dB =	17.66	0.046	0.81	0.914758114	0.74	293	0.25%
165 - 170 dB =	7.25	0.046	0.33	1	0.33	293	0.11%
170 - 175 dB =	2.39	0.046	0.11	1	0.11	293	0.04%
175 - 180 dB =	1.05	0.046	0.05	1	0.05	293	0.02%
> 180 dB =	5854.72	0.046	0.03	1	0.03	293	0.01%
				Total	**81.6 (rounded up to 82)**		**27.85%**

Table 10A-17: Calculations of numbers of common dolphin disturbed for the East Monopile WTG location, utilising the SCANS IV density estimate (Gilles *et al.*, 2023) (0.0272 animals per km^2).

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals with dose response applied	Celtic and Greater North Seas (CGNS) MU population size	% of the MU population
120 - 125 dB =	5854.72	0.027	158.08	0.0167801	2.65	102,656	0.00%
125 - 130 dB =	7333.30	0.027	198.00	0.045674844	9.04	102,656	0.01%
130 – 135 dB =	5061.38	0.027	136.66	0.105408014	14.40	102,656	0.01%
135 – 140 dB =	1200.55	0.027	32.41	0.207728316	6.73	102,656	0.01%
140 – 145 dB =	631.68	0.027	17.06	0.352963145	6.02	102,656	0.01%
145 – 150 dB =	360.18	0.027	9.72	0.523788037	5.09	102,656	0.00%
150 – 155 dB =	120.78	0.027	3.26	0.690285266	2.25	102,656	0.00%
155 – 160 dB =	42.49	0.027	1.15	0.824759073	0.95	102,656	0.00%
160 - 165 dB =	17.66	0.027	0.48	0.914758114	0.44	102,656	0.00%
165 - 170 dB =	7.25	0.027	0.20	1	0.20	102,656	0.00%
170 - 175 dB =	2.39	0.027	0.06	1	0.06	102,656	0.00%
175 - 180 dB =	1.05	0.027	0.03	1	0.03	102,656	0.00%
> 180 dB =	0.72	0.027	0.02	1	0.02	102,656	0.00%
				Total	**47.9 (rounded up to 48)**		**0.05%**

Table 10A-18: Calculations of numbers of minke whale disturbed for the East Monopile WTG location, utilising the SCANS IV density estimate (Gilles *et al.*, 2023) (0.0137 animals per km^2).

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals with dose response applied	CGNS MU population size	% of the MU population
120 - 125 dB =	5854.72	0.014	80.21	0.0167801	1.35	20,118	0.01%
125 - 130 dB =	7333.30	0.014	100.47	0.045674844	4.59	20,118	0.02%
130 – 135 dB =	5061.38	0.014	69.34	0.105408014	7.31	20,118	0.04%
135 – 140 dB =	1200.55	0.014	16.45	0.207728316	3.42	20,118	0.02%

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals with dose response applied	CGNS MU population size	% of the MU population
140 – 145 dB =	631.68	0.014	8.65	0.352963145	3.05	20,118	0.02%
145 – 150 dB =	360.18	0.014	4.93	0.523788037	2.58	20,118	0.01%
150 – 155 dB =	120.78	0.014	1.65	0.690285266	1.14	20,118	0.01%
155 – 160 dB =	42.49	0.014	0.58	0.824759073	0.48	20,118	0.00%
160 - 165 dB =	17.66	0.014	0.24	0.914758114	0.22	20,118	0.00%
165 - 170 dB =	7.25	0.014	0.10	1	0.10	20,118	0.00%
170 - 175 dB =	2.39	0.014	0.03	1	0.03	20,118	0.00%
175 - 180 dB =	1.05	0.014	0.01	1	0.01	20,118	0.00%
> 180 dB =	0.72	0.014	0.01	1	0.01	20,118	0.00%
				Total	**24.3 (rounded up to 25)**		**0.12%**

Table 10A-19: Calculations of numbers of minke whale disturbed for the East Monopile WTG location, utilising the Oriel site-specific survey estimate (0.26 animals per km^2).

SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose response applied)	CGNS MU population size	% of the MU population
120 - 125 dB =	5854.72	0.26	1522.23	0.0167801	25.54	20,118	0.13%
125 - 130 dB =	7333.30	0.26	1906.66	0.045674844	87.09	20,118	0.43%
130 – 135 dB =	5061.38	0.26	1315.96	0.105408014	138.71	20,118	0.69%
135 – 140 dB =	1200.55	0.26	312.14	0.207728316	64.84	20,118	0.32%
140 – 145 dB =	631.68	0.26	164.24	0.352963145	57.97	20,118	0.29%
145 – 150 dB =	360.18	0.26	93.65	0.523788037	49.05	20,118	0.24%
150 – 155 dB =	120.78	0.26	31.40	0.690285266	21.68	20,118	0.11%
155 – 160 dB =	42.49	0.26	11.05	0.824759073	9.11	20,118	0.05%
160 - 165 dB =	17.66	0.26	4.59	0.914758114	4.20	20,118	0.02%
165 - 170 dB =	7.25	0.26	1.89	1	1.89	20,118	0.01%
170 - 175 dB =	2.39	0.26	0.62	1	0.62	20,118	0.00%

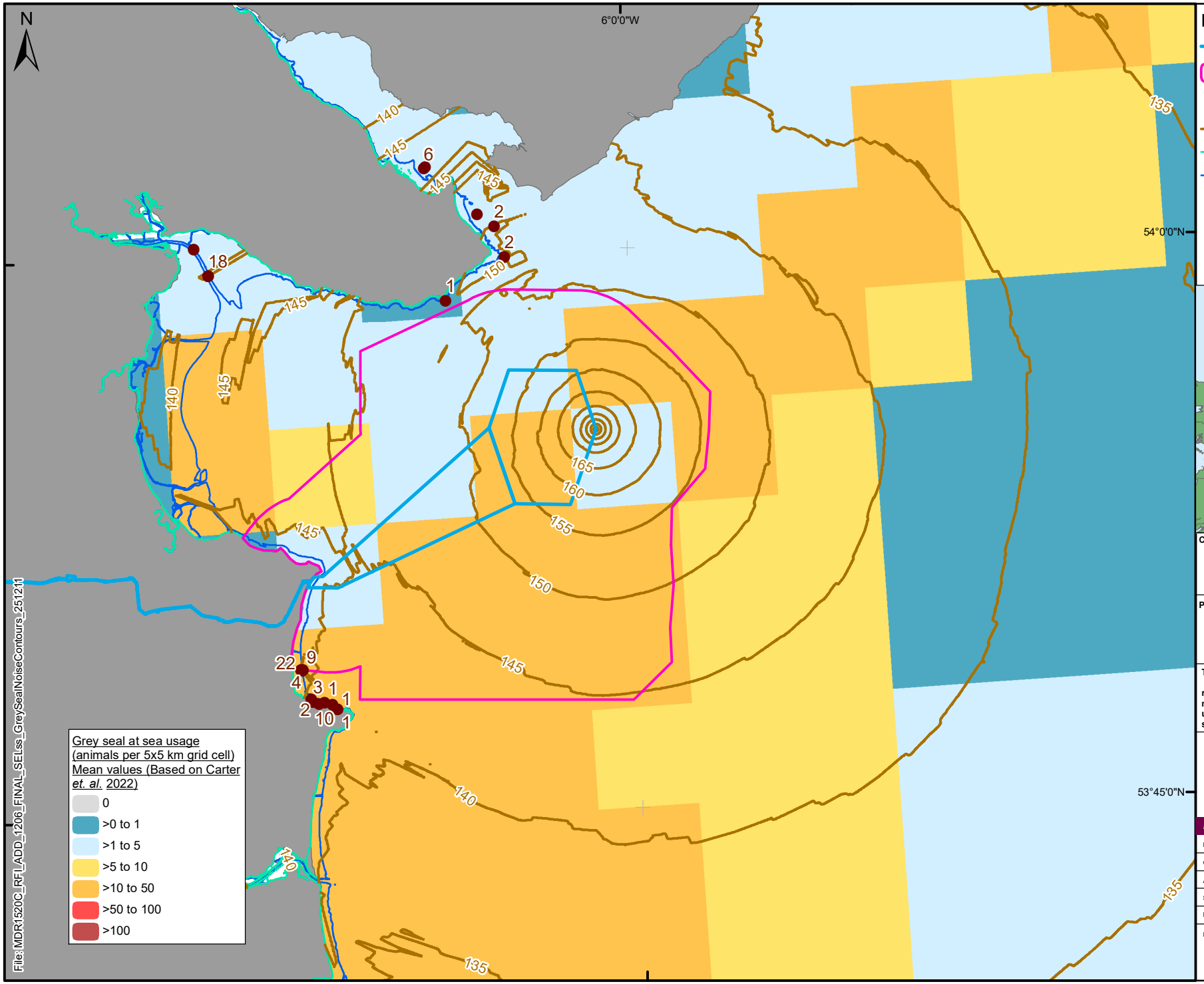
SEL_{ss} contour band	Area (km^2)	Density estimate (number animals per km^2)	Number of animals	Dose response (Graham *et al.*, 2017)	Number of animals (with dose response applied)	CGNS MU population size	% of the MU population
175 - 180 dB =	1.05	0.26	0.27	1	0.27	20,118	0.00%
> 180 dB =	0.72	0.26	0.19	1	0.19	20,118	0.00%
				Total	**461.2 (rounded up to 462)**		**2.29%**

Table 10A-20: Calculations of numbers of grey seal disturbed for the East Monopile WTG location, utilising density surface estimates from Carter *et al.* (2022).

SEL_{ss} contour band	Area (km^2)	Number of animals (derived from Carter *et al.*, 2022 density surface maps)	Dose response (Whyte *et al.*, 2020)	Number of animals (with dose response applied)	Grey Seal Reference population	% of the MU population
145 – 150 dB =	360.18	119.64	0.3637	43.52	5,882	0.74%
150 – 155 dB =	120.78	54.62	0.4731	25.85	5,882	0.44%
155 – 160 dB =	42.49	17.11	0.4871	8.33	5,882	0.14%
160 - 165 dB =	17.66	6.02	0.4852	2.93	5,882	0.05%
165 - 170 dB =	7.25	3.01	0.5438	1.64	5,882	0.03%
170 - 175 dB =	2.39	0	0.7625	0	5,882	0.00%
175 - 180 dB =	1.05	0	0.648	0	5,882	0.00%
> 180 dB =	0.72	0	1	0	5,882	0.00%
			Total	**82.24 (rounded up to 83)**		**1.40%**

Table 10A-21: Calculations of numbers of harbour seal disturbed for the East Monopile WTG location, utilising density surface estimates from Carter *et al.* (2022).

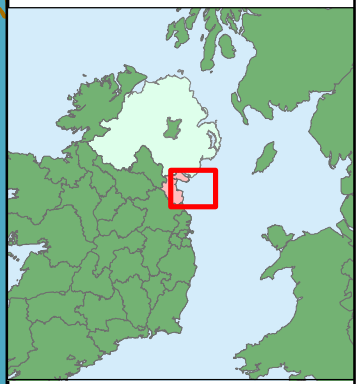
SEL_{ss} contour band	Area (km^2)	Number of animals (derived from Carter *et al.*, 2022 density surface maps)	Dose response (Whyte *et al.*, 2020)	Number of animals (with dose response applied)	Harbour seal Reference population	% of the MU population
145 – 150 dB =	360.18	114.3731457	0.3637	41.60	1,635	0.03
150 – 155 dB =	120.78	39.4036948	0.4731	18.64	1,635	0.01
155 – 160 dB =	42.49	12.89040186	0.4871	6.28	1,635	0.004
160 - 165 dB =	17.66	5.125813175	0.4852	2.49	1,635	0.002
165 - 170 dB =	7.25	2.378019627	0.5438	1.29	1,635	0.001
170 - 175 dB =	2.39	0	0.7625	0.00	1,635	0.000
175 - 180 dB =	1.05	0	0.648	0.00	1,635	0.000
> 180 dB =	0.72	0	1	0.00	1,635	0.000
			Total	**70.30 (rounded up to 71)**		**4.30%**



Legend

- Application Boundary
- Marine Mammal and Megafauna Study Area
- 2017/18 Grey Seal Individuals (number per haul out location)
- Noise contour (dB re 1 μPa^2s SEL_{ss})
- Mean High Water
- Mean Low Water

Data Sources: Client. Carter et al., 2022



Client

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Project

Oriel Wind Farm Project

Title

Figure 10A-2 Marine mammal disturbance ranges (SELss) for monopiles at the east modelled locations overlaid on grey seal at-sea usage (animals per 5x5 km grid cell) and grey seal sightings at haul-outs.

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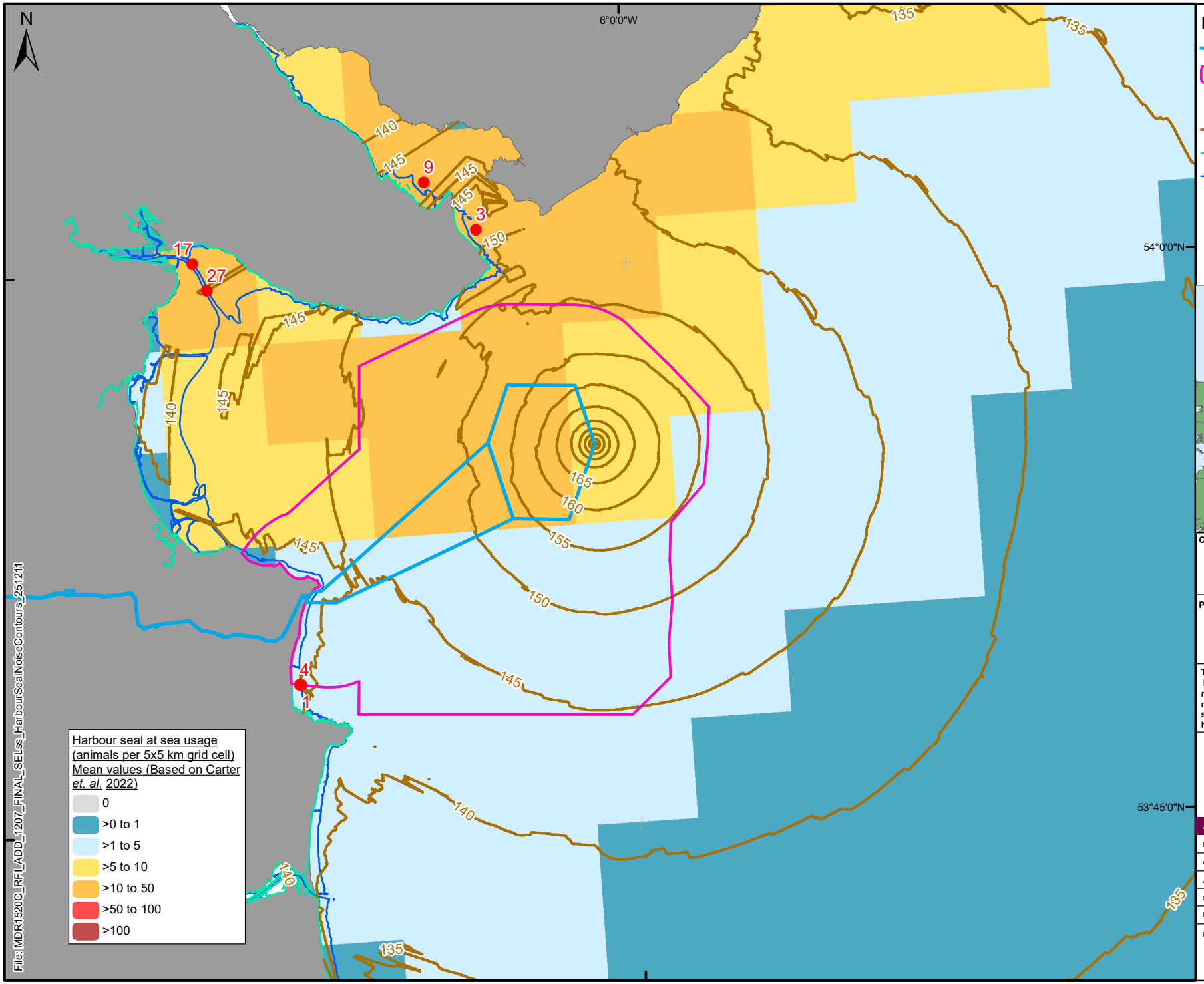
Issue Details

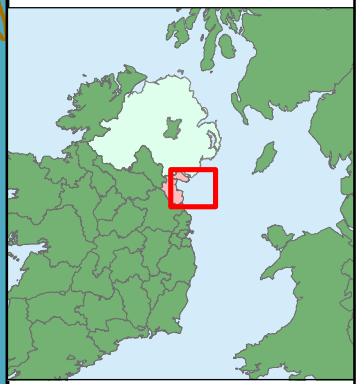
Drawn By: NG	**Project No.** MDR1520C
Checked By: NG	**File Ref:** MDR1520C_RFI_ADD_1206_FINAL
Approved By: BP	
Scale: 1:250,000 @ A4	**Projection:** ITM (IRENET95)
Date: 11/12/2025	Geographic Co-ordinates: ETRS89



Legend

- Application Boundary
- Marine Mammal and Megafauna Study Area
- 2017/18 Grey Seal Individuals (number per haul out location)
- Noise contour (dB re 1 μPa^2s SEL_{ss})
- Mean High Water
- Mean Low Water

Data Sources: Client. Carter et al., 2022



Client

ORIEL WINDFARM
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Project

Oriel Wind Farm Project

Title

Figure 10A-3 Marine mammal disturbance ranges (SELss) for monopiles at the east modelled locations overlaid on harbour seal at-sea usage (animals per 5x5 km grid cell) and harbour seal sightings at haul-outs.

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Issue Details

Drawn By: NG	**Project No.** MDR1520C
Checked By: NG	**File Ref:** MDR1520C_RFI_ADD_1207_FINAL
Approved By: BP	
Scale: 1:250,000 @ A4	**Projection:** ITM (IRENET95)
Date: 11/12/2025	Geographic Co-ordinates: ETRS89

In response to **RFI 9.K, 9.L**, and **9.P(iii)** Table 10.30 of volume 2B, chapter 10: Marine mammals and megafauna has been split into two tables; Table 10A-22 (Table 10.30A) using density estimates from SCANS-IV Block CS-D (Gilles *et al.,* 2023) and Table 10A-23 (Table 10.30B) using alternative density estimates (as per RFI 9L request), both for revised noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report). Each table clarifies whether the density represents the minimum or maximum density estimate for each species (as per **RFI 9.K** and **9.P**(iii) request). The densities presented in Table 10A-22 and Table 10A-23 (superseding Table 10-30 in volume 2B, chapter 10: Marine Mammals and Megafauna) represent a range, with a lower (minimum) and upper (maximum) value, rather than an 'average' and maximum, and therefore a 'mean' range is not required in this table.

Note, for all species, the numbers calculated within the strong and mild disturbance contours were for information purposes only as it was the dose-response numbers taken through to the modelling as agreed via consultation.

Table 10A-22: Supersedes Table 10.30 - Number of animals predicted to be disturbed within unweighted SEL_{ss} noise contours as a result of impact piling of monopiles at the east of the offshore wind farm area. Also shows number of animals predicted to be disturbed, calculated within unweighted SEL_{ss} noise contours, that equate to strong and mild disturbance thresholds under NMFS (2005), using density estimates from SCANS-IV Block CS-D (Gilles *et al.,* 2023) and revised underwater noise modelling.

Species	Density estimate (animals/km²)	Minimum or maximum density estimate	Density Source	MU population	All disturbance responses (5 dB contours (SEL_{ss}); Russel *et al.,* 2017)		Strong disturbance (equivalent to ≥ 160 dB re 1µPa (rms); NMFS, 2005)		Mild disturbance (equivalent to 140 – 160 dB re 1µPa (rms); NMFS, 2005	
					Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)
Harbour porpoise	0.28	Minimum	SCANS IV Block CS-D (Gilles *et al.,* 2023)	62,517	497	0.79	54	0.09	2,032	3.25
Bottlenose dolphin	0.235*	Maximum		8,326*	417	5.01	46	0.54	1,705	20.47
Common dolphin	0.027	N/A		102,656	48	0.05	6	0.01	63	0.06
Minke whale	0.014	Minimum		20,118	25	0.12	3	0.01	100	0.49

* Density generated using SCANS-IV data has been compared against a reference population estimated by summing the abundance within the Irish Sea SCANS-IV blocks

Table 10A-23: Supersedes Table 10-30 - Number of animals predicted to be disturbed within unweighted SEL_{ss} noise contours as a result of impact piling of monopiles at the east of the offshore wind farm area. Also shows number of animals predicted to be disturbed, calculated within unweighted SEL_{ss} noise contours, that equate to strong and mild disturbance thresholds under NMFS (2005), using alternative density estimates and revised underwater noise modelling.

Species	Density estimate (animals/km²)	Upper or lower density estimate	Density Source	MU population	All disturbance responses (5 dB contours (SEL_{ss}); Russel *et al.,* 2017)		Strong disturbance (equivalent to ≥ 160 dB re 1µPa (rms); NMFS, 2005)		Mild disturbance (equivalent to 140 – 160 dB re 1µPa (rms); NMFS, 2005	
					Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)
Harbour porpoise	1.33	Maximum	Monthly peak, Oriel site-specific surveys	62,517	2,360	3.77	256	0.41	9,648	15.43
Bottlenose dolphin	0.046	Minimum	SCANS III DSM; Lacey *et al.* (2022)	293	82	27.85	9	3.02	334	113.88

Species	Density estimate (animals/ km^2)	Upper or lower density estimate	Density Source	MU population	All disturbance responses (5 dB contours (SEL_{ss}); Russel *et al.*, 2017)		Strong disturbance (equivalent to ≥ 160 dB re 1µPa (rms); NMFS, 2005)		Mild disturbance (equivalent to 140 – 160 dB re 1µPa (rms); NMFS, 2005	
					Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)
Minke whale	0.26	Maximum	Oriel site-specific surveys	20,118	462	2.29	51	0.25	311	1.54
Grey seal	0.372	N/A	Carter *et al.* (2022)	5,882	83	1.40	81	1.37	1,424	24.20
Harbour seal	0.28	N/A		1,635	71	4.30	60	3.66	463	28.30

Based on a dose-response approach (derived from Graham *et al.* (2017), the most conservative estimate of disturbance predicted that between 497 harbour porpoise (using SCANS-IV density) and 2,360 harbour porpoise (using site-specific density) have the potential to be disturbed by piling, representing 0.79 to 3.77% of the MU population (Table 10A-22 and Table 10A-23). However, this represents the maximum number across the entire range of disturbance responses (from slight changes in behaviour, such as changes in swimming speed or direction, through to displacement). For example, considering the area within which a strong disturbance response could occur (out to a threshold of 160 dB re 1µ Pa (rms), a maximum of up to 256 harbour porpoise may be affected representing 0.41% of the MU population (using the site-specific density, Table 10A-23).

Disturbance is expected to affect fewer bottlenose dolphin, common dolphin and minke whale during piling, however the bottlenose dolphin population estimates (n=293, from IAMMWG, 2023; and n=8,326, derived from Gilles *et al.,* 2023) are significantly smaller than the relevant harbour porpoise population (n=62,517). Therefore, based on a dose-response approach (derived from Graham *et al.,* 2017 for harbour porpoise in the absence of an agreed dose-response for bottlenose dolphin), disturbance of up to 417 bottlenose dolphin (based on the SCANS-IV density estimate of 0.235 animals per km^2) represents 5.01% of the combined SCANS-IV blocks estimate (abundance estimate derived from Gilles *et al.,* 2023). This represents the most robust estimate as it is based upon the most recent density (and more precautionary density) estimate from the latest 2022 SCANS-IV survey, and it is most appropriate to compare against the abundance estimate derived from the same dataset (8,326 bottlenose dolphin based upon SCANS-IV Blocks CS-D and CS-E). Disturbance of up to 82 animals (based on the smaller SCANS-III DSE of 0.046 animals per km^2) represents 27.85% of the Irish Sea MU (abundance estimate derived from IAMMWG, 2023, based upon SCANS-III estimates) (see Table 10A-23). Considering the area within which a strong disturbance response could occur to 46 bottlenose dolphin have the potential to experience strong disturbance (above 160 dB re 1µ Pa (rms)) (representing 0.54% of the MU) see (Table 10A-23).

Based on a dose-response approach (derived from Whyte *et al.,* 2020) up to 83 grey seal individuals have the potential to be disturbed by piling, representing up to 1.40% of the GSRP. Up to 71 harbour seal have the potential to be disturbed by piling, representing up to 4.30% of the HSRP (Table 10A-23). Using the strong disturbance threshold (rather than dose response), up to 81 grey seal and 112 harbour seal have the potential to experience strong disturbance (above 160 dB re 1µ Pa (rms)) representing up to 1.38% and 6.83% of the GSRP and HSRP, respectively.

Mild disturbance for seals has previously been considered theoretically to occur over a larger area than strong disturbance and therefore has the potential to affect larger numbers of each species. However, Whyte *et al.* (2020) showed for harbour seal, that beyond 25 km (below 145 dB re 1µ Pa (rms)) from the piling noise source, no significant changes in seal density were detected. Therefore, modelling has predicted that the range of effect in which strong disturbance could occur is not likely to extend to haul-out sites in the vicinity of the offshore wind farm area for either grey seal (Figure 10-A2) or harbour seal (Figure 10-A3), regardless of whether piling occurs at the east or the west of the Project. Animals originating from these haul-out sites still have the potential to overlap with these contours but are not expected to experience severe behavioural effects. Barrier effects as a result of installation of monopiles however, could either prevent seals from travelling to forage from haul-out sites, or force seals (particularly harbour seal) to travel greater distances than is usual.

Population modelling

Updated population modelling was carried out using the updated numbers of animals disturbed following revised noise modelling (see Summary of subsea modelling section above, in response to advances in the field of underwater sound modelling, statutory consultation submissions and RFIs 9.G and 9.H) (appendix 10-4: Updated Subsea Noise Modelling Report**)** to investigate the potential for underwater noise associated with the installation of monopiles to affect the population trajectory over time for harbour porpoise, bottlenose dolphin, minke whale, grey seal and harbour seal. The modelling approach and methodology remains the same as detailed in appendix 10-3: Marine Mammal Population Modelling Report (iPCOD) of the EIAR, however numbers of animals disturbed (estimated using the dose-response approach) has been updated following revised noise modelling.

The time points modelled for the project alone were from time point 1, which corresponds to the start of piling at the Project, to time point 26 which corresponds to 25 years after the start of piling. In summary, modelling results for all species demonstrated that there may be a small, or negligible reduction in population size for

the impacted populations, however any changes that did occur would not be enough to significantly affect population trajectories over a generational scale (i.e. small changes in the simulated trajectories fall within the expected range of natural variation).

Harbour porpoise

Results of the iPCoD modelling for harbour porpoise against the CIS MU showed that the median ratio of the impacted population to the un-impacted population at all but two modelled timepoints was 1.0000: at time points 2 and 3 (corresponding to one year after the start of piling (inclusive of the full 26-day piling period)) this ratio was only marginally lower at 0.9999. The greatest modelled difference in number of animals between the un-impacted and the impacted populations was at time point 3 (43 fewer animals; 0.069% of the CIS MU). At time-point 2, the end of piling at the Project, there was a difference of 39 animals between the impacted and unimpacted population (0.06% of the MU). At time point 26, iPCoD modelling showed 24 fewer animals for the impacted population (0.038% of the CIS MU). As such there is considered to be no significant difference between the population trajectories for an un-impacted population and impacted population (see Figure 10-A4).

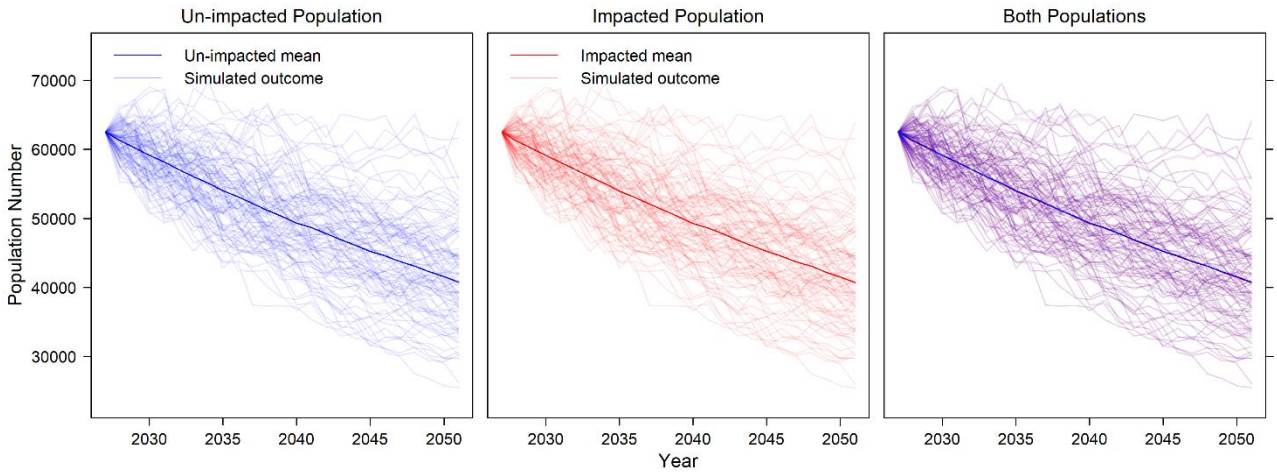


Figure 10-A4: Mean simulated population trajectories of harbour porpoise for the impacted vs un-impacted population over a 25-year simulation.

Bottlenose dolphin

Results of the iPCoD modelling for the SCANS-III density surfaces estimate for bottlenose dolphin compared against the Irish Sea MU population estimate (IAMMWG, 2023) showed that the median ratio of the impacted population to the un-impacted population at all modelled timepoints was 1.0000 (see section 1.2.1 in appendix 10-10: Cumulative iPCoD Modelling Report). The greatest modelled difference in number of animals between the unimpacted and the impacted populations was at time point 3 (six fewer animals; 2.05% of the population estimate). At time point 26 iPCoD modelling showed four fewer animals (1.37% of the 293 population estimate). iPCoD modelling results show that the difference between impacted and un-impacted populations is stable from time point 4 onwards. It is important to highlight that iPCoD does not currently allow for a density-dependent response, and as such there is no way for the impacted population to increase in size in iPCoD after the piling activity has ceased. As such, there is considered to be no significant difference between the population trajectories for an unimpacted population and impacted population (see Figure 10-A5).

For the SCANS-IV Block CS-D density estimate compared against the Irish Sea MU population estimate (Gilles *et al.,* 2023), results also showed that the median ratio of the impacted population to the unimpacted population at all modelled timepoints was 1.0000 (see section 1.2.1 in appendix 10-10: Cumulative iPCoD Modelling Report). The greatest modelled difference in number of animals between the un-impacted and the impacted populations was at time points 3 and 4 (19 fewer animals; 0.228% of the 8,326 population estimate) (corresponding to two years after the start of piling (inclusive of the full 26-day piling period)). At time-point 2, the end of piling at the Project, there was a difference of 18 animals between the impacted and unimpacted population (0.22% of the population estimate). At time point 26 iPCoD modelling showed 16 fewer animals (0.192% of the population estimate). iPCoD modelling results show that the difference

between impacted and un-impacted populations is stable from time point 6 onwards. There is considered to be no significant difference between the population trajectories for an unimpacted population and impacted population (see Figure 10-A6).

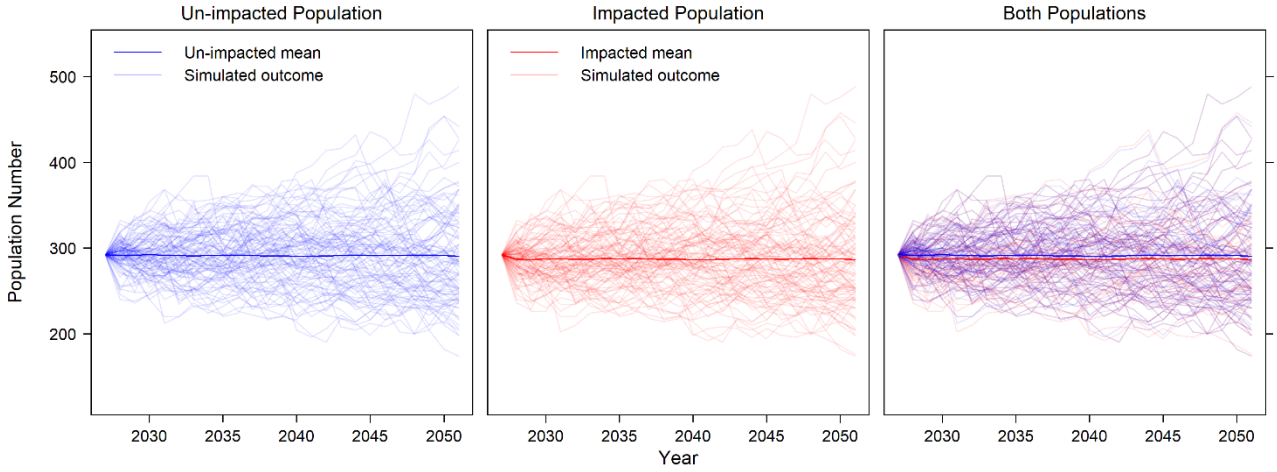


Figure 10-A5: Mean simulated population trajectories of bottlenose dolphin for the impacted vs un-impacted population over a 25-year simulation (SCANS-III abundance and Irish Sea MU).

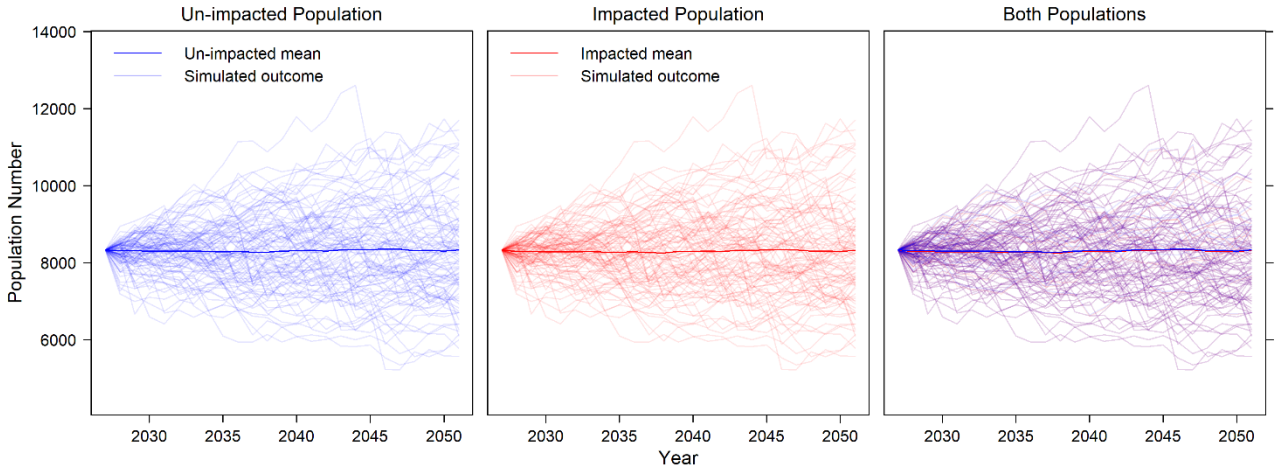


Figure 10-A6: Mean simulated population trajectories of bottlenose dolphin for the impacted vs un-impacted population over a 25 year simulation (SCANS-IV abundance and combined SCANS-IV blocks within the Irish Sea).

Minke whale

Results of the iPCoD modelling for minke whale against the CGNS MU showed an almost negligible difference in the growth trajectory of this species between the un-impacted population and impacted population and projected population values were the same for the un-impacted population and impacted population at all but one timepoints (a difference of one fewer animal at time point 5, representing 0.0049% of the CGNS MU, corresponding to four years after the start of piling, three years after piling has finished) (see section 1.2.1 in appendix 10-10: Cumulative iPCoD Modelling Report). At time-point 2, the end of piling at the Project, there was no difference in the numbers of animals between the impacted and unimpacted population (0.06% of the MU). The median counterfactual was 1.0000 through each of the 25-year simulations, and therefore it is considered that there is no difference between the population trajectories for the un-impacted population and impacted population (see Figure 10-A7).

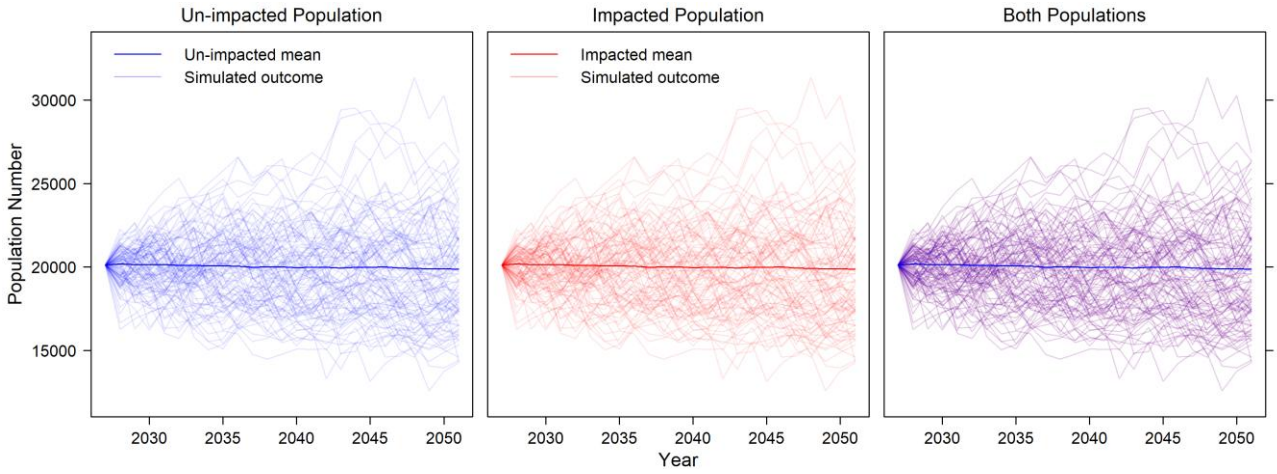


Figure 10-A7: Mean simulated population trajectories of minke whale for the impacted vs un-impacted population over a 25-year simulation.

Grey seal

Results of the iPCoD modelling for grey seal against the GSRP showed no difference in the growth trajectory of this species between the un-impacted population and impacted population and projected population values were the same for the un-impacted population and impacted population at all timepoints. The median counterfactual was 1.0000 through each of the 25-year simulations (see section 1.2.1 in appendix 10-10: Cumulative iPCoD Modelling Report), and therefore it is considered that there is no difference between the population trajectories for the un-impacted population and impacted population (see Figure 10-A8).

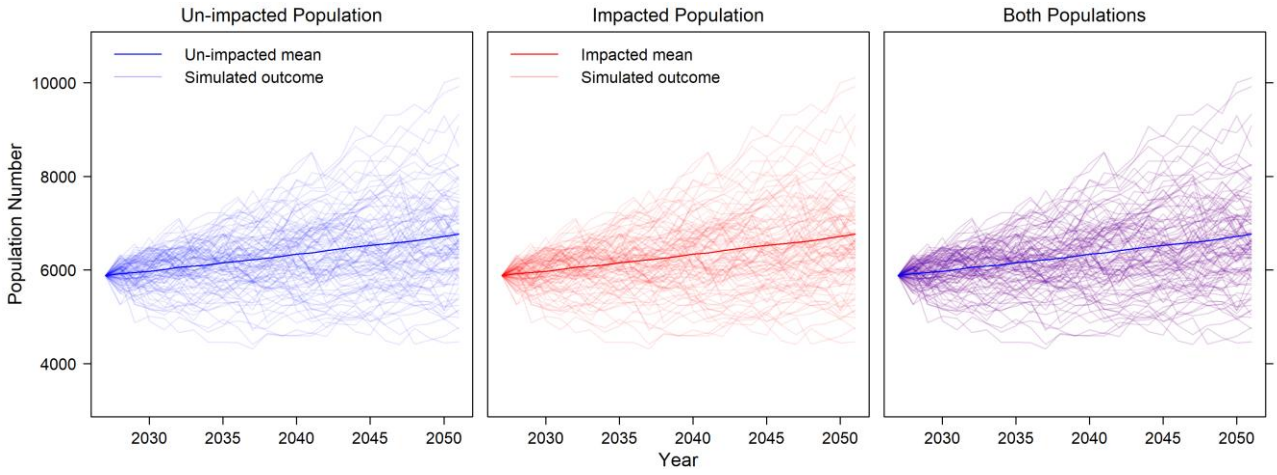


Figure 10-A8: Mean simulated population trajectories of grey seal for the impacted vs un-impacted population over a 25 year simulation.

Harbour seal

Results of the iPCoD modelling for harbour seal against the HSRP showed no difference in the growth trajectory of this species between the un-impacted population and impacted population and projected population values were the same for the un-impacted population and impacted population at all timepoints. The median counterfactual was 1.0000 through each of the 25-year simulations (see section 1.2.1 in appendix 10-10: Cumulative iPCoD Modelling Report), and therefore it is considered that there is no difference between the population trajectories for the un-impacted population and impacted population (see Figure 10-A9).

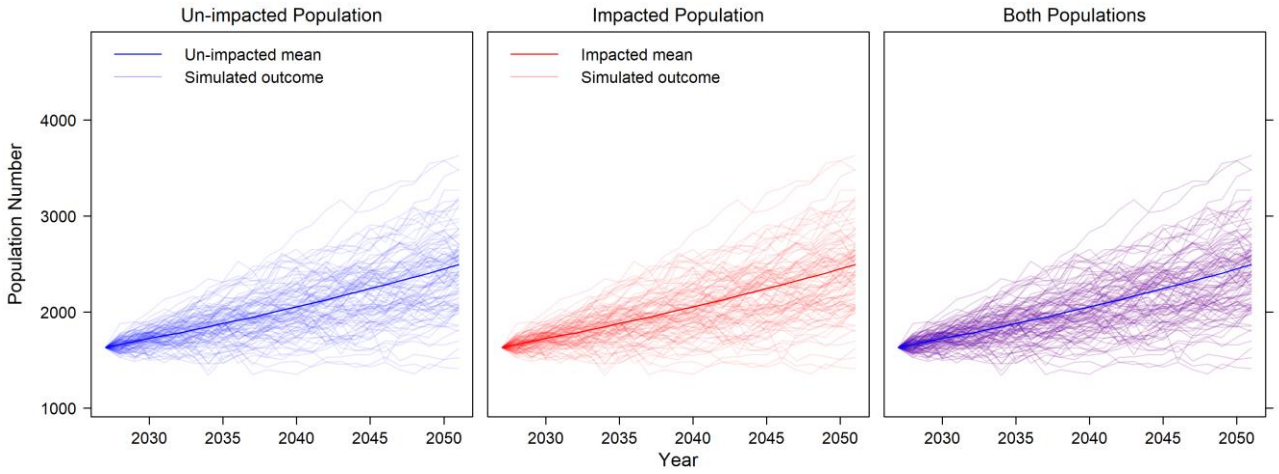


Figure 10-A9: Mean simulated population trajectories of harbour seal for the impacted vs un-impacted population over a 25-year simulation.

Therefore with the application of the revised underwater noise modelling, for behavioural disturbance for harbour porpoise, bottlenose dolphin, common dolphin, minke whale, grey seal and harbour seal, there would be no change to the conclusions of the assessment of effect.

The impact of disturbance on marine mammals is predicted to be of regional spatial extent, as it extends beyond the boundaries of the offshore wind farm area, medium-term duration, intermittent, and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of the impact could lead to small changes to behaviour and distribution in individuals, but not at a scale that would lead to any measurable population-level effects; any shifts would be relatively small in the context of the relevant geographic frames of reference. The impact would occur during piling only, which comprises a small fraction of the construction period; the duration and frequency of the impact are such that there would be minimal disruption to reproductive cycles. The **magnitude** is therefore, still considered to be **low** (and aligns with the conclusions of the EIAR).

In response to **RFI 9.V**, as shown above in Table 10A-22 and Table 10A-23 bottlenose dolphin was identified as the only species where >5% of the reference population are predicted to be impacted using the dose response approach (which feeds into iPCoD population modelling). However ,results of the updated iPCoD modelling for the project alone (as presented above) demonstrates that, regardless of the values applied to the quantitative assessment (SCANS III or SCANS IV), there was predicted to be no long term population effects on this species (and the median ratio of the impacted population to the unimpacted population at all modelled timepoints was 1.0000) (see Figure 10-A5 and Table 10A-6).

Therefore, whilst there may be minor temporary impacts on individuals during days of piling (small reductions in animals at certain time points between the impacted and unimpacted population), these do not translate to any measurable effects at the population level (i.e., median ratio of 1.0000, difference in animals of less than 2% of the MU and trajectory is stable over time). **Having applied the updated noise modelling (see Summary of Subsea Noise Modelling: Disturbance above) to the assessment, no changes are required to the conclusion of magnitude ('Low') reached in Table 10.14 of EIAR volume 2B, chapter 10: Marine Mammals and Megafauna.**

Sensitivity of the receptor

Injury

There are no changes or additions in response to RFIs to EIAR chapter 10: Marine Mammals and Megafauna.

Disturbance

There are no changes or additions in response to RFIs to EIAR chapter 10: Marine Mammals and Megafauna.

Significance of the effect

There are no changes or additions in response to RFIs to EIAR chapter 10: Marine Mammals and Megafauna.

Mitigation and residual effect

No changes to the existing information presented in chapter 10: Marine Mammals and Megafauna have been made, but additional information has been included in response to RFI 9.L (splitting of tables into SCANS-IV densities and other density sources). The significance of the residual effect remains unchanged from the assessment.

Whilst the assessment undertaken as part of the EIAR considered the best available advice at the time, advances have been made in the field of underwater sound modelling since the assessment was carried out, particularly in the field of noise generated by piling activities. Therefore (and additionally, in response to statutory consultation submissions and the further information requested regarding underwater noise modelling (RFIs 9.G and 9.H)) the source modelling and propagation modelling methodology applied to the subsea noise modelling was updated (see appendix 10-4: Updated Subsea Noise Modelling Report) for details of the revised source modelling method (using von Pein *et al.,* 2022) and revised 'line source' propagation model). Whilst no changes to the approach to the interpretation of the subsea noise modelling have been made for marine mammals and megafauna, the results of the revised noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report) and subsequent updated impact assessment have been presented.

A number of measures have been included in the Project, including a soft start to piling and the implementation of an MMMP. Mitigation will also be applied by use of an ADD, as an additional measure. As per the underwater noise modelling carried out for the EIAR, underwater noise modelling was carried out for the SEL_{cum} metric to determine the potential efficacy of using an ADD to deter marine mammals. The modelled scenario included the activation of an ADD for a period of 15 minutes prior to initiation of piling (i.e. ADD activation + piling initiation + soft start + ramp up) and was compared to the scenario with the implementation of measures included in the Project (designed-in and management measures) only (i.e. piling initiation + soft start + ramp up) to determine whether deployment of an ADD was of potential benefit to reducing the risk of injury to marine mammals.

Table 10-33 of volume 2, chapter 10: Marine Mammals and Megafauna has been updated with revised noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report (EIAR volume 2B Addendum), see Table 10A-24.

Table 10A-24: Supersedes Table 10-33: Summary of the SEL_{cum} injury ranges for marine mammals due to piling of single monopile at the east of the offshore wind farm area with measures included in the Project and mitigation (ADD) (N/E = threshold not exceeded).

Species / Group	Threshold (weighted SEL_{cum})	Range (m)	
		Measures included in the Project	Measures included in the Project + ADD
LF	PTS – 183 dB re 1 μPa^2s	1,135	N/E
	TTS – 168 dB re 1 μPa^2s	21,500	19,500
HF	PTS – 185 dB re 1 μPa^2s	N/E	N/E
	TTS – 170 dB re 1 μPa^2s	21	N/E
VHF	PTS – 155 dB re 1 μPa^2s	815	N/E
	TTS – 140 dB re 1 μPa^2s	14,500	13,000
PW	PTS – 185 dB re 1 μPa^2s	11	N/E
	TTS – 170 dB re 1 μPa^2s	5,520	3,890

The results of the modelling suggest that the use of an ADD will further reduce the risk of injury occurring in marine mammal receptors. For PTS (SEL_{cum} metric), with the inclusion of an ADD, thresholds are not exceeded in any species, and animals are expected to flee beyond the injury zones prior to the piling initiation (Table 10A-24). Over a duration of 15 minutes activation and based on a conservative swim speed of 1.5 m/s (Otani *et al.*, 2000) a marine mammal would be able to move a distance of 1,350 m. It is therefore anticipated that animals would be beyond the maximum injury zone predicted using the SPL_{pk} metric at soft start initiation (i.e. up to 653 m). Several studies provide evidence that ADDs deter different marine mammals over several hundreds of metres or indeed up to several kilometres from the source in a small number of cases (reviewed in Phillips *et al.* (2025)). In particular, minke whale, in which modelled SEL_{cum} injury ranges were greatest Table 10A-24) have been shown to make directed movements and increase their net swim speed at distances of greater than one kilometre from an ADD (Boisseau *et al.,* 2021).

The use of an ADD will also reduce the risk of TTS occurring in marine mammals. With the inclusion of an ADD, TTS ranges are reduced to 19,500m for minke whale; 13,000 m for harbour porpoise; 3,890m for grey seal and harbour seal. For high frequency cetaceans (bottlenose dolphin and common dolphin) the TTS threshold would not be exceeded (Table 10A-24).

In response to **RFI 9.L,** Table 10.34 has been split into two tables; Table 10A-25 (supersedes Table 10.34) for the number of animals potentially affected by PTS (auditory injury) and TTS arising from impact piling at the east of the offshore wind farm area based on SEL injury ranges **with mitigation** (soft start and soft start + mitigation (ADD) using density estimates from SCANS-IV Block CS-D (Gilles et al., 2023) and revised underwater noise modelling and Table 10A-26 (supersedes Table 10.34) for the number of animals potentially affected by PTS (auditory injury) and TTS arising from impact piling at the east of the offshore wind farm area based on SEL injury ranges with mitigation (soft start and soft start + mitigation (ADD) using alternative density estimates and revised underwater noise modelling. Each table clarifies whether the density represents the minimum or maximum density estimate for each species.

Table 10A-25: Supersedes Table 10.34: Number of animals potentially affected by PTS (auditory injury) and TTS arising from impact piling at the east of the offshore wind farm area based on SEL injury ranges (soft start and soft start + mitigation (ADD)) (N/E = threshold not exceeded), using density estimates from SCANS-IV Block CS-D (Gilles et al., 2023) and revised underwater noise modelling.

Species	Threshold (Weighted) SEL_{cum}	Measures applied	Density estimate (animals/ km^2)	Minimum or maximum density estimate	Density Source	MU population	Range (m)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour porpoise	PTS – 155 dB re 1 μPa^2s	Soft start	0.28	Minimum	SCANS IV Block CS-D (Gilles et al. 2023)	62,517	815	2.09	< 1	0.0009
	TTS – 140 dB re 1 μPa^2s						14,500	660.52	185	0.30
	PTS – 155 dB re 1 μPa^2s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 140 dB re 1 μPa^2s						13,000	530.93	149	0.24
Bottlenose dolphin	PTS – 185 dB re 1 μPa^2s	Soft start	0.235*	Maximum		8,326*	N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 μPa^2s						21	0.001	<1	0.000004
	PTS – 185 dB re 1 μPa^2s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 μPa^2s						N/E	N/A	N/A	N/A
Common dolphin	PTS – 185 dB re 1 μPa^2s	Soft start	0.027	N/A		102,656	N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 μPa^2s						21	0.001	<1	3.64×10^{-8}
	PTS – 185 dB re 1 μPa^2s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 μPa^2s						N/E	N/A	N/A	N/A
Minke whale	PTS – 183 dB re 1 μPa^2s	Soft start	0.014	Minimum		20,118	1,135	4.05	<1	0.00028
	TTS – 168 dB re 1 μPa^2s						21,500	1,452.2	20	0.10
	PTS – 183 dB re 1 μPa^2s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 168 dB re 1 μPa^2s						19,500	1194.59	17	0.081

* Density generated using SCANS-IV data has been compared against a reference population estimated by summing the abundance within the Irish Sea SCANS-IV blocks

Table 10A-26: Supersedes Table 10.34: Number of animals potentially affected by PTS (auditory injury) and TTS arising from impact piling at the east of the offshore wind farm area based on SEL injury ranges (soft start and soft start + mitigation (ADD)) (N/E = threshold not exceeded), using alternative density estimates and revised underwater noise modelling.

Species	Threshold (Weighted) SEL_{cum}	Measures applied	Density estimate (animals/km^2)	Minimum or maximum density estimate	Density Source	MU population	Range (m)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour porpoise	PTS – 155 dB re 1 µPa^{2}s	Soft start	1.33	Maximum	Monthly peak, Oriel site-specific surveys	62,517	815	2.09	3	0.0045
	TTS – 140 dB re 1 µPa^{2}s						14,500	660.52	879	1.41
	PTS – 155 dB re 1 µPa^{2}s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 140 dB re 1 µPa^{2}s						13,000	530.93	707	1.13
Bottlenose dolphin	PTS – 185 dB re 1 µPa^{2}s	Soft start	0.046	Minimum	SCANS III DSM; Lacey *et al.* (2022)	293	N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 µPa^{2}s						21	0.001	<1	0.00002
	PTS – 185 dB re 1 µPa^{2}s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 µPa^{2}s						N/E	N/A	N/A	N/A
Minke whale	PTS – 183 dB re 1 µPa^{2}s	Soft start	0.26	Maximum	Oriel site-specific surveys	20,118	1,135	4.05	2	0.0053
	TTS – 168 dB re 1 µPa^{2}s						21,500	1,452.2	378	1.88
	PTS – 183 dB re 1 µPa^{2}s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 168 dB re 1 µPa^{2}s						19,500	1,194.59	311	1.54
Grey seal	PTS – 185 dB re 1 µPa^{2}s	Soft start	0.327	N/A	Carter *et al.* (2022)	5,882	11	0.0004	<1	0.000002
	TTS – 170 dB re 1 µPa^{2}s						5,520	95.73	36	0.61
	PTS – 185 dB re 1 µPa^{2}s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 µPa^{2}s						3,890	47.54	18	0.30

Species	Threshold (Weighted) SEL_{cum}	Measures applied	Density estimate (animals/km^2)	Minimum or maximum density estimate	Density Source	MU population	Range (m)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour seal	PTS – 185 dB re 1 µPa^{2}s	Soft start	0.28	N/A		1,635	11	0.0004	<1	0.000007
	TTS – 170 dB re 1 µPa^{2}s						5,520	95.73	27	1.64
	PTS – 185 dB re 1 µPa^{2}s	Soft start + ADD					N/E	N/A	N/A	N/A
	TTS – 170 dB re 1 µPa^{2}s						3,890	47.54	14	0.81

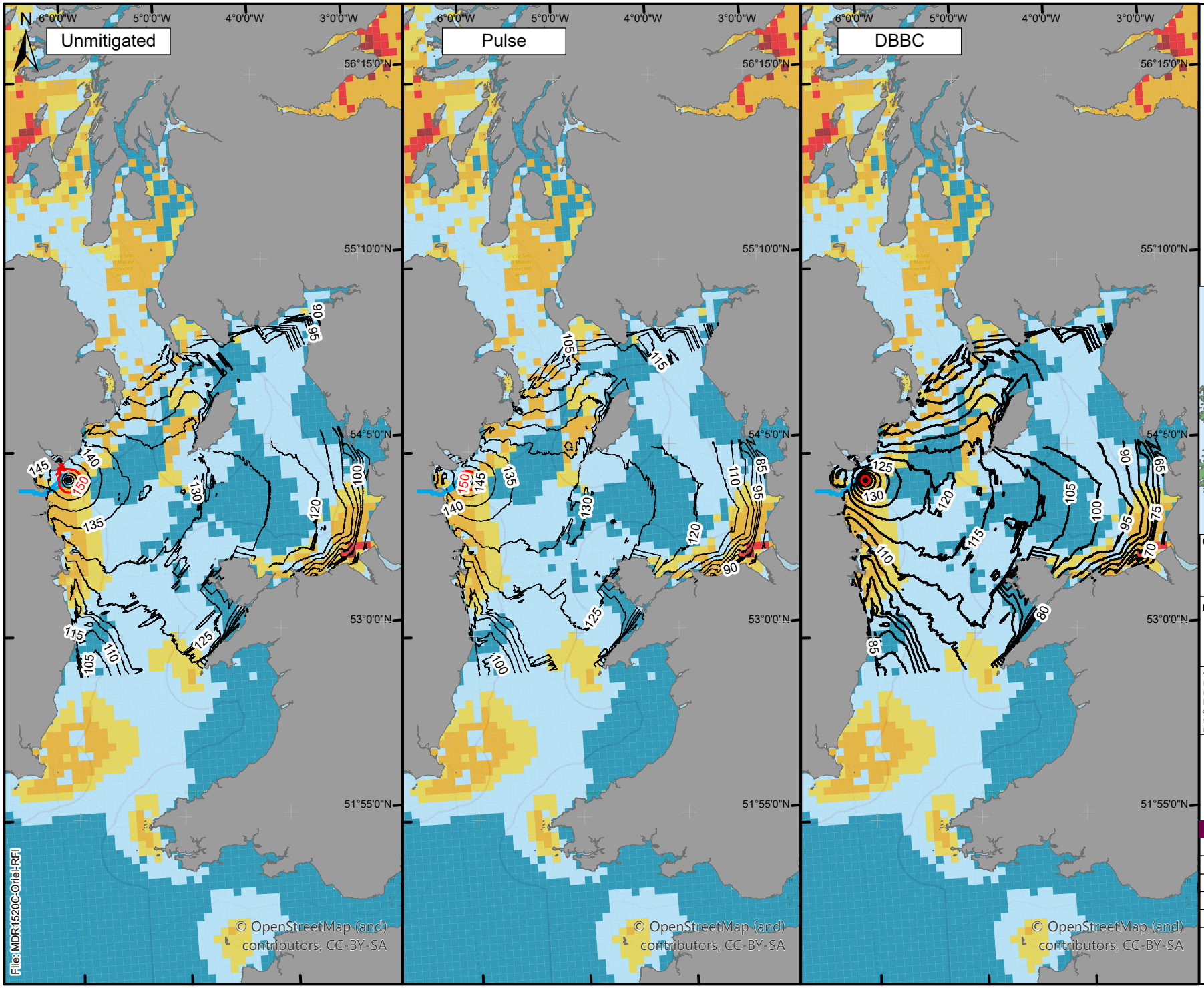
Since deployment of an ADD means that PTS thresholds would not be exceeded for any species, there would be no animals potentially exposed to noise levels that could result in PTS. Similarly, the TTS threshold would not be exceeded in high frequency cetaceans (bottlenose dolphin or common dolphin). With the inclusion of an ADD, the number of animals with the potential to experience TTS would be reduced compared to the number of animals with the potential to experience TTS, modelled without an ADD. For harbour porpoise between 185 (Table 10A-25) and 897 animals (Table 10A-26) (representing a maximum of 1.41% of the CIS MU) have the potential to experience TTS with measures included in the Project alone, compared to between 149 (Table 10A-25) and 707 (Table 10A-26) (representing a maximum of 1.13% of the CIS MU), with the inclusion of an ADD for 15 minutes. For minke whale between 20 to 378 animals (representing a maximum of 1.88% of the CGNS MU) (Table 10A-25, Table 10A-26) have the potential to experience TTS with measures included in the Project alone, compared to between 17 to 311 (representing a maximum of 1.54% of the CGNS MU) with the inclusion of an ADD (Table 10A-25, Table 10A-26). For grey seal 36 animals (representing 0.61% of the GSRP) have the potential to experience TTS with measures included in the Project alone, compared to 18 (representing 0.30% of the GSRP), with the inclusion of an ADD (Table 10A-26). For harbour seal 27 animals (representing 1.64% of the HSRP) have the potential to experience TTS with measures included in the Project alone, compared to 14 (representing a maximum of 0.81% of the HSRP), with the inclusion of an ADD (Table 10A-26).

As discussed previously, species-specific TTS thresholds developed by NMFS (2018), and those previously presented by Southall *et al.* (2007), define a TTS onset as the exposure required to produce 6 dB of TTS, from either direct measurements or extrapolation of available data. There is currently, however, extremely limited data on impulsive noise TTS onset in marine mammals upon which these thresholds are based (Southall *et al.,* 2019). It has been necessary to determine exposure functions for TTS to estimate the levels at which the onset of PTS could occur (as experiments inducing PTS in animals are considered unethical) and predicted exposures of 40 dB of TTS are considered to result in PTS onset (Southall *et al.,* 2007). For the purposes of developing these thresholds, TTS was considered to be “the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a subject’s normal hearing ability”, and which “is typically the minimum amount of threshold shift that can be differentiated in most experimental conditions” (Southall *et al.,* 2007). Thus, using a threshold for the onset of TTS would typically result in overestimates of potential ranges at which ecologically significant effects could occur. Coupled with the precautionary assumptions in the model, particularly with respect to the SEL_{cum} metric, this means that estimates of TTS are likely to be unrealistic and therefore should be interpreted with caution. However, the subsea noise modelling does illustrate that the use of an ADD can be used to reduce the risk of a temporary auditory impairment.

Therefore, the magnitude of the residual effect remains unchanged from the assessment. As such, the significance of the residual effect remains unchanged from the assessment.

Further measures

In response to **RFI 9.A(iii)** Noise Abatement Modelling was undertaken for a number of scenarios for the Project (see appendix 10-6: NAS Modelling Report for detailed acoustic modelling methodology, and appendix 10-7: NAS Technical Report - Marine Mammals, Megafauna and Fish for outputs of ecological noise modelling interpretation). The outputs of this work clearly demonstrate the potential for measurable reductions in auditory injury, TTS and disturbance impact ranges/areas at the Project. Figure 10-A10 has been presented below, which shows unweighted disturbance contours (SEL_{ss}) for unmitigated piling, piling with PULSE and piling with DBBC all at the east piling location, overlaid with grey seal at-sea usage (Carter *et al.,* 2022). Additionally, the threshold for strong disturbance (160 dB re 1 µPa SPL_{rms}) has been given in a red contour.



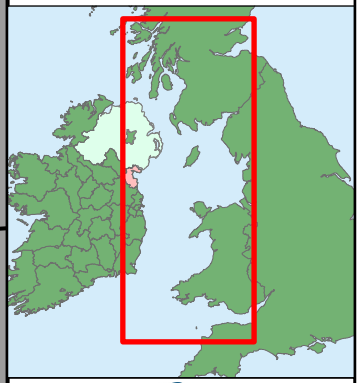
Legend

- Application Boundary
- Noise contour (dB re 1 µPa^{2}s SEL_{ss})
- Strong Disturbance (160 dBrms)

Grey seal at sea usage (animals per 5x5 km grid cell) Mean values (Based on Carter *et. al.* 2022)

- 0
- >0 to 1
- >1 to 5
- >5 to 10
- >10 to 50
- >50 to 100
- >100

Data Sources: Client. Marine Scotland



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title **Figure 10A-10**
Unweighted disturbance contours (SELss) for unmitigated piling, piling with PULSE and piling with DBBC all at the east piling location, overlaid with grey seal at-sea usage (Carter et al., 2022). Threshold for strong disturbance (160 dB re 1 uPa SPLrms) given in red contour.

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Issue Details

Drawn By: NG	**Project No.** MDR1520C
Checked By: NG	**File Ref:** MDR1520C-RFI-ADD-UWN-009-02.A1C01
Approved By: BP	
Scale: 1:3,300,000@ A4	**Projection:** ITM (IRENET95)
Date: 11/12/2025	Geographic Co-ordinates: ETRS89

The modelling assessed in this report (appendix 10-6: NAS Modelling Report) presents examples of the type of NAS that could be used on the Project, and it is highlighted that other options are, and will be, available (as detailed in the appendix 10.8: Comprehensive Review of Relevant Mitigation (Noise Abatement) & Thresholds). Given the range of reductions demonstrated (see Figure 10-A10) it is expected that application of NAS available at the time of construction will produce similar results. Furthermore, given that the impact assessment (set out in volume 2B, chapter 10: Marine Mammals and Megafauna) has already concluded no significant impact on marine mammals, it is considered that any application of NAS would simply further reduce the magnitude of effect on marine mammals for PTS, TTS and disturbance. Finally, given the potential for measurable reductions in impact zones, it is considered that this will also lead to a reduction in the Project's contribution to any potential underwater noise cumulative effect with other projects in the vicinity of the Project.

Finally, in an abundance of caution, for the short duration of hammer impact piling of the sacrificial casing (and limited number of days piling) the Project will be committing to reducing the level of underwater noise from pile driving through use of the MODIGA with internal air bubble ring, as its noise abatement solution (see appendix 10.8 Addendum: Comprehensive Review of Relevant Mitigation (Noise Abatement) & Thresholds).

The system manufacturer states that the MODIGA fitted with an internal air bubble ring can provide underwater noise reduction during piling. The MODIGA with internal air bubble ring will be placed on the seabed into which the sacrificial casing will be lowered. A hammer pile will then be inserted into the MODIGA and the sacrificial casing hammer piled through the unconsolidated sediments. The air bubble ring within the MODIGA will actively attenuate noise. It has been demonstrated that air-filled casings can offer a highly effective noise mitigation strategy for marine mammal and fish receptors, reducing received SEL and peak SPL sound levels by several decibels (precise reduction being dependent upon specific configurations (see section 1.3.2 in appendix 10-8). The proposed MODIGA with internal air bubble ring will lower sound transmission due to the acoustic impedance of air by reducing the proportion of vibrational energy from the pile transmitted through the air layer into the surrounding water. It was not possible to model the precise level of reduction of noise levels at this stage as this system will be bespoke to the Project, however, a noise modelling study was undertaken for a range of NAS options to demonstrate the efficacy of applying commercially available NAS technology during piling at the Project (Appendix 10-6: NAS Modelling Report). The level of noise abatement resulting from the air bubble ring inside the MODIGA casing will be modelled during the detailed design of the MODIGA system. It is expected that this will result in a noise abatement compared to an unmitigated piling scenario similar to the in-line hammer noise reduction unit (PULSE) technology.

The MODIGA was used at two offshore wind farms in the Bay of Biscay in France (see appendix 5-11: Supporting Information Demonstrating the Applicant's Experience on Other Offshore Wind Farm Projects), however, at present there is no data available to allow the Project to undertake noise modelling to specifically demonstrate the potential noise reductions. For the existing commercially available systems that were modelled for the Project, the results demonstrated a reduction in SEL and peak SPL in effect ranges for marine mammal and fish receptors (appendix 10-6: NAS Modelling Report). NAS modelled included: big bubble curtains (BBC), double big bubble curtains (DBBC) and the in-line hammer PULSE technology. Therefore, taking the theoretical considerations into account and the manufacturer's technical statement, the Project is confident that the MODIGA with internal air bubble ring will also provide suitable mitigation for piling.

10.10.2 Injury and/or disturbance to marine megafauna from elevated underwater noise during routine geophysical surveys

No changes to the existing information presented in the EIAR have been made, but additional information has been included in response to RFI 9.J. An assessment of the magnitude, sensitivity and conclusion on significance of effect is provided.

In response to **RFI 9.J,** the Applicant clarifies Ultra-short Baseline (USBL) positioning systems may be used during routine geophysical surveys during the operational and maintenance phase of the Project and has therefore presented an assessment of the potential impact from USBL on marine mammals and megafauna, for both auditory injury (Permanent Threshold Shift (PTS)) and Temporary Threshold Shift (TTS).

USBL is a sonar-like survey source with highly-directional signal (like a beam) which has been classed as non-impulsive noise because they generally comprise a single (or multiple discrete) frequency (e.g. a sine wave or swept sine wave) as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times (see appendix 10-6: NAS Modelling Report).

Underwater noise modelling for USBL has been undertaken based upon the likely typical parameters of USBL equipment, presented in Table 10A-27. Noise modelling used pulse rate calculate the sound exposure level (SEL) (which is normalised to one second) from the root mean square (rms) sound pressure level (SPL). Directivity corrections were calculated based on the transducer dimensions and ping frequency and taken from manufacturer's datasheets. The injury and disturbance ranges were based on the non-impulsive thresholds set out in Southall *et al*. (2019).

Table 10A-27: Typical USBL equipment parameters used in the Underwater Noise Technical Report.

Survey equipment type	Frequency(s), kHz	Source Level, dB re 1 µPa re 1 m	Pulse Rate, s-1	Pulse Width, ms	Beam Width, degrees
USBL	14	200	3	100	80

Operational and maintenance phase
Magnitude of impact

Injury

No changes to the existing information [or conclusions?] presented in the EIAR have been made, but additional information has been included in response to RFI 9.J for the assessment of USBL.

Sonar-like sources have very strong directivity which effectively means that there is only potential for injury when a marine mammal is directly underneath the sound source. Once the animal moves outside of the main beam, there is no potential for injury. The same is true in many cases for TTS where an animal is only exposed to enough energy to cause TTS when inside the direct beam from the equipment.

Table 10A-28 provides estimated ranges for auditory injury of marine mammals (PTS) and TTS for USBL. With respect to the spatial range within which there is a potential of PTS occurring to marine mammals as a result of USBL, PTS has the potential to occur out to a maximum of 53 m for Very High Frequency (VHF) cetaceans (harbour porpoise). For all other marine mammal hearing groups, the threshold is not exceeded and there is no potential for PTS.

TTS has the potential to occur out to a maximum of 1,284 m for VHF species (harbour porpoise), a maximum of 31 m for high frequency (HF) species (bottlenose dolphin and common dolphin), a maximum of 18 m for LF species (minke whale) and out to a maximum of 20 m for pinnipeds (grey seal and harbour seal).

The number of marine mammals with the potential to experience PTS and TTS within modelled ranges presented in **Table 10A-29** and Table 10A-30 were estimated using the most up to date species-specific density estimates (Table 10.7 in volume 2, chapter 10: Marine Mammals and Megafauna). **Table 10A-29** presents the numbers of animals with the potential to experience PTS and TTS using SCANS IV density estimates for relevant cetacean species whilst Table 10A-30 presents the numbers of animals with the potential to experience PTS and TTS using alternative density estimates for relevant species (cetaceans and pinnipeds) (as requested for RFI 9L). See Table 10-6 of volume 2, chapter 10: Marine Mammals and Megafauna for data sources.

Table 10A-28: Potential impact ranges (m) for marine mammals during USBL, based on the non-impulsive SEL thresholds from Southall *et al.* (2019) (N/E refers to a threshold not exceeded).

Survey type	Effect	Hearing group impact range, m			
		LF	HF	VHF	PCW
USBL	PTS	N/E	N/E	53	N/E

	TTS	18	31	1,284	20

Table 10A-29: Number of animals potentially affected by PTS (auditory injury) and TTS arising from USBL, based on the non-impulsive SEL thresholds from Southall *et al.* (2019) for SCANS IV density estimates (cetaceans) (N/E = not exceeded).

Species	Threshold (Unweighted peak)	Density estimate - SCANS IV (animals/km^2)	MU population	Range (km)	Area of sea within zone of impact (km^2)	Number animals within zone of impact	Proportion of MU population (%)
Harbour porpoise	PTS - 173 dB re 1 µPa^{2}s	0.280	62,517	0.053	0.01	<1	4 x 10^{-6}
	TTS - 153 dB re 1 µPa^{2}s			1.284	5.18	2	2 x 10^{-3}
Bottlenose dolphin	PTS - 198 dB re 1 µPa^{2}s	0.235	8,326	N/E	N/A	N/A	N/A
	TTS - 178 dB re 1 µPa^{2}s			0.031	0.003	<1	9 x 10^{-6}
Common dolphin	PTS - 198 dB re 1 µPa^{2}s	0.027	102,656	N/E	N/A	N/A	N/A
	TTS - 178 dB re 1 µPa^{2}s			0.031	0.003	<1	8 x 10^{-8}
Minke whale	PTS - 199 dB re 1 µPa^{2}s	0.014	20,118	N/E	N/A	N/A	N/A
	TTS - 179 dB re 1 µPa^{2}s			0.018	0.001	<1	7 x 10^{-8}

Table 10A-30: Number of animals potentially affected by PTS (auditory injury) and TTS arising from USBL, based on the non-impulsive SEL thresholds from Southall *et al.* (2019) for alternative density estimates (cetaceans and seals) (N/E = not exceeded).

Species	Threshold (Unweighted Peak)	Alternative Density estimate (animals/km^2)	MU population	Range (km)	Area of sea within zone of injury (km^2)	Number animals within zone of injury	Proportion of MU population (%)
Harbour porpoise	PTS - 173 dB re 1 µPa^{2}s	1.33	62,517	0.053	0.01	<1	2 x 10^{-5}
	TTS - 153 dB re 1 µPa^{2}s			1.284	5.18	7	1x 10^{-2}
Bottlenose dolphin	PTS - 198 dB re 1 µPa^{2}s	0.046	293	N/E	N/A	N/A	N/A
	TTS - 178 dB re 1 µPa^{2}s			0.031	0.003	<1	5 x 10^{-5}
Minke whale	PTS - 199 dB re 1 µPa^{2}s	0.26	20,118	N/E	N/A	N/A	N/A
	TTS - 179 dB re 1 µPa^{2}s			0.018	0.001	<1	1 x 10^{-6}
Grey seal	PTS - 201 dB re 1 µPa^{2}s	0.372	5,882	N/E	N/A	N/A	N/A
	TTS - 181 dB re 1 µPa^{2}s			0.02	0.001	<1	8x 10^{-6}
Harbour seal	PTS - 201 dB re 1 µPa^{2}s	0.28	1,635	N/E	N/A	N/A	N/A

TTS - 181 dB re 1 μPa^2s	0.02	0.001	<1	2×10^{-5}

For auditory injury, due to low predicted ranges, it is predicted that there is the potential for no more than one harbour porpoise to experience PTS as a result of USBL surveys. The threshold for PTS was not exceeded for any other hearing group.

For TTS, it is predicted that there is the potential for up to seven harbour porpoise to experience TTS as a result of USBL surveys, for the maximum density estimate of 1.33 animals per km^2 (less than 0.0001% of the MU) (Table 10A-30). Applying the SCANS IV density estimate for harbour porpoise (**Table 10A-29**) there is the potential for up to two animals to experience TTS as a result of USBL surveys (less than 0.0001% of the MU). For all other species, regardless of density estimate less than one animal has the potential to experience TTS.

The geophysical surveys are considered to be short term, as inspection of inter-array cables and offshore export cable will be undertaken across a survey campaign duration of up to 14 days per survey (i.e. one 14-day survey window for inspection of inter-array cables; one 14-day survey window for inspection of offshore export cable), up to a maximum of once every five years over the 40-year lifetime of the Project. Similarly, inspection of offshore wind turbine foundations will be conducted up to a maximum of every five years during the Project lifespan, and each survey campaign will last up to 14 days. If all survey campaigns were to be carried out consecutively, this would represent a maximum of 42 days of geophysical surveying every five years, however actual surveying is not expected to occur for the entire survey window, as time has been included here to account for weather and technical downtime.

Mitigation for injury during surveys using geophysical survey equipment deployed from a conventional vessel will involve the use of Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) to ensure that the risk of injury over the defined mitigation zone is reduced in line with the NPWS guidance (NPWS, 2014). A soft start will be applied where equipment allows. The largest auditory injury range was predicted as 449 m (harbour porpoise) and it is considered that standard industry measures will be effective at reducing the risk of injury over this distance. Full details of measures and associated procedures are presented in appendix 5-4 Addendum: Marine Megafauna Mitigation Plan.

Overall, the magnitude of the impact for USBL during routine geophysical surveys is predicted to be of very limited spatial extent, medium-term duration (i.e. maximum duration of geophysical survey) and highly intermittent. Whilst the impact itself would occur during the operational and maintenance phase only, the effect of PTS should it occur, would be permanent. The effect of TTS and the impact itself (i.e. during the geophysical surveys) is reversible. It is predicted that the impact will affect the receptor directly, noting impacts are limited to under the highly-directional noise source. The impact could lead to PTS and/or TTS in a low number of animals but this would not be at a scale that would lead to any measurable population-level effects. The magnitude for PTS and TTS as assessed in the assessment provided in chapter 10: Marine Mammals and Megafauna (volume 2B) is not changed by this additional information and is therefore still considered to be low.

Disturbance

No changes to the existing information [or conclusions?] presented in the EIAR have been made, but additional information has been included in response to RFI 9.L.

In response to RFI 9.L, Table 10.38 has been split into two tables; Table 10A-31 (Table 10.38A) using density estimates from SCANS-IV Block CS-D (Gilles *et al.,* 2023) and Table 10A-32 (Table 10.38B) using alternative density estimates, both for revised noise modelling. Each table clarifies whether the density represents the minimum or maximum density estimate for each species.

Table 10A-31: Supersedes Table 10.38: Number of animals potentially affected by disturbance arising from geophysical site investigation surveys, using density estimates from SCANS-IV Block CS-D (Gilles et al., 2023).

Species	Hearing group (NMFS, 2018)	Estimated density (animals per km^2)	Minimum or maximum density estimate	Density Source	Number animals within zone of disturbance	Percentage of population (%)
Harbour porpoise	VHF	0.28	Minimum	SCANS IV Block CS-D; Gilles et al. (2023)	2	0.003
Bottlenose dolphin	HF	0.036*	Maximum		< 1	0.018
Common dolphin	HF	0.008	N/A		2	0.0016
Minke whale	LF	0.014	Minimum		<1	0.0004

* Density generated using SCANS-IV data has been compared against a reference population estimated by summing the abundance within the Irish Sea SCANS-IV blocks

Table 10A-32: Supersedes Table 10.38: Number of animals potentially affected by disturbance arising from geophysical site investigation surveys using alternative density estimates.

Species	Hearing group (NMFS, 2018)	Estimated density (animals per km^2)	Minimum or maximum density estimate	Number animals within zone of disturbance	Number animals within zone of disturbance	Percentage of population (%)
Harbour porpoise	VHF	1.330	Maximum	Monthly peak, Oriel site-specific surveys	9	0.013
Bottlenose dolphin	HF	0.008	Minimum	SCANS III DSM; Lacey et al. (2022)	< 1	0.098
Minke whale	LF	0.26	Maximum	Oriel site-specific surveys	<1	0.008*
Grey seal	PW	0.372	N/A	Carter et al. (2022)	3	0.039
Harbour seal	PW	0.280			2	0.107

* Omitted by mistake in volume 2B, chapter 10L Marine Mammals and Megafauna of the EIAR.

Sensitivity of receptor

No changes to the existing information presented in the EIAR have been made, but additional information has been included in response to RFI 9.J.

Overarching marine mammal sensitivity to geophysical survey equipment is discussed in detail in volume 2B, EIAR chapter 10: Marine Mammals and Megafauna. Open water noise measurements from USBL equipment are very limited in the public domain. Pace *et al.* (2021) measured noise levels at varying distances (0 m, 100 m, 500 m and 2000 m) from acoustic sources at sampling stations in the Danish North Sea. When the USBL was active, the combined source was detectable above background ambient noise at the maximum recording distance of 2 km. At a distance of ~1 km from the source, broadband received levels were ≤ 140 dB re 1 µPa (SPL_{pk}), ≤ 130 dB re 1 µPa (SPL_{pk}), and application of VHF cetacean (harbour porpoise) frequency weighting indicated noise levels of < 120 dB re 1 µPa (SPL_{rms}, VHF frequency-weighted), expected to be higher than ambient noise levels. Pace *et al.* (2021) demonstrated no potential for instantaneous PTS-onset from the USBL source tested, but the potential for behavioural disturbance within a limited spatial extent (i.e. a few hundred metres).

Whilst operational frequencies of USBL (e.g. 14 kHz, Table 10A-27) may overlap with the generalised hearing range of marine mammals (Table 10A-33), USBL will mostly operate at the lower end of the range at which harbour porpoise and dolphin species are most sensitive to auditory impact. The source levels of USBL equipment are below the PTS-onset thresholds for all cetaceans except harbour porpoise. For harbour porpoise the USBL is likely to only overlap with a small portion of an animal's hearing. Furthermore, a marine mammal is unlikely to stay within the direct beam of the USBL and noise levels are expected to rapidly attenuate with distance from source, and sound levels outside of the direct beam being considerably lower. Furthermore, marine mammals are likely to respond to vessel noise prior to entering this area. Some USBLs have also previously been considered unlikely to lead to incidental take[2] (as defined in the Marine Mammal Protection Act (NOAA, 2025)) in NMFS analyses (NMFS, 2020) and Ruppel *et al.,* (2022).

Table 10A-33: Marine mammal hearing groups with estimated hearing range and greatest sensitivity, from NMFS (2024) and Southall *et al.* (2019)

Hearing group	Generalised Hearing Range (from NMFS (2024))	Estimated region of greatest sensitivity (from Southall et al. (2019))
LF	7 hZ to 36 kHz	200 Hz to 19 kHz
HF	150 Hz to 160 kHz	8.8 to 110 kHz
VHF	200 Hz to 165 kHz	12 to 140 kHz
PCW	40 Hz to 90 kHz	1.9 to 30 kHz

Injury

For PTS, marine mammals are assessed as having limited resilience, limited ability to adapt behaviour to sustain ecological functioning, and limited ability to recover from the effect in the short and long term, given the potential for the impact to result in a change in both reproduction and survival rates. Receptors are of national/international value. The sensitivity of the receptor to PTS as assessed in the EIAR is not changed by this additional information and is therefore still therefore considered to be **high**.

For TTS, marine mammals are assessed as having some resilience, have an ability to adapt behaviour such that ecological function can be maintained, and high recoverability. Receptors are of national/international value. The sensitivity of the receptor to TTS as assessed in the EIAR is not changed by this additional information and is therefore still therefore considered to be **medium**.

Significance of effect

Overall, the magnitude of the impact of PTS is deemed to be **low** and the sensitivity of the receptor is considered to be **high**. There would be no change to the national/international value of these species. The effect as assessed in the EIAR is not changed by this additional information and will, therefore, remain as **slight adverse significance**, which is not significant in EIA terms.

Overall, the magnitude of the impact of TTS is deemed to be **low** and the sensitivity of the receptor is considered to be **medium**. There would be no change to the national/international value of these species. The effect as assessed in the EIAR is not changed by this additional information and will, therefore, remain as **slight adverse significance**, which is not significant in EIA terms.

[2] "Take" as defined in the Marine Mammal Protection Act means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.

10.10.3 Injury and/or disturbance to marine megafauna from vessel and other construction activities

Construction Phase

Magnitude of impact

Injury

No changes to EIAR chapter 10: Marine Mammals and Megafauna.

Disturbance

No changes to the information presented in chapter 10: Marine Mammals and Megafauna have been made, but additional information has been included in response to RFI 9.L.

In response to RFI 9.L, Table 10.41 has been split into two tables; Table 10A-34 (Table 10.41) using density estimates from SCANS-IV Block CS-D (Gilles *et al.,* 2023) and Table 10A-35 (Table 10.41) using alternative density estimates, both for revised noise modelling. Each table clarifies whether the density represents the minimum or maximum density estimate for each species (under species name).

Table 10A-34: Supersedes Table 10.41A: Number of animals with the potential to be disturbed by construction vessels and pile drilling within estimated disturbance ranges for marine mammals (continuous sources), using density estimates from SCANS-IV Block CS-D (Gilles et al., 2023). Maximum or minimum density estimate has been clarified under each species name.

Source	Range (km)	Area (km^2)	Estimated number of marine mammals with the potential to be disturbed							
			Harbour porpoise (Maximum density)		Bottlenose dolphin (Maximum density)		Common dolphin N/A		Minke whale (Minimum density)	
			Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)
Sand wave clearance; Installation vessel, construction vessel (DP); rock placement vessel and cable installation vessels	3.6 km	40.69	12	0.018	10*	0.11	12	0.01	< 1	0.002
Boulder clearance	755 m	1.79	< 1	0.001	< 1*	0.005	< 1	0.0004	< 1	0.0001
Jack up rig	< 20 m	< 0.001	*Negligible*							
Tug/anchor handlers; guard vessels	3.4 km	36.3	11	0.016	9*	0.10	10	0.009	< 1	0.002
Survey vessel and support vessels; CTVs; Scour / Cable Protection / Seabed Preparation / Installation Vessels	8.5 km	226.86	64	0.102	54*	0.64	62	0.06	4	0.157
Pile drilling	1.083 km	3.68	2	0.002	< 1*	0.01	2	0.0009	< 1	0.0003

* Density generated using SCANS-IV data has been compared against a reference population estimated by summing the abundance within the Irish Sea SCANS-IV blocks

Table 10A-35: Supersedes Table 10.41: Number of animals with the potential to be disturbed by construction vessels and pile drilling within estimated disturbance ranges for marine mammals (continuous sources), using alternative density estimates.

Source	Range (km)	Area (km2)	Estimated number of marine mammals with the potential to be disturbed									
			Harbour porpoise (Minimum density)		Bottlenose dolphin (Minimum density)		Minke whale (Minimum density)		Grey seal N/A		Harbour seal N/A	
			Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)	Number of animals	Proportion of MU population (%)	Number animals	Proportion of MU population (%)	Number animals	Proportion of MU population (%)
Sand wave clearance; Installation vessel, construction vessel (DP); rock placement vessel and cable installation vessels	3.6 km	40.69	55	0.086	2	0.63	11	0.05	15	0.257	12	0.696
Boulder clearance	755 m	1.79	<3	0.003	< 1	0.03	< 1	0.002	< 1	0.011	< 1	0.031
Jack up rig	< 20 m	< 0.001	*Negligible*									
Tug/anchor handlers; guard vessels	3.4 km	36.3	49	0.077	2	0.57	10	0.046	14	0.229	11	0.621
Survey vessel and support vessels; CTVs; Scour / Cable Protection / Seabed Preparation / Installation Vessels	8.5 km	226.86	302	0.483	11	3.56	59	0.29	85	1.434	64	3.885
Pile drilling	1.083 km	3.68	5	0.008	< 1	0.057	< 1	0.005	2	0.023	2	0.063

Sensitivity of the receptor

No changes to the information presented in chapter 10: Marine Mammals and Megafauna have been made, but additional information has been included in response to RFI 9.Z on collision risk.

The conclusion of 'high' sensitivity of marine mammals to 'injury or death due to collision with vessels', as part of section 10.10.3 (of volume 2B, chapter 10: Marine Mammals and Megafauna) remains unchanged, however the following sections provide detail on additional data from Irish waters, as requested in RFI 9.Z. The additional information does not change the conclusions of the assessment.

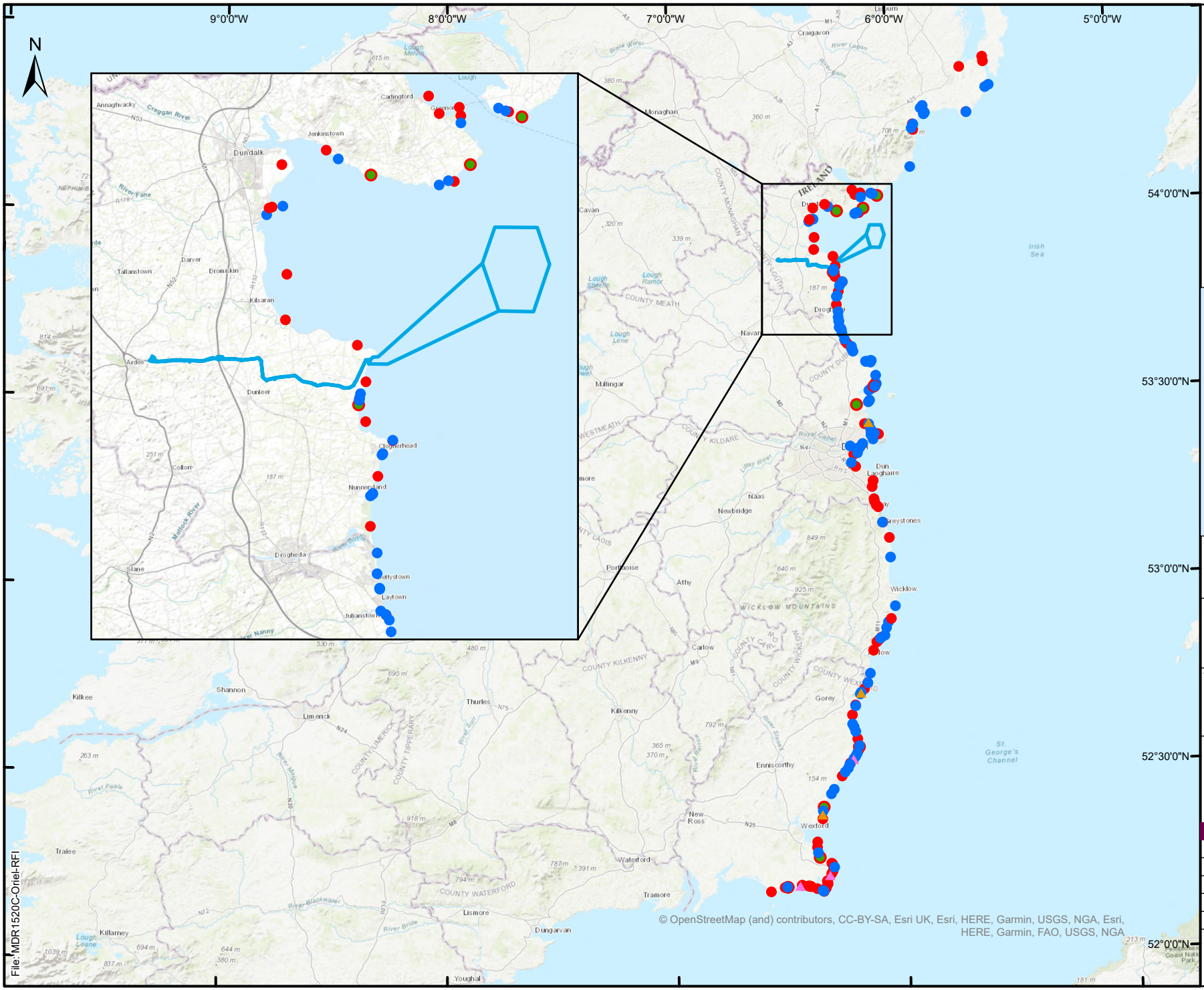
The most recent five years of strandings data (2020 and 2025) for the key marine mammal important ecological features (as determined in volume 2B, chapter 10: Marine Mammals and Megafauna) in the Irish Sea geographic region were obtained from the Irish Whale and Dolphin Group (IWDG) (Figure 10-A11). A total of 224 strandings were documented for the Irish Sea region between 2020 and 2025 (Figure 10-A12), for five key species: harbour porpoise *Phocoena phocoena*, common dolphin, leatherback turtle *Dermochelys coriacea*, minke whale, and basking shark *Cetorhinus maximus*. Records of 'common or striped dolphin' *Stenella coeruleoalba* were also included as these animals could fall under common dolphin.

The majority of strandings comprised harbour porpoise (n = 113; 50.4%) and common dolphin (n = 94; 42.0%), together accounting for over 92% of all recorded events. This could indicate either higher relative abundance, greater susceptibility to stranding, or increased detection/reporting rates for these species. Strandings of common or striped dolphin (n = 10; 4.5%), leatherback turtle (n = 3; 1.3%), minke whale (n = 3; 1.3%), and basking shark (n = 1; 0.4%) were comparatively rare, but represent broader diversity of marine megafauna susceptible to collision risk in Irish waters. The greatest species diversity was seen in 2024, with all six species represented.

Evidence of bycatch and/or entanglement were recorded where possible, alongside notes per stranding which included information on the state of the animal (such as lesions, fin slices, cut fins). Mention of vessel collision was recorded in two of the 224 records:

- 13/07/2022 basking shark with the note "Ship strike. Came into port on bow of ship";
- 24/07/2021 harbour porpoise with the note "Possible boat strike - injuries on tail stock/tail consistent with propeller damage".

The IWDG also provided necropsy reports from 2014 to 2020 (Levesque *et al.*, 2020). Out of a total of 73 necropsied animals, only one short-beaked common dolphin was allocated under "physical trauma (boat/ship strike)" as a cause of death.



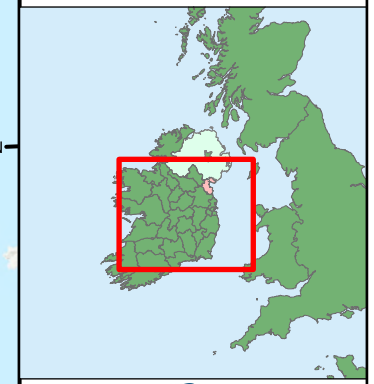
Legend

Application Boundary

Cetacean Stranding Location by Species

- basking shark
- common dolphin
- common or striped dolphin
- harbour porpoise
- leatherback turtle
- minke whale

Data Sources: Client. IWDG Cetacean Stranding Scheme



Client

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

Project

Oriel Wind Farm Project

Title **Figure 10A-11**
Strandings from July 2020 to July 2025 for the Irish Sea region, for key species, from IWDG strandings database.

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Issue Details

Drawn By: NG	**Project No.** MDR1520C
Checked By: NG	**File Ref:** MDR1520C-RFI-ADD-UWN-011-02.A1C01
Approved By: BP	
Scale: 1:1,500,000 @ A4	**Projection:** ITM (IRENET95)
Date: 11/12/2025	Geographic Co-ordinates: ETRS89

File: MDR1520C-Oriel-RFI

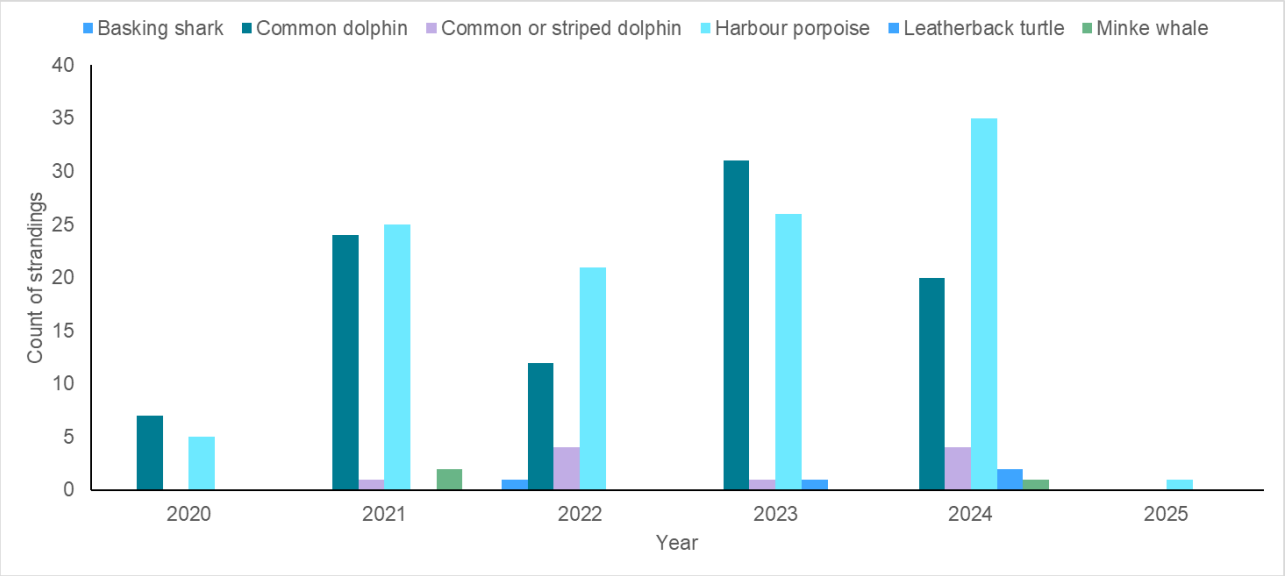

Figure 10-A12: Number of strandings from July 2020 to July 2025 per year for each species, from IWDG strandings database.

Data from the Irish Whale & Dolphin Group Deep Diving and Rare Species Investigation Programme (DDRIP) (Irish Whale Dolphin Group (IWDG), 2025) for rarer species around Ireland was obtained. From May 2022 to April 2025, over the course of the project, 18 species which are considered rare and/or deep diving were examined under DDRIP, demonstrating the presence of rarer species around Ireland (Irish Whale Dolphin Group (IWDG), 2025). Seven partial examinations were carried out on two fin whales *Balaenoptera physalus*, two humpback whales *Megaptera novaeangliae*, two sperm whales *Physeter macrocephalus* and one Cuvier's beaked whale *Ziphius cavirostris*); five full post-mortem examinations were carried out in situ of one northern bottlenose whale *Hyperoodon ampullatus*, three True's beaked whales *Mesoplodon mirus*, and one bottlenose dolphin; and six full post-mortem examinations were carried out at the Athlone, Cork and Backweston Regional Vet Labs (RVL) on two Risso's dolphins *Grampus griseus*), one pygmy sperm whale *Kogia breviceps*, one dwarf sperm whale *Kogia sima*, one white-beaked dolphin *Lagenorhynchus albirostris* and one Sowerby's beaked whale *Mesoplodon bidens*. IWDG (2025) stated there has been a well-documented increase in recent years in cetacean stranding records along the Irish coast, which has included rare and deep diving species - particularly individual Sowerby's and Cuvier's beaked whales (both live strandings and dead). Mass strandings of deep diving species, which have been considered Unusual Mortality Events (UME), have also increased, the cause of which remain unknown. It is acknowledged the cause of death (COD) may be difficult to establish even after a full post-mortem examination. Physical trauma (boat/ship strike) was included as a possible COD, which signifies physical trauma consistent with impact from a boat or ship and includes blunt trauma to dorsal/lateral aspect of body wall and/or injuries consistent with propeller strike. In the final report from IWDG (2025), only one adult female bottlenose dolphin (which was not a target species of the DDRIP project) had a COD of "Physical Trauma/Live stranding" but did not detail vessel strike, with the IWDG (2024) suggesting it may be bycatch.

In summary, based on Irish Sea stranding and necropsy data, vessel collision is a rare but present risk for marine mammals and megafauna in Irish waters, accounting for less than 1% of recorded strandings (2 out of 224 strandings) and necropsy-confirmed deaths (1 out of 73 necropsied animals). While the majority of strandings involve harbour porpoise and common dolphin (92% of strandings), only isolated cases of vessel strike have been documented and other causes of death are more commonly recorded. There is also evidence of confirmed ship strike of basking shark. It is important to acknowledge that stranding records may underrepresent actual collision rates due to difficulty in detecting vessel strike injuries (especially if decomposition is advanced). Further, not all animals killed by vessels strand on shore and some collisions may go unreported or unrecognised. Finally, it is highlighted that the information drawn from this data aligns with the literature presented under the assessment of collision risk in volume 2B, chapter 10: Marine Mammals and Megafauna.

Significance of the effect

Whilst updates have been made in response to RFIs, the overall conclusions of the assessment of significance in chapter 9 Addendum: Fish and Shellfish Ecology remain unchanged. As such, there are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.10.4 Changes in the fish and shellfish community affecting marine megafauna prey resources

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.10.5 Electromagnetic Fields (EMF) from subsea electrical cabling may disrupt behaviour of basking shark

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.10.6 Injury and/or disturbance to marine megafauna from operational underwater noise

In response to RFI 9.M, an assessment of potential impacts from operational underwater noise is presented below.

Operational and maintenance phase

Magnitude of impact

Noise from operational wind turbines comes in two forms; the aerodynamic sound from the blades moving through the air leading to the characteristic ‘swish-swish’ sound and the mechanical sound associated with machinery housed in the nacelle of the wind turbine (Marmo *et al.*, 2013) As aerodynamic sound travels through the surrounding air to the interface between the air and water, due to the large impedance contrast it is almost entirely reflected and therefore little aerodynamic sound enters the marine environment.

However sound levels from operating windfarms are likely to be audible to marine mammals and sources of underwater low frequency noise (Tougaard *et al.*, 2020). Operational noise is primarily low frequency (well below 1 kHz) (Thomsen *et al.*, 2006) and for the majority of marine mammal species, the hearing sensitivity below 1 kHz is relatively poor. The low frequency noise may be more likely to overlap with the hearing range of LF cetacean species such as minke whale. Minke whale communication signals have been demonstrated to be below 2 kHz (Edds-Walton, 2000, Gedamke *et al.*, 2001, Mellinger *et al.*, 2000, Risch *et al.*, 2013, Risch *et al.*, 2014) with the most sensitive hearing range (the region with thresholds within 40 dB of best sensitivity) to extend from 30 to 100 Hz up to 7.5 to 25 kHz, depending on the specific model (Tubelli *et al.*, 2012).

Noise modelling (see appendix 10-6: NAS Modelling Report) is based on a wind farm with 25 monopile foundations (see EIAR chapter 5: Project description), each with 15 MW capacity resulting in a cumulative capacity of 375 MW. Underwater sound from the operational wind turbine generators has been estimated based on the methodology presented in Tougaard *et al.* (2020), with modelling conducted using an empirical approach based on turbine power, wind speed and distance from the wind turbine to estimate received sound level (see appendix 10-4: Updated Subsea Noise Modelling Report) as no detailed data from the manufacturer on underwater sound emissions from the specific turbines was available. The most important factor explaining measured SPL levels from operational turbines is distance to the turbines, with smaller effects of wind speed and turbine size (Tougaard *et al.*, 2020). Tougaard *et al.* (2020) highlights noise is well below ambient levels unless it is very close to the individual turbines in locations with high ambient noise from shipping or high wind speeds.

Modelling was performed for the largest (i.e. highest power rating) wind turbine (see EIAR chapter 5: Project description for full details of turbine dimensions) using a 10 m/s wind speed (it should be noted that during periods of higher wind speeds the sound level produced by the wind turbines will increase, although it is likely that the ambient sound levels will also increase due to higher wind speeds and wave conditions during these periods, which may result in additional masking of wind turbine sounds). The Project has a unique high level of certainty with respect to modelling, as the number of turbines are known and turbines dimensions are

confirmed (see EIAR chapter 5: Project description), and this allows for a high level of confidence in the impact assessment.

The calculated injury ranges (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)) for marine mammals are based on 24 hours exposure for a static animal, presented in Table 10A-36. It should be noted that it is highly unlikely that a marine mammal would stay static for 24 hours or even a few hours, and this is therefore a highly precautionary assessment.

Table 10A-36: Potential PTS/TTS ranges for marine mammals due to operational wind turbine sound (static animals 24 hour exposure)

Species/Group	PTS threshold (dB re 1 μPa^{2}s)	PTS range (m)	TTS threshold (dB re 1 μPa^{2}s)	TTS range (m)
Low Frequency	199	5	179	35
High Frequency	198	N/E	178	N/E
Very High Frequency	173	N/E	153	N/E
Phocid carnivore in water	201	N/E	181	10

Auditory injury

This conservative approach suggested that LF cetaceans (minke whale) would need to remain within 5 m of an operational wind turbine for a period of 24 hours for the PTS threshold to be exceeded. The PTS threshold was not exceeded for high frequency (bottlenose dolphin, common dolphin) or very high frequency cetaceans (harbour porpoise) or seal species. Unlike seals, which have been reported as foraging around operational wind turbine structures most likely due to the growth of benthic communities on the introduced hard substrate (Russell *et al.*, 2014) baleen whales (minke whale) are unlikely to remain close to turbine foundations as there would be limited benefit in terms of foraging.

The impact is predicted to be of very local spatial extent (up to 5 m range), long term duration (over the lifetime of the project), intermittent and irreversible. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

TTS

This conservative approach suggested that LF cetaceans (minke whale) would need to remain within 35 m of an operational wind turbine for a period of 24 hours for the TTS threshold to be exceeded, and seal species would need to remain within 10 m of an operational wind turbine for a period of 24 hours for the TTS threshold to be exceeded. The TTS threshold was not exceeded for high frequency cetaceans (bottlenose dolphin, common dolphin) or very high frequency cetaceans (harbour porpoise).

The impact is predicted to be of local spatial extent (up to 35 m range), long term duration (over the lifetime of the project), intermittent and the effect will be of medium to low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Disturbance

Beyond the zone of injury, noise levels are such that they no longer result in physical injury but can result in disturbance to marine mammal behaviour. Noise modelling predicted that potential disturbance to marine mammals could occur within approximately 170 m of each wind turbine, based on the threshold of 120 dB re 1 μPa (rms).

The impact is predicted to be of local spatial extent (up to 170 m extent), with marine mammals able to move out of the area of disturbance if required, long term duration (over the lifetime of the project), intermittent and

the effect will be of medium reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be **negligible**.

Sensitivity of receptor

Thomsen *et al.* (2006) reported at 100 m distance from 1.5 MW turbines, underwater sound would be audible to both harbour porpoise and harbour seal. At 1,000 m, Thomsen *et al.* (2006) suggested the signal to ambient or background sound ratio is too low for detection in harbour porpoise, but detection by harbour seal might be possible. However, Thomsen *et al.* (2006) caveat the ambient sound values used in this study were extrapolated from measurements obtained in the Baltic, and the ambient sound in most parts of the North Sea is much higher and will decrease the radius of detection significantly.

During early measurements of underwater sound due to operational turbines, Madsen *et al.* (2006) concluded that the underwater sound from operating wind turbines is limited to low frequencies (below 1 kHz) and of low intensity and would therefore be unlikely to affect marine mammals with main hearing sensitivities at higher frequencies (i.e. VHF and HF cetaceans and PCW).

Studies using long term frequency data from wind farms with 5 MW turbines (Alpha Ventus, Germany) (Stöber and Thomsen, 2021) found that whilst operational noise can be identified, levels hardly exceed beyond ambient noise levels in areas near main shipping traffic routes and therefore marine mammals in high traffic areas may not be able to discern operational wind turbine sound from background levels. Stöber and Thomsen (2021) analysed individual frequencies and predicted a correlation between sound pressure levels (SPLs) and the operational status of the wind turbines as well as the wind speed, but the total impact of the operational sound was mostly negligible.

Nedwell *et al.* (2007) analysed measurements of underwater sound inside and outside of four different offshore wind farms in British waters. Results showed that the operational sound levels were low and only exceeded background levels close to the wind turbines (<1 km). For harbour seal, results for Kentish Flats (30 three MW turbines) showed the perceived sound levels were just a few decibels higher inside the wind farm than outside, and Nedwell *et al.* (2007) stated that as the perceived level of sound was low, there was predicted to be no effect on individuals. Qualitatively the study provides some indication of the low sensitivity of marine mammals to wind turbine operational sound, however, whilst this study is well-known, the noise level metrics used in the study have not been widely adopted for impact assessment (and therefore the sound level values in the paper have not been presented here to avoid any confusion or comparisons with the metrics now commonly adopted for assessment purposes).

Tougaard *et al.* (2009) studied recordings of underwater sound from three wind farms in Denmark (450 kW, 500 kW and 2 MW turbines) and found that turbine sound was only measurable above ambient sound at frequencies below 500 Hz. Total SPL was in the range 109–127 dB re 1µPa rms, measured at distances between 14 and 20 m from the foundations. This study estimated the maximum distance where harbour seal could perceive the sound for different wind farms to be between 2.5 and 10 km. For porpoises, 63 m maximum distance of perception was found. The study concluded that the sound is unlikely to exceed injury thresholds at any distance from the turbines and the sound is considered incapable of masking acoustic communication by harbour seal and harbour porpoise.

Marmo *et al.* (2013) reported that rotational imbalances tend to occur at very low frequencies (<50 Hz), whilst gear meshing and electromagnetic interactions tend to occur at low to moderate frequencies (8 Hz to 2 kHz). Wind turbines produce vibration and related sound between 0.5 Hz to 2 kHz which overlaps frequency bands that are detectable by species living in UK waters (Marmo *et al.*, 2013), although noting that these frequencies only overlap the peak sensitivities for LF cetaceans. Marmo *et al.* (2013) also modelled vibration produced by a generic 6 MW wind turbine across the 10 Hz to 2 kHz frequency band and predicted that modelled sound levels are likely to be audible to marine mammals particularly at wind speeds of approximately 15 m/s when the generic wind turbines are producing maximum power. Species with hearing specialised to LF, such as minke whale, may in certain circumstances detect the wind farm at least 18 km away and are the species most likely to be affected by sound from operational wind turbines. Harbour seal, grey seal and bottlenose dolphin were not considered to be at risk of displacement by the operational wind farm modelled.

Norro *et al.* (2011) compared measurements of a range of different foundation methods and turbine ratings in the Belgian part of the North Sea, as well as comparing those to other European waters. The authors

found a slight increase in SPL compared to the ambient noise measured before the construction of the wind farms. They concluded that even the highest increases found within the dataset (20 to 25 dB re 1µ Pa) are likely to be within the natural range of variation in baseline noise and therefore, even with the long-term nature of this impact (lifespan of the wind farm), the operational noise would not cause a significant impact.

Stöber and Thomsen (2021) collated 16 scientific publications about underwater sound levels related to the operation of offshore wind turbines and summarised the broadband rms ranged from 129 to 166 dB re 1µPa @ 1m, with general increasing trend with increasing nominal power output (MW). Stöber and Thomsen (2021) predicted an underwater source level of 177 dB re 1µPa @ 1m for a geared turbine with a nominal power of 10 MW (using the regression line for peak spectral levels). Whilst the 10 MW example was predicted to cause behavioural disturbance of up to 6.3 km (based on the 120 dB_{rms} threshold) this was below typical noise levels for main installation vessels.

It is therefore considered likely that large amounts of baseline shipping noise present in the vicinity of the Project would mask much of the operational wind farm sound. It likely to be a function of distance and if animals are very close to monopiles at the Project, then the operational sound may still be detected. Studies to date have focused on smaller wind turbines (1.5 to 5 MW) than those for the Project (15 MW), but underwater noise modelling has been carried out to support the conclusions of the impact of injury and/or disturbance to marine megafauna from operational underwater noise.

Conservatively, it is considered that there is a potential that the ability of cetaceans to find their prey may be hindered to some extent within the Project due to the potential masking of acoustic cues from large operational wind turbines. However, man-made structures in the marine environment are known to act as artificial reefs, providing structure and habitat for many fish species and attracting small pelagic fish, thus increasing food availability for cetaceans and pinnipeds in the presence of offshore wind farms and attracting marine mammal species.

Marine mammal species (harbour porpoise, minke whale, white-beaked dolphin, harbour seal and grey seal) have been frequently recorded around offshore wind farms (Diederichs *et al.*, 2008, Lindeboom *et al.*, 2011, Russell *et al.*, 2014, Scheidat *et al.*, 2011), suggesting operational noise does not prevent animals from utilising the habitat within windfarms. Russell *et al.* (2014) used high resolution Global Positioning System (GPS) data to show how grey seal and harbour seal traced anthropogenic infrastructure (including wind turbines and subsea pipelines) for foraging. Using state-space models, Russell *et al.* (2014) concluded that these animals are using structures to successfully forage. Therefore, whilst operational noise may influence the marine environment, it may not be at a level that would interrupt marine mammal behaviours. Acoustic results from a T-POD measurement within a Dutch wind farm (Egmond an Zee) found that relatively more harbour porpoises were found in the wind farm area compared to the two reference areas (Lindeboom *et al.*, 2011, Scheidat *et al.*, 2011), concluding that the presence within the wind farm area was due to increased food availability as well as the exclusion of fisheries and reduced vessel traffic in the wind farm (shelter effect).

Auditory injury

PTS

All marine mammals are deemed to have limited resilience to PTS, limited ability to adapt behaviour to sustain ecological functioning, limited ability to recover from the effect in the short and long term, and high international value. Due to the permanence of the effect, the sensitivity of the receptor to PTS is therefore, considered to be **high**.

TTS

All marine mammals are deemed to have high resilience to TTS, have the ability to adapt behaviour to sustain ecological functioning, high ability to recover from the effect in the short and long term, and high international value. The sensitivity of the receptor to TTS is therefore, considered to be **low**.

Behavioural disturbance

Operational noise is considered to lead to some disturbance, with modelling based on the threshold of 120 dB re 1 µPa (rms) (for continuous/non impulsive noise). This is equivalent to the Level B harassment threshold (NMFS, 2005) which is defined as ‘having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to,

migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild' (NMFS, 2005). It is worth noting that the Level B threshold of 120 dB re 1 µPa (rms) is very close to the level of background noise that typically exists in the marine environment, and using these levels may overestimate the impact of disturbance on marine mammals that reside within areas of high ambient background noise. For example in total noise maps presented in Farcas *et al.* (2020), annual median (p50) baseline noise levels around the Oriel Project range from ~103 to ~127 dB re 1 µPa whilst more recent maps showed annual median broadband (63 Hz - 4 kHz) sound level data for UK water reached ~125 dB re 1 µPa in the west Irish Sea (Farcas *et al.*, 2025), with 39.8 % of the UK Celtic Seas exceeding 110 dB in 2022, 13.8 % exceeding 120 dB and 1.5% exceeding 130 dB (Farcas *et al.*, 2025).

All marine mammals are deemed to have some resilience to behavioural disturbance with some potential impairment of ecological functioning if remaining within the vicinity of the operational turbines, but high ability to adapt behaviour (avoidance), high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Auditory injury (PTS)

Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. The effect will, therefore, be of **slight adverse significance**, which is not significant in EIA terms.

TTS

Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **low**. The effect will, therefore (conservatively), be of **slight adverse significance**, which is not significant in EIA terms.

Disturbance

Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is conservatively considered to be **medium**. The effect will, therefore (conservatively), be of **slight adverse significance**, which is not significant in EIA terms.

10.10.7 Mitigation and residual effects

In response to **RFI 9.C**, appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (MMMP) has been updated to address ADD deterrence and clarify the relevant mitigation measures to be utilised, including the Applicant's commitment to using specified devices. Piling of wind turbines at the Project was modelled with the inclusion of an ADD, for a period of 15 minutes prior to the commencement of piling, to determine whether deployment of an ADD was of potential benefit to reducing the risk of injury to marine mammals. Conservative swim speeds (see Table 10-18 volume 2B, chapter 10: Marine Mammals and Megafauna) were used to determine the distance an animal would move during ADD activation, representing a precautionary approach to assessment, with results suggesting that the use of an ADD will further reduce the risk of injury occurring in marine mammal receptors. In finalising the details of the MMMP, the most appropriate device, target species to deter, alongside factors such as the number of ADDs required to cover the risk zone will be considered. It will have considered if one ADD is sufficient to target multiple species/hearing groups if desired. These details will be finalised post-consent, as part of the procurement process based upon the final project design envelope, prior to construction and will be detailed in the final MMMP.

In response to RFI 9.F, appendix 5-4 Addendum: Marine Megafauna Mitigation Plan confirms (on page 5) that the MMMP has been prepared in accordance with the NPWS (2014) guidance. The Applicant confirms the MMMP complies with all aspects of NPWS (2014) guidance and has provided further detail here below.

For piling, the MMMP states, 'as per the NPWS (2014) guidance, a 30-minute constant effort pre-piling search will be undertaken'. The Applicant specifies a 1,000 m mitigation zone for piling, in line with the

NPWS (2014) guidance which states 'pile driving activity shall not commence if marine mammals are detected within a 1,000 m radial distance of the pile driving sound source, i.e., within the Monitored Zone'. For the revised underwater noise modelling (see appendix 10-4: Updated Subsea Noise Modelling Report) the maximum range over which PTS was predicted to occur in the was 653 m (SPL_{pk}) and 1,135 m (SEL_{cum}). As such the maximum injury range for SPL_{pk} is predicted to be less than the standard 1,000 m mitigation zone for pile-driving proposed by the NPWS (2014) guidance, in line with the EIAR. The 1,135 m for the SEL_{cum} metric falls outside this mitigation zone range, which differs from that presented in the EIAR. However, with the application of an ADD (in addition to measures included in the Project) the threshold for PTS (SEL_{cum}) would not be exceeded for any species and therefore is less than the standard 1,000 m mitigation zone for pile-driving. As detailed in the MMMP, in addition to visual and acoustic monitoring, an ADD will be deployed at the start of the pre-piling search in close proximity to the pile to be installed. The ADD will be activated for a minimum period of 15 minutes to allow animals sufficient time to disperse, while also minimising the additional noise produced by the device and emitted into the marine environment. Visual and acoustic monitoring will continue throughout the ADD deployment to ensure that marine mammals have left the mitigation zone prior to the start of piling.

As set out in 'Further Measures' under section 10.10.1, the outputs of the NAS modelling (undertaken in response to RFI 9A.iii, and set out in detail in appendix 10-7: NAS Technical Report - Marine Mammals, Megafauna and Fish) clearly demonstrate the potential for measurable reductions in auditory injury, TTS and disturbance impact ranges/areas. Given the range of reductions demonstrated (see Figure 10-A10) it is expected that application of NAS available at the time of construction will produce similar results. Furthermore, given that the impact assessment (set out in volume 2B, chapter 10: Marine mammals and Megafauna) has concluded no significant impact on marine mammals, it is considered that any application of NAS would simply further reduce the magnitude of effect on marine mammals for PTS, TTS and disturbance.

Despite the assessment of injury and/or disturbance to marine megafauna from underwater noise during pile driving concluding no significant impact, the Project is committed to the consideration of noise abatement measures for the purpose of reducing sound levels from construction piling and subsequently a MODIGA with internal air bubble has been included in the further measures (under section 10.10.1).

The Applicant will comply with NPWS (2014) guidance on delaying soft start if an animal is sighted in the mitigation zone. Soft start for piling shall not commence until at least 30 minutes have elapsed with no marine mammals detected within the Monitored Zone by the MMO, and will be followed by the appropriate soft start (and ramp up procedure) which will include continued monitoring by the MMO. As detailed in section 1.6.1 of the MMMP, if marine megafauna are detected within the mitigation zone during the pre-piling search or soft-start, piling will not commence or at least the hammer energy should not be further increased until at least 30 minutes after the last visual or acoustic detection of the animal.

With regards to soft starts for piling, this will involve the implementation of lower hammer energies (i.e. approximately 10-15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels, as detailed in Table 1-4 of appendix 5-4 Addendum: Marine Megafauna Mitigation Plan. This aligns with the NPWS (2014) guidance on pile driving which states 'in commencing a pile driving operation where the output peak sound pressure level (in water) from any source including equipment testing exceeds 170 dB re: 1µPa @1m an appropriate Ramp-up Procedure (i.e., "soft-start") must be used'. As detailed in section 1.6.1 of appendix 5-4 Addendum: Marine Megafauna Mitigation Plan, the ADD will be turned off immediately after the piling activity has commenced and the soft start is the gradual, incremental increase of piling power over a minimum of 20 minutes, in line with NPWS (2014) guidance which states 'over a period of 20 to 40 minutes'. If for any reason there is a break in piling activity for greater than 10 minutes, then the pre-piling search and ADD activation, and a full soft start and ramp up procedure should be repeated before piling recommences. Section 1.6.2 of appendix 5-4 Addendum: Marine Megafauna Mitigation Plan details the piling reporting requirements as per the NPWS (2014) guidance, which includes operations reports, MMO/PAM reports and Annex A.1 demonstrates that the Applicant will use the standard data forms.

For geophysical surveys (e.g. multibeam echo sounders (MBES)) the NPWS (2014) guidance details that 'acoustic surveying using the above equipment shall not commence if marine mammals are detected within a 500 m radial distance of the sound source intended for use, i.e., within the Monitored Zone'. The MMMP confirms with the NPWS (2014) guidance (see sections 1.5.2 and 1.6.3 of the MMMP); mitigation for injury during geophysical site investigation surveys from a conventional vessel will involve the use of MMOs and PAM to ensure that the risk of injury over the defined mitigation zone (of 500 m) is reduced in line with the

NPWS (2014) guidance. The maximum injury range (PTS) from volume 2B, chapter 10: Marine mammals and Megafauna was 227 m for harbour porpoise (and 449 m for TTS, for harbour porpoise), which lies well within the 500 m mitigation zone. As detailed in section 1.6.3 of the MMMP, a constant effort pre-survey search will be undertaken by at least two accredited and experienced MMOs and a PAM Operator to monitor the specified 500 m radial mitigation zone to minimise the likelihood of marine mammals being present within this range. The MMO shall conduct pre-start-up visual monitoring at least 30 minutes before the geophysical survey is due to commence (in accordance with section 4.3.4(ii) of the NPWS (2014) guidance) and shall not commence until at least 30 minutes have elapsed with no marine mammals detected by the MMO within the mitigation zone. In line with section 4.3.4(ii) of the NPWS (2014) guidance, sound-producing activities will only commence in daylight hours where effective visual monitoring, as performed and determined by the MMO, has been achieved. In accordance with the NPWS (2014) guidance, where effective visual monitoring, as determined by the MMO, is not possible (including in circumstances in which poor visibility prevents the 500 m mitigation zone from being visually monitored) the sound-producing activities shall be postponed until effective visual monitoring is possible (see section 1.6.3 of the MMMP).

In line with NPWS (2014) guidance (point 10 in section 4.3.4ii), the MMMP confirms if there is a break in sound output for a period greater than 30 minutes (e.g. due to equipment failure, shut-down, survey line or station change) then all pre-survey monitoring and a subsequent soft-start procedure (where appropriate) will be undertaken. As per point 11 in section 4.3.4ii of the NPWS (2014) guidance, the MMMP states for higher output survey operations which have the potential to produce injurious levels of underwater sound (including the MBES methods expected to be employed in geophysical surveying for the Project), there will be a regulatory requirement to adopt a shorter 5-10 minute break limit after which period all pre-survey monitoring and a subsequent soft-start (where appropriate following pre-survey monitoring) shall recommence as for start-up.

The MMMP states a soft start will also be implemented where this is within technical capabilities of the survey equipment, in line with section 4.3.4 (i). Seismic surveys in the NPWS (2014) guidance. This can include ramp up from a lower energy start up, or the device shall be switched “on” and “off” in a consistent sequential manner over a period of 20 minutes prior to commencement of the full necessary output. The Applicant confirms in all cases where a soft-start is employed the delay between the end of the soft-start and the necessary full output must be minimised to prevent unnecessary high-level sound introduction into the environment, in line with paragraph 9, under 4.3.4 (i). Seismic surveys in the NPWS (2014) guidance.

Section 1.6.4 of the MMMP details the geophysical acoustic surveying reporting requirements as per the NPWS (2014) guidance, which includes operations reports, MMO/PAM reports and Annex A.2 demonstrates the Applicant will use the standard data forms.

In addition, the Applicant confirms the use of distance estimation formula will follow the same approach suggested for distance estimation by the Joint Nature Conservation Committee (JNCC) (JNCC, 2017b) (as discussed in Marine Mammal Observer Association (MMOA) (2024)) and will use standard trigonometric equations for calculation. The MMMP has been updated for clarity (see section 1.6.1 in appendix 5-4 Addendum: Marine Megafauna Mitigation Plan (EIAR volume 2A Addendum).

In response to RFI 9.D, the Project is committed to the consideration of noise abatement measures for the purpose of reducing sound levels from construction piling. As set out in ‘Further Measures’ under section 10.10.11, the outputs of the NAS modelling (undertaken in response to RFI 9.A.iii, and set out in detail in appendix 10-7: NAS Technical Report - Marine Mammals, Megafauna and Fish) clearly demonstrate the potential for measurable reductions in auditory injury, TTS and disturbance impact ranges/areas at the Project. For the existing commercially available systems that were modelled for the Project, the results demonstrated a reduction in SEL and peak SPL effect ranges for marine mammal and fish receptors (Appendix 10-6: NAS Modelling Report). NAS modelled included: big bubble curtains (BBC), Double big bubble curtains (DBBC) and the in-line hammer PULSE technology (see Figure 10-A10). Therefore, taking the theoretical considerations into account and the manufacturer’s technical statement, the Project is confident that the MODIGA with internal air bubble ring will also provide suitable additional mitigation for piling. Furthermore, given that the impact assessment (set out in volume 2B, chapter 10: Marine Mammals and Megafauna) has already concluded no significant impact on marine mammals, it is considered that any application of NAS (including the MODIGA with internal air bubble ring) would simply further reduce the magnitude of effect on marine mammals for PTS, TTS and disturbance. As such, the Applicant concludes that the consideration of temporal mitigation is unnecessary and would be disproportional to the risk as piling is limited to 26 days total.

10.10.8 Future monitoring

The project is committed to undertaking subsea noise monitoring during monopile installation to confirm the noise abatement achieved by the proposed MODIGA with internal air bubble ring (see appendix 5-16: Monitoring Programme (EIAR volume 2A Addendum).

10.11 Cumulative Impact Assessment

An updated Cumulative Impact Assessment is provided in appendix 3-2: Cumulative Impact Assessment Report (EIAR volume 2A Addendum). **The assessment concludes that there is no change to the conclusions reached in the cumulative assessment provided in chapter 10: Marine Mammals and Megafauna (EIAR volume 2B).**

In response to RFI 9.T further discussion has been added on masking and behaviour impacts in the cumulative noise impact assessment on marine mammals.

As described in section 10.10.1 of chapter 10: Marine Mammals and Megafauna, marine mammals, particularly cetaceans, can generate and detect sound, and are dependent on sound for many aspects of their lives (i.e. prey-identification; predator avoidance; communication and navigation). Increases in anthropogenic noise may consequently lead to a potential effect within the marine environment. Four zones of influence have been described by Richardson *et al*. (1995) 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). This assessment considers the zones of injury (auditory) and disturbance (i.e. responsiveness). There is insufficient scientific evidence to properly evaluate masking and no relevant threshold criteria to enable a quantitative assessment, and therefore it is not appropriate to map masking impacts.

Studies are available that evaluate masking, such as Branstetter and Sills (2022), Erbe *et al.* (2019); (Erbe *et al.*, 2016), but all conclude more research is required. Studies generally focus on three categories (Branstetter and Sills, 2022):

1. behavioural response studies evaluating whether animals change their behaviour to mitigate auditory masking (Holt *et al.*, 2009) (such the Lombard effect (Holt *et al.*, 2009, Scheifele *et al.*, 2005); relocating (Frankel and Clark, 2000, Southall, 2005); or changing vocalisations to improve detectability (Marley *et al.*, 2017, Serrano and Terhune, 2001);

2. in-situ noise measurements to inform modelling efforts; and

3. direct study of hearing in noise.

Branstetter and Sills (2022) concluded more research is needed to better understand the mechanisms of auditory masking in marine mammals, and to improve the accuracy of masking predictions in the marine environment. Erbe *et al.* (2019) provided a detailed review on studies of masking in mysticetes (baleen whales) and pinnipeds, but the authors conclude that understanding on the potential effects of watercraft noise is still lacking and a number of knowledge gaps remain. Similarly, Erbe *et al.* (2016) reviewed the understanding and potential framework of assessment of masking in marine mammals, but the authors highlight predicting masking is complex and difficult given the variety of factors that must be accounted for, and more research is needed (particularly before masking can be incorporated into regulation strategies or approaches for mitigation).

Masking (such as hindering prey capture) has been considered in the assessment provided in volume 2B, chapter 10: Marine Mammals and Megafauna, where relevant (i.e. within sections assessing the sensitivity of marine mammal receptors to behavioural disturbance) but it is not possible to assess masking alone quantitatively and robustly in the absence of agreed thresholds for any phases of the project (including the operational and maintenance phase). Behavioural impacts (disturbance) to marine megafauna from underwater noise during piling, routine geophysical surveys, vessels and other construction activities are all assessed in detail within section 10.10 of chapter 10: Marine Mammals and Megafauna, based on robust modelling, and all concluded non-significant effects. Therefore, given masking is a more subtle interference of acoustic perception, whereas behavioural disturbance represents a more pronounced and potentially

harmful disruption to marine mammal behaviour and ecology, it is considered that no significant effect would be concluded from an assessment of masking and therefore there would be no change to the validity or conclusions of the cumulative assessment presented in volume 2B, chapter 10: Marine Mammals and Megafauna.

In response to RFI 9.T, a justification is provided below for not modelling cumulative impacts based on concurrent construction with and without noise abatement with at least one other windfarm in the Irish Sea.

It is not possible to undertake underwater noise modelling for piling of the Project alongside another offshore wind projects with and without noise abatement, as this would require access to commercially confidential project parameters and decisions on noise abatement, which are not available in the public domain. It is considered that cumulative iPCoD modelling with the updated noise modelling, and modelling and comparison of piling with and without NAS (appendix 10-6: NAS Modelling Report and appendix 10-7: NAS Technical Report - Marine Mammals, Megafauna and Fish) already satisfies the request for iPCoD modelling [for the Project alongside another offshore wind project (with and without noise abatement)]. Further work would not result in a change to the significance of effect, for reasons outlined below.

Firstly, a robust but precautionary CIA for the impact of piling was undertaken for the Project (as presented in volume 2B, chapter 10: Marine Mammals and Megafauna) and non-significant effects were concluded. For the CIA each relevant project is considered in detail with regard to the maximum design scenario (MDS) in terms of foundation types, hammer energy, temporal coverage (e.g. years of construction, piling schedules), distance from the Project, and where quantitative information is available the maximum impact ranges. Where no quantitative information is presented, the Applicant precautionarily assumed injury and disturbance ranges would be in the same order of magnitude as those presented for projects with quantitative information. The Applicant assumed, as a precautionary approach, that construction phases for the other Phase 1 offshore wind farm projects (which did not present quantitative information at the time of submission) could overlap temporally with the construction phase of the Project, with potential for piling operations to coincide. The CIA carried out is highly precautionary as it:

- Includes all relevant projects within a large ZoI that encompasses marine mammals wide-ranging nature, some of which may not ever gain consent;
- Uses the MDS for each project, which combines worse-case scenarios across projects leading to highly conservative assessment;
- Assumes similar injury disturbance ranges when quantitative data is missing, when impacts may be substantially less;
- Assumes direct temporal overlap of construction phases. Projects may not provide the granularity of the piling window and may use the offshore construction window which may be different to reality. In reality this is highly unlikely to occur, given the limited resource for piling vessels etc;
- Did not include potential Noise Abatement Systems (NAS) (see below for further details) - subsequent modelling of piling with NAS technology (appendix 10-6: NAS Modelling Report) showed a reduction in injury and disturbance ranges and therefore any inclusion of NAS would only reduce the magnitude of potential effects, with no potential for a significant cumulative effect.

A review of the Project CIA has also been undertaken as part of the response to further information (see appendix 3-2: Cumulative Impact Assessment Report (EIAR volume 2A Addendum), which included quantitative information as presented in the respective EIAR's of the east coast Phase 1 projects (and other projects in the marine mammal study area). The review concluded that whilst there would be small changes to the information presented in the Project's CIA, the significance of effect would remain as 'slight adverse' significance for injury and/or disturbance to marine megafauna from underwater noise during pile-driving.

Additionally, cumulative iPCoD population modelling for the Phase 1 projects in the Irish Sea was undertaken (Sinclair, 2024) (and is presented in Annex A of appendix 10-10: Cumulative iPCoD Modelling Report) and no significant impacts to any marine mammal species from piling at the five offshore wind farm projects was predicted. Whilst this was not presented in the EIAR for the Project, the Applicant provided project-specific parameters for this to be undertaken robustly. Furthermore, updated cumulative iPCoD

modelling has been carried out with new noise modelling (presented in appendix 10-10: Cumulative IPCoD Modelling Report) and concluded no significant impacts to any marine mammal species from piling at the five offshore wind farm projects was predicted.

Finally, the Phase 1 projects have also committed to implementing phased piling as part of a Piling Strategy should construction programmes overlap.

10.11.1 Methodology

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.11.2 Assessment of significance

Injury and/or disturbance to marine megafauna from underwater noise during piling-driving / drilling

Construction phase

In response to RFI 9.U, the Applicant has presented the cumulative percentage of disturbed individuals for each species within the respective Management Unit, under the magnitude of impact section.

In response to RFI 9.X, updated cumulative iPCoD is presented with updated project information for each cumulative project and updated noise modelling for the Project.

In addition, in response to RFI 9.V, a justification has been provided below for the assessment of low magnitude for Injury and/or disturbance to marine megafauna from underwater noise during piling-driving / drilling, under the magnitude of impact section.

Magnitude of impact

The cumulative percentage of disturbed animals for each species within the respective MU for cetacean species, whose MUs are comparable across projects (i.e. all projects used the same reference population) and align with those applied to the Project, has been presented in Table 10A-38. For harbour porpoise the MU is the Celtic and Irish Sea MU (62,517 animals), for bottlenose dolphin the MU is the Irish Sea MU (293 animals) and for short-beaked common dolphin and minke whale the MU is the Celtic and Greater North Sea MU (102,656 and 20,118 respectively).

However for pinniped species, the reference populations differ substantially by project (see Table 10A-37), and therefore it is not appropriate to compare the cumulative percentage of disturbed animals from all projects to the Project reference population (which is markedly lower than Morgan Offshore Wind Project Generation Assets, Mona Offshore Wind Project, Awel y Môr Offshore Wind Farm and Morecambe Offshore Windfarm Generation Assets).

Table 10-46 in chapter 10: Marine Mammals and Megafauna has also been updated (see Table 10A-38) to show the maximum number of animals with the potential to be disturbed (applying a dose-response disturbance approach) as a result of piling at the Project and cumulative projects located in the eastern Irish Sea, with updated project information for each cumulative project and updated noise modelling for the Project. Numbers of animals disturbed at the Morgan Offshore Wind Project Generation Assets, Mona Offshore Wind Project and Morecambe Offshore Windfarm Generation Assets were originally derived from the Preliminary Environmental Information Reports (PEIRs) for each project but have been updated with the latest numbers from the Environmental Statements for these projects.

As such, updated cumulative modelling was carried out for the CIA, presented in appendix 10-10: Cumulative iPCoD Modelling Report. Sinclair (2024) carried out cumulative population modelling for the five Irish Sea Phase 1 ORE projects prior to publication of their respective EIAR's (see Annex A in appendix 10-10: Cumulative iPCoD Modelling Report) as these are the projects closest to the Project and therefore with most potential for cumulative interactions. However, the CIA identified other projects within the Irish Sea (in English and Welsh waters to the east of the Irish Sea) which were also considered as these fell within the Marine Mammal Cumulative Study Area (given the wide-ranging nature of marine mammals). Appendix 10-

10: Cumulative iPCoD modelling therefore presents the cumulative population modelling for all projects screened in to the CIA: the Project, North Irish Sea Array (hereafter referred to as NISA) (NISA Windfarm Ltd., 2024), Dublin Array (Bray Offshore Wind Limited. and Kish Offshore Wind Limited., 2025), Codling Wind Park (Codling Wind Park Limited, 2024), Arklow Bank Wind Park (SSE Renewables, 2024), Morgan Offshore Wind Project: Generation Assets (hereafter referred to as Morgan Generation Assets) (Morgan Offshore Wind Ltd., 2025), Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2023), Awel y Môr Offshore Wind Farm (RWE Renewables UK, 2022), Morecambe Offshore Windfarm: Generation Assets (hereafter referred to as Morecambe Generation Assets) (Morecambe Offshore Wind Ltd, 2025) and Mooir Vannin Generation Project (Ørsted, 2025).

Sinclair (2025) highlights the quantitative assessment in a CIA involves summing the predicted number of animals impacted by each project per year—often assuming all projects operate simultaneously without overlapping disturbance ranges—which can lead to unrealistic estimates, summarised below:

- Limits on vessel availability - due to limited information on construction schedules, CIAs often unrealistically assume many OWFs are constructing simultaneously (such as nine Irish Sea projects piling in one year), despite a shortage of available installation vessels in Europe and the reality of vessel availability for piling.

- Based on MDSs: CIA assessments present worst-case scenarios based on each project's MDSs to cover all possible build options, but these often differ greatly from what is actually constructed, leading to overly conservative and unrealistic impact predictions in CIAs. Using worst-case values in CIAs results in significant overestimation of impacts until project design and mitigation measures are refined, often post consent.

- Population modelling – requires high level of assumptions based on MDSs, assumptions in piling schedules, maximum numbers of animals disturbed, and iPCoD does not include spatial aspects of CIA projects, such as how close in proximity they are.

Table 10A-37: Grey seal and harbour seal reference populations used for each individual cumulative project.

Project	Grey seal reference population	Harbour seal reference population
Oriel Wind Farm Project	Oriel specific Grey Seal Reference Population (GSRP) (Northern Ireland n=2,008; East Ireland, n=1,662; South East Ireland, n=2,211) is 5,882 animals	Oriel specific Harbour Seal Reference Population (HSRP): Northern Ireland East Ireland, South East Ireland = 1,635 animals
Morgan Offshore Wind Project: Generation Assets (Morgan Offshore Wind Ltd., 2023)	OSPAR Region III = 60,780 Morgan specific GSRP: Wales, Northwest England, Northern Ireland, Southwest Scotland seal management unit (SMU) plus Isle of Man reference population plus East Ireland and South East Ireland regions = 13,563	Morgan specific HSRP: Wales, NW England, N. Ireland SMUs = 1,427
Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2023)	OSPAR Region III = 60,780 Mona specific GSRP: Wales, Northwest England, Northern Ireland, Southwest Scotland Management Unit plus Isle of Man reference population plus East Ireland and South East Ireland regions = 13,563	Mona specific HSRP: Wales, NW England, N. Ireland SMUs = 1,427
Awel y Môr Offshore Wind Farm (RWE Renewables UK, 2022)	OSPAR Region III MU = 66,100 / Wales and NW England SMU = 5,000	Species not assessed
Morecambe Offshore Windfarm Generation Assets (Morecambe Offshore Wind Ltd, 2025)	Combined Northwest England and Isle of Man (IoM) count = 1,044 animals. Morecambe specific GSRP = Northwest England MU, Wales MU, Northern Ireland MU, IoM resident population, plus East	NW England MU and Northern Ireland MU = 1,413

Project	Grey seal reference population	Harbour seal reference population
	Ireland and South East Ireland regions = 10,504 animals	
Arklow OWF (SSE Renewables, 2024)	East region of RoI = 1,662 animals.	East region of RoI = 182 animals.
Codling OWF (Codling Wind Park Limited, 2024)	East RoI and Northern Ireland MU = 6,056 animals.	East RoI and Northern Ireland MU =1,365 animals.
NISA OWF (NISA Windfarm Ltd., 2024)	East RoI, South-east RoI, Northern Ireland MU = 6,056 animals.	East RoI and Northern Ireland MU = 1,635 animals.
Dublin Array OWF (Bray Offshore Wind Limited. and Kish Offshore Wind Limited., 2025)	East RoI, South-east RoI, Northern Ireland MU = 6,056 animals.	East RoI, South-east RoI, Northern Ireland MU = 1,365 animals.
Mooir Vannin (Ørsted, 2025)	Northern Ireland, North-west England, South-west Scotland and Wales SMUs, and East Irish region = 11,230 animals.	Northern Ireland, North-west England, South-west Scotland and Wales SMUs = 3,529 animals.

Table 10A-38: Supersedes Table 10-46 Updated table for maximum number of animals with the potential to be disturbed (applying a dose-response disturbance approach where possible for consistency) as a result of piling at Oriel Wind Farm Project and cumulative projects located in the Irish Sea (projects for which quantitative information is available).

Project	Reference	Distance from Oriel Wind Farm Project (km)	Animals with the potential to be disturbed											
			Harbour porpoise		Bottlenose dolphin		Common dolphin		Minke whale		Grey seal		Harbour seal	
			Number animals	Proportion of MU (%)	Number animals	Proportion of MU	Number animals	Proportion of MU	Number animals	Proportion of MU	Number animals	Proportion of Reference Population	Number animals	Proportion of Reference Population
Oriel Wind Farm Project	Section 6.1.2	-	2,360	3.77%	82* 417^	27.85%* 5.01%^	48	0.05%	462	2.29%	83	1.40%	71	4.34%
Morgan Offshore Windfarm Generation Assets	Morgan Offshore Wind Ltd. (2023)	119.49	1,007	1.61%	5	1.71%	3	0.00%	67	0.33%	61	0.47%	1	0.01%
Mona Offshore Wind Farm	Mona Offshore Wind Ltd (2023)	127.04	1,142	1.82%	7	2.39%	3	0.00%	72	0.36%	31	0.24%	1	0.01%
Awel y Môr Offshore Wind Farm	RWE Renewables UK, (2022)	142.37	275	0.44%	23	7.85%	17	0.02%	36	0.18%	81	1.38%	Species not assessed	
Morecambe Offshore Windfarm Generation Assets	Morecambe Offshore Wind Ltd (2025)	151.25	1,857.90	2.97%	56.3	19.22%	127.6	0.12%	24.9~	0.12%	0.151	0.009%	0.001	0.0084%
Arklow OWF	SSE Renewables (2024)	107.1	3,380	5.41%	2092	713.96%	429	0.42%	400	1.99%	299	18.00%	1	0.53%
Codling OWF	Codling Wind Park Limited (2024)	61.4	2,667	4.27%	2,060^	24.74%	2,393	2.33%	134	0.67%	394	6.51%	6	0.44%

Project	Reference	Distance from Oriel Wind Farm Project (km)	Animals with the potential to be disturbed											
			Harbour porpoise		Bottlenose dolphin		Common dolphin		Minke whale		Grey seal		Harbour seal	
			Number animals	Proportion of MU (%)	Number animals	Proportion of MU	Number animals	Proportion of MU	Number animals	Proportion of MU	Number animals	Proportion of Reference Population	Number animals	Proportion of Reference Population
NISA OWF	NISA Windfarm Ltd. (2024)	16.2	3,896	6.23%	2,346^	28.18%	410	0.40%	222	1.10%	790	13.04%	200	14.65%
Dublin Array OWF	Bray Offshore Wind Limited. and Kish Offshore Wind Limited. (2025)	61.2	995	1.59%	699	8.40%	81	0.08%	57	0.28%	177	2.92%	13	0.95%
Mooir Vannin Generation Project	Ørsted (2025)	125	2,381	3.76	8	2.69	1	0.01	12	0.006	938	8.35	1	0.03
Cumulative total numbers of animals / proportion of the MU with the potential to be disturbed from all CIA projects:			21,517	31.86%	7378.3 7713.3	836.99% 814.15%	3,513	3.44%	1,487	7.33%	2,873	52.22%	458	20.97%

* Using SCANS-III density

^ Using SCANS-IV density.

~ No dose response available, therefore used maximum estimate.

As shown above in Table 10A-38, those species where >5% of the reference population are predicted to be impacted (when cumulative projects are summed) include harbour porpoise (31.86% of the CIS MU), bottlenose dolphin (836.99% of the IS MU (IAMMWG, 2022); 811% of the abundance estimate derived from SCANS-IV surveys from Block CS-D and Block CS-E (Gilles *et al.*, 2023)), minke whale (7.32% of the MU), grey seal (52.22% of the MU) and harbour seal (20.96% of the MU). Given the percentages of the reference populations impacted, updated population modelling was carried out for the CIA.

Cumulative Impact Population Consequences of Disturbance (iPCoD) modelling was conducted for the Phase 1 projects (Sinclair, 2024) to assess whether the combined disturbance from pile driving activities across the five Irish east coast Phase 1 Offshore Windfarm Projects would lead to population-level impacts on four marine mammal species: harbour porpoise, bottlenose dolphin, harbour seal, and grey seal. The results of the Sinclair (2024) cumulative population modelling indicated no significant impacts to any of these marine mammal species from disturbance from piling. Modelled populations are projected to maintain a stable trajectory over the long term, and it is important to note that the iPCoD model currently does not incorporate density-dependent population responses, meaning it cannot simulate population increases following disturbance.

Updated cumulative modelling (with revised Project alone modelling and additional Tier 1 projects) was carried out for the CIA (and in response to RFI 9X) and is presented in appendix 10-10: Cumulative iPCoD Modelling Report. The results from this modelling study sit alongside the previous cumulative iPCoD modelling which was undertaken for the Irish Phase 1 projects only (Sinclair *et al.* 2024) although will be more conservative as it considers additional projects within the eastern part of the Irish Sea region.

As detailed in appendix 10-10: Cumulative iPCoD Modelling Report:

- For harbour porpoise, cumulative piling is predicted to result in only a very small decline in population size over 25 years, and the impacted population was predicted to continue at a stable trajectory. Therefore, the effect is very small relative to the CIS MU reference population and is unlikely to produce any population-level change.
- For bottlenose dolphin, cumulative piling could cause an initial small decline in population size in response to piling and then continues on a stable long-term trajectory at approximately 96% of the mean un-impacted population. As the iPCoD model lacks density-dependence, the model does not allow for recovery above this reduced level. The Project alone represents only 26 days of piling, and population modelling for the Project alone found no population-level impacts.
- For minke whale, cumulative piling was predicted to produce negligible change in population size over 26 years. Even though there were some declines in the population during cumulative piling, this was relatively small in relation to the Celtic and Greater North Seas MU reference population and therefore not sufficient to result in any changes at the population level.
- For grey seal, median counterfactual of population size for the cumulative scenario remained at 1 throughout the 26-year simulation and the mean counterfactuals remained close to 1 throughout the cumulative piling period, suggesting that even though there were some very small declines in the population during cumulative piling, this was relatively small in relation to the combined SMUs reference population.
- For harbour seal, median and median counterfactuals of population size for the cumulative scenario remained at 1 throughout the 26-year simulation suggesting no long-term disturbance of the harbour seal population in relation to the combined SMUs reference population.

It is considered that the cumulative population modelling in appendix 10-10: Cumulative iPCoD Modelling Report has shown no significant impacts to any marine mammal species resulting from disturbance from cumulative pile driving at projects within the Irish Sea region, and the relative contribution of the Project (which is only 26 days of piling) to cumulative disturbance is minimal. Results from the revised iPCoD modelling for the Project alone (section 10.10.1) found that there may be a small, or negligible reduction in population size for the impacted populations for all species, however any changes that did occur would not be enough to significantly affect population trajectories and therefore the contribution of the Project to any cumulative changes in population (which were not considered to result in long-term population consequences) would be minimal.

Therefore, the Applicant considers the predicted impacts to be of “low” magnitude and not of a scale that would result in any measurable population-level effects. Particularly with the implementation of the Marine Mammal Mitigation Protocol (MMMP) (appendix 5-4 Addendum: Marine Megafauna Mitigation Plan) and a

Piling Strategy (as a measure included in the project as presented in chapter 10: Marine Mammals and Megafauna) which commits to further reduction of impacts from piling, the Applicant considers “low magnitude” to be appropriate.

In summary, whilst individual animals may experience some individual changes in behaviour and distribution, these effects are relatively minor within the relevant geographic context, affecting only a small proportion of the MUs and there are no significant impacts to marine mammals from disturbance at a population level (as illustrated in the iPCoD modelling in appendix 10-10: Cumulative iPCoD Modelling Report). Piling is intermittent across cumulative projects, and the duration and frequency of the impact are such that there would be minimal disruption to reproductive cycles. In addition, the Applicant has committed to a Piling Strategy which includes phased piling alongside other adjacent offshore wind farms in the western Irish Sea should construction programmes overlap and will set out measures for collaboration with other projects to reduce the potential for an in-combination effect. Although some individual-level effects may occur these are not expected to occur at a scale sufficient to produce measurable population-level consequences. This assessment is reinforced by the cumulative iPCoD modelling for all Phase 1 projects in proximity to the Project, which supports the conclusion of negligible population-level impacts. Therefore the Applicant considers the conclusion of ‘low’ magnitude for the cumulative assessment of injury and/or disturbance to marine megafauna from underwater noise during piling-driving / drilling is appropriate and robust.

Sensitivity of receptor

No changes to EIAR chapter 10: Marine Mammals and Megafauna.

Significance of effect

No changes to the conclusions of significance effect for cumulative piling in EIAR chapter 10: Marine Mammals and Megafauna.

Injury and/or disturbance to marine megafauna from elevated underwater noise during geophysical surveys

No changes to EIAR chapter 10: Marine Mammals and Megafauna.

Injury and/or disturbance to marine megafauna from vessel activities

No changes to EIAR chapter 10: Marine Mammals and Megafauna.

Cumulative impact assessment of injury and/or disturbance to marine megafauna from operational underwater noise

In response to RFI 9.Y, an assessment of potential impacts from operational underwater noise in terms of the cumulative assessment has been included.

Operational and maintenance phase

Magnitude of impact

The specific projects screened into the CIA for injury and/or disturbance to marine megafauna from operational underwater noise are outlined in Table 10.43 of volume 2, chapter 10: Marine Mammals and Megafauna. For projects which have since made an application have published their Environmental Statement / EIAR since the submission of the Project’s planning application, the latest publicly available information has been used.

Projects include:

- North Irish Sea Array (NISA) (NISA Windfarm Ltd., 2024);
- Dublin Array (Bray Offshore Wind Limited. and Kish Offshore Wind Limited., 2025);
- Codling Wind Park (Codling Wind Park Limited, 2024);

- Arklow Bank Wind Farm (Phase 2) (SSE Renewables, 2024);
- Morgan Offshore Wind Project: Generation Assets (Morgan Offshore Wind Ltd., 2025);
- Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2024);
- Awel y Môr Offshore Wind Farm (RWE Renewables UK, 2022);
- Morecambe Offshore Windfarm: Generation Assets (Morecambe Offshore Windfarm Ltd, 2024); and
- Mooir Vannin Generation Project (Ørsted, 2025).

NISA (NISA Windfarm Ltd., 2024) scoped out operational noise in their EIAR, stating the underwater noise produced during operational activity (such as offshore maintenance, repair and replacement works, reburial or replacement of array cable) will be largely dominated by the associated vessel noise, which has been assessed separately. If an individual project has scoped out the impact, they consider it to not constitute a pathway for a significant effect, and in line with the screening criteria in volume 2A, appendix 3-1: CIA Screening Annex, the data provided by the project does not provide enough evidence for a robust assessment of cumulative effects to be completed. However, NISA is located 16 km from the Project, and therefore it is considered highly unlikely that auditory injury (PTS), temporary threshold shift (TTS)-onset and disturbance ranges from operational noise from monopiles at NISA would overlap spatially with the Project (e.g. the Oriel Project's impact ranges were a maximum of 5 m for PTS, 35 for TTS and 170 m for disturbance) and therefore no cumulative effect is predicted.

Similarly, Dublin Array scoped out operational noise in their EIAR (Bray Offshore Wind Limited. and Kish Offshore Wind Limited., 2025) and lies further (64.9 km) from the Project. Any potential spatial overlap is highly unlikely and therefore no cumulative effect is predicted.

Codling Wind Park assessed auditory injury (PTS) and TTS-onset for operational noise in their EIAR (Codling Wind Park Limited, 2024). The report concluded that both PTS and TTS impact ranges (using the non-impulsive noise criteria from Southall *et al.* (2019) are less than 100 m and therefore of 'negligible' magnitude. Given Codling Wind Park lies 82.5 km from the Project and the impacts related to operational noise from turbines are expected to be highly localised to within the close vicinity of the respective projects, it is considered highly unlikely that auditory injury (PTS), TTS-onset and disturbance ranges would overlap spatially and therefore no cumulative effect is predicted.

Arklow Bank Wind Farm (Phase 2) scoped out injury and/or disturbance to marine mammals from operational underwater noise in their EIAR (SSE Renewables, 2024) and lies 111.2 km from the Project. Any potential spatial overlap is highly unlikely and therefore no cumulative effect is predicted.

Morgan Offshore Wind Project: Generation Assets (Morgan Offshore Wind Ltd., 2025) assessed underwater noise from wind turbine operation and presented potential injury ranges for marine mammals calculated based on 24 hours exposure for a static animal. A maximum PTS range of 5 m was reported for minke whale, with the PTS threshold not exceeded for HF or VHF cetaceans, or seal species, and therefore concluded 'negligible' magnitude for PTS. TTS was not assessed in Morgan Offshore Wind Ltd. (2025). Potential behavioural disturbance to all species of marine mammal could occur within approximately 160 m of each wind turbine at the Morgan Offshore Wind Project: Generation Assets and the EIAR concluded 'low' magnitude. Given Morgan Offshore Wind Project: Generation Assets lies 119.49 km from the Project and the impacts related to operational noise from turbines are expected to be highly localised to within the close vicinity of the respective projects, it is considered highly unlikely that auditory injury (PTS), TTS-onset or disturbance ranges would overlap spatially and therefore no cumulative effect is predicted. Morgan Offshore Wind Project: Generation Assets excluded operational noise from their marine mammal CEA assessment.

Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2024) assessed underwater noise from wind turbine operation and presented potential injury ranges for marine mammals calculated based on 24 hours exposure for a static animal. A maximum PTS range of 5 m was reported for minke whale, with the PTS threshold not exceeded for HF or VF cetaceans, or seal species, and therefore the EIAR concluded 'negligible' magnitude for PTS. TTS was not assessed in Mona Offshore Wind Ltd (2024). Behavioural disturbance to all species of marine mammal could occur within approximately 160 m of each wind turbine at the Mona Offshore Wind Project and the EIAR concluded 'low' magnitude. Given Mona Offshore Wind Project lies 127.04 km from the

Project, it is considered highly unlikely that auditory injury (PTS), TTS-onset or disturbance ranges would overlap spatially and therefore no cumulative effect is predicted. Mona Offshore Wind Project excluded operational noise from their marine mammal CEA assessment.

Awel y Môr Offshore Wind Farm RWE Renewables UK (2022) assessed barrier effects qualitatively from operational noise, citing other reviews which concluded operational wind farm noise will have negligible effects (Brasseur *et al.*, 2012, Madsen *et al.*, 2006, Teilmann *et al.*, 2006) and the EIAR concluded 'negligible' magnitude. Given Awel y Môr Offshore Wind Farm lies 142.37 km from the Project, it is considered highly unlikely that auditory injury (PTS), TTS-onset or disturbance ranges would overlap spatially and therefore no cumulative effect is predicted. Awel y Môr Offshore Wind Farm excluded operational noise from their marine mammal CEA assessment due to highly localised impact and negligible significance.

Morecambe Offshore Windfarm: Generation Assets assessed TTS and disturbance from underwater noise of operational wind turbines (Morecambe Offshore Windfarm Ltd, 2024), and included PTS in site-specific underwater noise modelling. Modelling assuming an average 6 m/s wind speed and for SEL_{cum} calculations, it was assumed that the operational wind turbine noise is present 24 hours a day. Morecambe Offshore Windfarm: Generation Assets results indicated that any marine mammal would have to be less than 100 m (ranges smaller than 100 m for SEL_{cum} were not presented and, therefore, may overestimate the maximum impact range) from the turbine to be exposed to noise levels that could induce PTS or TTS (based on the Southall et al. (2019) non-impulsive thresholds). Disturbance was based quantitatively on a review of scientific literature on marine mammals and operational windfarms, the noise levels associated operational WTGs, and the duration of the operational life of the Project. Morecambe Offshore Windfarm: Generation Assets concluded PTS is unlikely to occur in marine mammals (as an animal would have to remain within less than 100 m for any potential risk of PTS) and therefore concluded that PTS is highly unlikely and was not assessed further. The magnitude for TTS and disturbance was assessed as 'negligible' and 'low' respectively. Given Morecambe Offshore Windfarm: Generation Assets lies 151.25 km from the Project, it is considered highly unlikely that auditory injury (PTS), TTS-onset and disturbance ranges would overlap spatially and therefore no cumulative effect is predicted. Morecambe Offshore Windfarm: Generation Assets assessed underwater noise in their CEA but concluded 'minor adverse significance' for all marine mammal species based upon the geographical spread of the projects in the wider Irish Sea region and the small impact ranges arising from operational turbines.

Mooir Vannin Generation Project (Ørsted, 2025) assessed disturbance due to operational WTG noise only, using a qualitative approach based on current publicly available literature, with no noise modelling carried out. The magnitude of disturbance from operational WTG noise for harbour porpoise, common dolphin, bottlenose dolphin, minke whale, harbour seal and grey seal was assessed as 'negligible'. Mooir Vannin Generation Project did not assess operational WTG noise in their CEA. Given Mooir Vannin Generation Project lies 125 km from the Project, it is considered highly unlikely that disturbance ranges would overlap spatially and therefore no cumulative effect is predicted.

Considering the very small impact ranges modelled at both the Project and cumulative projects, and the distance between projects (>16 km from the Oriel Project), it is considered highly unlikely there would be a cumulative effect of injury and/or disturbance to marine megafauna from operational underwater noise. Marine mammals are unlikely to remain in close proximity to turbines for such a period of time which may cause PTS, and are able to adapt their behaviour to mitigate any behavioural disturbance.

Auditory injury

PTS

For PTS, the impact is predicted to be of very local spatial extent to each individual project, long term duration (over the lifetime of the projects), intermittent and the effect is irreversible. It is predicted that the impact will affect the receptor directly. The cumulative magnitude is therefore considered to be **negligible**.

TTS

For TTS, the impact is predicted to be of local spatial extent to each individual project, long term duration (over the lifetime of the projects), intermittent and the effect will be of medium to low reversibility. It is predicted that the impact will affect the receptor directly. The cumulative magnitude is therefore considered to be **negligible**.

Disturbance

The impact is predicted to be of local spatial extent to each individual project, with marine mammals able to move out of the area of disturbance if required, long term duration, intermittent and the effect will be of medium reversibility. It is predicted that the impact will affect the receptor directly. The cumulative magnitude is therefore considered to be **negligible**.

Sensitivity

The sensitivity to operational noise for marine mammals has set out for the Oriel Project alone and is not repeated here.

Auditory injury
PTS

All marine mammals are deemed to have limited resilience to PTS, limited ability to adapt behaviour to sustain ecological functioning, limited ability to recover from the effect in the short and long term, and high international value. Due to the permanence of the effect, the sensitivity of the receptor to PTS is therefore, considered to be **high**.

TTS

All marine mammals are deemed to have high resilience to TTS, have the ability to adapt behaviour to sustain ecological functioning, high ability to recover from the effect in the short and long term, and high international value. The sensitivity of the receptor to TTS is therefore, considered to be **low**.

Behavioural disturbance

All marine mammals are deemed to have some resilience to behavioural disturbance with some potential impairment of ecological functioning if remaining within the vicinity of the operational turbines, but high ability to adapt behaviour (avoidance), high recoverability and international value. The sensitivity of the receptor is therefore, considered to be **medium**.

Significance of effect

Auditory injury
PTS

Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **high**. The cumulative effect will, therefore, be of **slight adverse significance**, which is not significant in EIA terms.

TTS

Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is considered to be **low**. The cumulative effect will, therefore (conservatively), be of **slight adverse significance**, which is not significant in EIA terms.

Disturbance

Overall, the magnitude of the impact is deemed to be **negligible** and the sensitivity of the receptor is conservatively considered to be **medium**. The cumulative effect will, therefore (conservatively), be of **slight adverse significance**, which is not significant in EIA terms.

10.12 Transboundary effects

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.13 Interactions

There are no changes to EIAR chapter 10: Marine Mammals and Megafauna.

10.14 Summary of impacts, mitigation measures and residual effects

Table 10A-39 supersedes table 10-48 of volume 2B, chapter 10: Marine Mammals and Megafauna) presents an updated summary of the potential impacts, mitigation measures and residual effects for the project alone, showing the inclusion of operational noise impacts. Changes are shown in blue text.

Table 10A-40 (supersedes table 10-48 of volume 2B, chapter 10: Marine Mammals and Megafauna) presents an updated summary of the potential cumulative impacts, mitigation measures and residual effects. Changes are shown in blue text.

In response to **RFI 9.W**, the Applicant acknowledges errors in the sensitivity conclusions of the CIA section of volume 2B, chapter 10: Marine Mammals and Megafauna. Whilst the detailed discussion of sensitivity for each impact in volume 2B, chapter 10: Marine Mammals and Megafauna remains valid and the evidence still stands and remains unchanged, the Applicant agrees the final conclusions of sensitivity should align with those for the project alone assessments. Therefore for clarity, the CIA summary table is updated with the corrected sensitivities for clarity (Table 10A-40) (changes highlighted in blue text). No changes to the significance of effect resulted from these updates.

Table 10A-39: Supersedes Table 10.48: Summary of potential environment effects, mitigation and monitoring. The ranges presented reflect the magnitude/sensitivities with respect to different species.

Description of impact		Phase			Measures included in Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
		C	O	D							
Injury and/or disturbance to marine megafauna from underwater noise during pile-driving	Injury	✓	×	×	MMMP (implementation of a soft-start, and MMOs / PAM Operators); Piling Strategy	C: Low to medium	C: Low to high	C: Imperceptible or slight adverse	None	Imperceptible or slight adverse	None
	Disturbance	✓	×	×	Piling Strategy	C: Low	C: Low to medium	C: Imperceptible or slight adverse	None	Imperceptible or slight adverse	None
	Injury	✓	×	×	MMMP (implementation of a soft-start, and MMOs / PAM Operators); Piling Strategy	C: Negligible to medium	C: Low to high	C: Imperceptible or slight adverse	ADD	Imperceptible or slight adverse	None
Injury and/or disturbance to marine megafauna from elevated underwater noise during geophysical surveys	Injury	×	✓	×	MMMP (implementation of a soft-start (where possible), and MMOs / PAM Operators)	O: Low	O: Medium to High	O: Slight adverse	None	Slight adverse	None
	Disturbance	×	✓	×	N/A	O: Low	O: Medium	O: Slight adverse	None	Slight adverse	None
Injury and/or disturbance to marine megafauna from vessel and other construction activities	Auditory injury	✓	✓	✓	N/A	C: Low O: Low D: Low	C: Medium to High O: Medium to High D: Medium to High	C: Slight adverse O: Slight adverse D: Slight adverse	None	Slight adverse	None
	Collision risk	✓	✓	✓	Vessel Code of Conduct	C: Negligible O: Negligible D: Negligible	C: High O: High D: High	C: Slight adverse O: Slight adverse D: Slight adverse	None	Slight adverse	None
	Disturbance	✓	✓	✓	N/A	C: Low O: Low D: Low	C: Low O: Low D: Low	C: Imperceptible O: Imperceptible D: Imperceptible	None	Imperceptible	None

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Description of impact		Phase C	Phase O	Phase D	Measures included in Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Changes in the fish and shellfish community affecting marine megafauna prey resources		✓	✓	✓	N/A	C: Low O: Low D: Low	C: Negligible or low O: Negligible or low D: Negligible or low	C: Imperceptible O: Imperceptible D: Imperceptible	None	Imperceptible	None
Electromagnetic Fields (EMF) from subsea electrical cabling may disrupt *behaviour of basking shark (Cetorhinus maximus)*		✗	✓	✗	N/A	O: Low	O: Low	O: Imperceptible	None	Imperceptible	None
Injury and/or disturbance to marine megafauna from operational underwater noise	Injury	✗	✓	✗	N/A	Negligible	High (PTS) Low (TTS)	Slight adverse (PTS and TTS)	None	Slight adverse	None
	Disturbance					Negligible	Medium	Slight adverse	None	Slight adverse	None

Table 10A-40: Supersedes Table 10-48: Summary of potential cumulative environment effects, mitigation and monitoring.

Description of impact		Phase C	Phase O	Phase D	Measures included in the Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Injury and/or disturbance to marine megafauna from underwater noise during pile-driving	Injury	✓	×	×	MMMP (implementation of a soft-start, and MMOs/PAM Operators)	C: Negligible to low	C: Low to high	C: Imperceptible or slight adverse	ADD deployment	Imperceptible or slight adverse	None
	Disturbance	✓	×	×	N/A	C: Low	C: Low - medium	C: Imperceptible or slight adverse	None	Imperceptible or slight adverse	None
Injury and/or disturbance to marine megafauna from elevated underwater noise during geophysical surveys	Injury	×	✓	×	MMMP (implementation of a soft-start, and MMOs/PAM Operators)	O: Low	O: Medium - High	O: Slight adverse	None	Slight adverse	None
	Disturbance	×	✓	×	N/A	O: Low	O: Medium	O: Slight adverse	None	Slight adverse	None
Injury and/or disturbance to marine megafauna from vessel activities	Auditory injury	✓	✓	✓	N/A	C: Low O: Low D: Low	C: Medium to High O: Medium to High D: Medium to High	C: Slight adverse O: Slight adverse D: Slight adverse	None	Imperceptible or slight adverse	None
	Collision risk	✓	✓	✓	Vessel Code of Conduct	C: Negligible O: Negligible D: Negligible	C: High O: High D: High	C: Slight adverse O: Slight adverse D: Slight adverse	None	Slight adverse	None
	Disturbance	✓	✓	✓	N/A	C: Low O: Low D: Low	C: Low O: Low D: Low	C: Imperceptible or slight adverse O: Imperceptible or slight adverse D: Imperceptible or slight adverse	None	Imperceptible or slight adverse	None

Description of impact		Phase C	Phase O	Phase D	Measures included in the Project	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Injury and/or disturbance to marine megafauna from operational underwater noise	Injury	×	✓	×	N/A	Negligible	High (PTS) Low (TTS)	Slight adverse (PTS and TTS)	None	Slight adverse	None
	Disturbance					Negligible	Medium	Slight adverse	None	Slight adverse	None

References

Boisseau, O., McGarry, T., Stephenson, S., Compton, R., Cucknell, A.C., Ryan, C., McLanaghan, R. and Moscrop, A., 2021. Minke whales Balaenoptera acutorostrata avoid a 15 kHz acoustic deterrent device (ADD). Marine Ecology Progress Series, 667, pp.191-206. Elmegaard, S. L., Teilmann, J., Rojano-Donate, L., Brennecke, D., Mikkelsen, L., Balle, J. D., Gosewinkel, U., Kyhn, L. A., Tonnesen, P., Wahlberg, M., Ruser, A., Siebert, U., Tgelberg Madsen, P. 2023. *Wild harbour porpoises startle and flee at low received levels from acoustic harassment device*. Scientific reports 13.1 (2023): 16691.

Booth, C. G., Brannan, N., Dunlop, R., Friedlander, A., Isojunno, S., Miller, P., Quick, N., Southall, B. and Pirotta, E. (2022). *A sampling, exposure and receptor framework for identifying factors that modulate behavioural responses to disturbance in cetaceans*. Journal of Animal Ecology, 91 (10), pp.1948-1960. DOI:10.1111/1365-2656.13787.

Boyd, I., Lockyer, C. and Marsh, H. (1999). *Reproduction in marine mammals.* Washington and London, Smithsonian Institutional Press.

Branstetter, B. K. and Sills, J. M. (2022). *Mechanisms of auditory masking in marine mammals*. Animal Cognition, 25 (5), pp.1029-1047.

Brasseur, S., Aarts, G., Meesters, E., van Polanen Petel, T., Dijkman, E., Cremer, J. and Reijnders, P. (2012). *Habitat preferences of harbour seals in the Dutch coastal area: analysis and estimate of effects of offshore wind farms*. Report C043-10.

Bray Offshore Wind Limited. and Kish Offshore Wind Limited. (2025). *Dublin Array EIAR Volume 3: Chapter 5: Marine Mammals.* Offshore Infrastructure Assessment Chapters

Carter, M. I. D., Boehme, L., Duck, C. D., Grecian, W. J., Hastie, G. D., McConnell, B. J., Miller, D. L., Morris, C. D., Moss, S. E. W., Thompson, D., Thompson, P. M. and Russell, D. J. F. (2020). *Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles.* Sea Mammal Research Unit, University of St Andrews pp.74.

Codling Wind Park Limited. (2024). *Volume 3 Chapter 11 Marine Mammals.* Codling Wind Park Environmental Impact Assessment Report pp.222.

Cronin, M., Duck, C., Cadhla, O., Nairn, R., Strong, D. and O'Keeffe, C. (2007a). *An assessment of population size and distribution of harbour seals in the Republic of Ireland during the moult season in August 2003*. Journal of Zoology, 273 (2), pp.131-139.

Cronin, M., Gerritsen, H., Reid, D. and Jessopp, M. (2016). *Spatial Overlap of Grey Seals and Fisheries in Irish Waters, Some New Insights Using Telemetry Technology and VMS*. PLOS ONE, 11 (9), pp.e0160564. DOI:10.1371/journal.pone.0160564.

Cronin, M. A., Duck, C. D. and Ó Cadhla, O. (2007b). *Aerial surveying of grey seal breeding colonies on the Blasket Islands, Co. Kerry, the Inishkea Group, Co. Mayo and the Donegal Coast, Ireland*. Journal for Nature Conservation, 15 (2), pp.73-83. DOI:10.1016/j.jnc.2006.11.001.

Diederichs, A., Hennig, V., Niels, G. a. and SH, B. (2008). *Investigation of the bird collision risk and the responses of harbour porpoises in the offshore wind farms Horns Rev, North Sea and Nysted, Baltic Sea, in Denmark Part II: Harbour porpoises.* University at Hamburg

Duck, C. and Morris, C. (2019). *Aerial surveys of seals in Ireland 2017 to 2018.* National Parks and Wildlife Service, Department of Culture,

Heritage and the Gaeltacht. Ireland. Irish Wildlife Manuals, No. 111.

Edds-Walton, P. L. (2000). *Vocalizations of minke whales balaenoptera acutorostrata in the St. Lawrence estuary*. Bioacoustics, 11 (1), pp.31-50. DOI:10.1080/09524622.2000.9753448.

Ellison, W. T., Southall, B. L., Frankel, A. S., Vigness-Raposa, K. and Clark, C. W. (2018). *An acoustic scene perspective on spatial, temporal, and spectral aspects of marine mammal behavioral responses to noise*. Aquatic Mammals, 44 (3).

Erbe, C., Marley, S. A., Schoeman, R. P., Smith, J. N., Trigg, L. E. and Embling, C. B. (2019). *The effects of ship noise on marine mammals—a review*. Frontiers in Marine Science, 6, pp.606.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R. (2016). *Communication masking in marine mammals: A review and research strategy*. Marine Pollution Bulletin, 103 (1), pp.15-38. DOI:https://doi.org/10.1016/j.marpolbul.2015.12.007.

Farcas, A., Merchant, N. and Seddon, R. (2025). *UK Marine Strategy Descriptor 11 ship noise assessment data for 2018 to 2022* [Online]. Available at: https://doi.org/10.14466/CefasDataHub.172. Accessed on: September 2025.

Farcas, A., Powell, C. F., Brookes, K. L. and Merchant, N. D. (2020). *Validated shipping noise maps of the Northeast Atlantic*. Science of The Total Environment, 735, pp.139509. DOI:10.1016/j.scitotenv.2020.139509.

Frankel, A. and Clark, C. (2000). *Behavioral responses of humpback whales (Megaptera novaeangliae) to full-scale ATOC signals*. The Journal of the Acoustical Society of America, 108 (4), pp.1930-1937.

Gedamke, J., Costa, D. P. and Dunstan, A. (2001). *Localization and visual verification of a complex minke whale vocalization*. The Journal of the Acoustical Society of America, 109 (6), pp.3038-3047. DOI:10.1121/1.1371763.

Gilles, A., Authier, M., Ramirez-Martinez, N. C., Araújo, H., Blanchard, A., Carlström, J., Eira, C., Dorémus, G., Fernández-Maldonado, C., Geelhoed, S. C. V., Kyhn, L., Laran, S., Nachtsheim, D., Panigada, S., Pigeault, R., Sequeira, M., Sveegaard, S., Taylor, N. L., Owen, K., Saavedra, C., Vázquez-Bonales, J. A., Unger, B. and Hammond, P. S. (2023). *Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys.* Final report published 29 September 2023 pp.64.

Government of Ireland. (2024a). *Ireland's Marine Strategy Part 1: Article 8,9 and 10 Report.* pp.140.

Government of Ireland. (2024b). *Ireland's Marine Strategy Part 1: Article 8, 9 and 10 report Annex III.* pp.310.

Graham, I. M., Pirotta, E., Merchant, N. D., Farcas, A., Barton, T. R., Cheney, B., Hastie, G. D. and Thompson, P. M. (2017). *Responses of bottlenose dolphins and harbor porpoises to impact and vibration piling noise during harbor construction*. Ecosphere, 8 (5), pp.e01793. DOI:10.1002/ecs2.1793.

Harris, S. and Yalden, D. (2008). *Mammals of the British Isles: handbook.* Mammal society.

Holt, M. M., Noren, D. P., Veirs, V., Emmons, C. K. and Veirs, S. (2009). *Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise*. The Journal of the Acoustical Society of America, 125 (1), pp.EL27-EL32.

IAMMWG. (2022). *Updated abundance estimates for cetacean Management Units in UK waters.* JNCC Report No. 680 (Revised March 2022). Joint Nature Conservation Committee. Peterborough. 0963-8091. pp.22.

Irish Whale Dolphin Group (IWDG). (2019). *Minke whale* [Online]. Available at: https://iwdg.ie/cms_files/wp-content/uploads/2019/04/Minke-whale-profile.pdf. Accessed on.

Irish Whale Dolphin Group (IWDG). (2024). *Deep-Diving and Rare Species Investigation Programme (DDRIP) Year Two Final Report.* pp.57.

Irish Whale Dolphin Group (IWDG). (2025). *Deep-Diving and Rare Species Investigation Programme (DDRIP) Year Three Final Report.* pp.46.

JNCC. (2017a). *JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys.* Joint Nature Conservation Committee. Aberdeen, Scotland pp.28.

JNCC. (2017b). *JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (seismic survey guidelines) 2017* [Online]. Available at: https://hub.jncc.gov.uk/assets/e2a46de5-43d4-43f0-b296-c62134397ce4. Accessed on.

JNCC. (2020). *Guidance on noise management in harbour porpoise SACs* [Online]. Available at: https://hub.jncc.gov.uk/assets/2e60a9a0-4366-4971-9327-2bc409e09784. Accessed on: July 2024.

JNCC. (2024). *Impulsive noise in the Southern North Sea SAC and other harbour porpoise SACs (2022–2024).* JNCC. Peterborough

Levesque, S., O'Donovan, J., Daly, M., Murphy, S., O'Connell, M. F., Jepson, P. D., Deaville, R., Barnett, J. and Berrow, S. (2020). *Supply of Vertebrate Necropsy and Sample Recovery Services Merged Final Reports: EMFF 2014-2020.* Marine Institute Report Series. EMFF Operational Programme 2014-2020

Lindeboom, H. J., Kouwenhoven, H. J., Bergman, M. J. N., Bouma, S., Brasseur, S., Daan, R., Fijn, R. C., de Haan, D., Dirksen, S., van Hal, R., Hille Ris Lambers, R., ter Hofstede, R., Krijgsveld, K. L., Leopold, M. and Scheidat, M. (2011). *Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation*. Environmental Research Letters, 6 (3).

Lockyer, C. (1995). *Investigation into the life history of the harbour porpoise in British Waters.*

Madsen, P., Wahlberg, M., Tougaard, J., Lucke, K. and Tyack, P. (2006). *Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs*. Marine Ecology Progress Series, 309, pp.279-295. DOI:10.3354/meps309279.

Marine Mammal Observer Association (MMOA). (2024). *Distance Estimation using Reticular Binoculars* [Online]. Available at: https://mmo-association.org/about-us/news/distance-estimation-using-reticular-binoculars. Accessed on.

Marley, S. A., Salgado Kent, C. P., Erbe, C. and Parnum, I. M. (2017). *Effects of vessel traffic and underwater noise on the movement, behaviour and vocalisations of bottlenose dolphins in an urbanised estuary*. Scientific Reports, 7 (1). DOI:10.1038/s41598-017-13252-z.

Marmo, B., Roberts, I., Buckingham, M. p., King, S. and Booth, C. (2013). *Modelling of Noise Effects of Operational Offshore Wind Turbines including noise transmission through various foundation types.* Scottish Government. Edinburgh, Scotland. 5.

Mellinger, D. K., Carson, C. D. and Clark, C. W. (2000). *Characteristics of minke whale Balaenoptera acutorostrata pulse trains recorded near Puerto Rico*. Marine Mammal Science, 16 (4), pp.739-756. DOI:10.1111/j.1748-7692.2000.tb00969.x.

Mona Offshore Wind Ltd. (2023). *Volume 2, Chapter 9: Marine Mammals.* Mona Offshore Wind Project: Preliminary Environmental Information Report

Mona Offshore Wind Ltd. (2024). *Volume 2, Chapter 4: Marine Mammals (F01).* Mona Offshore Wind Project Environmental Statement

Morecambe Offshore Wind Ltd. (2025). *Volume 5 Chapter 11 Marine Mammals Rev05.* Morecambe Offshore Windfarm: Generation Assets Environmental Statement pp.419.

Morecambe Offshore Windfarm Ltd. (2024). *Volume 5 Chapter 11 Marine Mammals Rev01.* Morecambe Offshore Windfarm: Generation Assets Environmental Statement. PINS Document Reference: 5.1.11.

Morgan Offshore Wind Ltd. (2023). *Volume 2, Chapter 9: Marine Mammals.* Morgan Offshore Wind Project: Generation Assets - Preliminary Environmental Information Report

Morgan Offshore Wind Ltd. (2025). *Volume 2, Chapter 4: Marine Mammals.* Morgan Offshore Wind Project Generation Assets Environmental Statement pp.496.

National Biodiversity Data Centre. (2025). *Bottlenose dolphin* [Online]. Available at: https://species.biodiversityireland.ie/profile.php?taxonId=134666#:~:text=No%20fixed%20breeding%20season%20but,place%20within%20those%20months%20also. Accessed on.

NBDC. (2024). *Ireland Biodiversity Maps: online mapping tool, National Biodiversity Data Centre, Ireland,* [Online]. Available at: https://maps.biodiversityireland.ie/Map. Accessed on: 01 February 2024.

Nedwell, J. R., Parvin, S. J., Edwards, B., Workman, R., Brooker, A. G. and Kynoch, J. E. (2007). *Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters.* COWRIE. Report No. 544R0738. pp.85pp.

NISA Windfarm Ltd. (2024). *Volume 3 Chapter 14 Marine Mammal Ecology.* North Irish Sea Array Environmental Impact Assessment Report pp.194.

NMFS. (2018). *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts.* U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59. pp.178.

NMFS. (2020). *Takes of Marine Mammals Incident to Specified Activities; Taking Marine Mammals Incidental to Offshore Wind Construction Activities off of Virginia.* pp.30933–30948.

NMFS. (2024). *Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (v3): Underwater and In-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts.* NOAA. US Department of Commer. NMFS-OPR-71. pp.182.

NMFS. (2025). *National Marine Fisheries Service: Summary of Recommended Marine Mammal Protection Act Acoustic Thresholds.* NMFS pp.7.

NOAA. (2025). *Laws & Policies: Marine Mammal Protection Act* [Online]. Available at: https://www.fisheries.noaa.gov/topic/laws-policies/marine-mammal-protection-act. Accessed on: September 2025.

Norro, A., Rumes, B. and Degraer, S. (2011). *Chapter 3: Characterisation of the operational noise, generated by offshore wind farms in the Belgian part of the North Sea.* Offshore wind farms in the Belgian part of the North Sea. Selected findings from the baseline and targeted monitoring pp.18-26.

NPWS. (2025). *Grey Seal* [Online]. Available at: https://www.npws.ie/marine/marine-species/grey-seal. Accessed on: 17 July 2025.

NRW. (2023). *NRW's Position on assessing behavioural disturbance of harbour porpoise (Phocoena phocoena) from underwater noise. Position statement.* NRW. Version 1.0.

Ørsted. (2025). *Volume 2, Chapter 5: Marine Mammals.* Mooir Vannin Generation Project Environmental Impact Statement pp.274.

Pace, F., Robinson, C., Lumsden, C. E. and Martin, S. B. (2021). *Underwater Sound Sources Characterisation Study: Energy Island, Denmark.* Technical report by JASCO Applied Sciences for Fugro Netherlands Marine B.V.:152. Document 02539, Version 2.1.

Phillips, B., Roberts, A., Buckland, L., Canning, S., Goulding, A., Mendes, S., Prior, A., De Silva, R., Stephenson, S., Wilson, J. and McGarry, T. (2025). *Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation (Version 5.0).* JNCC. Peterborough. JNCC Report No. 615.

Risch, D., Clark, C., Dugan, P., Popescu, M., Siebert, U. and Van Parijs, S. (2013). *Minke whale acoustic behavior and multi-year seasonal and diel vocalization patterns in Massachusetts Bay, USA*. Marine Ecology Progress Series, 489, pp.279-295. DOI:10.3354/meps10426.

Risch, D., Siebert, U. and Sofie. (2014). *Individual calling behaviour and movements of North Atlantic minke whales (Balaenoptera acutorostrata)*. Behaviour, 151 (9), pp.1335-1360. DOI:10.1163/1568539x-00003187.

Russell, D. J. F., Brasseur, S. M. J. M., Thompson, D., Hastie, G. D., Janik, V. M., Aarts, G., McClintock, B. T., Matthiopoulos, J., Moss, S. E. W. and McConnell, B. (2014). *Marine mammals trace anthropogenic structures at sea*. Current Biology, 24 (14), pp.R638-R639.

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J. and Reijnders, P. (2011). *Harbour porpoises (Phocoena phocoena) and wind farms: a case study in the Dutch North Sea*. Environmental Research Letters, 6 (2), pp.025102. DOI:10.1088/1748-9326/6/2/025102.

Scheifele, P. M., Andrew, S., Cooper, R. A., Darre, M., Musiek, F. E. and Max, L. (2005). *Indication of a Lombard vocal response in the St. Lawrence River beluga*. The Journal of the Acoustical Society of America, 117 (3), pp.1486-1492.

Scottish Renewables. (2019). *Appendix 11.2 Marine Mammal Information and Survey Report.* East Anglia ONE North Offshore Windfarm pp.110.

Seawatch Foundation. (2012). *The short-beaked common dolphin in UK waters* [Online]. Available at: https://seawatchfoundation.org.uk/wp-content/uploads/2012/07/Common_Dolphin.pdf. Accessed on: 17 July 2025.

Serrano, A. and Terhune, J. M. (2001). *Within-call repetition may be an anti-masking strategy in underwater calls of harp seals (Pagophilus groenlandicus)*. Canadian Journal of Zoology, 79 (8), pp.1410-1413.

Sigray, P., Andersson, M., André, M., Azzellino, A., Borsani, J. F., Bou, M., Castellote, M., Ceyrac, L., Dellong, D., Folegot, T., Hedgeland, D., Juretzek, C., Klauson, A., Leaper, R., Le Courtois, F., Liebschner, A., Maglio, A., Mueller, A., Norro, A., Novellino, A., Outinen, O., Popit, A., Prospathopoulos, A., Thomsen, F., Tougaard, J., Vukadin, P. and Weilgart, L. (2023). *Setting EU Threshold Values for impulsive underwater sound, Technical Group on Underwater Noise (TG NOISE).* MSFD Common Implementation Strategy. Publications Office of the European Union, Luxembourg

Sinclair, R. R. (2024). *Phase 1 Irish Offshore Wind Farms Cumulative iPCoD modelling.* Environmental Impact Assessment Report Volume 4: Appendix 11.4 Phase 1 Irish Offshore Wind Farms Cumulative iPCoD modelling

Sinclair, R. R. (2025). *Challenges and Solutions for Offshore Wind Farm Cumulative Effects Assessments for Marine Mammals.* PrePARED Report: 007

Southall, B. L. (2005). *Shipping noise and marine mammals: a forum for science, management, and technology*. *Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium.*

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr, C. R., Kastak, D., Ketten, D. R., Miller, J. H., Nachtigall, P. E. and Richardson, W. J. (2007). *Marine mammal noise-exposure criteria: initial scientific recommendations*. Aquatic Mammals*,* 33 (4)**,** pp.414-521.

Southall, B. L., Tollit, D., Amaral, J., Clark, C. W. and Ellison, W. T. (2023). *Managing human activity and marine mammals: A biologically based, relativistic risk assessment framework*. Frontiers in Marine Science*,* 10. DOI:10.3389/fmars.2023.1090132.

SSE Renewables. (2024). *Volume II, Chapter 11: Marine Mammals.* Arklow Bank Wind Park 2 Environmental Impact Assessment Report pp.334.

Stöber, U. and Thomsen, F. (2021). *How could operational underwater sound from future offshore wind turbines impact marine life?* Journal of the Acoustical Society of America*,* 149 (3)**,** pp.1791. DOI:10.1121/10.0003760.

Teilmann, J., Tougaard, J. and Carstensen, J. (2006). *Summary on harbour porpoise monitoring 1999-2006 around Nysted and Horns Rev Offshore Wind Farms.* Report to Energi E2 A/S and Vattenfall A/S

Thompson, P. M., Benhemma-Le Gall, A., Lee, R., Stephenson, S., Mason, T. and Abad Oliva, N. (2025). *Predicted and observed responses of harbour porpoises to pile driving noise at Moray West Offshore Wind Farm.* PrePARED Report. No. 008.

Thomsen, F., Lüdemann, K., Kafemann, R. and Piper, W. (2006). *Effects of offshore wind farm noise on marine mammals and fish.* COWRIE. Hamburg, Germany

Tougaard, J. (2021). *Thresholds for behavioural responses to noise in marine mammals. Background note to revision of guidelines from the Danish Energy Agency.* DCE – Danish Centre for Environment and Energy. 225. pp.31.

Tougaard, J., Henriksen, O. D. and Miller, L. A. (2009). *Underwater noise from three types of offshore wind turbines: estimation of impact zones for harbor porpoises and harbor seals*. Journal of the Acoustical Society of America*,* 125 (6)**,** pp.3766-73. DOI:10.1121/1.3117444.

Tougaard, J., Hermannsen, L. and Madsen, P. T. (2020). *How loud is the underwater noise from operating offshore wind turbines?* Journal of the Acoustical Society of America*,* 148 (5)**,** pp.2885. DOI:10.1121/10.0002453.

Tubelli, A. A., Zosuls, A., Ketten, D. R., Yamato, M. and Mountain, D. C. (2012). *A prediction of the minke whale (Balaenoptera acutorostrata) middle-ear transfer function*. J Acoust Soc Am*,* 132 (5)**,** pp.3263-72. DOI:10.1121/1.4756950.

Vattenfall and Scottish Renewables. (2015). *Appendix 12.2: Baseline Marine Mammal Technical Report.* pp.73.

Verfuss, U. and Sparling, C. E. (2025). *SMRU Consulting Temporary Threshold Shift (TTS) Position Statement.* pp.4.

Whyte, K. F., Russell, D. J. F., Sparling, C. E., Binnerts, B. and Hastie, G. D. (2020). *Estimating the effects of pile driving sounds on seals: Pitfalls and possibilities*. The Journal of the Acoustical Society of America, 147 (6), pp.3948. DOI:10.1121/10.0001408.