Environmental Impact Assessment Report - Volume 2B Addendum

# Chapter 9 Addendum:
# Fish & Shellfish Ecology

ORIEL WINDFARM
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# ORIEL WIND FARM PROJECT

## Environmental Impact Assessment Report - Addendum
## Chapter 9 Addendum: Fish and Shellfish Ecology

MDR1520C
EIAR– Chapter 9 Addendum
A1 C01
December 2025

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# Contents



# Figures

# Tables

# 9 CHAPTER 9 ADDENDUM – FISH AND SHELLFISH ECOLOGY

## 9.1 Introduction

This Addendum provides information to supplement the assessment of fish and shellfish ecology presented in chapter 9: Fish and Shellfish Ecology (Environmental Impact Assessment Report (EIAR) volume 2B) (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 9A-1 outlines the specific information requested according to the referencing used in the ‘Schedule-Further Information Request’ provided by ACP (e.g. 10.A which refers to Study Area). Table 9A-1 also indicates where the corresponding information / responses can be found within this chapter 9 Addendum: Fish and Shellfish Ecology, or within the Response to Submissions Report and provides a concluding statement on any resulting updates or changes to the assessment presented in the chapter 9: Fish and Shellfish Ecology (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 (EIAR volume 2B Addendum).

The headings and subheadings in this Addendum correspond to those used in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B). However, within the ‘Assessment of Significance’ section (9.10), two new impact assessments have been added in response to RFI 10.E. These new assessments cover ‘colonisation of hard structures’ (section 9.10.6) and ‘disturbance to fish from underwater noise’ (section 9.10.7). 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 9A-1: Further information requested on Fish and Shellfish Ecology and details on Applicant's response.**

| Reference | Request for Further Information | Response / Reference where information is presented | Concluding statement |
|---|---|---|---|
| **Study Area** | | | |
| **10.A** | The Fish and Shellfish Ecology EIAR chapter has considered both a 'Western Irish Sea Fish and Shellfish Ecology' Study Area, and a 'Fish and Shellfish Ecology' Study Area. It is stated that the 'Western Irish Sea Fish and Shellfish Ecology' Study Area will be used to aid in determining the baseline, and for the determination of magnitude of impacts that extend beyond the project boundary.<br>Whilst it is appropriate that the 'Western Irish Sea Fish and Shellfish Ecology' Study Area is used in the determination of a baseline, its use may result in decreased perception of impacts to local populations and/or critical supporting habitat.<br>Further, the 'Western Irish Sea Fish and Shellfish Ecology' Study Area is referenced across a wide range of impacts in the determination of impact magnitude and significance, even when those impacts do not extend beyond the project boundary. This has the potential to result in an underestimate of local population impacts.<br>As such, the Board considers that while the 'Western Irish Sea Fish and Shellfish Ecology' Study Area is acceptable to establish the baseline, this study area is too large to contextualise impacts. The applicant is requested that, where impacts have been assessed against the 'Western Irish Sea Fish and Shellfish Ecology' Study Area, these are reassessed against a more appropriate study area so that impact magnitude is assessed against a more suitable frame of reference. | The full EIAR was reviewed, and updates were made in section 9.10.4 and section 9.10.5 of this chapter 9 Addendum: Fish and Shellfish Ecology. | All references to the two study areas used in the EIAR were checked for context, with changes made to accurately assess impacts relative to the most appropriate study area; the key impacts updated were Long-term subtidal habitat loss and EMFs.<br>The long-term subtidal habitat loss impact assessed two receptors (Nephrops and sandeels) against the 'Western Irish Sea Fish and Shellfish Ecology Study Area'.<br>The EMF impact assessed most fish and shellfish receptors against the 'Western Irish Sea Fish and Shellfish Ecology Study Area' in chapter 9: Fish and Shellfish (EIAR volume 2B). This has been corrected to 'Fish and Shellfish Ecology Study Area' in the updated assessment in this Addendum.<br>The updates have not resulted in any changes to the approach taken to the assessment of fish and shellfish ecology, or the conclusions reached in the assessment in the chapter 9: Fish and Shellfish (EIAR volume 2B). |
| **Baseline Environment** | | | |
| **10.B** | Table 9-8 of EIAR Chapter 9 indicates a number of species determined as being unlikely to occur within the study area, based on results of the 2007 Baseline Survey. Results of this survey are not presented in the EIAR, and these determinations can, therefore, not be verified. In certain cases, these findings appear to contradict those indicated in other sources, including Ellis *et al.* (2012), and therefore results of this survey should not be considered in isolation of other available data. The applicant is requested to include the 2007 Baseline Survey report/results as an Appendix in the EIAR, as well as providing a review of how the different sources were applied proportionally in the assessments. | See section 9.7.2 | The justifications of importance of important ecological features (IEFs) in Table 9A-2 (which replaces Table 9-8 in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B)) have been clarified to refer to appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B). It should be noted that the justifications of importance of IEFs were based on the entire baseline characterisation and not solely the 2007 baseline study, which provided a more limited characterisation of the baseline compared to the comprehensive characterisation |

| Reference | Request for Further Information | Response / Reference where information is presented | Concluding statement |
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| | | | presented in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B). Therefore, this Technical Report should be referred to instead of the 2007 Baseline survey report, because all of the data in the assessment is taken from this report.<br><br>This clarification has not resulted in any changes to the approach taken to the assessment of fish and shellfish ecology, or the conclusions reached in the assessment in chapter 9: Fish and Shellfish (EIAR volume 2B). |
| **10.C** | With regard to Atlantic herring, the Board notes the submission of Appendix 09-02: Herring Spawning Technical Report. This report identifies a wide area of habitat suitable for Atlantic herring spawning, both within and surrounding the Project Area, with a 'Main Area of Spawning Aggregation' adjacent to the northwest corner of the Project Area. The report also recommends that further data collection is undertaken "*to gain a better understanding of the specific location of the grounds within Dundalk Bay and the precise timing of the spawning events to validate the extent of the spawning period".* Data and anecdotal evidence suggest a spawning period of mid-August to March. The findings made within this report are not referenced within the EIAR, and adequate consideration of potential impacts on this herring population are not made within the assessment. The Board, therefore, requests that the applicant applies the findings of the Herring Spawning Technical Report in the impact assessment for Atlantic herring throughout the EIAR. | See sections 9.10.1 and 9.10.2. | Additional information on specific herring spawning grounds and spawning periods for the Mourne stock have been added, with reference to appendix 9-2: Herring Spawning Technical Report (EIAR volume 2B) where appropriate and additional data sources. This additional information has provided extra detail but has not changed the overall assessment method or conclusions presented in chapter 9: Fish and Shellfish (EIAR volume 2B). |
| **10.D** | Any potential mitigation measures deemed necessary as a result of the updated assessment required at B and C above should be clearly identified and considered in any updated application documentation. | See section 9.10.8. | Detail on potential piling spatial and temporal scheduling to avoid herring spawning grounds and spawning periods has been provided. |
| **Impacts Scoped Out of the Assessment** | | | |
| **10.E** | The Board has concerns in terms of potential impacts which have either been scoped out for Fish and Shellfish Ecology, or have not been considered (see Table 9-11 of Chapter 9 of the EIAR): | | |

| Reference | Request for Further Information | Response / Reference where information is presented | Concluding statement |
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| | i) Seabed disturbance leading to the release of sediment contaminants and resulting potential effects on fish and shellfish ecology is scoped out. The justification for scoping states that "*site specific sediment contamination levels are unknown*", but that "*there is limited potential of contamination to sediments from anthropogenic activities given the levels identified within the offshore wind farm area and offshore cable corridor*". It is not clear whether data were available to support this statement. Further justification states that this impact was scoped out based on negligible impacts identified to Benthic Ecology receptors. The Board requests that the applicant review and justify the scoping out of this impact given the sensitivity of the area in terms of fish and shellfish ecology. The planning documentation should be updated accordingly.<br>ii) Impacts associated with unexploded ordnance (UXO) are not considered within the assessment of impacts within the Fish and Shellfish Ecology Chapter of the EIAR. As a source of impulsive noise, UXO has the potential for significant impacts on marine receptors, including Fish and Shellfish impact assessments, or that rationale is provided as to why it is to be scoped out. Evidence available from the relevant supporting information (e.g. Appendix 5-13: UXO Desk Study) should be referenced.<br>iii) Colonisation of hard structures is scoped out of assessment. Whilst the scoping decision suggests that the total area of hard infrastructure is likely to be "extremely small", Table 9-9 indicates that up to 50% of cables may require cable protection. It is also noted that this impact was scoped into the assessment of Benthic Ecology (EIAR Chapter 8). It is requested that the impact of the colonisation of hard structures is reconsidered and is scoped in and fully assessed. | See section 9.8.3 and section 9.10.6. | Additional justification has been added to justify scoping out of seabed disturbance leading to the release of sediment contaminants and not considering the clearance of UXO.<br>The colonisation of hard structures impact has been scoped in and assessed in section 9.10.6. The conclusion is that the effect will be of slight adverse significance, which is not significant in EIA terms. |
| **Injury and/or Disturbance to Fish from Underwater Noise during Pile-Driving** | | | |
| **10.F** | The Board considers, based on the application documentation, that the assessment and consideration of underwater noise, appear under precautionary with regard to modelling and impact assessment, as follows: | See section 9.10.2. | The injury and/or disturbance to fish from underwater noise during pile-driving impact has been updated with the revised modelling outputs and figures. The update has not resulted in any changes to conclusion of the assessment of fish and shellfish ecology in |

| Reference | Request for Further Information | | Response / Reference where information is presented | Concluding statement |
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| | | | | the chapter 9: Fish and Shellfish (EIAR volume 2B). |
| | i) | While the use of soft start procedures is considered a mitigation for marine mammals, industry best practice would suggest that fish are to be considered a stationary receptor and, therefore, the references to '*expected fleeing behaviour*' are not relevant to fish. This approach has the potential to greatly underestimate the impact ranges on fish populations. The applicant is invited to revise the planning documentation with fish considered as stationary receptors or justify this methodology. | See section 9.10.2. | Fleeing and stationary receptors have been presented in Table 9A-6. The updates have not resulted in any changes to the conclusion reached in the assessment in chapter 9: Fish and Shellfish (EIAR volume 2B). |
| | ii) | It appears that there is an error in the EIAR, in that the wrong table from the Subsea Noise Technical Report (Appendix 10-02) has been transposed into Table 9-17 of the EIAR (Table 1-20 of Appendix 10-02 was transposed, but it should have been Table 1-21). The transposed data indicate reduced ranges when compared to the correct data and may result in the magnitude of impacts associated with underwater noise having been underrepresented. This should be corrected (noting a request for further changes presented in point iii below). | See section 9.10.2. | The corrected outputs have been inserted into Table 9A-5 and Table 9A-6 in this Addendum (which supersede Tables 9-16 and 9-17 respectively in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B)), with no overall change to the assessment approach or conclusion. |
| | iii) | With regard to the noise modelling employed in the assessment, the Board has already noted above in Section 10 H of this report that the equation used has recently been reviewed within Wood et al. (2023)[4], and 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 applicant is requested to address these concerns and, in particular, to provide a justification for the modelling methodology employed. In this regard, the Board is concerned that the EIAR has adopted an under precautionary approach to underwater noise. | See section 9.10.2. | The updated modelling outputs have been presented in appendix 10-4: Updated Subsea Noise Modelling Report (EIAR volume 2B Addendum) and these have been used to update impact ranges in Table 9A-5 and Table 9A-6, with no overall change to the assessment approach or conclusion from the assessment in chapter 9: Fish and Shellfish (EIAR volume 2B). |
| | iv) | Underwater noise impacts should be updated to ensure impacts are measured against the most sensitive hearing receptor group (fish with a swim bladder used in hearing e.g. Atlantic herring). | See section 9.10.2. | Additional detail on herring physiological adaptations for hearing has been added under the Behaviour subheading in section 9.10.2, in the paragraph beginning 'As set out in chapter 9: Fish and Shellfish (EIAR volume 2B)'. This has clarified the reasoning behind herring being highly sensitive but this has not changed the conclusion of the |

| Reference | Request for Further Information | | Response / Reference where information is presented | Concluding statement |
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| | | | | assessment carried out in the chapter 9: Fish and Shellfish Ecology (EIAR volume 2B). Specifically, the impacts arising from underwater noise on the most sensitive receptor group (i.e. herring in this case) was already substantively assessed in compliance with best scientific evidence and no further assessment. |
| | v) | The total area anticipated to be impacted by underwater noise effects, at each dB threshold, should be presented alongside figures. | See section 9.10.2. | The impacted areas for the SELcum metric have been added to Table 9A-6, with the small areas reflecting the slight adverse significance conclusion. |
| | vi) | Given the extensive distance of Temporary Threshold Shift (TTS) on fish with a swim bladder used in hearing, the location of sensitive Atlantic herring spawning grounds within the boundary of the site, and the sensitivities of the species in terms of their spawning habitat in the region, the applicant is requested to assess the possibility for the use of Noise Abatement Systems (NAS) to reduce the spatial impact of underwater noise associated with impact piling beyond soft start procedures. | See section 9.10.8 | While the conclusion of the assessment of effects of injury and/or disturbance to fish from underwater noise during pile-driving concluded that effects would be of slight adverse significance, which is not significant in EIA terms (in line with the conclusion made in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), further mitigation to reduce underwater noise emissions have been committed to and are set out 9.10.8. |
| | vii) | Further to the above, the applicant is requested to provide additional information in relation to the decision to scope out the potential disturbance to fish from underwater noise generated by wind turbines during operation and impacts to fish from geophysical survey noise generated during operational and maintenance surveys, in light of any updates to the modelling requested above and to ensure impacts are measured against the most sensitive hearing receptor group (fish with a swim bladder used in hearing e.g. Atlantic herring). | See section 9.8.3 and section 9.10.7 | This impact pathway has now been scoped into the assessment with a full consideration of noise from geophysical surveys, vessel noise and operational turbines are now fully considered in this Addendum. Also, the disturbance to fish from underwater noise generated by vessels, o*perational* wind turbines *and* from geophysical survey h*ave been fully* assessed as a single impact in section 9.10.7, with a conclusion of slight adverse significance, which is not significant in EIA terms.<br>The conclusion to this assessment is that no significant effects are predicted on fish and shellfish IEFs. |

| Reference | Request for Further Information | Response / Reference where information is presented | Concluding statement |
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| **Increased suspended sediment concentrations and associated sediment deposition** | | | |
| **10.G** | The determination of magnitude of increased suspended sediments (SSCs) as presented in the EIAR, Section 9.10.3 of Chapter 9, excludes a number of important factors when determining potential impacts. Whilst consideration is given to SSCs, no quantitative assessment is made relating to spatial extent of plumes at given concentrations, or to sedimentation depth over spatial extent. Concentrations over distance, sediment settlement depths over distance, and actual peak concentrations should be presented in heatmaps. Values should also be consistent and represent the worst-case scenario (e.g. sediment concentrations are indicated to be both500 mg/l, and up to 2000mg/l within this section). Determinations of magnitude, sensitivity, and significance are required to be revised in line with and informed by provided values. | See section 9.10.3. | Updated marine processes modelling was performed in chapter 7 Addendum: Marine Processes, and this has been incorporated into the magnitude section of the impact assessment in section 9.10.3. There was no change to the conclusions of magnitude of impact or significance of effect from chapter 9: Fish and Shellfish (EIAR volume 2B). |
| **Electromagnetic Fields (EMF) from Subsea Electrical Cabling** | | | |
| **10.H** | Having regard to submissions from observers, the current understanding of the potential impacts associated with EMF in the marine environment is frequently updated via published academic research and reviews. It is requested that reference to additional and recent literature is incorporated into the assessment to ensure findings are supported by the most current understanding of potential impacts. | See section 9.10.5. | A summary of more recent research (which became available since publication of the EIAR) on the effects of EMFs on fish and shellfish ecology has been provided in section 9.10.5. The findings of recent research remain in line with and support the information provided in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), and therefore the assessment conclusion was in compliance with the best practice approach and no change was required. |
| **10.I** | Background measures have been provided in microtesla, however, contextualisation of EMF magnitude is given in milligauss. Differences between these units should be discussed, or sources should be used that use similar units to allow for a comparison between baseline conditions and operational conditions. Where magnitude is assessed, further clarity is required when discussing the findings of CSA (2019), and additional explanation as to how these values compare to those anticipated in association with this development as no information relating to cable design is presented. | See section 9.10.5. | All uses of μT from the EIAR have been converted to mG.<br>Additional clarification on the CSA (2019) reference has been added to the magnitude section, with reference to the project-specific magnitude. The remaining assessment approach has not changed nor have the overall conclusions of the assessment from chapter 9: Fish and Shellfish (EIAR volume 2B). |

| Reference | Request for Further Information | Response / Reference where information is presented | Concluding statement |
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| **Cumulative Impact Assessment** | | | |
| **10.J** | In terms of cumulative impacts, the applicant is requested to consider the findings of the proposed North Irish Sea Array project application documentation which potentially overlaps with the Oriel project in terms of underwater noise. This should also be considered in terms of the potential wider ecological impacts on fish stocks/prey base, which are essential to fully assess the impact on other important ecological features such as seabirds, marine mammals and megafauna. | Refer to updated cumulative assessment in appendix 3-2 Addendum: Cumulative Impact Assessment Report (EIAR volume 2A Addendum). | There are no changes to the approach or conclusions reached in the updated cumulative impact assessment provided in chapter 9: Fish and Shellfish (EIAR volume 2B). |
| **10.K** | Assessment of the cumulative impacts of underwater noise should be reassessed, following any changes made to underwater noise modelling, as requested in previous comments. Potential impacts on vulnerable species (e.g. Atlantic herring) should be assessed when considering potential for barrier effects restricting access to potential spawning habitat at a wider scale than presented in the application documentation and should also be considered in the context of the operational phase of the projects. | Refer to updated cumulative assessment in appendix 3-2 Addendum: Cumulative Impact Assessment Report (EIAR volume 2A Addendum). | Appendix 3-2 Addendum: Cumulative Impact Assessment (EIAR volume 2A Addendum) provides an updated Cumulative Impact Assessment. The assessment concludes that there is no change to the cumulative assessment conclusions provided in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).<br>Information on potential barrier effects has been incorporated for assessment of herring spawning and vulnerable diadromous species in section 9.10.2, with a conclusion of no barrier effects occurring from piling activities. |
| **Other** | | | |
| **10.L** | In terms of the data validity and limitations (Section 9.7.4 of Chapter 9 of the EIAR), the Board notes that additional literature has been used to corroborate information used in older datasets used to inform the Fish and Shellfish Ecology Technical Report (Appendix 9-1 of the EIAR), and in particular, the baseline evaluation or impact assessment. The applicant is requested to provide the additional literature referred to in order to substantiate assumptions and statements. | See sections 9.6.1 and 9.7.4. | Clarification has been included on data limitations in section 9.7.4. The information referred to in section 9.7.4 of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) were those set out in the appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B) (specifically Table 1-1 and those included in the reference list) which were used to corroborate and validate information presented in older reports, such as such as Ellis *et al.*, 2012 and Coull *et al.*, 1998.<br>Further additional references have also been included in this Addendum. |

| Reference | Request for Further Information | Response / Reference where information is presented | Concluding statement |
|---|---|---|---|
| **10.M** | There appears to be some ambiguity around the determination of magnitude of impacts in the EIAR. It is noted that where the significance of an impact is determined to fall within the category of slight/moderate, they are exclusively determined as being 'slight'. Evidence should be presented to indicate the rationale for these assessment determinations. | See sections 9.10.1, 9.10.2, 9.10.3, and 9.10.5. | Where the potential exists for interpretation of the significance conclusion based on different magnitudes, justification has been added to the conclusions to clarify how the conclusion was reached. |

## 9.2 Purpose of this chapter

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.3 Study area

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.4 Policy context

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.5 Consultation

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.6 Methodology to inform the baseline

### 9.6.1 Desktop study

The following additional data sources have been considered within the baseline characterisation to validate some of the assumptions made with regard to spawning and nursery habitats:

- Updating Fisheries Sensitivity Maps in British Waters (Aires *et al.*, 2014); and
- Spawning and nursery grounds of forage fish in Welsh and surrounding waters Distribution of adult and juvenile forage fish species during autumn and winter (Campanella and van der Kooij, 2021).

### 9.6.2 Identification of designated sites

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.7 Baseline environment

### 9.7.1 Designated sites

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

### 9.7.2 Important ecological features

In response to RFI 10.B, the justifications for importance of IEFs have been clarified in Table 9A-2 below. The justifications for importance of IEFs presented in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) were based on all the information presented in the baseline characterisation (appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B)), rather than the 2007 baseline study alone. As such, the text referring to the justifications of importance has been updated in this document for plaice, conger eel, cod, haddock, whiting, anglerfish, lesser/greater sandeel, mackerel, sprat, small-spotted catshark, nursehound, tope, spurdog, rays, skate, edible crab, Norway lobster, European lobster, and other crustaceans species. All other species justifications have remained the same as presented in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B). The updates to the justifications did not result in any changes to the overall importance of any species.

**Table 9A-2: Summary of fish and shellfish important ecological features (IEFs) and their value/importance within the Fish and Shellfish Ecology Study Area. Note: this has only been updated for those species set out above and should be reviewed alongside Table 9-8 of chapter 9: Fish and Shellfish (EIAR volume 2B).**

| Common Name | Scientific Name | Importance | Justification |
|---|---|---|---|
| **Demersal Fish** | | | |
| **Benthic Fish** | | | |
| Plaice | *Pleuronectes platessa* | Regional | Low intensity nursery and low intensity spawning habitat. Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Commercially important fish species in the region. |
| Conger eel | *Conger conger* | Local | No known spawning or nursery grounds in the area. Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. |
| **Benthopelagic Fish** | | | |
| Cod | *Gadus morhua* | National | Low intensity spawning and high intensity nursery ground. Fish and Shellfish Ecology Study Area coincides with Irish Sea Cod Recovery Plan area. Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Commercially important species. Listed by OSPAR as threatened and/or declining and listed as vulnerable on the IUCN Red List. |
| Haddock | *Melanogrammus aeglefinus* | Regional | Spawning ground of unspecified intensity. Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Commercially important fish species in the region. IUCN Status: Vulnerable. |
| Whiting | *Merlangius merlangus* | Regional | Low intensity spawning and high intensity nursery habitats. Commercially important fish species in the region and a key prey species for other marine species (particularly harbour porpoise). Not identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data, but is also a target for local fisheries. |
| Anglerfish | *Lophius piscatorius* | Local | Low intensity nursery ground. Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Important commercial species in the Irish Sea, but not in local area. |
| Lesser sandeel | *Ammodytes tobianus* | Local | Low intensity nursery and spawning ground. Important prey species for fish, birds and marine mammals. Commercially important species. Not identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. |
| Greater sandeel | *Hyperoplus lanceolatus* | | |
| **Pelagic Fish** | | | |
| Mackerel | *Scomber scombrus* | Regional | Low intensity nursery and spawning ground. Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Important prey species for larger fish, birds and marine mammals. |
| Sprat | *Sprattus sprattus* | Local | Spawning ground of undetermined intensity. Not identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Important prey species for larger fish, birds and marine mammals. |

| Common Name | Scientific Name | Importance | Justification |
|---|---|---|---|
| **Elasmobranchs** | | | |
| Small-spotted catshark | *Scyliorhinus canicula* | Local | Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Common and listed as of Least Concern on the IUCN Red List. |
| Nursehound | *Scyliorhinus stellaris* | Regional | Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Common, but listed as of Near Threatened on the IUCN Red List due to declines in the Mediterranean population. |
| Tope | *Galeorhinus galeus* | Regional | Low intensity nursery ground. Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Listed on Ireland Red List as Vulnerable. |
| Spurdog | *Squalus acanthias* | National | Not identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data; the area has been identified as a high intensity nursery ground. Listed on Ireland Red List as Endangered. |
| Rays | - | Local | Rays (most likely including thornback and spotted rays) were identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Low intensity nursery ground. Listed on Ireland Red List as Least Concern. |
| Skate | *Dipturus batis* | Regional | Not identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data, including records of this species occurring in the general area. Skate are listed as Critically Endangered on the IUCN Red List. |
| **Shellfish** | | | |
| **Crustaceans** | | | |
| Edible crab | *Cancer pagurus* | Regional | Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Important commercial species. |
| Norway lobster | *Nephrops norvegicus* | Regional | Spawning and nursery area 2.3 km and 5.8 km from the Project site. Not identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. Second most valuable species fished by the Irish fleet and an important fishery in the local area. |
| European lobster | *Homarus gammarus* | Regional | Identified as likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences. Important commercial species and desktop data. |
| Other crustaceans | - | Local | Other crustaceans including velvet swimming crab, green shore crab, swimming crabs, spider crabs and brown shrimp have been identified as being likely to occur within the Project site in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B), based on habitat preferences and desktop data. They are all important commercial species, but not in the local area. |

### 9.7.3 Future baseline scenario

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

### 9.7.4 Data validity and limitations

In response to RFI 10.L, additional clarification has been added to support the use of the literature throughout the assessment. The literature considered in the baseline characterisation covers a long time period and gives consideration to location-specific up-to-date publications concerning fish and shellfish occurrence, distributions and habitats, including fish and shellfish spawning grounds, which reaffirm the findings of historical publications. This approach provided a robust and extensive characterisation of all species and communities which have the potential to occur within the Fish and Shellfish Ecology Study Area. This robust characterisation provides high confidence that the identified IEFs appropriately represent the existing environment, with further information sources being highly unlikely to identify new IEFs or to change any which have been previously identified.

The data sources used in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) were detailed in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B). This used the most up to date publicly available information obtained from the applicable data sources cited. As set out in appendix 9-1: Fish and Shellfish Ecology Technical Report (EIAR volume 2B) the data collected is based on long-term existing literature, consultation with stakeholders, wider available survey data and identification of habitats to inform likely fish and shellfish species. In regard to EMF (and in response to RFI 10.H), this is a developing area of research, and more recent findings of studies have been incorporated into the sensitivity of the fish and shellfish IEFs in section 9.10.5. This represents the best available scientific information for impacts on fish and shellfish IEFs at the time of drafting.

Where older datasets are used, such as Ellis *et al.*, 2012 and Coull *et al.*, 1998, fish and shellfish spawning, and nursery grounds are unlikely to have significantly changed and these datasets are informed by long term datasets which show consistent patterns in fish habitats. Specifically, the findings of these reports were corroborated by Aires *et al.* (2014) and Campanella and van der Kooij (2021), which investigated fish spawning and nursery grounds across the Irish Sea to update existing datasets. The studies found similar distributions for most species but were more spatially focused on smaller areas or did not cover as wide a range of species as in previous studies, and therefore the Ellis *et al.* (2012) and Coull *et al*. (1998) studies continue to be used for assessments of fish and shellfish spawning ground distribution as these are expected to remain consistent over time.

## 9.8 Key parameters for assessment

### 9.8.1 Project design parameters

The project description is provided in chapter 5: Project Description (EIAR volume 2A). Table 9-9 of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) outlines the project description parameters that have been used to inform the assessment of potential impacts of the construction, operational and maintenance, and decommissioning phases of the Project of fish and shellfish ecology receptors.

Due to the potential for unexpected ground conditions and obstructions, the final route and length of the offshore export cable and offshore inter-array cables will be confirmed during construction (see design flexibility details in chapter 5: Project Description (EIAR volume 2A). For the purposes of the assessment, the maximum length of cables has been considered to ensure the potential for maximum impact is assessed. Should the lengths of cables be lower than those specified then the potential for effects will be the same (or slightly less) than those outlined in assessment.

In response to RFI 10.E (iii) and 10.F (v), the following impacts have been considered in this Addendum, having been scoped out of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B):

- Colonisation of hard structures; and
- Disturbance to fish from underwater noise generated by vessels, wind turbines, and geophysical surveys.

The following table therefore provides the project design parameters for these two impacts which are assessed in section 9.10 below. All other parameters and impacts are unchanged.

**Table 9A-3: Project design parameters considered for the assessment of potential impacts on fish and shellfish ecology in this Addendum.**

| Potential impact | Phase[1] C | O | D | Project design parameters | Justification |
|---|---|---|---|---|---|
| Colonisation of hard structures | x | ✓ | x | **Operational and maintenance phase**<br>Introduction of up to 356,807 $m^2$ of hard structures, remaining for the operational lifetime of the Project, due to:<br>• Presence of 26 (i.e. 25 x WTG + 1 x OSS) monopile foundations, including scour protection;<br>• Presence of cable protection associated with 41 km inter-array cables and 16 km offshore cables. Assumes up to 50% of inter-array cable route and up to 50% of offshore cable corridor may require cable protection; and<br>• Operational phase up to 40 years. | These values account for the WTG and OSS foundation types and associated scour protection, maximum length of cables and cable protection resulting in greatest extent of habitat loss. |
| Disturbance to fish from underwater noise generated by vessels, wind turbines, and geophysical surveys | ✓ | ✓ | ✓ | **Operational and Maintenance Phase**<br>Operation of 25 WTGs on monopile foundations.<br>**Construction, Operational and maintenance, and Decommissioning phases**<br>Vessel types include jack-up barges, tug/anchor handlers, cable installation vessels, scour/cable protection installation vessels, guard vessels, survey vessels, crew transfer vessels (CTVs).<br>A maximum 475 vessel round trips during the construction phase, 352 vessel round trips per year during the operational and maintenance phase and 475 vessel round trips during the decommissioning phase.<br>Other construction includes:<br>• Monopile drilling at each location with six days drilling for each monopile = cumulative total of 156 days drilling over construction phase;<br>• Cable trenching for inter-array and offshore cable; and<br>• Cable laying for inter-array and offshore cable.<br>Routine geophysical surveys of wind turbine foundations, inter-array cables and offshore cable:<br>• Multibeam echosounder (MBES) expected to be the only method of geophysical survey to be employed;<br>• Survey campaigns estimated to occur once every five years for 40-year lifetime of Project;<br>• Surveys to be conducted using one survey vessel;<br>• Duration of 14 days per survey;<br>• 42-day duration per survey campaign (three surveys per campaign);<br>• 42 vessel round trips per survey campaign; and<br>• Maximum total of 294 survey vessel round trips for lifetime of Project. | Greatest range of vessel types and greatest number of round trips.<br>First survey campaign expected to occur in year 5, and final campaign in year 35, equating to seven survey campaigns.<br>Assumes daily vessel trip for every day of each 14-day survey window. |

### 9.8.2 Measures included in the Project

The Applicant notes a typo in the second row of the first column in Table 9-10 of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B). The sentence should read;

'The cables will be buried below the seabed wherever possible, to a minimum burial depth of 0.5 m and a maximum burial depth of 3 m.'

### 9.8.3 Impacts scoped out of the assessment

In Response to RFI 10.E (i), Additional site-specific justification has been added to the seabed disturbance leading to release of sediment contaminants impact (Table 9A-4). In response to RFI 10.E (ii), a row and justification has been added for scoping out of impacts related to the clearance of UXO. In response to RFI 10.E (iii), the 'Colonisation of hard structures' impact has been removed from this table and assessed in section 9.10.6 of this Addendum.

The disturbance to fish from underwater noise generated by vessels (all phases), wind turbines (operational and maintenance phase only) and geophysical surveys are now assessed as a single impact in section 9.10.7.

**Table 9A-4: Impacts scoped out of the assessment for fish and shellfish ecology.**

| Potential impact | Justification |
|---|---|
| Seabed disturbance leading to the release of sediment contaminants and resulting potential effects on fish and shellfish ecology | Site specific sediment sampling for contaminants was undertaken within the project boundaries in September 2024 as outlined in appendix 8-3 Addendum: Sediment Chemistry Survey. The site-specific survey recorded that organochlorines, PCBs, total extractable hydrocarbons, tributyltin and dibutyltin, polycyclic aromatic hydrocarbons and most metals at all stations were below all relevant impact thresholds. Only arsenic slightly exceeded the lower limit of the Cronin *et al.* (2006) guidelines at one station (27.2 mg/kg, compared to the lower level threshold of 20 mg/kg). The EIAR set out in Table 9-11 in section 9.8.3 that there is limited potential of contamination to sediments from anthropogenic activities given the sediment types and lack of anthropogenic activities which might lead to sediment contamination and site specific surveys have demonstrated this to be the case.<br>As such, there is no pathway for a negative effect on fish and shellfish receptors from this impact and this impact has therefore been scoped out of the assessment. |
| Clearance of Unexploded Ordnance (UXO) leading to effects on fish and shellfish ecology | As outlined in chapter 5: Project Description (EIAR volume 2A) (see section 5.5.2), there is low risk of encountering UXO during the development of the Project and as such, UXO clearance is not anticipated to be required, In the unlikely event UXOs are found, the location of infrastructure will be adjusted to avoid the obstacle. As there will be no requirement for the clearance of UXOs there will be no impact on fish and shellfish ecology. |

## 9.9 Impact assessment methodology

### 9.9.1 Overview

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

### 9.9.2 Impact assessment criteria

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

### 9.9.3 Designated sites

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.10 Assessment of significance

### 9.10.1 Temporary subtidal habitat loss/disturbance

In response to RFI 10.C, additional information on the impact of temporary subtidal habitat loss/disturbance on herring spawning grounds has been added to the section 9.10.1 Construction phase subheading 'Sensitivity of the receptor', in the paragraph beginning 'In relation to the herring spawning grounds…'.

In response to RFI 10.M, specific justification text has been added to the significance conclusions in all phases. The overall assessment conclusions have remained unchanged.

### Construction phase

#### Magnitude of impact

The magnitude of the impact is unchanged from chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

#### Sensitivity of the receptor

The information on sensitivities of fish and shellfish receptors to this impact remains unchanged with the following sections providing updates or further details on species sensitivities.

In relation to herring spawning grounds, appendix 9-2: Herring Spawning - Technical Report (EIAR volume 2B) details the extent of these within and around the Fish and Shellfish Ecology Study Area. Whilst 709,500 $m^2$ of habitat could be temporarily lost or disturbed, this is unlikely to have a significant effect on the herring population. This only represents 1.3% of the overall offshore wind farm area and offshore cable corridor and therefore represents an even smaller proportion of suitable herring spawning habitats (noting that much of the offshore wind farm area is not suitable for herring spawning). Evidence published in Campanella and van der Kooij (2021) indicated the presence of high density adult and juvenile herring in the Mourne stock nearshore areas in the Dundalk Bay to Portrane region. Section 4.4 of appendix 9-2: Herring Spawning – Technical Report (EIAR volume 2B), recorded potential spawning grounds in Dundalk Bay, associated with underlying coarse substrate and rock and boulders in the west and north of the Application Boundary (Figure 9A-2), but concluded that construction activities which cause temporary habitat loss were unlikely to significantly impact existing overlapping spawning grounds or nearby extensive spawning grounds as identified by Ellis *et al.* (2012) and Coull *et al.* (1998). The construction impacts considered in this assessment are also temporary and sediments which may be used for herring spawning will recover fully following cessation of construction activities, as set out in the EIAR. As the impact will only affect a small proportion of suitable herring spawning ground for a short term duration with recovery of seabed sediments expected to occur quickly following construction completion, there is unlikely to be any significant impact on these habitats.

#### Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of most fish and shellfish receptors is considered to be low. The sensitivity of herring is considered to be medium, with the potential for a small proportion of suitable herring spawning grounds to be impacted. The effect will, therefore, be of **imperceptible to slight adverse significance**, with an **overall slight adverse significance** for all receptors including herring spawning, which is not significant in EIA terms.

This conclusion is based on only a small proportion of the offshore wind farm area and offshore cable area being affected by temporary habitat loss and disturbance (i.e. up to 1.3% of this area), with only a small proportion of this total area affected at any one time. Only a small proportion of this 1.3% of affected area is suitable for herring spawning, with most of the sediments in the offshore wind farm area not being suitable for herring spawning. Therefore, temporary habitat loss impacts on herring spawning habitats will be minimal in the context of the large areas of suitable spawning ground in the wider are outside the project boundaries. Also, the recovery of seabed substrates/sediments are expected to be rapid, with fish and shellfish IEFs including spawning herring quickly recolonising affected areas.

## Operational and maintenance phase

### Significance of effect

Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of most fish and shellfish receptors is considered to be low, with herring sensitivity considered to be medium. The effect will, therefore, be of **imperceptible or slight adverse significance**, with an **overall imperceptible significance**, which is not significant in EIA terms. This is based on only a small proportion of the offshore wind farm area and offshore cable area being impacted by temporary habitat loss (i.e. 0.7% of this area), with only a small proportion of this total area being affected at any one time. As the suitable herring spawning grounds will represent only a small proportion of this area (with most sediments in the offshore wind farm area being unsuitable for herring spawning), the impact will not be significant. Also, the high recovery potential of all fish and shellfish IEFs including spawning herring support this conclusion.

## Decommissioning phase

### Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of most fish and shellfish receptors is considered to be low, with herring sensitivity considered to be to medium. The effect will, therefore, be of **slight adverse significance**, which is not significant in EIA terms. This is based on the same justification as for the construction phase.

## 9.10.2 Injury and/or disturbance to fish from underwater noise during pile-driving

In response to RFI 10.C, additional specific information on nearby herring spawning activity at spawning grounds in the region has been added below.

In response to RFI 10.F, the injury and disturbance ranges have been updated throughout the sensitivity section of this assessment based on the outputs of revised noise modelling. The overall conclusions remain unchanged.

In response to RFI 10.F (i), Table 9A-6 sets out injury ranges for both fleeing and stationary receptors.

In response to RFI 10.F (ii), the corrected outputs from revised modelling have been inserted into Table 9A-5 and Table 9A-6 and are discussed for behavioural effects below.

In response to RFI 10.F (iii), all tables and relevant text have been updated with the revised underwater noise modelling.

In response to RFI 10.M, specific justification text has been added to the significance conclusion in the construction phase. The overall assessment conclusion has remained unchanged.

## Construction Phase

### Magnitude of impact

The magnitude of the impact is unchanged from chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

### Sensitivity of the receptor

The information on sensitivities of fish and shellfish receptors to underwater noise remains unchanged from chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), with the following sections providing updates or further details on species sensitivities.

#### Injury

Injury ranges for fish have been updated to account for revised site specific underwater noise modelling for the Project (see appendix 10-4: Updated Subsea Noise Modelling Report (EIAR volume 2B Addendum)) and to account for both static and moving receptors. The impact ranges presented in Table 9A-5 and Table 9A-6 therefore supersede the equivalent ranges presented in Tables 9-16 and 9-17 in the chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), respectively. The modelled piling location in the updated underwater noise modelling was changed to the west of the offshore wind farm area, though the modelling location does not materially affect the impact ranges shown below.

**Table 9A-5: Summary of peak pressure injury ranges for fish due to installation of one monopile at the west of the offshore wind farm area (assuming hammer energy of 3,500 KJ).**

| Fish Type | Injury Type | 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 9A-6: Summary of $SEL_{cum}$ injury ranges for fleeing and static fish group receptors due to the installation of one monopile at the west of the offshore wind farm area (N/E = threshold not exceeded).**

| Fish Type | Injury Type | Threshold ($SEL_{cum}$, dB re 1 µPa$^2$s) | Range (m) Moving | Range (m) Static | Area of effect (km$^2$) Moving | Area of effect (km$^2$) Static |
|---|---|---|---|---|---|---|
| No swim bladder (particle motion detection) | Mortality | 219 | N/E | 385 | N/E | 0.47 |
| | Recoverable injury | 216 | N/E | 516 | N/E | 0.84 |
| Swim bladder not involved in hearing (particle motion detection) | Mortality | 210 | 21 | 935 | 0.001 | 2.75 |
| | Recoverable injury | 203 | 147 | 1,860 | 0.068 | 10.87 |
| Swim bladder involved in hearing (primarily pressure detection) | Mortality | 207 | 51 | 1,250 | 0.008 | 4.91 |
| | Recoverable injury | 203 | 147 | 1,860 | 0.068 | 10.87 |
| Fish eggs and larvae | Mortality | 210 | 935 | 935 | 2.75 | 2.75 |
| All fish types | Temporary threshold shift (TTS) | 186 | 5,520 | 9,620 | 96 | 291 |

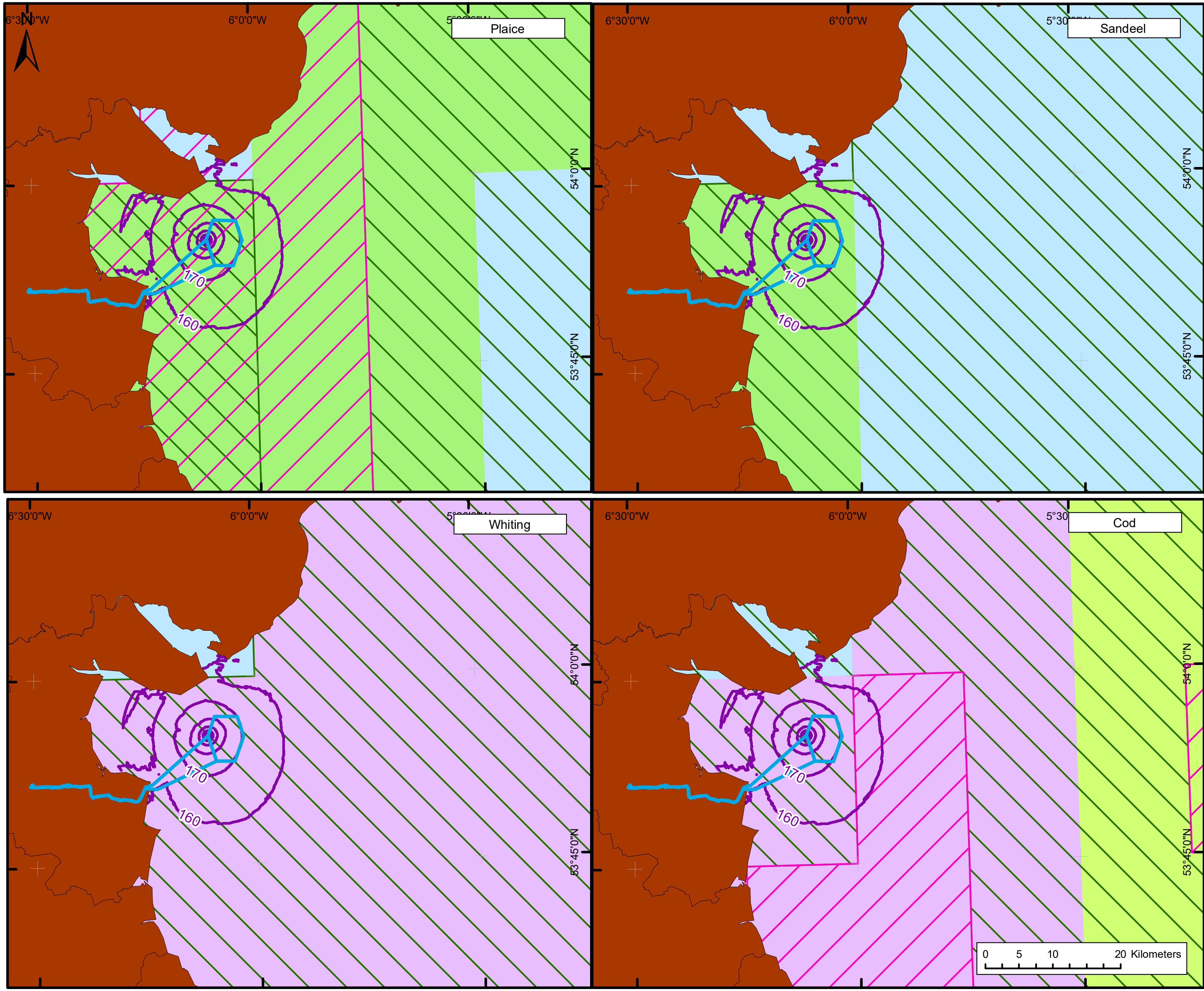
### Behaviour

The following section has been amended to account for the updated underwater modelling outputs (see appendix 10-4: Updated Subsea Noise Modelling Report (EIAR volume 2B Addendum)) - and to provide further detail on herring spawning, accounting for site specific information on Mourne herring spawning grounds presented in appendix 9-2: Herring Spawning Technical Report (EIAR volume 2B).

Figure 9A-1 shows the updated modelled underwater noise levels for the west piling location, relative to key fish spawning habitats in the vicinity of the offshore wind farm area. The modelled outputs show that noise attenuation is rapid with distance from foundation location. They also indicate that, based on a behavioural response occurring at levels in excess of 160 dB re 1 µPa $SPL_{peak}$, fish may exhibit behavioural responses within approximately 13 km to 22 km from the source in the west. It should be noted, however, that this noise level is lower than the levels reported by the existing studies on the effect of noise on fish behaviour. These results broadly align with qualitative thresholds for behavioural effects on fish as set out in Table 9-18 of the chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), with moderate risk of behavioural effects in the range of hundreds to thousands of metres from the piling activity, depending on the species. Although spawning and nursery habitats are present within the Fish and Shellfish Ecology Study Area (e.g. for plaice, sole, herring and sandeel), these extend over a wide area across the Western Irish Sea Fish and Shellfish Ecology Study Area. The relative proportion of these habitats affected by piling operations at any one time will therefore be small in the context of the wider habitat available. Further, the duration of piling (i.e. piling being intermittent events occurring on up to 26 days during the construction phase) is also a relatively short term and temporary disturbance in the context of spawning seasons for these species.

As set out in chapter 9: Fish and Shellfish (EIAR volume 2B), increased tolerance (and decreased sensitivity) to underwater sound may occur for some fish and shellfish during key life history stages, such as spawning or migration. This was demonstrated in an investigation into the impact of impulsive seismic air gun surveys on feeding herring schools, which found a slight but not significant reduction in swimming speed when exposed to the sound impact (Peña *et al.*, 2013). The findings of this survey indicated that feeding herring did not display avoidance responses to seismic sound sources, even when the vessel came into close proximity to herring, which indicated an awareness of and response to impulsive anthropogenic sound, which would be expected in response to piling, but not a significant response when fish were highly motivated to remain within an area – in this case during feeding, but potentially also in spawning. Herring are known to be highly sensitive to underwater sound, due to possessing ancillary hearing structures which involve gas ducts extending into the skull, which allows detection of extremely high frequency sounds (Mann *et al.*, 2001). Herring have been found to exhibit significant but reversible diving reactions when exposed to sounds up to 168 dB re 1 µPa SPL in response to sonar sound sources (Doksæter *et al.*, 2012), which is above the 160 dB re 1 µPa $SPL_{peak}$ behavioural threshold used in the modelling.

With regard to herring spawning, another example of herring showing some tolerance to underwater sound (other than Peña *et al.*, 2013) is from a spawning herring survey undertaken whilst piling was occurring at the Gunfleet Sands offshore wind farm within the relatively enclosed environment of the Thames estuary. Aggregations of spawning herring were caught within 10 to 15 km of active piling on the spawning grounds at Eagle Bank and Colne Bar, thus indicating that spawning was not entirely disrupted by piling at Gunfleet Sands offshore wind farm. This study suggests that herring's biological driver to use these grounds to spawn may have overridden the potential behavioural effects of percussive piling sound on herring (Brown and May Marine Ltd, 2009).




## Legend

- Application Boundary

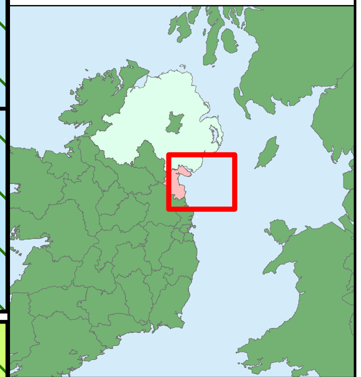
Spawning Grounds (Ellis *et al.*, 2012)

- High Intensity
- Low Intensity

Nursery Grounds (Ellis *et al.*, 2012)

- High Intensity (Ellis *et al.*, 2012)
- Low Intensity (Ellis *et al.*, 2012)
- West Noise contours: dB re 1 μPa (SPLpeak)

**Data Sources:** Ellis et al 2012, Coull, K.A., Johnstone, R, and Rogers, S.I. (1998)



**Client**

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

**Project**

**Oriel Wind Farm Project**

**Title** **Figure 9A-1 Modelled underwater noise levels (peak pressure) associated with installation of monopiles within the offshore wind farm area and identified key fish spawning and nursery areas**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*Issue Details*

| | | | |
|---|---|---|---|
| Drawn By: | MJ | Project No. | MC000038 (MDR1520C) |
| Checked By: | MJ | File Ref: | |
| Approved By: | TH | | MC000038_FAS_E_1205_FINAL |
| Scale: | 1:750,000 @ A4 | Projection: | ITM (IRENET95) |
| Date: | 09/12/2025 | | Geographic Co-ordinates: ETRS89 |

NOTE:
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
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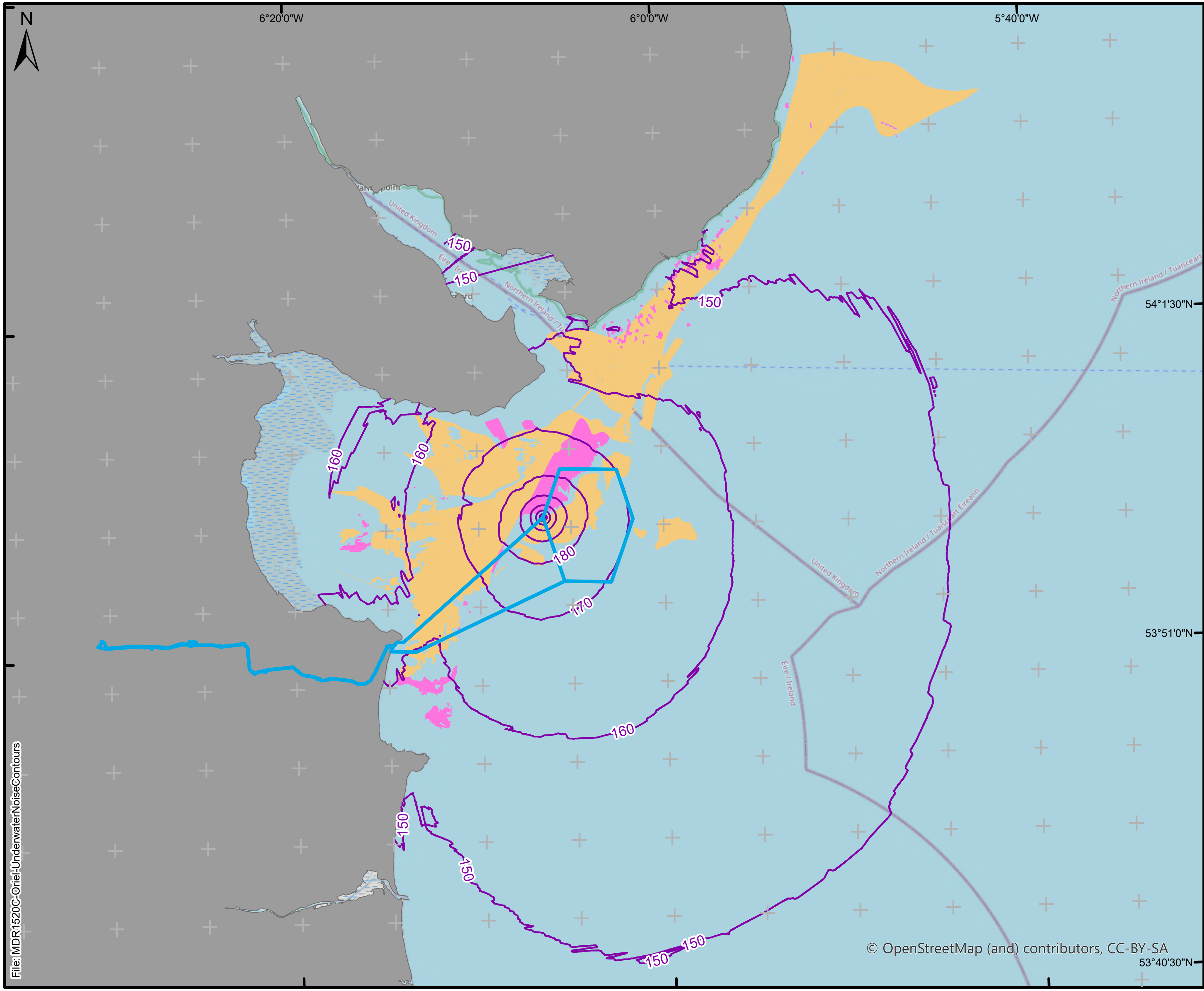


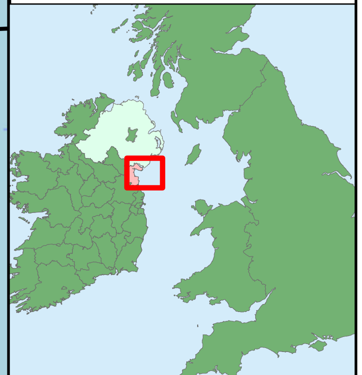

## Legend

- Application Boundary
- West Noise contours: dB re 1 µPa (SPLpeak)

EU SeaMap (2023) - MSFD Broadscale Habitat Types

- Coarse sediments
- Rock and biogenic reef

**Data Sources:** Client. EMODnet, Seiche



**Client**

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

**Project**

**Oriel Wind Farm Project**

**Title Figure 9A-2**
**Potential Herring Spawning Grounds within the Fish and Shellfish Ecology Study Area overlapping with underwater noise levels from installation of monopiles**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*Issue Details*

| | |
|---|---|
| **Drawn By:** MJ/LM | **Project No.** MDR1520C |
| **Checked By:** KL | **File Ref:** |
| **Approved By:** KL | MDR1520C-UWN-003-01_FINAL |
| **Scale:** 1:300,000 @ A4 | **Projection:** ITM (IRENET95) |
| **Date:** 18/08/2025 | Geographic Co-ordinates: ETRS89 |

With specific reference to spawning grounds in the vicinity of the Project, there is potential for piling activities to affect herring spawning activities in the Mourne spawning grounds which extend throughout the Fish and Shellfish Ecology Study Area, inshore towards Dundalk Bay and north along the coast of Northern Ireland (see appendix 9-2: Herring Spawning Technical Report (EIAR volume 2B)). While there would be some overlap between noise emissions and these coarse sediment and rock and biogenic reef spawning habitats (as defined by areas of coarse sediment and rock and biogenic reef; see Figure 9A-2), any effects of noise would be short term, temporary and entirely reversible. This may include avoidance behaviour during piling (noting the Peña *et al*., 2013 study above which indicated that herring may tolerate some noise in some circumstances) but normal behaviour will return following cessation of piling. Furthermore, this disruption to herring spawning would only occur if piling occurs during the spawning season and would be limited in duration (i.e. up to 26 discreet piling events and up to 26 days piling). The herring spawning period for the Mourne stock has been broadly identified in appendix 9-2: Herring Spawning Technical Report (EIAR volume 2B) as occurring between mid-August to early March in the north and western Irish Sea. This was refined to a spawning period of September to November (ICES., 2013), supporting previously work by Coull *et al.* (1998) which identified a September to October peak herring spawning period for the Mourne stock. As set out above, any impacts on spawning herring (should piling occur during the peak spawning period) will be intermittent and short-term, with recovery to baseline conditions expected following cessation of piling. This would include potential behavioural effects affecting the ability of spawning herring to access favourable spawning habitats (e.g. barrier effects). While these effects may occur, any effect would be short term and temporary and would not affect the success of spawning across the Mourne spawning grounds.

The behavioural effects from the underwater noise, at the levels expected as a result of the pile driving for the Project, are likely to be limited for diadromous fish species, which could have the potential to experience barrier effects to their migration if impacted by underwater noise from piling. As noted in the paragraphs above, Figure 9A-1 indicates the noise contours associated with piling operations at the maximum hammer energy, with noise levels in excess of 160 dB re 1 µPa $SPL_{peak}$, are expected to lead to behavioural effects on fish, including diadromous fish (noting that species such as Atlantic salmon are expected to have relatively low sensitivity to noise). Broadly, the range at which these behavioural responses are likely to occur is approximately 13 km to 22 km from the noise source and as demonstrated in Figure 9A-1 and Figure 9A-2, with this only extending to small sections of the coast at the greatest hammer energies (i.e. lower hammer energies would result in smaller contours). Therefore, there is a large area still available for diadromous fish to navigate along the coast, whilst mostly avoiding the noise source, when migrating to and from rivers in which these species may spawn (e.g. River Boyne and River Blackwater SAC and other non-SAC rivers on the east coast of Ireland). This, combined with the intermittent and short term nature of piling noise, indicates there is a very low potential for diadromous species to experience barrier effects to migration when moving from freshwater systems into and within the marine environment.

**Summary**

Therefore, given the varying levels of sensitivity associated with identified fish IEFs when modelled as both moving and static receptors, fish groups 2, 3 and 4, which include salmonids, scombridae, gadoids, eels, herring, sprat and shads, are deemed to be of medium to high vulnerability, medium recoverability and of local to international importance within the Fish and Shellfish Ecology Study Area. The sensitivity of all of these fish receptors (whether moving or static) is therefore considered to be medium, which aligns with the conclusions of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

Fish group 1 (elasmobranchs and flatfish), modelled as both moving and static receptors, are deemed to be of low vulnerability, medium recoverability and of local to regional importance within the Fish and Shellfish Ecology Study Area. The sensitivity of these fish receptors is therefore considered to be low.

Shellfish species are likely to experience short term localised, sub lethal physiological and behavioural effects from piling activities, although changes to population size and structure are considered unlikely.

All shellfish species are considered to have low vulnerability, high recoverability and of local to national importance within the Fish and Shellfish Ecology Study Area. The sensitivity of these shellfish receptors is therefore considered to be low, which aligns with the conclusions of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

### Significance of the effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the fish and shellfish receptors is considered to be low to medium. The effect will, therefore, be of **slight adverse significance**, which is not significant in EIA terms, and which aligns with the conclusions of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

## 9.10.3 Increased suspended sediment concentrations and associated sediment deposition

In response to RFI 10.G, specific consideration of updated marine processes modelling (see chapter 7 Addendum: Marine Processes) has been added to the magnitude of effect section of the impact assessment below.

In response to RFI 10.M, specific justification text has been added to the significance of effect conclusions in all phases. The overall assessment conclusions have remained unchanged from chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

### Construction phase

#### Magnitude of effect

Updated marine processes modelling was carried out and is presented in chapter 7 Addendum: Marine Processes. The updated modelling indicated that much of the drilled material associated with the installation of the monopiles would settle in the immediate vicinity of the installation at maximum levels of 100 mm, and a depth of 0.3 mm of deposition at a range of several hundred metres. This is due to the slow drilling rate of 0.25 m/hour allowing fines to be widely dispersed while larger material settles at the release point.

The installation of offshore cables would lead to distribution of the sediment with an expected deposition depth of less than 20 mm, with the majority of sediment settling close to cable trenches, and final settled depths expected to be less than 5 mm beyond the offshore cable corridor. All other model outputs remained the same and with respect to impacts on fish and shellfish IEFs, the magnitude is unchanged from chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

The increased SSCs and associated sediment deposition is predicted to be of localised spatial extent, short term duration, intermittent and high reversibility due to site hydrodynamics. It is predicted that the impact will affect fish and shellfish receptors directly. The magnitude is therefore, considered to be low.

#### Sensitivity of the receptor

As set out in the EIAR, all fish and shellfish receptors (with the exception of European lobster) within the Fish and Shellfish Ecology Study Area are deemed to be of low vulnerability, high recoverability and of local to international importance. The degree to which species are affected by this impact will depend on life history stages and strategies, with herring eggs deposited on the seabed being more sensitive, while pelagic spawning fish species are less sensitive. Overall, due to the high recovery potential, the sensitivity of the fish and shellfish receptors is therefore, considered to be low, in line with the conclusions reached in the EIAR.

Lobster are deemed to be of medium vulnerability, high recoverability and regional importance in the Fish and Shellfish Ecology Study Area and the sensitivity of the receptor is therefore, considered to be low, in line with the conclusions reached in the EIAR.

#### Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the fish and shellfish receptors is considered to be low. The effect will, therefore, be of **imperceptible to slight adverse significance**, with an **overall imperceptible adverse significance**, which is not significant in EIA terms. This conclusion is based on the rapid dissipation of sediments to background levels reducing the potential for impact on fish and shellfish receptors and the very high recovery potential for all IEFs. This is the same as the significance conclusion reached in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

## Operational and maintenance phase

### Significance of effect

Overall, the magnitude of the impact (e.g. due to cable repair/reburial events) is deemed to be low and the sensitivity of the fish and shellfish receptors is considered to be low. The effect will, therefore, be of **imperceptible to slight adverse significance**, with an **overall imperceptible adverse significance**, which is not significant in EIA terms. This conclusion is based on the rapid dissipation of sediments to background levels reducing the potential for impact on fish and shellfish receptors and the very high recovery potential for all IEFs. This is the same as the significance conclusion reached in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

## Decommissioning phase

### Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the fish and shellfish receptors is considered to be low. The effect will, therefore, be of **imperceptible to slight adverse significance**, with an **overall imperceptible adverse significance**, which is not significant in EIA terms. This conclusion is based on the rapid dissipation of sediments to background levels reducing the potential for impact on fish and shellfish receptors and the very high recovery potential for all IEFs. This is the same as the significance conclusion reached in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

# 9.10.4 Long-term subtidal habitat loss

## Operational and maintenance phase

In response to RFI 10.A, the following paragraph provides clarity on consideration of this impact in the context of the Fish and Shellfish Study Area and the Western Irish Sea Fish and Shellfish Ecology Study Area, which is relevant to both the magnitude of impact and the sensitivity of the receptors.

Impacts of long term habitat loss will be restricted entirely to within the Fish and Shellfish Ecology Study Area (i.e. within project boundaries) and therefore effects on fish and shellfish IEFs would only occur within this area. However, as fish and shellfish IEF occurrence and distribution extends throughout the wider Western Irish Sea Fish and Shellfish Ecology Study Area, this provides some context for long term habitat loss effects. Species which depend on soft sediment environments will lose habitat, but this will only represent a very small proportion of similar habitat available within the Fish and Shellfish Ecology Study Area (i.e. within project boundaries) and the wider Western Irish Sea Fish and Shellfish Ecology Study Area, and therefore the overall loss will be minimal. Also, the introduction of hard substrates will provide habitats for colonisation by hard substrate species and associated fish and shellfish species (discussed below in section 9.10.6).

In relation to some species, such as *Nephrops* and sandeel (both of which are referenced in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), suitable habitats including spawning grounds overlap with the project boundaries but extend beyond the project boundaries into the wider Irish Sea. The proportion of habitats affected within the Fish and Shellfish Ecology Study Area will be very limited (i.e. up to 0.4% of this area) such that there are not predicted to be significant effect on these species. When considering habitats available in the wider Western Irish Sea Fish and Shellfish Study Area the effect is further reduced.

### Sensitivity of the receptor

In response to RFI 10.A, the study area referred to in the following paragraph has been updated to the Fish and Shellfish Ecology Study Area.

European lobster and *Nephrops* are deemed to be of high vulnerability and of regional importance within the Fish and Shellfish Ecology Study Area. The sensitivity of these shellfish receptors is therefore, considered to be medium.

Sandeel are deemed to be of high vulnerability and of regional importance within the Fish and Shellfish Ecology Study Area. Due to the specific habitat requirement of these species, the sensitivity of these fish receptors is considered to be medium.

#### Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of the fish and shellfish receptors is considered to be low to medium. The effect will, therefore, be of **imperceptible or slight adverse significance**, which is not significant in EIA terms. This is unchanged from chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

## 9.10.5 Electromagnetic fields (EMF) from subsea electrical cabling

In response to RFI 10.A, the sensitivity conclusion for the paragraph beginning 'All other fish and shellfish receptors' has been updated to refer to the Fish and Shellfish Ecology Study Area.

In response to RFI 10.H, the assessment has been updated to consider additional recent research which has been summarised in the sensitivity section. The overall conclusion remains the same.

In response to RFI 10.J, all uses of µT have been converted to mG. Also, additional clarification on the CSA (2019) reference has been added to the magnitude section, and a description of the project-specific magnitude has been added. The rest of the assessment remains the same.

In response to RFI 10.M, specific justification text has been added to the significance of effect conclusion in the operational and maintenance phase. The overall assessment conclusion has remained unchanged from chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

### Operational and maintenance phase

#### Magnitude of impact

The presence and operation of inter-array cables and offshore cable within the offshore wind farm area and offshore cable corridor may lead to a localised EMF affecting fish and shellfish receptors. EMF comprise both the electrical (E) fields, measured in volts per metre (V/m), and the magnetic (B) fields, measured in microtesla (µT) or milligauss (mG). Background measurements of the magnetic field are approximately 50 µT (or 500 mG) in the North Sea, and the naturally occurring electric field in the North Sea is approximately 25 µV/m (Tasker *et al*., 2010). It is common practice to block the direct electrical field (E) using conductive sheathing, meaning that the EMFs that are emitted into the marine environment are the magnetic field (B) and the resultant induced electrical field (iE). It is generally considered impractical to assume that cables can be buried at depths that will reduce the magnitude of the B field, and hence the sediment-sea water interface iE field, to below that at which these fields could be detected by certain marine organisms on or close to the seabed (Gill *et al*., 2005, Gill *et al*., 2009). By burying a cable, the magnetic field at the seabed is reduced due to the distance between the cable and the seabed surface as a result of field decay with distance from the cable (CSA, 2019).

CSA (2019) found EMF levels directly over live AC undersea power cables associated with offshore wind energy projects range between 65 mG and 5 mG for inter-array cables (34.5 kV or 66 kV, and 155 to165 mm in diameter) respectively and 165 mG and 10 mG for export cables (138 kV to 230 kV, and 20 cm to 30 cm in diameter), at heights of 1 m above the seabed and at the seabed surface, respectively. At lateral distances of between 3 m and 7.5 m from the cable, magnetic fields greatly reduced to between 10 mG and <0.1 mG for inter-array cables, and 15 mG and <0.1 mG for export cables, at heights of 1 m above the seabed and at the seabed surface, respectively.

The induced electric fields directly over live AC undersea power cables ranged between 1.7 mV/m and 0.1 mV/m for inter-array cables and 3.7 mV/m and 0.2 mV/m for export cables, at heights of 1 m above the seabed and at the seabed surface, respectively. At lateral distances of between 3 m and 7.5 m electric fields reduced to between 0.01 mV/m and 1.1 mV/m for inter-array cables and 0.02 mV/m and 1.3 mV/m for export cables at heights of 1 m above the seabed and at the seabed surface respectively.

As detailed in Table 9A-3, the Project will operate up to 41 km of 66 kV inter-array cables and up to 16 km of 220 kV offshore export cables, buried up a depth of between 0.5 m and 3 m where practical. Cable protection may be required along 50% of the length of both cable types. As such, the reported EMF levels from CSA (2019) are broadly comparable to those anticipated from the Project.

The impact therefore is predicted to be of local spatial extent (i.e. restricted to within Fish and Shellfish Ecology Study Area), long term duration (i.e. the lifetime of the Project), continuous and irreversible during the operational and maintenance phase (recoverability is possible following completion of decommissioning).

It is predicted that the impact has the potential to affect both fish and shellfish receptors directly. The magnitude is therefore, considered to be low.

### Sensitivity of the receptor

As set out above, this section provides an overview of the latest research on the effects of EMF on fish and shellfish which were not available at the time of writing of the EIAR. This is a developing area of research and there are recognised evidence gaps, which are noted by industry groups such as the Scottish Marine Energy Research Programme (Xoubanova and Lawrence, 2022), with recommendations for improving access to fisheries data to understand if displacement of fish and shellfish species occurs due to EMFs, with research ongoing to determine any effects. However, further information is presented here which was not available at the time of EIAR drafting. More recent research has shown both large yellow croaker *Larimichthys crocea* and the black sea bream *Acanthopagrus schlegelii* showing reduced swimming velocity and increased antioxidant enzyme production when exposed to EMF levels of a minimum of 15,000 mG, but this did not impact nutrient absorption capacity and was reversible to baseline conditions within several days (Xu *et al.*, 2025). Also, zebrafish Danio rerio showed increased response times and reduced learning performance when exposed to EMF fields of 600 mG (Ziegenbalg *et al.*, 2025). It should be noted that these EMF levels are considerably higher than those predicted to be associated with buried cables for the Project.

In regard to egg and larvae EMF exposure risks, a recent study found pike and sea trout eggs exhibited increased mortality, but vimba bream *Vimba vimba* and common chub *Leuciscus cephalus* eggs showed no significant change in mortality (Jan and Tański, 2025). This indicates that egg mortality is species-dependent, with this supported by eggs of the Atlantic haddock *Melanogrammus aeglefinus* showing no mortality, malformations, or changes in egg hatching when exposed to a range of EMFs from 1.26 mG, to 503 mG (Guillebon *et al.*, 2025). Similarly, pike *Esox Lucius* embryos were statistically unaffected in terms of spatial distribution and survival by exposure to 0.15 to 1.34 mG EMFs around 110 kV high voltage transmission cables, or EMFs of 5.23 to 9.56 mG around 220 kV cables (Krzystolik *et al.*, 2024). However, significant numbers of hatched larvae exhibited heart rates of over 100 beats per minute, and significant reductions in yolk sac reserves even at the lowest EMF intensity (Guillebon *et al.*, 2025). Similar physical responses were also noted in zebrafish larvae in their first four days of growth, with exposure to EMFs increasing heart rates and reducing sleep periods (Lavinya, 2025).

Specimens of the American mud crab *Rhithropanopeus harrisii* were experimentally exposed to electromagnetic fields for eight days, with oxygen consumption rate, ammonia excretion rates, and haemolymph osmolality measured against baseline controls. The study found that none of these metrics were impacted significantly by either EMFs (Jakubowska-Lehrmann *et al.*, 2025). Table 9A-7 presents updated information on the sensitivity of lobsters and crabs to EMF impacts.

In terms of elasmobranch research, fourteen small-spotted catshark *Scyliorhinus canicula* were exposed to 150 mG AC, 196 mG DC, and control treatments. No startle responses were noted at EMF onset, no altered movement toward or away from the cable was recorded, and crossings only reduced by 25% over the DC EMFs compared to the AC and control trials (Hermans *et al.*, 2025).

Also, the potential of electromagnetic fields to hinder movement of diadromous species into and out of the marine environment is recognised (Lennox *et al.*, 2025), but further research is required to determine the magnitude of this impact (Verhelst *et al.*, 2025). The assessment in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) applied the latest available scientific information in relation to this field of study at the time of drafting. Having regard to the latest research, published following the drafting of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), the overall sensitivity or significance results remain unchanged.

**Table 9A-7: Relationship between geomagnetic field detection, electro-sensitivity, and the ability to detect 50/60-Hz AC fields in common marine fish and shellfish species (adapted from CSA, 2019).**

| Species Group | Detect Geomagnetic Field | Detect Electric Fields | Evidence from Laboratory Studies of 50/60-Hz EMF from AC Power Cables | Evidence from Field Studies of AC Power Cables |
|---|---|---|---|---|
| Lobsters and crabs | Yes, for some lobster species (Lohmann *et al.*, 1995; Hutchison *et al.,* 2018) | Not tested (Normandeau *et al.,* 2011) | No effect at 800,000 µT or 8,000,000 mG (Ueno *et al.,* 1986) | Distribution unaffected by 60-Hz AC cable operating up to 800 mG (Love *et al.*, 2017). |

Note: the only change to this table from Table 9-19 in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) is the presentation of EMFs in both μT and mG for Lobsters and crabs.

Elasmobranch species are deemed to be of medium vulnerability and of local importance in the Fish and Shellfish Ecology Study Area. The sensitivity of the receptor is therefore, considered to be low.

Migratory fish species are deemed to be of medium vulnerability and of regional to international importance in the Fish and Shellfish Ecology Study Area. The sensitivity of the receptor is therefore, considered to be low to medium.

All fish and shellfish receptors are deemed to be of low vulnerability and of local to regional importance in the Fish and Shellfish Ecology Study Area. The sensitivity of these fish and shellfish receptors is therefore, considered to be low.

### Significance of effect

Overall, the magnitude of the impact is deemed to be low and the sensitivity of fish and shellfish including migratory fish receptors is considered to be low to medium. The effect will, therefore, be of **imperceptible to slight adverse significance**, with an **overall slight adverse significance**, which is not significant in EIA terms. This conclusion is based on the dissipation of EMFs to background levels at short distances from the cables as per the best scientific evidence available at the time of drafting. It should be noted that there is some uncertainty with regard to effects of EMFs on some fish and shellfish species, and this ongoing research has been covered in this updated assessment.

## 9.10.6 Colonisation of hard structures

In response to RFI 10.E (iii), the impact of colonisation of hard structures has now been scoped into the assessment included in this Addendum.

Within the offshore wind farm area, sediments are dominated by mud and sand sediment with a smaller proportion of coarse sediments, while the offshore cable corridor is dominated by circalittoral mud and coarse sediment. As such, the introduction of hard substrates due to installation of foundation structures and associated scour protection, and any cable protection, will have an indirect effect on fish and shellfish ecology receptors through the colonisation of these hard substrates (i.e. through provision of new habitats which attract fish and shellfish IEFs).

## All phases

### Magnitude of impact

Colonisation of hard structures is expected to occur directly on all introduced structures, including monopile foundations, associated scour protection and cable protection associated with inter-array cables and offshore cables. As set out in Table 9A-3, the project design estimates up to 356,807 $m^2$ of habitat created due to installation of these infrastructures. These hard structures will represent areas upon which colonisation of epifaunal species may occur. Specifically, it is expected that the foundations and cable protection will be colonised by epifaunal species already occurring within the area, such as tunicates, bryozoans, mussels, and barnacles, and these benthic colonising species will likely attract increased abundances of demersal and pelagic fish and shellfish species.

The colonisation of artificial hard structures has implications for fish and shellfish species in UK waters. These structures introduce novel substrates into predominantly soft-sediment environments, altering habitat availability and therefore potentially impacting community composition through the introduction of artificial reefs (Rouse *et al.*, 2020). Sessile benthic organisms, such as barnacles, mussels, and bryozoans (Sebens, 1991), often rapidly colonise these surfaces, outcompeting native soft-bottom species for space and resources (Rouse *et al.*, 2019, Smith *et al.*, 2016), with this providing a food source for fish and shellfish species. This shift can lead to a change in benthic communities and a reduction in benthic biodiversity, but a potential increase in fish and shellfish biodiversity (Bender *et al.*, 2020) due to increased feeding opportunities in the newly introduced heterogenous environment (Langhamer, 2012), particularly in areas where natural hard substrates are scarce. Also, herring spawning is associated with coarse gravel, small stone, and shell fragments (Service, 2007), which may increase surrounding the new foundations following the establishment of mollusc species around turbines (e.g. mussel shells which may accumulate around turbines/scour protection providing additional spawning habitat).

The impact is considered to be of local spatial extent (restricted to within the Fish and Shellfish Ecology Study Area), long term duration (the lifetime of the Project), continuous and irreversible during the construction and operational and maintenance phases (recovery to baseline conditions is possible following removal of hard structures during decommissioning). It is predicted that the impact has the potential to affect fish and shellfish receptors indirectly. The magnitude is therefore considered to be low.

#### Sensitivity of the receptor

The sensitivity of species to these changes varies widely depending on their ecological traits. The majority of fish and shellfish species introduced alongside the hard substrata will be typically associated with rocky habitats, and therefore the overall biodiversity of the impacted area may increase (Andersson *et al.*, 2009). This was noted at the Lillgrund offshore wind farm (Bergström *et al.*, 2013) and the Walney offshore wind farm extension, three years post-construction (CMACS, 2014). Vertical relief and complex surfaces can favour filter feeders and predators (Bierwagen *et al.*, 2018), altering trophic dynamics and potentially leading to cascading ecological effects among fish and shellfish species (Moreno-Sánchez *et al.*, 2016). Monitoring at the Lillgrund offshore wind farm found no overall increase in fish numbers, but redistribution of fish was noted towards the foundations and introduced hard infrastructure including cable protection for cod, eel, and eelpout *Zoarcidae* sp. (Andersson and Öhman, 2010).

Recent analysis has found that hard substrata including cable protection structures consistently increase species richness in the long term, with the species composition changing towards a shellfish-dominated hard substrate community (Coolen *et al.*, 2020). Studies on the effects of vertical structures and offshore wind farms on fish and benthic assemblages in the Baltic Sea (Wilhelmsson *et al.*, 2006a, Wilhelmsson *et al.*, 2006b) showed increased abundances of small demersal fish species in the vicinity of structures, and finfish species have a neutral to positive likelihood of benefitting from the introduction of hard substrata (Linley *et al.*, 2007).

The sensitivity of shellfish species, particularly commercially important species like mussels and oysters, is also influenced by biofouling communities that develop on hard structures (Callaway, 2018, Degraer *et al.*, 2020), due to an expansion of their natural habitats substrata (Linley *et al.*, 2007). These communities can alter water flow, nutrient availability, and larval settlement patterns (Karlsson *et al.*, 2022). For instance, post-construction monitoring at Horns Rev offshore wind farm in the North Sea noted that the hard substrata were used as a hatchery or nursery grounds for several shellfish species including edible crab *Cancer pagurus* (Vattenfall, 2006). Also, lobsters, crabs, and demersal fish including cod and wrasse have been noted to use these structures for shelter, feeding, or spawning (Rouse *et al.*, 2020), although this may increase predation risk or suboptimal conditions if abundance increases beyond the natural capacity of the local environment (Karlsson *et al.*, 2022). Despite these potential benefits, consideration needs to be given to species-specific responses and regional ecological baselines to ensure that the introduction and colonisation of hard structures does not negatively impact local habitats.

All fish and shellfish receptors are deemed to be of low vulnerability and of local to international importance within the Fish and Shellfish Ecology Study Area. The sensitivity of these fish and shellfish receptors is therefore considered to be low.

#### Significance of the effect

Overall, the magnitude of the impact is deemed to be low, and the sensitivity of all fish and shellfish receptors is considered to be low. The effect will, therefore, be of **imperceptible to slight beneficial significance** particularly for those species associated with hard substrates, with an **overall significance of at worst imperceptible benefit**, which is not significant in EIA terms. This is due to the minor change in substrates (hard substrates are known to occur in the area) leading to a relatively limited change in fish and shellfish IEFs in the Fish and Shellfish Ecology Study Area.

### 9.10.7 Disturbance to fish from underwater noise generated by vessels, wind turbines, and geophysical survey noise

As part of the response to RFI 10.F (v), the underwater noise impacts to fish from vessels, wind turbines, and geophysical survey noise have now been scoped into the assessment included in this Addendum.

## All Phases

### Magnitude of impact

Underwater noise modelling presented in appendix 10-2: Subsea Noise Technical Report (EIAR volume 2B) showed that underwater noise generated from vessels will be low and effects from noise emissions would only occur if fish species remained within immediate vicinity of the vessel (i.e. within metres) for a period longer than 12 hours, which is highly unlikely. As such, there is little potential for significant effects (either injury or behavioural disturbance) on fish and shellfish receptors from this impact during all phases.

Noise generated by operational wind turbines is of a very low frequency and low sound pressure level (Andersson *et al.*, 2011). Studies have found that sound levels are only high enough to possibly cause a behavioural reaction within metres from a wind turbine (Andersson *et al.*, 2011, Sigray and Andersson, 2011) and therefore such levels are unlikely to have potentially significant effects on fish and shellfish receptors. This was confirmed by site specific underwater noise modelling (appendix 10-4: Updated Subsea Noise Modelling Report (EIAR volume 2B Addendum), which demonstrated that where effects would occur (e.g. injury or behavioural effects), these would be limited to within a few metres from the operational wind turbines (where effects occur at all). As such, there is no potential for significant effects on fish and shellfish receptors from operational turbines during the operational and maintenance phase.

Routine geophysical surveys are planned to allow inspection of offshore infrastructure foundations, inter-array cables and export cables during the operational and maintenance phase, and these have the potential to cause direct or indirect effects (including injury or disturbance) on fish and shellfish IEFs. There are no thresholds in relation to noise from high frequency sonar (>10 kHz, as typically used in geophysical surveys) included in Popper *et al*., (2014). This is because the hearing range of fish species falls well below the frequency range of high frequency sonar systems. Consequently, it is not anticipated that there will be any significant effects (injury or behaviour) of noise from high frequency geophysical surveys on fish and shellfish receptors as these are likely to be outside their hearing range.

As set out above, effects of noise from vessels, operational turbines and geophysical surveys (should any occur) are expected to be highly localised spatial extent, short term duration (for any individual activity in any phase), intermittent and high reversibility following cessation of activities. It is predicted that the impact will affect fish and shellfish receptors directly or indirectly dependent on species life strategies. The magnitude is considered to be negligible.

### Sensitivity of receptor

Underwater noise can potentially negatively impact fish species through physical injury and/or behavioural effects. Although adult fish are highly mobile and are generally able to vacate the area and avoid physical injury if they are out with the immediate vicinity of the noise generating activity, larvae and spawn are not highly mobile and are therefore more susceptible to injury from sound energy.

As set out in section 9.10.2 of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) where sensitivity of fish to underwater noise is discussed in detail, for assessing the effects of underwater noise on fish the most relevant criteria are considered to be those contained in Popper *et al.* (2014), with these guidelines setting out numerical criteria for injury due to difference sources of noise (see appendix 10-2: Subsea Noise Technical Report (EIAR volume 2B) and appendix 10-4: Updated Subsea Noise Modelling Report (EIAR volume 2B Addendum). Where insufficient data exists to determine a quantitative threshold value, the risk is categorised in relative terms as high, moderate, or low, at three distances from the source: near (in the tens of metres), intermediate (in the hundreds of metres), or far (in the thousands of metres).

Table 9A-8 below sets out guidelines for injury thresholds from non-impulsive noise such as vessel noise as set out in Popper *et al.* (2014).

**Table 9A-8: Guideline criteria for injury in fish due to non-impulsive noise (Popper *et al.*, 2014).**

| Type of animal | Mortality and potential mortal injury | Recoverable injury | TTS |
|---|---|---|---|
| Fish: no swim bladder (particle motion detection) | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Moderate<br>(Intermediate) Low<br>(Far) Low |
| Fish: where swim bladder is not involved in hearing (particle motion detection) | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Moderate<br>(Intermediate) Low<br>(Far) Low |
| Fish: where swim bladder is involved in hearing (primarily pressure detection) | (Near) Low<br>(Intermediate) Low<br>(Far) Low | 170 dB re 1 µPa (rms) for 48 hours | 158 dB re 1 µPa (rms) for 12 hours |
| Eggs and larvae | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Low<br>(Intermediate) Low<br>(Far) Low | (Near) Low<br>(Intermediate) Low<br>(Far) Low |
| Notes: Range of effect classified as Near = tens of metres / Intermediate= hundreds of metres / Far = thousands of metres. Relative risk classified as high, moderate or low | | | |

The Popper *et al.* (2014) guidelines also set out criteria for disturbance from different noise sources, with the risk of behavioural effects categorised as high, moderate, or low, with distances from the source recorded as near (in the tens of metres), intermediate (in the hundreds of metres), or far (in the thousands of metres) (see Table 9A-9 for criteria for non-impulsive sound).

**Table 9A-9: Guideline criteria for onset of behavioural effects in fish due to non-impulsive sound (Popper *et al.*, 2014).**

| Type of Animal | Relative Risks of Behavioural Effects |
|---|---|
| Fish: no swim bladder (particle motion detection) | (Near) Moderate<br>(Intermediate) Moderate<br>(Far) Low |
| Fish: where swim bladder is not involved in hearing (particle motion detection) | (Near) Moderate<br>(Intermediate) Moderate<br>(Far) Low |
| Fish: where swim bladder is involved in hearing (primarily pressure detection) | (Near) High<br>(Intermediate) Moderate<br>(Far) Low |
| Eggs and larvae | (Near) Moderate<br>(Intermediate) Moderate<br>(Far) Low |

A number of fish species have spawning and nursery grounds overlapping the Fish and Shellfish Ecology Study Area, and these may be sensitive to underwater noise from vessels, operational wind turbines, and geophysical surveys.

Of highest sensitivity to underwater noise are species such as herring (clupeids) and cod (gadoids) where swim bladder is involved in hearing. These species are most susceptible to barotrauma from underwater noise. There are spawning areas for herring and cod within the Fish and Shellfish Ecology Study Area and overlapping with the Project, but any areas potentially impacted by these noise sources represent a negligible area compared to the extensive spawning and nursery grounds within the project boundaries and the wider Western Irish Sea Fish and Shellfish Ecology Study Area.

Atlantic salmon and sea trout also have swim bladders; however, these are not involved in hearing. They are still susceptible to barotrauma, but less so in comparison to clupeid and gadoid species. Flatfishes, such as plaice, mackerel, sandeels, elasmobranchs and shellfish do not have swim bladders so have low sensitivity to underwater noise as they are less susceptible to barotrauma. However, as set out above the scale of effects of these noise sources would be negligible in the context of the available habitats for these species and there is no risk of significant effects (injury or behavioural) on any fish or shellfish species from these noise sources.

Fish and shellfish species IEFs are deemed to be of low vulnerability, high recoverability, and local to international importance. The sensitivity of the receptor is therefore considered to be low.

#### Significance of the effect

Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the fish and shellfish species IEFs is considered to be low. The effect will, therefore, be of **imperceptible or slight significance**, with an **overall imperceptible adverse significance**. This conclusion is based on the scale of effects which would be restricted to the immediate vicinity of any noise sources, should any effects occur at all.

### 9.10.8 Mitigation and residual effects

The updated assessments presented above remain unchanged from the overall conclusions reached in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B) with respect to significance of effects on fish and shellfish receptors and therefore no further mitigation is required for any of the impacts identified above.

Despite the assessment of injury and/or disturbance to fish 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.

The Project will use a drive-drill methodology for the monopile installation which minimises the piling duration. For each monopile, a sacrificial casing will be piled into place to stabilise the upper unconsolidated sediments. A rotary drill is then inserted inside the sacrificial casing which will drill down to the full embedment depth required for the monopile. The drill will then be removed and the monopile inserted and grouted into place.

For the short duration of impact piling of the sacrificial casing, the Project proposes to use the MODIGA (as described in chapter 5 Addendum: Project Description) with an internal air bubble ring as its noise abatement solution (see appendix 10-8: Comprehensive Review of Relevant Mitigation (Noise Abatement) (EIAR volume 2B Addendum)). The system manufacturer states that the MODIGA fitted with an internal air bubble ring can provide underwater noise reduction during piling. The MODIGA 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: Comprehensive Review of Relevant Mitigation (Noise Abatement) (EIAR volume 2B Addendum)). 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 (EIAR volume 2B Addendum)).

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 (EIAR volume 2A)), however, at present there is no data available to allow the Project to undertaken noise modelling to specifically demonstrate the potential noise reductions. However, 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 (EIAR volume 2B Addendum)) and therefore, taking the theoretical considerations into account and the manufacturer’s technical statement, the Project is confident that the MODIGA technology will also provide suitable mitigation for piling.

The Project is committed to undertaking subsea noise monitoring during installation of the monopiles to confirm the noise abatement achieved by the proposed MODIGA casing technology as outlined in appendix 5-16: Monitoring Programme (EIAR volume 2A).

In addition, to further reduce disturbance to spawning herring during the construction phase, piling activities will be scheduled to avoid piling in the northwest corner of the offshore wind farm area during the key spawning period for herring (i.e. September and October; (ICES., 2013; 1998). This would reduce impacts on areas of coarse sediment (preferred habitat for herring spawning) known to occur in this part of the offshore wind farm area (see Figure 9A-2). As set out in section 9.10.7 of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B), surveys of herring spawning activity will also be undertaken pre, during and post construction which will help to further refine the spawning period and distributions which will inform scheduling of construction operations during the peak herring spawning period.

### 9.10.9 Future monitoring

The updated assessment of effects has not changed the overall assessment of all impacts on fish and shellfish receptors and therefore no future monitoring is required for this impact beyond those set out in section 9.10.7 of chapter 9: Fish and Shellfish Ecology (EIAR volume 2B). The Applicant is committed to monitoring during all phases of the Project and further details are provided in the Monitoring Programme (see appendix 5-16: Monitoring Programme in EIAR volume 2A Addendum).

## 9.11 Cumulative Impact Assessment (CIA)

An updated Cumulative Impact Assessment is provided in appendix 3-2 Addendum: Cumulative Impact Assessment Report (EIAR volume 2A Addendum). The assessment concludes that there is no change to the cumulative assessment conclusions provided in chapter 9: Fish and Shellfish Ecology (EIAR volume 2B).

## 9.12 Transboundary effects

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.13 Interactions

There are no changes to EIAR chapter 9: Fish and Shellfish Ecology.

## 9.14 Summary of impacts, mitigation measures and residual effects

Table 9A-10 presents an updated summary of the potential impacts, mitigation measures and residual effects in respect to fish and shellfish including the additional impacts assessed in this Addendum. Changes are shown in blue text.

**Table 9A-10: Summary of potential 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| Temporary subtidal habitat loss/disturbance | ✓ | ✓ | ✓ | None | C: Low<br>O: Negligible<br>D: Low | Low to medium | C: Slight adverse<br>O: Imperceptible adverse<br>D: Slight adverse | None | C: Slight adverse<br>O: Imperceptible adverse<br>D: Slight adverse | None |
| Injury and/or disturbance to fish from underwater noise during pile-driving | ✓ | × | × | During piling operations, soft starts will be used, with lower hammer energies used at the beginning of the piling sequence before increasing energies to the higher levels. | Low | Low to medium | Slight adverse | None | Slight adverse | None |
| Increased suspended sediment concentrations and associated sediment deposition | ✓ | ✓ | ✓ | None | C: Low<br>O: Low<br>D: Low | Low | C: Imperceptible adverse<br>O: Imperceptible adverse<br>D: Imperceptible adverse | None | C: Imperceptible adverse<br>O: Imperceptible adverse<br>D: Imperceptible adverse | None |
| Long-term subtidal habitat loss | × | ✓ | × | None | Low | Low to medium | Imperceptible or slight adverse | None | Imperceptible or slight adverse | None |
| Electromagnetic fields (EMF) from subsea electrical cabling | × | ✓ | × | Burial and protections of cables. | Low | Low to medium | Slight adverse | None | Slight adverse | None |
| Colonisation of hard structures | ✓ | ✓ | ✓ | None | Low | Low | Imperceptible to slight beneficial | None | Imperceptible to slight beneficial | None |
| Disturbance to fish from underwater noise generated by vessels, wind turbines, and geophysical survey noise | ✓ | ✓ | ✓ | None | Negligible | Low | Imperceptible | None | Imperceptible adverse | None |

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