Morven South Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 2, Chapter 9: Fish and Shellfish Ecology

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9 Fish and Shellfish Ecology

9.1 Introduction

9.1.1.1 This chapter of the Morven South Offshore Wind Array Project (hereafter "Morven South") Environmental Impact Assessment (EIA) Report (hereafter, the EIA Report) presents the assessment of the likely significant effects (as per the EIA Regulations as defined in Volume 1, Chapter 2: Policy and Legislation) on fish and shellfish ecology. Specifically, this chapter considers the potential impacts of Morven South seaward of Mean High Water Springs (MHWS) during the construction, Operations and Maintenance (O&M) and decommissioning phases.

9.1.1.2 The assessment presented in this chapter has relied upon, or informed the following technical chapters and reports:

- Volume 2, Chapter 7: Physical Processes;
- Volume 2, Chapter 8: Benthic Subtidal Ecology;
- Volume 2, Chapter 10: Marine Mammals;
- Volume 2, Chapter 11: Ornithology;
- Volume 3, Annex 7.1: Physical Processes Technical Report;
- Volume 3, Annex 8.1: Benthic Subtidal Ecology Shared Technical Report;
- Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report;
- Volume 3, Annex 10.2: Underwater Sound Shared Technical Report.

9.1.1.3 Fish and shellfish ecology was reported on in the Scoping Report for the Morven Option Lease Agreement Site (hereafter, the "Morven Site Scoping Report") (Morven Offshore Wind Limited (MvOWL), 2023). As described in Volume 1, Chapter 4: Site Selection and Consideration of Alternatives, the Morven Option Lease Agreement Site has since been divided into two smaller projects, Morven South and Morven North.

9.1.1.4 The potential impacts to fish and shellfish ecology are considered to generally be the same (or less) for Morven South as identified in the Morven Site Scoping Report. Consequently, there has been no change in the methodology or impacts that were scoped in or out in the Morven Site Scoping Report for fish and shellfish ecology. The advice provided by the Marine Directorate Licensing Operations Team (MD-LOT) in the Morven Site Scoping Opinion (MD-LOT, 2023) relevant to Morven South, has therefore been considered for the development of this chapter.

9.1.1.5 This chapter presents and assesses up-to-date parameters for Morven South and explains if and how any assessment aspects differ from the information set out in the Morven Site Scoping Report.

9.2 Study areas

9.2.1.1 Two study areas have been defined for fish and shellfish ecology (Figure 9.1):

- The Morven South Fish and Shellfish Ecology Study Area, which includes the Morven South Boundary plus a buffer extending from 5km to 14km around the Morven South Boundary. This buffer encompasses the area surveyed during the site specific benthic survey campaign, has been used to inform the baseline, within and in the immediate vicinity, of the Morven South Boundary.
- The Regional Fish and Shellfish Ecology Study Area is defined by a 100km buffer zone around the Morven South Boundary and Morven North Boundary. This 100km buffer zone was considered to encompass any direct and indirect impacts (including underwater sound from piling) and to characterise the fish and shellfish ecology baseline. This buffer zone also encompasses the Forth and Tay Scottish Marine Region (SMR) waters; desk-based data collated within this region has been used to inform the baseline description for coastal fish and shellfish receptors such as diadromous fish. As illustrated in Figure 9.1, landmasses have been excluded from the Regional Fish and Shellfish Ecology Study Area. However, as diadromous

fish migrate between the marine environment and freshwater habitats, it should be noted that it also includes rivers and other freshwater habitats flowing into it to account for the life histories of diadromous species. Any freshwater-resident fish species within the rivers and freshwater habitats along the coast of the Regional Fish and Shellfish Ecology Study Area are, however, out with the scope of this assessment.

9.2.1.2 In the Morven Site Scoping Report (MvOWL, 2023), the Regional Fish and Shellfish Ecology Study Area extended to the boundary of the Charting Progress 2 Northern North Sea region, which extends out to the boundary of the Northern North Sea (Marine Scotland, 2025). Since Scoping, the Regional Fish and Shellfish Ecology Study Area has been reduced, based upon expert opinion, and to align with the largest potential ZoI (i.e. the ranges modelled for underwater sound effects; see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report and Section 9.11.3) and the potential for interactions with migratory species. This was supported during the Quarter 1 (Q1) 2025 targeted consultation to MD-LOT.

9.2.1.3 The study areas for fish and shellfish ecology for the Morven Option Lease Agreement Site (hereafter the “Morven Site”) were presented and agreed during the scoping process for the Morven Offshore Wind Project. The study areas for Morven South for fish and shellfish ecology were presented to and confirmed by the MD-LOT via a “Targeted Consultation Exercise” undertaken in Q1, 2025 and as detailed in Table 9.6.

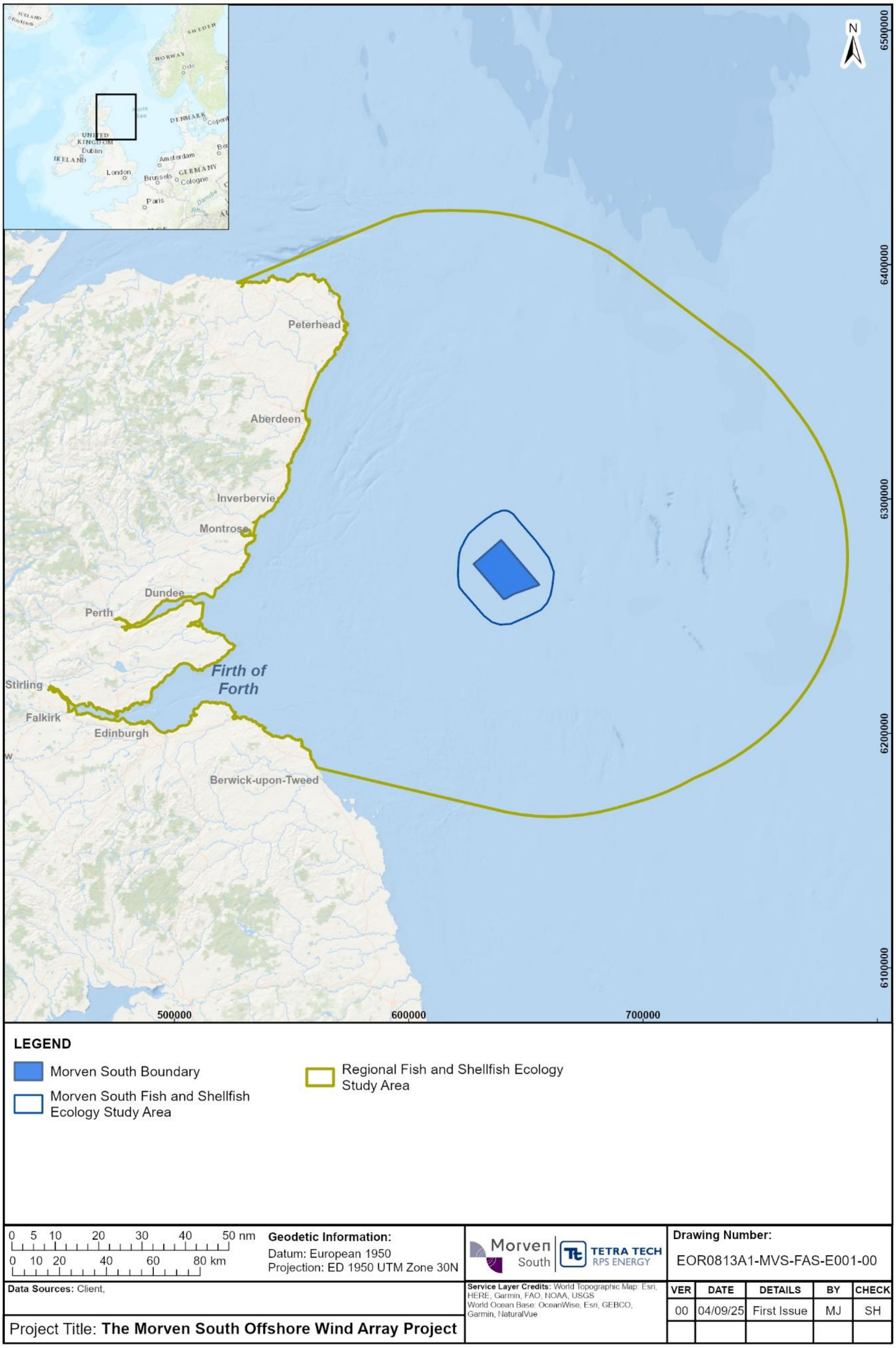

Figure 9.1: The Morven South and Regional Fish and Shellfish Ecology Study Areas

9.3 Legislative and policy context

9.3.1.1 Policy and legislation on renewable energy infrastructure is presented in Volume 1, Chapter 2: Policy and Legislation. Policy and legislation specific to fish and shellfish ecology is contained in the Marine and Coastal Access Act (MCAA) 2009, the Habitats Regulations, Scotland's National Marine Plan, the Sectoral Marine Plan (SMP),the United Kingdom (UK) Marine Policy Statement and others. A summary of the legislative provisions relevant to fish and shellfish ecology are provided in Table 9.1 below, with other relevant policy provisions set out in Table 9.2 to Table 9.6.

Table 9.1: Summary of legislation relevant to fish and shellfish ecology

Summary of relevant legislation	How and where considered in the EIA report
MCAA 2009 Marine Protected Areas (MPAs) (Scottish waters) and Marine Conservation Zones (MCZs) (English waters) existing beyond the 12nm limit are designated under the MCAA 2009. MPAs and MCZs are areas that have been designated for the purpose of conserving marine flora and fauna, marine habitats, and features of geological or geomorphological interest (Section 117 of the MCAA 2009).	All relevant MPAs in Scottish offshore waters (beyond 12nm) are listed in Section 9.7.3 and further described in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report. The fish and shellfish features of these MPAs have been assessed for Morven South alone and cumulatively in Sections 9.11 and 9.13. No MCZs designated for fish and shellfish features were identified in the Regional Fish and Shellfish Ecology Study Area (see Section 9.7.3).
Habitats Regulations Before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which is likely to have a significant effect on a European offshore marine site or a European site (either alone or in combination with other plans or projects), and is not directly connected with or necessary to the management of the site, a competent authority must make an appropriate assessment of the implications of the plan or project for that site in view of that site's conservation objectives.	All relevant designated sites are listed in Section 9.7.3, along with their proximity to the Morven South Boundary. The relevant fish and shellfish features of these designated sites have been assessed for Morven South alone and cumulatively in Sections 9.11 and 9.13. Adverse effects on integrity of European sites with relevant fish and shellfish features have been assessed in accordance with the Habitats Regulations in the Report to Inform Appropriate Assessment (RIAA) (Report to Inform Appropriate Assessment Part 2: Special Area of Conservation (SAC) Assessments).
The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention; 1979) The principal aims of the Convention are to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention).	These acts and conventions have been used to determine Important Ecological Feature (IEF) status for fish and shellfish ecology. Fish and shellfish species listed under these laws and conventions have been assigned as international or national importance depending on the different legislation that applies to them (see Section 9.7.4).
The Wildlife and Countryside Act 1981 (as amended) The Wildlife and Countryside Act 1981 was enacted primarily to implement the Birds Directive and Bern Convention in Great Britain.	
The Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention 1979) This convention was adopted in Bonn, Germany, on 23 June 1979, and entered into force on 1 November 1983. The Bonn Convention brings together the States through which migratory animals pass, the	

Summary of relevant legislation	How and where considered in the EIA report
Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.	
Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 This Act is the key governing legislation for Scotland's district salmon fishery boards, and it sets out the provisions for the constitution, composition and financing of the boards. It is also the framework for a number of other important regulatory areas, including legal methods of fishing and offences, close times, local regulatory measures, protection of juvenile and spawning salmon, passage of salmon, and general powers relating to appointment of water bailiffs and enforcement of salmon and freshwater fisheries law.	
The International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) 2004 This is an international maritime treaty which requires signatory flag states to ensure that ships flagged by them comply with standards and procedures for the management and control of ships' ballast water and sediments.	Compliance with this convention will be undertaken by all vessels associated with Morven South as an industry standard. This is considered in the designed-in mitigation for Invasive Non-Native Species (INNS), see Section 9.10.
Marine Strategy Framework Directive (Directive 2008/56/EC) 2008 The Marine Strategy Framework Directive is a European Directive originally aimed at achieving or maintaining Good Environmental Status (GES) in European marine regions and sub-regions.	A range of GES descriptors are relevant to this chapter: • Descriptor 1: Marine biodiversity; • Descriptor 4: Food webs; • Descriptor 6: Seabed integrity; • Descriptor 11: Energy, including underwater sound. Under this directive, each of these descriptors has a range of goals and targets required to achieve GES. It could be assumed that as all impacts have been concluded as not significant in EIA terms, then Morven South would be acting in a way in which maintains GES, with regards to fish and shellfish ecology.
Marine Strategy Regulations 2010 These regulations require action to be taken to achieve or maintain GES in UK seas.	
The Sandeel (Prohibition of Fishing) (Scotland) Order 2024 Prohibits sandeel fishing in Scottish waters.	This act has been considered as part of the future baseline scenario in Section 9.7.5, as it could impact sandeel populations (and species dependent on them) in the future.

Table 9.2: Summary of provisions within Scotland's National Marine Plan of relevance to fish and shellfish ecology (Scottish Government, 2015)

Summary of relevant policy	How and where considered in the EIA report
Chapter 4: General policies	
General Policy 5 (Climate Change): Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.	The impact of climate change on the fish and shellfish ecology baseline has been considered in Section 9.7.5. Further assessment on climate change in general is presented in Volume 2, Chapter 18: Climate Change.
General Policy 9 (National Heritage) of the National Marine Plan requires that development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species; (b) Not result in a significant impact on the national status of Priority Marine Features (PMFs); and (c) Protect and, where appropriate, enhance the health of the marine area.	Protected fish and shellfish species (including PMFs) within the Regional Fish and Shellfish Ecology Study Area are detailed in Table 9.15. The potential for Morven South to impact the national status of PMFs has been incorporated into Section 9.11 and 9.13.
General Policy 9 (National Heritage) paragraph 4.47 of the National Marine Plan: The Marine Acts place a duty on all regulators to ensure that there is no significant risk of hindering the achievement of the conservation objectives of an MPA before giving consent to an activity. Where an ongoing activity presents a significant risk of hindering the achievement of the conservation objectives of an MPA there will be a management intervention. This intervention will be practical and proportionate, utilising the most appropriate statutory mechanism to reduce the risk	Sections 9.11 and 9.13 present assessments of the significance of the effects of Morven South alone and cumulatively on fish and shellfish ecology receptors, including on the features of the relevant designated sites, such as MPAs.
General Policy 10 INNS: Opportunities to reduce the introduction of INNS to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.	Designed-in mitigation measures are detailed in Table 9.20, and include the development of and adherence to an Environmental Management Plan (EMP). This will include actions to minimise INNS and will be submitted as part of the application.
General Policy 21 Cumulative impacts: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.	Section 9.13 assesses the significance of the effects of Morven South cumulatively with other plans and projects.
Chapter 8: Wild salmon and diadromous fish	
WILD FISH 1: The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making.	Sections 9.11 and 9.13 include assessments of the significance of the effects of the Morven South (alone and cumulatively) on diadromous fish species.

Table 9.3: Summary of the Sectoral Marine Plan and Draft Sectoral Marine Plan for Offshore Wind Energy relevant to fish and shellfish ecology (Scottish Government, 2020, 2025)

Summary of relevant policy	How and where considered in the EIA report
General policies	
The potential adverse effects on other marine users, economic sectors and the environment resulting from further commercial scale offshore wind development should be minimised.	The potential for adverse effects on the identified fish and shellfish receptors have been considered fully in Sections 9.11 and 9.13, with consequent effects on other environmental receptors (e.g. marine mammals and ornithology) and commercial fisheries considered in Volume 2, Chapters 10, 11 and 12 (Marine Mammals, Offshore Ornithology and Commercial Fisheries, respectively).
Draft SMP from 2025	
Plan level effects on migratory fish, including from displacement and physical injury, have been identified across all option areas individually and cumulatively with other developments. However, uncertainty, in part related to an inability to identify connectivity back to individual natal rivers once species are in the marine environment, means that detailed assessment of impacts is expected at the project level.	The potential for barriers to migration to and from natal rivers for diadromous fish has been considered throughout the assessment for Morven South, in Sections 9.11 and 9.13.

Table 9.4: Summary of the United Kingdom Marine Policy Statement relevant to fish and shellfish ecology (UK Government, 2011)

Summary of relevant policy	How and where considered in the EIA report
Ensure a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species and our heritage assets.	The potential for adverse effects on fish and shellfish receptors has been considered fully in Sections 9.11 and 9.13 for Morven South alone and cumulatively with other plans and projects.
The marine environment plays an important role in mitigating climate change.	The impact of climate change on the fish and shellfish ecology baseline has been considered in Section 9.7.5. Further assessment on climate change in general is presented in Volume 2, Chapter 18: Climate Change.
Biodiversity is protected, conserved and where appropriate recovered and loss has been halted.	The potential for adverse effects on the biodiversity of fish and shellfish receptors has been considered fully in Sections 9.11 and 9.13 for Morven South alone and cumulatively with other plans and projects.
Marine businesses are acting in a way which respects environmental limits and is socially responsible.	This chapter considers the possibility for Morven South to restrict environmental limits with regards to fish and shellfish ecology. It could be assumed that as all impacts have been concluded as not significant in EIA terms, then Morven South would be acting in a way in which respects environmental limits, with regards to fish and shellfish ecology.
The use of the marine environment is spatially planned where appropriate and based on an	In terms of an ecosystem approach, the potential for consequent effects on other environmental

Summary of relevant policy	How and where considered in the EIA report
ecosystems approach which takes account of climate change and recognises the protection and management needs of marine cultural heritage according to its significance.	receptors (e.g. marine mammals and ornithology) are considered in Volume 2, Chapters 10 and 11 (Marine Mammals, and Ornithology, respectively). The impact of climate change on the fish and shellfish ecology baseline has been considered in Section 9.7.5. Further assessment on climate change in general is presented in Volume 2, Chapter 18: Climate Change.
Sound evidence and monitoring underpin effective marine management and policy development.	The baseline environment for fish and shellfish ecology has been characterised using sound evidence sources from scientific literature, governmental data, and site-specific survey results (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report).

Table 9.5: Summary of the National Planning Policy Framework 4 (Scottish Government, 2023a)

Summary of relevant policy	How and where considered in the EIA report
Part 2 – National Planning Policy: Climate mitigation and adaptation To encourage, promote and facilitate development that minimises emissions and adapts to the current and future impacts of climate change.	The impact of climate change on the baseline environment and how this may influence the assessment of effects is considered in Section 9.7.5. Further assessment on climate change in general is presented in in Volume 2, Chapter 18: Climate Change.
Part 2 – National Planning Policy: Biodiversity To protect biodiversity, reverse biodiversity loss, deliver positive effects from development and strengthen nature networks.	The potential for adverse effects on the biodiversity of fish and shellfish species within the marine environment has been considered fully in Section 9.11 for Morven South alone and in Section 9.13 for the Whole Project and cumulative assessment.

9.4 Consultation

9.4.1.1 The approach to consultation for Morven South is set out in Volume 1, Chapter 5: Consultation. A summary of the issues raised during consultation activities undertaken to date specific to fish and shellfish ecology is presented in Table 9.6, together with how these issues have been considered in the production of this fish and shellfish ecology EIA Report chapter. Further detail is presented within Volume 3, Annex 5.1: Consultation.

Table 9.6: Summary of key consultation issues raised during consultation activities undertaken for Morven South of relevance to fish and shellfish ecology

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
18 April 2023	NatureScot: Scoping Workshop	Confirmed their agreement with most of the information presented. Recommended the use of two datasets on sandeels: Langton *et al.* (2021) and sandeel modelling data available on the National Marine Plan Interactive (NMPI) mapping platform.	These datasets have been included in the detailed baseline characterisation provided in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report. The latter NMPI data source has been sourced from European Marine Observation and Data Network (EMODnet, 2025).
		Agreed that ocean quahog (*Arctica islandica*) and horse mussel (*Modiolus modiolus*) should be assessed within the benthic ecology chapter.	These species have been assessed in Volume 2, Chapter 8: Benthic Subtidal Ecology.
		Agreed with Fisheries Management Scotland (FMS) regarding the impact of EMF being assessed in the cumulative assessment even if it is of negligible significance in the project alone assessment.	The impact of EMF has been assessed cumulatively with other projects (see Section 9.13.7).
		Agreement on the use of Popper *et al.* (2014) for underwater sound modelling and the use of a 160dB threshold for behavioural disturbance (based on a number of literature sources).	The Popper *et al.* (2014) thresholds have been used in the underwater sound modelling (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report).
30 November 2023	MD-LOT: Scoping Opinion	The Scottish Ministers are broadly content with both of the study areas presented two study areas presented by the Developer and the Developer's proposal to consider ocean quahog and horse mussels within the benthic ecology chapter.	The Regional Fish and Shellfish Ecology Study Area has been refined, based on the Applicant's onexpert opinion and experience of consenting in this region, and to align with the ranges modelled for underwater sound effects (i.e. behavioural, injury and mortality; see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report). This was supported during the Q1 2025 targeted consultation with MD-LOT, see paragraph 9.2.1.2 for more information. Ocean quahog and horse mussel have been assessed in Volume 2, Chapter 8: Benthic Subtidal Ecology.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		The Scottish Ministers highlight the representation from FMS recommending that the River Deveron, River Ugie, River Ythan and River Don are fully considered in the assessment process. The Scottish Ministers request that the Developer considers the FMS representation when compiling the EIA Report.	These rivers flow into the Regional Fish and Shellfish Ecology Study Area (see Figure 9.2), and thus the salmonid features of these rivers are included as part of this assessment. As no significant effects were predicted for diadromous fish within the Regional Fish and Shellfish Ecology Study Area (see Sections 9.11 and 9.13), no significant effects upon the diadromous fish species migrating to and from the Rivers Deveron, Ugie, Ythan, and Don has been concluded. The FMS representation has been considered in the relevant rows of this table.
		The Scottish Ministers advise that more detail on the (Environmental Deoxyribonucleic Acid (eDNA) methodology should be provided prior to commencement of surveys, in line with the NatureScot representation. The Scottish Ministers are content that the majority of relevant data sources have been identified to characterise the baseline however advise to include the additional data sources highlighted in the NatureScot representation.	The additional data sources were considered and incorporated, where relevant, into this chapter and in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report. Regarding the eDNA methodology, all eDNA surveys were completed prior to Scoping, with no further surveys undertaken.
		The Scottish Ministers are broadly content with the impacts scoped in and out; however, advise that the NatureScot representation as regarding underwater noise and vibration, Electromagnetic Fields (EMF) impacts and changes in prey species availability must be fully implemented in the EIA Report. In addition, the Scottish Ministers advise that the Scottish Fishing Federation (SFF) and FMS representations are given full consideration.	The NatureScot recommendation regarding underwater sound and EMF (see relevant rows below) has been considered in the assessment presented in Section 9.11.3 and 9.11.7. The potential impacts upon fish and shellfish receptors assessed in this chapter have informed the impact "changes in prey availability" in Volume 2, Chapter 10: Marine Mammals and Volume 2, Chapter 11: Offshore Ornithology.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
			The SFF and FMS scoping response representations (from 30 November 2023) are detailed in full further down in this table.
		Changes in prey species availability consideration must be given in the EIA Report to ensure that impacts to key prey species and their habitats are considered for the Proposed Development and cumulatively with other offshore wind developments. The Scottish Ministers direct the Developer to NatureScot's advice in this regard and advise that this must be fully addressed and implemented in the EIA Report.	Many fish and shellfish species are key prey items for larger fish, marine mammals and birds. The potential impacts upon fish and shellfish receptors assessed in this chapter have informed the impact "changes in prey availability" in Volume 2, Chapter 10: Marine Mammals and Volume 2, Chapter 11: Offshore Ornithology.
		The Scottish Ministers are broadly content with the approach in Section 8.2.8 of the Scoping Report, however advise that assessment should quantify where possible the likely impacts to key PMFs and consider whether this could lead to a significant impact on the national status of the PMFs under consideration, and that the additional guidance identified by NatureScot regarding underwater noise and Unexploded Ordnance (UXO) clearance should be included.	PMF status has been used in the definition of Important Ecological Features (IEFs), and thus the assessment considers whether the PMF status of various species could potentially be significantly impacted.
		The Scottish Ministers are largely content with the embedded mitigation commitments outlined in Section 8.2.7 of the Scoping Report, alongside the commitment for additional mitigation measures if required, and advise that the full range of mitigation measures and published guidance is considered and discussed in the EIA Report.	Designed-in mitigation measures are presented in Section 9.10.
		The EIA Report must provide details on how marine INNS will be considered, monitored, and recorded and how they are taken account of within biosecurity plans for each phase of the Proposed Development.	The development and adherence to an INNS Management Plan (INNSMP) is a designed-in measure (see Section 9.10).

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		Further information on proposed monitoring for fish and shellfish receptors must be discussed in the EIA Report and advise to engage directly with NatureScot in this regard.	Given that no significant effects were predicted, there was no monitoring proposed for fish and shellfish, as detailed in 9.13.3.
		The Scottish Ministers advise that the EIA Report must consider the cumulative effects of key impacts such as habitat change or loss, particularly in relation to diadromous fish as well as key fish and shellfish species that contribute ecological importance as a prey resource, as detailed in the NatureScot representation.	A full cumulative assessment has been undertaken, presented in Section 9.13.
		The Developer considers potential transboundary impacts in Section 8.2.11 and Appendix 1 of the Scoping Report. The Scottish Ministers agree with the conclusions of the Developer's screening assessment, in line with the NatureScot representation.	No transboundary impacts were predicted to occur (see Section 9.14).
30 November 2023	NatureScot: Scoping Response	Ecosystem assessment - Increasingly, there is a need to understand potential impacts holistically at a wider ecosystem scale in addition to the standard set of discrete individual receptor assessments. This assessment should focus on potential impacts across key trophic levels particularly in relation to the availability of prey species. This will enable a better understanding of the consequences (positive or negative) of any potential changes in prey distribution and abundance from the development of the wind farm on seabird and marine mammal (and other top predator) interests and what influence this may have on population level impacts.	Key prey species (e.g. forage fish) have been identified and assessed as IEFs throughout the assessment (see Section 9.7.4). In addition, impacts of fish aggregation and associated predator-prey relationships have been assessed for Morven South alone and cumulatively with other projects (see Sections 9.11 and 9.13). Many fish and shellfish species are key prey items for larger fish, marine mammals and birds. The potential impacts upon fish and shellfish receptors assessed in this chapter have informed the impact 'changes in prey availability' in Volume 2, Chapter 10: Marine Mammals and Volume 2, Chapter 11: Offshore Ornithology.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		We agree with the study area as detailed in Section 8.2.2 of the Scoping Report, which has been split into two zones - The Array Project Fish and Shellfish Ecology Study Area and The Regional Fish and Shellfish Ecology Study Area.	The Regional Fish and Shellfish Ecology Study Area has been refined, based on the Applicant's expert opinion and experience of consenting in this region, and to align with the ranges modelled for underwater sound effects (i.e. behavioural, injury and mortality; see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report). See paragraph 9.2.1.2 for more information.
		We acknowledge that the Zone of Influence (ZoI) for impacts associated with underwater sound will be defined through modelling.	Further information on the underwater sound modelling is presented in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report.
		We agree that ocean quahog and horse mussels should be considered within the benthic ecology chapter of the EIA.	These species have been assessed in Volume 2, Chapter 8: Benthic Subtidal Ecology.
		We support the proposed approach of carrying out a desk-based review of existing fish and shellfish ecology data, focusing on sourcing data that has been collected within or near to the study area. We support the list of existing datasets as described in table 8.7. We note that this will be supplemented by site specific survey data obtained from a benthic ecology characterisation survey.	A detailed baseline characterisation is presented in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report.
		We advise that the following sources should also be considered in the EIA Report: • Feature Activity Sensitivity Tool (FeAST), which is due to be updated shortly with fish and shellfish information. • Franco A., Smyth K., Thomson S. (2022) Developing Essential Fish Habitat maps for fish and shellfish species in Scotland. Report to the	Where relevant, FeAST has been considered as part of the assessment presented throughout Section 9.11, however it should be noted that the only fish and shellfish receptors listed on FeAST are sandeels and common skate *Dipturus batis*. The other recommended source was considered, where relevant in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		Scottish Government, December 2022. DOI:10.7489/12450-1.	
		We agree with the species identified within the EIA Scoping Report with regards to fish and shellfish ecology.	These species have been carried forward to the assessment presented here as IEFs (see Section 9.7.4).
		Tables 8.12 and 8.13 summarise the potential impacts to be scoped in and scoped out of the assessment, respectively. We broadly support the proposed approach subject to our advice below.	The advice below has been noted and incorporated, where relevant, into the assessment presented in this chapter.
		We agree that underwater sound impacts should be scoped in for the construction and decommissioning project phases. This should include sandeel (as well as migratory and spawning fish species) as they may be present at the development site all year round, have a close association with the seabed or may be unable to flee from noisy activities. We welcome the specific consideration of UXO clearance in the assessment.	Underwater sound has been considered in the construction and decommissioning phases (see Table 9.7) for all fish and shellfish IEFs, including sandeels, diadromous, and spawning fish species.
		We welcome the scoping in of EMF effects, noting that this impact pathway is not that well understood at present. The impacts from EMF should be considered for all relevant fish species, including elasmobranch species, Nephrops (*Nephrops norvegicus*) and diadromous fish, including migratory fish. We note and welcome the Scottish Marine Energy Research (ScotMER) project "A Targeted Approach to Defining EMF from Subsea Cables and Understanding Potential Impacts on Fish and Benthic Species".	The impact of EMF has been assessed for all fish and shellfish IEFs (Table 9.7). However, outputs of the referenced ScotMER project were not available at the time of writing.
		We advise consideration is required in the EIA Report to ensure that impacts to key prey species (such as sandeel species, herring (*Clupea harengus*), mackerel (*Scomber scombrus*) and sprat (*Sprattus sprattus*) and their habitats	These species have been carried forward to the assessment presented here as IEFs (see Section 9.7.4), and their importance in marine food webs included in their IEF justification. The potential

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		are considered for this development alone and cumulatively with other wind farms. We recognise that most EIA Reports concentrate on receptor specific impacts. However, increasingly we need to understand impacts at the ecosystem scale. Therefore, consideration across key trophic levels will enable better understanding of the consequences (positive or negative) of any potential changes in prey distribution and abundance on marine mammal (and other top predator) interests and how this may influence population level impacts with consideration of how this loss and or disturbance may affect the recruitment of key prey (fish) species through impacts to important spawning or nursery ground habitats should also be assessed.	impacts upon fish and shellfish receptors assessed in this chapter have informed the impact "changes in prey availability" in Volume 2, Chapter 10: Marine Mammals and Volume 2, Chapter 11: Offshore Ornithology.
		The Predators and Prey Around Renewable Energy Developments (PrePARED) project may be helpful in the understanding of predator-prey relationships in and around offshore wind projects.	Outputs of the PrePARED project have been incorporated into the assessment, where relevant and available.
		Relevant guidance that should be included is the Joint Nature Conservation Committee (JNCC) guidance on underwater sound and the UXO clearance - joint interim position statement[1].	The referenced JNCC guidance has since been withdrawn, the updated policy paper has been included instead (UK Government, 2025).
		Section 8.2.8 of the EIA Scoping Report lists guidance documents to be used in the fish and shellfish assessment. We broadly support the approach to assessment set out in Section 8.2.8.	This response has been noted, and the approach to assessment is presented in Section 9.8.

[1] https://www.gov.uk/government/publications/marine-environment-unexploded-ordnance-clearance-joint-interim-position-statement

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		We broadly support the approach to assessment set out in Section 8.2.8. We note that the applicant has highlighted the importance of key prey species such as herring, mackerel, sprat and sandeel, and will look at habitat suitability for sandeel. We advise that in relation to PMFs the assessment should quantify, where possible, the likely impacts to key fish and shellfish PMF species. It should assess whether these could lead to a significant impact on the national status of the PMF being considered.	PMF status has been used in the definition of IEFs, and thus the assessment considers whether the PMF status of various species could potentially be significantly impacted.
		Potential cumulative impacts are considered in Section 8.2.9. The EIA Report should consider the cumulative effects of key impacts such as habitat loss/change, especially in relation to diadromous fish as well as key fish and shellfish species that contribute ecological importance as a prey resource. This may differ depending on the life stage being considered.	Both temporary and long-term habitat loss have been assessed cumulatively in Section 9.13.
		We are generally content with the embedded commitments described in Section 8.2.7, along with the commitment for additional mitigation measures if required. We advise that the full range of mitigation measures and published guidance is considered and discussed in the EIA Report.	All designed-in measures applicable to fish and shellfish ecology are presented in Section 9.10.
		It is proposed that an EMP will set out mitigation measures and procedures relevant, but not limited to, the management of INNS. The EIA Report should provide details on how marine INNS will be considered, monitored and recorded as well as being taken account of within biosecurity plans for each phase of the development.	Details on all designed-in measures applicable to fish and shellfish ecology are presented in Section 9.10, including the EMP (which includes the INNSMP).

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		No specific monitoring for fish and shellfish is mentioned in the Scoping Report. Further information on proposed fish and shellfish monitoring should be discussed in the EIA Report – we are content to discuss this further during pre-application as required.	Given that no significant effects were predicted, there was no monitoring proposed for fish and shellfish, as detailed in 9.13.3.
		We are aware of Marine Directorate proposals to carry out infield measurement of EMF to better understand impacts on benthic and fish species through the aforementioned ScotMER project. Therefore, any input this project could assist with, either from project measurements or contributions to this wider work, would be very beneficial.	Client to confirm any potential for input to this.
		Potential transboundary impacts are considered in Section 8.2.11 and Appendix 1. We agree with the conclusions of the screening assessment.	No transboundary impacts were predicted to occur (see Section 9.14).
30 November 2023	Natural England: Scoping Response	Natural England advises that the River Tweed is within the Regional Fish and Shellfish Ecology Study Area. The River Tweed SAC is designated for Atlantic salmon (*Salmo salar*) sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra planeri*) and river lamprey (*Lampetra fluviatilis*). We note that this site and species have been included in table 8.11 and considered in the HRA screening	This SAC has been included in the baseline characterisation (see Table 9.13). However, brook lamprey has not been considered in this assessment as it is not present within the marine environment, thus out with the remit for this assessment.
30 November 2023	FMS: Scoping Response	FMS have a number of outstanding questions and concerns about the potential negative effects of the proposed development on diadromous fish, including Atlantic salmon and sea trout (*Salmo trutta*). It is important they can be assured that all potential negative impacts have been assessed in full, and mitigations put in place. Where uncertainty remains, the developer should be required to contribute to research which will help fill these evidence gaps, as a condition of operational consent. Where uncertainty remains, the developer	This concern was noted. As no significant effects upon diadromous species were predicted, there was no monitoring proposed for fish and shellfish, as detailed in 9.13.3.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		should be required to contribute to research which will help fill these evidence gaps, as a condition of operational consent. In addition, and in the light of the nature crisis, we believe that all developers should contribute to projects designed to conserve and restore important habitat at a catchment scale.	
		Under ScotMER, the Diadromous Fish Receptor Group has identified evidence gaps related to the health, distribution, and impacts on Diadromous fish (salmon, sea trout). Scottish Government has published an 'evidence map' which identifies and scores these evidence gaps according to a specific prioritisation process. It is important that the relevant evidence gaps are considered in full by the applicant, and developers should contribute to filling these evidence gaps as a specific condition of consent. In addition, and in the light of the nature crisis, we believe that all developers should contribute to projects designed to conserve and restore important habitat at a catchment scale.	This assessment has concluded that there will be no significant adverse effects on diadromous fish species (see Sections 9.11 and 9.12). Given this finding, the Applicant is not proposing to commit to undertaking any further monitoring or research for diadromous fish.
		To properly assess Environmental Statements for developments, information on the use of the development area by diadromous fish should be provided. If such information is lacking then a suitable monitoring strategy should be devised, either for the site in question or through contributing to strategic projects undertaken through ScotMER. Any monitoring strategies must include pre-construction monitoring in order that baseline information on movement, abundance, swimming depth, and feeding behaviour, can be collected.	A detailed baseline on diadromous fish within the Regional Fish and Shellfish Ecology Study Area has been provided in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		Offshore developments have the potential to directly and indirectly impact diadromous fish. We would therefore expect developers to assess and, where necessary, mitigate the potential impacts of the development. These potential impacts have been highlighted through ScotMER, and include: • Avoidance (including exclusion from particular rivers and subsequent impacts on local populations); • Disorientation effects that could potentially affect behaviour, susceptibility to predation or by-catch; • Impaired ability to locate normal feeding grounds or river of origin; and delayed migration.	Where relevant, the impacts assessed for Morven South alone and cumulatively with other projects consider these key areas for diadromous fish, particularly the potential for barrier effects from natal rivers,or behavioural disturbance which could impair navigational ability. For example, the potential for underwater sound to cause avoidance, disorientation, or impaired ability to navigate and migrate has been considered as 'behavioural disturbance' in Section 9.11.3 and 9.13.3.
		Underwater sound and vibration effects during construction: avoidance of such activities during key life stages, such as the smolt run, should be considered as a mitigation measure.	Underwater sound has been assessed for both Morven South alone and cumulatively with other plans and projects (Sections 9.11 and 9.12).
		EMFs from subsea cables have the potential to interact with European eels (*Anguilla anguilla)* and possibly salmonids if their migration or movement routes take them over sub-sea cables. The Earth's magnetic field is a cue used for migration, so anything that interferes with this signal is an important consideration. All cables should be buried to at least a depth of 1.5m where possible or covered with rock armour to an equivalent depth where burial is not possible. We are aware that Marine Scotland have undertaken some research to investigate electro-magnetic force impacts on adult and post smolt salmon and European eels. Whilst for salmon this work did not demonstrate any significant response to	As detailed in Table 9.19, there will be a target burial depth of 1m, with a minimum and maximum burial depth of 0.5m and 3m for all subsea cables. Where burial is not possible, cable protection will be applied. While no EMF modelling was conducted for Morven South, modelling for other OWF and cable projects has illustrated that a 0.5m cable burial depth was sufficient to reduce EMF levels to baseline levels within metres from the cable at the seabed (National Grid, 2025a, Seagreen, 2023). For more detail, see Section 9.11.7.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		the magnetic field in terms of alarm, avoidance, accelerated or decelerated swimming, it did not provide any information on interference with the salmon's ability to detect and utilise the Earth's magnetic field.	
		Disturbance or degradation of the benthic environment (including secondary effects on prey species): it is important to ensure that such effects are quantified and assessed in the Environmental Statement. Particular consideration should be given to potential effects on important habitats for feeding and shelter for the marine phase of sea trout (a PMF) and any area that might impact early feeding opportunities for all diadromous species.	Temporary and long-term habitat loss have been assessed for Morven South alone and cumulatively with other plans and projects (Sections 9.11 and 9.12).
		Aggregation effects: construction of wind turbines often result in the loss of some habitat types (such as soft sediment) and creation of new, artificial vertical habitats. The associated increase in species diversity can attract fish and ultimately predators. The potential for these structures to aggregate predators, and act as predation 'hot-spots', particularly when located in marine areas utilised by diadromous fish for feeding or migration, should be assessed in full. This is an important consideration in the case for seals, and some species of birds. We do not consider that the scoping report has adequately recognised the potential for new hard substrates to act as a fish aggregating device, and potentially attract larger predators, nor has it considered the impact of those predators on species passing through the development. The secondary impact of predators on diadromous fish should be fully considered in the EIA.	Colonisation of artificial hard structures and associated fish aggregation and reef effects have been assessed for Morven South alone and cumulatively with other plans and projects (Sections 9.11 and 9.12).

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		Visual effects: moving turbine blades above the surface of the water may have a range of effects on diadromous fish and may even present a potential barrier effect to migratory species. Moving turbine blades will be visible to fish over large areas near offshore windfarms, particularly in the case of epipelagic species like salmonids, which swim near the ocean surface. Broad visual effects can be direct (those associated with the perception of reflected light from turbines via the visual image represented in Snell's window - a phenomenon by which an underwater viewer sees everything above the surface through a cone of light of width of about 96 degrees). Flicker effects from turbines are only expected to occur during the brief period of the day when receptor, turbine and sun are aligned and therefore represent a sub-set of the larger potential effects arising from direct perception of movement above the surface. As fish are susceptible, and therefore highly sensitive, to predation from above, how they perceive and react to such movement requires further investigation. Previous attempts to explore this phenomenon have focussed on shadow flicker, and neglect the wider effects detailed above. There is currently no information on the risk of visual effects of moving turbine blades. However, we would highlight that there is accumulating evidence for widespread avoidance of offshore turbines by large-bodied birds. If this is the case for migratory fish, then site specific and cumulative impact studies will be required. This potential impact should be scoped into the EIA.	This impact is proposed to be scoped out of the assessment, with full justification provided in Table 9.8.
		On a wider point, Table 8.12 does not appear to propose anything more than a desk-based study to consider these potential impacts. We do not consider that this is appropriate or sufficient, given the evidence gaps identifies in the ScotMER Diadromous Fish Receptor	This assessment has concluded that there will be no significant adverse effects on diadromous fish species (see Sections 9.11 and 9.12). Given this finding, the Applicant is not proposing to commit to

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		Group. As identified above, we expect developers to be required to contribute to research which will help fill these evidence gaps, as a condition of operational consent.	undertaking any further monitoring or research for diadromous fish.
		There is a clear and urgent need to fund, plan and start strategic research on the movement, abundance, swimming depth, feeding behaviour and impact pathways relevant to diadromous fish. Such research would clearly feed into the potential mitigation measures that might be deemed appropriate, and the conditions under which such mitigation should be enacted. Developer work together to fund strategic monitoring, in order to allow more certainty for all involved. Understanding of many of these risks is insufficient to support proposals for mitigation even at this late stage when substantial developments are being submitted for licensing. The cumulative impact of this proposal alongside those developments already submitted or likely to follow in the near future is potentially even greater.	
		In recognition that the marine phases of both Atlantic salmon and sea trout are included on the list of PMFs - the habitats and species of greatest conservation importance in inshore waters, it is important that the following rivers are also fully considered in the consenting and assessment process: River Deveron, River Ugie, River Ythan, and River Don.	These rivers flow into the Regional Fish and Shellfish Ecology Study Area and are therefore considered as part of the baseline environment (see Figure 9.2).
30 November 2023	SFF: Scoping Response	Since the Scoping Report acknowledges some impacts of the wind turbines on fish behaviour near the wind turbines, SFF would like to see the *"Underwater sound from wind turbine operation"* to be scoped in to determine the limit/depth of wind turbine sound impacts on the fish near	Underwater sound from operational turbines has been scoped out as per the justification provided in Table 9.8.

Date	Consultee and type of consultation	Summary of issue(s) raised	Applicant's response to issue raised and, if applicable, where considered in this chapter
		the wind turbine and to ensure the behavioural changes amongst the fish are not severe/detrimental.	
3 March 2025	Targeted consultation letter from MvOWL to MD-LOT	The revised Regional Fish and Shellfish Ecology Study Area was proposed and included in this consultation letter and agreed upon.	Section 9.2

9.5 Scope of the assessment

9.5.1 Impacts scoped into the assessment

9.5.1.1 The scope of this EIA Report has been developed in consultation with relevant statutory and non-statutory consultees as detailed in Table 9.6. Taking into account the scoping and consultation process, Table 9.7 summarises the potential impacts which have been scoped into this assessment. Where an impact is likely to occur within a specific development phase of Morven South, this is indicated within each relevant topic chapter (a '✓' is used to denote the phase the potential impact can occur, conversely a 'X' outlines there is no impact within this project phase), where relevant.

Table 9.7: Potential impacts scoped into the fish and shellfish ecology assessment

C= Construction, O= Operations and Maintenance, D= Decommissioning phases

Potential impact	Phase			Activity
	C	O	D	
Temporary habitat loss and disturbance	✓	✓	✓	There is potential for temporary, direct habitat loss and disturbance due to pre-foundation installation activities, cable installation works (including UXO clearance, anchor placements and pre-cabling seabed clearance), and spud can leg placement from jack-up operations. Temporary habitat loss/disturbance may also occur during the O&M phase (e.g. cable repair/reburial, use of jack-up vessels to facilitate wind turbine component repairs). Finally, there is potential for temporary, direct habitat loss and disturbance due to decommissioning activities (such as infrastructure removal) resulting in potential effects on fish and shellfish ecology.
Underwater sound impacting fish and shellfish receptors	✓	×	✓	There is potential for disturbance, injury and mortality to sensitive fish and shellfish species due to underwater sound produced during construction activities such as piling and UXO clearance. In addition, there is potential for underwater sound produced by decommissioning activities (such as infrastructure removal), although this will be of a far lower extent than the construction phase due to the absence of piling and UXO clearance. .
Increased Suspended Sediment Concentrations (SSCs) and associated deposition	✓	✓	✓	Sediment disturbance arising from construction activities (e.g. foundation and cable installation including drilling and any deposits arising, UXO clearance, and seabed preparation), maintenance operations (e.g. cable repair and reburial), and decommissioning activities (e.g. cable and foundation removal) may result in indirect impacts on fish and shellfish communities due to temporary increases in SSCs and associated sediment deposition (i.e. smothering effects).
Long-term habitat loss	✓	✓	✓	There is the potential for long-term habitat loss to occur directly under all foundation structures and associated scour protection, and under any cable protection required. As foundations are installed throughout the construction phase, this impact is also relevant to the construction phase although it will largely occur throughout the O&M phase. Permanent habitat loss may occur under any infrastructure that is not

Potential impact	Phase			Activity
	C	O	D	
				decommissioned at the end of the lifetime of Morven South, such as cable or scour protection.
Colonisation of hard structures and associated fish aggregation	×	✓	×	It is expected that artificial seabed structures (e.g. scour/cable protection and foundations) will become colonised by a variety of marine organisms in the offshore environment, leading to localised biodiversity increases. These may result in an artificial reef effect and subsequent fish aggregation.
EMF from subsea electrical cables	×	✓	×	The presence of subsea inter-array and inter-connector cables associated with Morven South may generate EMFs, which could be released into the marine environment. Fish and shellfish species may be able to detect these EMFs emitted and have a behavioural response.

9.5.2 Impacts scoped out of the assessment

9.5.2.1 A summary of the impacts scoped out, together with justification for scoping them out and whether the approach has been agreed with key stakeholders through either scoping or consultation, is presented in Table 9.8.

Table 9.8: Impacts scoped out of the assessment for fish and shellfish ecology

C= Construction, O= Operations and Maintenance, D= Decommissioning phases

Potential impact	Phase			Justification
	C	O	D	
Accidental release of pollutants	✓	✓	✓	Sources such as vessels, vehicles, machinery, and other equipment have the potential to accidentally release pollution during phases of development. Measures setting out standards of procedure within post consent plans including an EMP will help manage the risk. The plans will address accidental spills, discuss all potential contaminant releases, and include details in case of an emergency. The EMP will also set out good practice techniques and use information and guidelines from the International Maritime Organisation (IMO), and International Convention for the Prevention of Pollution from Ships (MARPOL). The likelihood of spills occurring through the development stages is very low and if a spill was to occur the magnitude will be minimised due to the measures undertaken within the EMP. In addition, following relevant Health, Safety and Environment (HSE) procedures is also listed as a designed-in measure, which will help mitigate any risk of pollution incidents (see Section 9.10). With the assessment of the impact of accidental pollutant release, pending consultation with stakeholders, relevant groups and feedback from the Scoping Report, it is proposed that this impact is scoped out of consideration within the EIA for Fish and Shellfish Ecology. This was agreed upon with consultees as part of the Scoping Opinion (Table 9.6).
Release of sediment-bound contaminants	✓	✓	✓	Seabed disturbance associated with construction, maintenance and decommissioning activities (e.g. foundation and cable installation) could lead to the remobilisation of sediment-bound contaminants that may result in harmful and adverse effects on fish and shellfish communities. Site specific sampling within the Morven South Fish and Shellfish Ecology Study Area has shown levels of sediment contaminants are very low, in line with background levels. Samples from all stations except ENV054, located outside of the Morven South Fish and Shellfish Ecology Study Area were below the Centre for Environment, Fisheries and Aquaculture (Cefas) Action Level (AL) 1 and AL2 as well as below Canadian Threshold Effect Level (TEL) and Probable Effect Level (PEL) for metals, Polychlorinated Biphenyls (PCBs) and Polycyclic Aromatic Hydrocarbons (PAHs). Station ENV054 was above Cefas AL1 and Canadian TEL for arsenic and showed elevated levels of other elements (see Volume 3, Annex 8.1: Benthic Subtidal Ecology Shared Technical Report for more information). The risk of sediment-bound contaminants being present in concentrations likely to be harmful to fish and shellfish ecology is considered negligible, as station ENV054 is located outside of Morven South and is, therefore, unlikely to face direct disturbance. This potential impact was scoped out of the assessment. This was agreed upon with consultees as part of the Scoping Opinion (Table 9.6).

Potential impact	Phase			Justification
	C	O	D	
Underwater sound from wind turbine operation	N/a	✓	N/a	Sound Pressure Levels (SPL) and frequencies from operational wind turbines are low (Andersson *et al.*, 2011); as such, behavioural changes amongst fish occur only within a few metres of a wind turbine (Sigray and Andersson, 2011). Underwater sound from wind turbine operation has, has, therefore, been scoped out of the assessment as the potential effects on fish and shellfish receptors from wind turbine sound are likely to be insignificant. This was agreed upon with consultees as part of the Scoping Opinion (Table 9.6).
Underwater sound from vessels	✓	✓	✓	The occurrence of vessels associated with all phases of Morven South is not likely to represent a significant change from baseline sound levels of shipping, and fish are not believed to be sensitive to vessel sound. For these reasons, underwater sound from vessels has been scoped out of the assessment. This was agreed upon with consultees as part of the Scoping Opinion, wherein no consultation was received contrary to this (Table 9.6).
Shadow flicker from moving turbines and visual effects upon diadromous fish	N/a	✓	N/a	The only published study on the effect of shadow flicker on a diadromous fish species focussed on Atlantic salmon within rivers (Dodd and Briers, 2021). This study concluded that there is no specific evidence available to support or refute any biological or ecological impact of shadow flicker from wind turbine blades on Atlantic salmon and that any potential impact of offshore wind turbines was outwith the scope of the study (Dodd and Briers, 2021). The literature investigating the potential impacts from wind turbine shadow flicker (in the form of flickering light) typically relates to research on possible human impacts (Haac *et al.*, 2022, Harding *et al.*, 2008, Nordman, 2010). In the marine environment, Atlantic salmon and sea trout typically swim from near the surface down to multiple tens of metres in depth (Godfrey *et al.*, 2015, Holm *et al.*, 2006), and therefore could be exposed and/or receptive to visual stimuli, associated with offshore infrastructure. Considering the distance of the wind turbines from the coast (where it is anticipated that visual, olfactory, and or magnetic stimuli for diadromous fish returning to natal rivers play an important navigational role (Cresci *et al.*, 2017, Hasler and Scholz, 1983, Hedger *et al.*, 2008, Keefer and Caudill, 2014), it is not expected that the wind turbines associated with Morven South will result in behavioural responses in diadromous species during migration. Furthermore, considering the height of the turbine blades above the surface of the water, in the context of other visual stimuli such as distortions of the water surface, rough and turbid sea state, annual daylight hours and cloud cover, it is unlikely that shadow flicker effects will have significant adverse effects on diadromous fish migrating to and from natal rivers along the coast.

Potential impact	Phase			Justification
	C	O	D	
				A more recent, theoretical, study by Williamson *et al.* (2024) concluded that wind turbines could generate visual cues for aquatic receptor organisms and that the cues have the potential to be aversive (Williamson *et al.*, 2024). However, the authors noted that the paper presented the physics involved to support the formulation and testing of a biological hypotheses to investigate the direct visual and flicker effects, as opposed to an observed effect (Williamson *et al.*, 2024). This additional reference, therefore, does not present any new information nor evidence to adequately assess this impact for diadromous fish receptors. The purpose of this EIA is to identify and proportionately assess significant impacts upon fish and shellfish receptors using strong scientific evidence. Where available, industry guidance has also been utilised (such as the Scottish Government's Wild Salmon Strategy (2022) or Wild Salmon Strategy Implementation Plan (2023c)). Therefore, the information summarised here is considered to be sufficient to scope out the impact of shadow flicker on fish and shellfish receptors, with a particular emphasis on diadromous fish. This aligns with the approach taken by other wind projects in Scotland, such as Muir Mhor (2024), which scoped this impact out using similar justification. Similarly, this impact was not requested or assessed in the recently consented Berwick Bank OWF or Mona OWF (Mona Offshore Wind Ltd, 2024, SSE Renewables, 2022b).

9.6 Approach to baseline characterisation

9.6.1.1 The fish and shellfish ecology baseline environment has been largely characterised through a literature review of key desktop datasets and reports alongside a review of site specific data collected for other topics (see Table 9.9). This list is not exhaustive; further datasets and reports are covered in more detail within Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report.

9.6.2 Relevant guidance

9.6.2.1 The following publications have been consulted throughout this assessment for fish and shellfish ecology:

- Marine environment: UXO Joint Position Statement (UK Government, 2025);
- Guidelines for Ecological Impact Assessment (EcIA) in the UK and Ireland (Chartered Institute for Ecology and Environmental Management (CIEEM, 2024));
- Screening Spatial Interactions between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Habitat (Kyle-Henney *et al.*, 2024, Reach *et al.*, 2013);
- Screening Spatial Interactions between Marine Aggregate Application Areas and Sandeel Habitat (Latto *et al.*, 2013, Reach *et al.*, 2024);
- Scottish Wild Salmon Strategy (Scottish Government, 2022);
- Marine Evidence Based Sensitivity Assessment (MarESA) – A Guide (Tyler-Walters *et al.*, 2018);
- Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.*, 2014).

9.6.3 Desktop study

9.6.3.1 Information on fish and shellfish ecology within the Regional Fish and Shellfish Ecology Study Area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 9.9 below.

Table 9.9: Summary of key desktop reports used to characterise the fish and shellfish ecology baseline

Title	Source	Year	Author
Survey data/reports available through the International Council for the Exploration of the Seas (ICES), including, International Bottom Trawl Survey (IBTS).	ICES	2025	ICES.
EMODnet broadscale seabed habitat map for Europe (EUSeaMap).	EMODnet – Seabed Habitats	2025	EMODnet – Seabed Habitats.
JNCC MPA Mapper.	JNCC	2025	JNCC.
Berwick Bank Offshore Wind Farm (OWF) EIA Report.	SSE Renewables	2022	SSE Renewables.
Rod catch data.	Scottish Government	2023	Scottish Government.
Berwick Bank OWF Scoping Report.	SSE Renewables	2021	SSE Renewables.
Distribution model for lesser sandeel.	Marine Scotland Science (MSS) (Now Marine Directorate – Science, Evidence,	2021	Langton *et al.*

Title	Source	Year	Author
	Digital and Data (MD-SEDD))		
Seagreen Phase 1 (Seagreen Alpha and Seagreen Bravo): Natural Fish and Shellfish Resource Environmental Statement chapter for the optimised project.	Seagreen Wind Energy Ltd.	2018	Seagreen.
Updating fisheries sensitivity maps in British waters.	Marine Scotland	2014	Aires *et al.*
Spawning and nursery grounds of selected fish species in UK waters.	Cefas	2012	Ellis *et al.*
Fisheries Sensitivity Maps.	Cefas	1998	Coull *et al.*

9.6.4 Identification of designated sites

9.6.4.1 All designated sites within the Regional Fish and Shellfish Ecology Study Area and the qualifying features of those sites that could be affected by the construction, O&M or decommissioning phases of Morven South were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the Regional Fish and Shellfish Ecology Study Area were identified.
- Step 2: Information was compiled on the relevant fish and shellfish features for each of these sites.
- Step 3: Using the above information and expert judgement, designated sites were included for further consideration if:
  - a designated site directly overlaps with the Morven South Boundary;
  - a designated site and its associated features could be located within the potential ZoI for impacts associated with Morven South.

9.6.5 Site specific surveys

9.6.5.1 A summary of the surveys used to inform the fish and shellfish ecology assessment of effects is outlined in Table 9.10 and further detail of the survey methodologies and results is included within Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report.

Table 9.10: Summary of site specific surveys

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Environmental Baseline Survey and Habitat Assessment.	Morven Site plus a buffer of up to 14km.	Grab sampling, Drop Down Video (DDV), and sediment and seawater eDNA sampling.	Gardline.	April to August 2022.	Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report
Ornithology and marine megafauna Digital Aerial Surveys (DAS).	Morven Site plus a 4km buffer.	Monthly DAS undertaken to assess the ornithology and marine mammal baselines.	APEM.	January 2021 to September 2023.	

9.7 Baseline environment

9.7.1 Overview of baseline environment

9.7.1.1 The fish and shellfish baseline within the Regional Fish and Shellfish Ecology Study Area is typical of the northern North Sea and includes a range of marine fish (teleost fish and elasmobranchs), diadromous species, and shellfish. The full baseline characterisation is presented in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report, with a summary provided here.

Marine fish

9.7.1.2 The marine fish assemblage includes both commercial and non-commercial species. Demersal teleost species include a range of gadoids including blue whiting (*Micromesistius poutassou*), cod (*Gadus morhua*), European hake (*Merluccius merluccius*), haddock (*Melanogrammus aeglefinus*), ling (*Molva molva*), Norway pout (*Trisopterus esmarkii*), saithe (*Pollachius virens*), and whiting (*Merlangius merlangus*). The flatfish assemblage included lemon sole (*Microstomus kitt*), and plaice (*Pleuronectes platessa*). Other demersal teleost fish species included anglerfish (*Lophius piscatorius*) and sandeel species (including Raitt's sand eel (*Ammodytes marinus*) and lesser sandeel (*Ammodytes tobianus*)). Pelagic teleost species include herring, sprat, and mackerel. Alongside sandeels, these species are considered to be key forage fish species in the North Sea, meaning that they are an important prey resource for other fish species, alongside birds and marine mammals (van der Kooij *et al.*, 2021).

9.7.1.3 Elasmobranch species present within the Regional Fish and Shellfish Ecology Study Area include spotted ray (*Raja montagui*), thornback ray, tope shark (*Galeorhinus galeus*), small-spotted catshark (*Scyliorhinus canciula*), spurdog (*Squalus acanthias*), thorny skate (*Amblyraja radiata*) and cuckoo ray (*Leucoraja naevus*).

Diadromous fish

9.7.1.4 Eight diadromous fish species were identified with the potential to occur within the Regional Fish and Shellfish Ecology Study Area and the coastal areas along the east of Scotland: Atlantic salmon, sea trout, sea lamprey, river lamprey, European eel, allis shad (*Alosa alosa*), twaite shad (*Alosa fallax*), and European smelt (*Osmerus eperlanus*). However, river lamprey and European smelt are primarily coastal species and, therefore, unlikely to interact with the Morven South Boundary, given its distance offshore (see Figure 9.2). Therefore, diadromous species that were carried forward for assessment were: Atlantic salmon, sea trout, European eel, sea lamprey, allis shad and twaite shad. Although freshwater pearl mussel (*Margaritifera margaritifera*) is not found in the offshore environment, the species depends on the Atlantic salmon and sea trout during their parasitic larval stage (Taeubert and Geist, 2017). Therefore, freshwater pearl mussel has been considered in this assessment alongside the diadromous fish species.

9.7.1.5 Diadromous fish species (and freshwater pearl mussel) are highly protected under various nature conservation legislation (such as the Habitats Regulations for some species). As such, a range of designated sites were identified within the Regional Fish and Shellfish Ecology Study Area with Atlantic salmon, sea lamprey, and freshwater pearl mussel as qualifying features (see Section 9.7.3). Although not designated sites, consultation received as part of the Scoping Opinion highlighted the importance of the nearshore/river habitats of the following rivers for Atlantic salmon and sea trout: River Deveron, River Ugie, River Ythan and River Don (see Section 9.4). All these rivers flow into the Regional Fish and Shellfish Ecology Study Area (see Figure 9.2) and thus salmonids migrating to and from these rivers are encompassed in this assessment as IEFs.

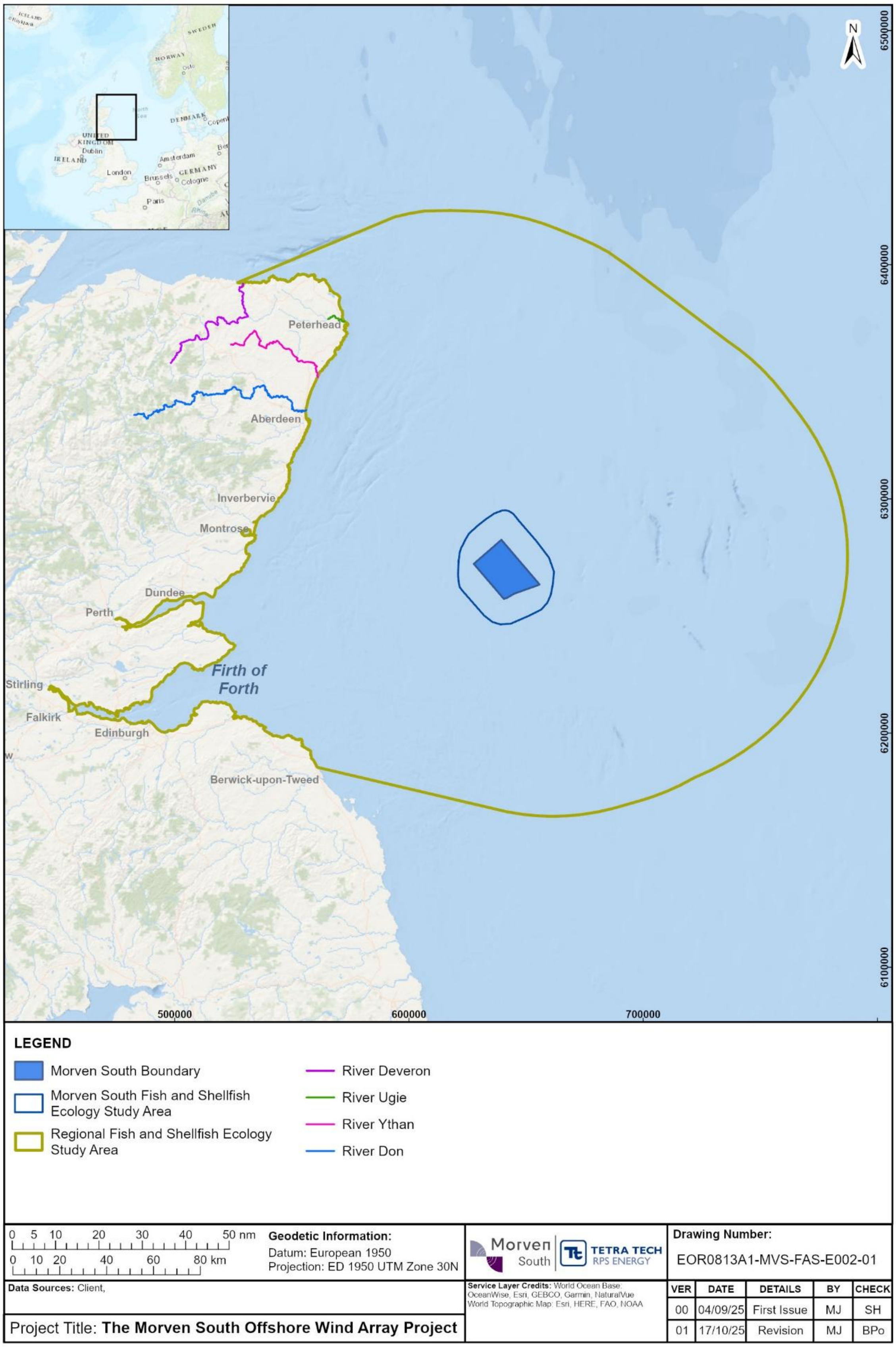

Figure 9.2: Rivers Deveron, Don, Ugie, and Ythan

Shellfish

9.7.1.6 The shellfish baseline was largely characterised by fisheries landings data, the results of site specific surveys for Morven South and other offshore wind projects in the Regional Fish and Shellfish Ecology Study Area. Key shellfish species identified include edible crab (*Cancer pagurus*), European lobster (*Homarus gammarus*), Nephrops (also known as "Norway lobster"), velvet swimming crab (*Necora puber*), and king and queen scallop (*Pecten maxiumus* and *Aequipecten opercularis*). Other shellfish species identified included shrimp species, common whelk (*Buccinum undatum*), razor clams (*Ensis* spp.) and cephalopods.

9.7.2 Spawning and nursery grounds

9.7.2.1 Within the Regional Fish and Shellfish Ecology Study Area, spawning and nursery grounds were identified for 16 teleost fish species, four elasmobranch species, and Nephrops (Table 9.11).

Table 9.11: Species with spawning and nursery grounds within the Regional Fish and Shellfish Ecology Study Area (adapted from Coull *et al.* (1998) and Ellis *et al.* (2012))

Species	Spawning grounds	Spawning intensity	Nursery grounds	Nursery intensity
Teleost Fish				
Anglerfish	×	-	✓	Low
Blue whiting	×	-	✓	Low
Cod	✓	Low	✓	High and low
European hake	×	-	✓	Low
Haddock	×	-	✓	Unspecified
Herring	✓	Undetermined	✓	High and low
Lemon sole	✓	Undetermined	✓	Unspecified
Ling	×	-	✓	Low
Mackerel	×	-	✓	Low
Norway pout	✓	High and low	✓	Unspecified
Plaice	✓	Low	✓	Low
Sandeel	✓	High and low	✓	Low
Saithe	×	-	✓	Unspecified
Sprat	✓	Undetermined	✓	Unspecified
Whiting	✓	Low	✓	High and low
Elasmobranchs				
Common skate	×	-	✓	Low
Spotted ray	×	-	✓	Low
Spurdog	×	-	✓	Low
Tope shark	×	-	✓	Low
Shellfish				
Nephrops	✓	Undetermined	✓	Unspecified

9.7.2.2 Spawning periods for species which have spawning grounds overlapping or within close vicinity to the Morven South Boundary are presented in Table 9.12.

Table 9.12: Main spawning periods for species with spawning grounds overlapping with the Morven South Boundary, Morven North Boundary, or both (adapted from Coull *et al.* (1998) and Ellis *et al.* (2012))

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod												
Herring*												
Lemon sole												
Plaice												
Norway pout												
Sandeel												
Sprat												
Whiting												
Key		Spawning period						Key spawning period				

* Herring spawning grounds are present at the northernmost tip of the Morven North Boundary only

9.7.2.3 There was no favourable habitat for Nephrops identified within the Morven South Fish and Shellfish Ecology Study Area during the site specific benthic surveys undertaken. The site specific particle size analysis data that the Morven South Fish and Shellfish Ecology Study Area was unsuitable for herring spawning, using the methodology defined in Kyle-Henney *et al.* (2024) and Reach *et al.* (2013) (see Figure 9.3). For sandeel species, however, over half of the sample locations within the Morven South Fish and Shellfish Ecology Study Area were assessed to be marginal seabed habitat using the methodology defined in Reach *et al.* (2024) and Latto *et al.* (2013) (see Figure 9.4).

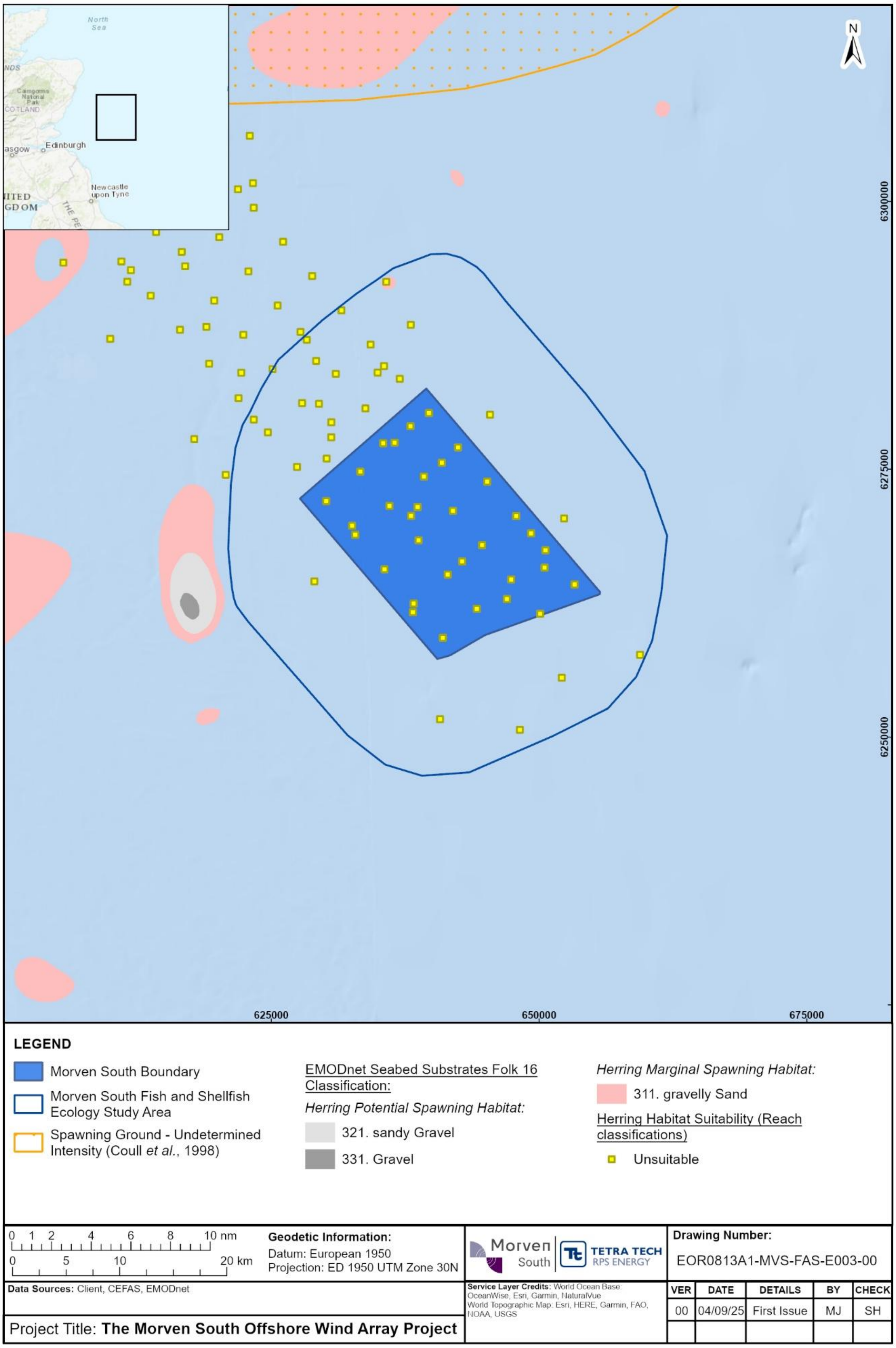

Figure 9.3: Herring spawning habitat suitability from site specific data, alongside EMODnet substrate data (EMODnet, 2025)

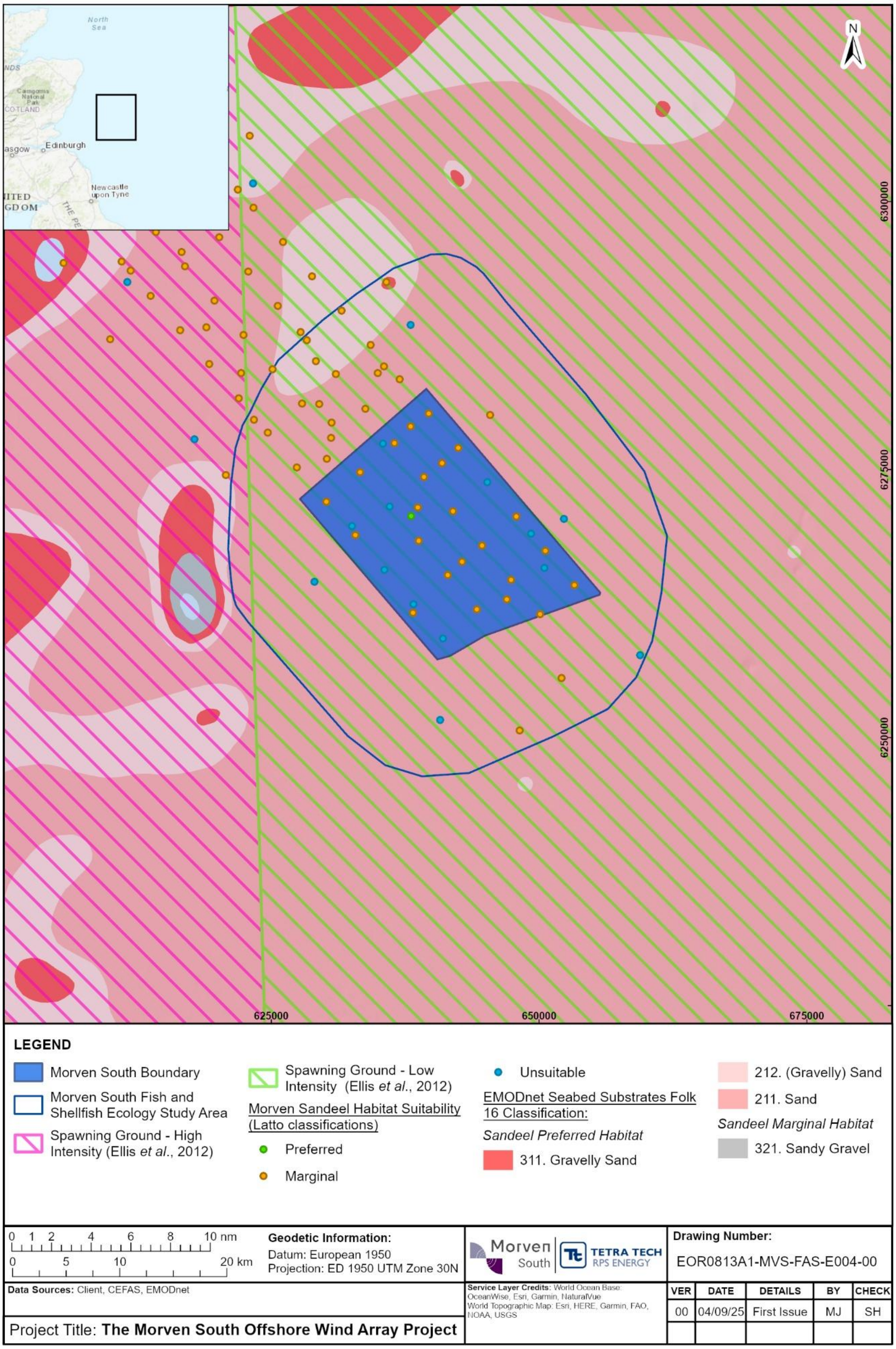

Figure 9.4: Sandeel seabed habitat suitability from site specific data, alongside EMODnet substrate data (EMODnet, 2025)

9.7.3 Designated sites

9.7.3.1 Designated sites identified for fish and shellfish ecology are described in Table 9.13 and shown on Figure 9.5. With the exception of the Turbot Bank MPA, the identified designated sites are rivers and estuaries designated for diadromous fish (alongside obligate freshwater pearl mussel).

Table 9.13: Designated sites and relevant qualifying interest features for the fish and shellfish ecology chapter

Designated site	Closest distance to Morven South (km)	Relevant qualifying interest feature (s)
Turbot Bank MPA.	75.4	Sandeel (Raitt's sandeel and lesser sandeel).
River Dee Special Area of Conservation (SAC).	93.6	Atlantic salmon and freshwater pearl mussel.
River South Esk SAC.	101.1	Atlantic salmon and freshwater pearl mussel.
Tweed Estuary SAC.	108.5	Sea lamprey (and river lamprey, however this species is not considered further in the assessment, see paragraph 9.7.1.4).
River Tweed SAC and Site of Special Scientific Interest (SSSI).	113.2	Atlantic salmon and sea lamprey (and river lamprey, however this species is not considered further in the assessment, see paragraph 9.7.1.4).
River Tay SAC.	149.7	Atlantic salmon and sea lamprey (and river lamprey, however this species is not considered further in the assessment, see paragraph 9.7.1.4).
River Spey SAC.	207.3	Atlantic salmon, freshwater pearl mussel, and sea lamprey.
River Teith SAC.	215.0	Atlantic salmon and sea lamprey (and river lamprey, however this species is not considered further in the assessment, see paragraph 9.7.1.4).

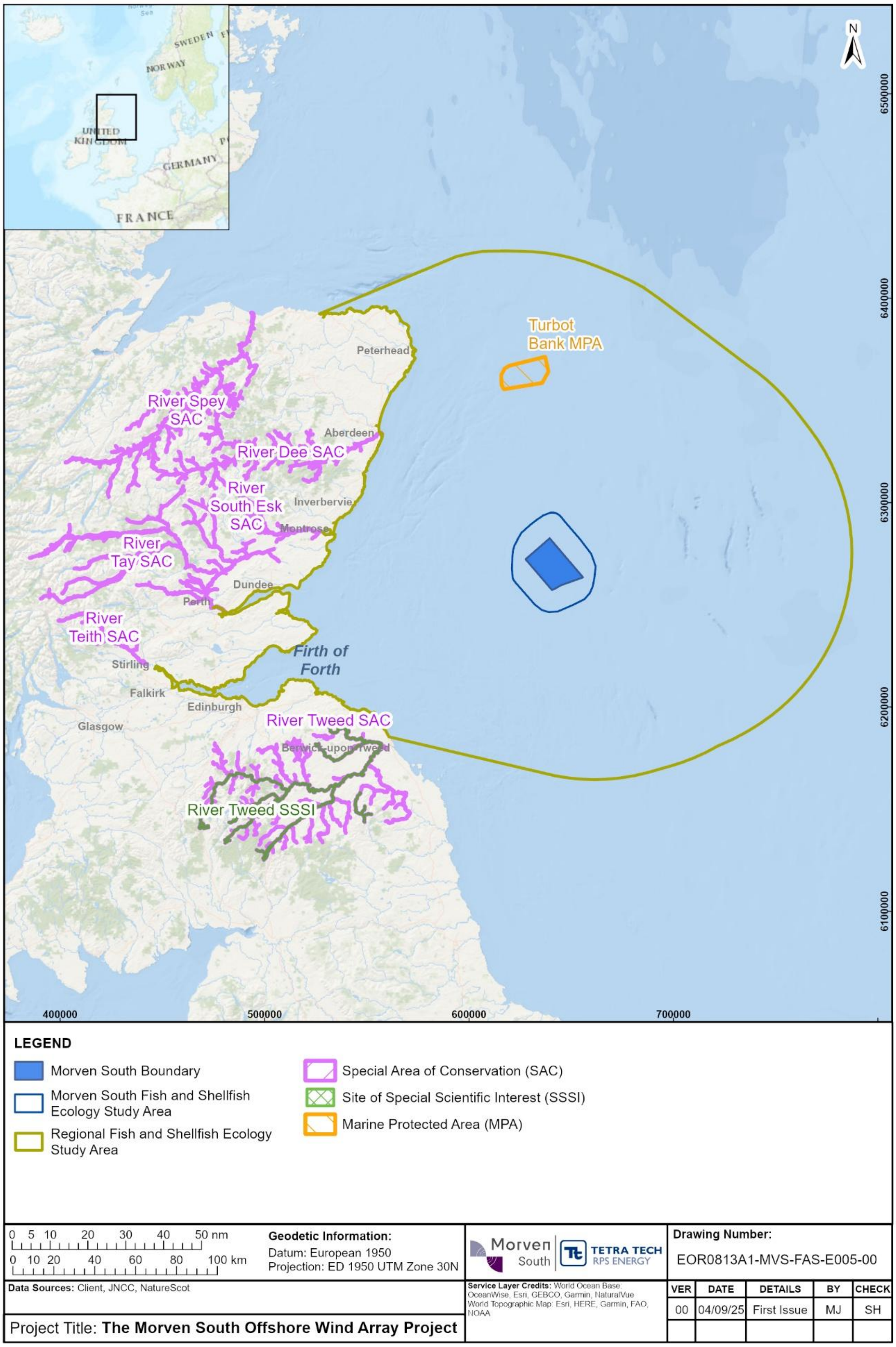

Figure 9.5: Designated Sites with fish and shellfish qualifying interest features relevant to the fish and shellfish ecology chapter

9.7.4 Important Ecological Features

9.7.4.1 In accordance with CIEEM guidelines (2024), IEFs have been identified for assessment within this chapter. Ecological features (habitats, species, ecosystems and functions/processes) recorded within the Regional Fish and Shellfish Ecology Study Area have been evaluated and a nature conservation value assigned based on the criteria set out in Table 9.14.

9.7.4.2 The defining characteristics and the classification of IEFs within the Regional Fish and Shellfish Ecology Study Area are provided in Table 9.15 with justifications for the importance rankings. The IEFs will be taken forward for assessment. Impacts on IEFs will be described in terms of the magnitude of that impact and correlated against the sensitivity of each IEF to each impact, to produce a statement of significance.

9.7.4.3 Within the assessments presented in Section 9.11 and 9.13, IEFs have been grouped into categories where relevant when assessment criteria were applicable across multiple IEFs. This prevented repetition in the assessment and allowed for a proportionate EIA. Where IEFs have a different magnitude of impact, sensitivity of receptor and/or significance of effect than other IEFs within an overarching group (i.e. herring and sandeel within the Marine Fish IEFs), this has been explicitly stated.

Table 9.14: Defining Criteria for Important Ecological Features

Value of IEF	Defining criteria
International	Internationally designated sites and protected species. Species protected under international law that are listed as a qualifying feature of an internationally designated site within the Regional Fish and Shellfish Ecology Study Area (e.g. Annex II species). Species protected under international law (including the Bonn Convention, the Bern Convention, or the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)).
National	Species protected under national law (e.g. listed on the Scottish Biodiversity List (SBL), species listed as qualifying features of MPAs, or under the Wildlife and Countryside Act 1981). Annex II species which are not listed as qualifying interests of SACs in the Regional Fish and Shellfish Ecology Study Area. Oslo Paris Convention (OSPAR) List of Threatened and/or Declining Species, and International Union for the Conservation of Nature (IUCN) Red List species that have nationally important populations within the Regional Fish and Shellfish Ecology Study Area, particularly in the context of species/habitat that may be rare or threatened in Scottish waters. Species that are listed as PMFs as they have been deemed features characteristic of Scottish marine environment and are likely to be one of the characteristic species within the Regional Fish and Shellfish Ecology Study Area. Species that have spawning or nursery areas within or within close vicinity to the Morven South Boundary that are important nationally (e.g. may be primary spawning/nursery area for that species).
Regional	OSPAR List of Threatened and/or Declining Species, and IUCN Red List species that have regionally important populations within the Regional Fish and Shellfish Ecology Study (i.e. are locally widespread and/or abundant). Species that are of commercial value to the fisheries which operate within the Regional Fish and Shellfish Ecology Study.

Value of IEF	Defining criteria
	Species that form an important prey item for other species of conservation or commercial value and that are key components of the fish and shellfish assemblages within the Regional Fish and Shellfish Ecology Study. Species that have spawning or nursery areas within or within close vicinity to the Morven South Boundary that are important regionally (i.e. species may spawn in other parts of Scottish waters, but this is a key spawning/nursery area).
Local	Species that are of commercial importance but do not form a key component of the fish and shellfish assemblages within or within close vicinity to the Morven South Boundary (e.g. they may be exploited in shallower/deeper waters outside of these areas). Species which are common throughout Scottish waters but forms a component of the fish assemblages in the Regional Fish and Shellfish Ecology Study Area.

Table 9.15: Important Ecological Features within the Regional Fish and Shellfish Ecology Study Area

IEF	Importance	Justification
Teleost fish		
Anglerfish	National	Nursery grounds are present throughout the Morven South Boundary. Listed as a PMF.
Blue whiting	National	Nursery grounds are present throughout the Morven South Boundary. Listed as a PMF. Listed on the SBL.
Cod	National	Listed as a PMF. Listed by OSPAR as threatened and/or declining and listed as Vulnerable on the IUCN Red List. Listed on the SBL. Spawning and nursery grounds are present within the Morven South Boundary.
European hake	National	Nursery grounds are present throughout the Morven South Boundary. Listed on the SBL.
Haddock	Regional	Nursery grounds are present throughout the Morven South Boundary. Listed as Vulnerable on the IUCN Red List. An important commercial species, but not locally.
Herring	National	Important prey species for larger fish, birds and marine mammals. Nursery grounds are present throughout the Morven South Boundary. Known to have spawning grounds within the Regional Fish and Shellfish Ecology Study Area, with core spawning habitats to the north and south of the Nursery grounds are present throughout the Morven South Boundary. Listed as a PMF. Listed on the SBL.
Lemon sole	Regional	Spawning and nursery grounds are present throughout the Morven South Boundary.
Ling	National	Nursery grounds are present throughout the Morven South Boundary. Listed as a PMF. Listed on the SBL.
Mackerel	National	Important prey species for larger fish, birds and marine mammals. Nursery grounds are present throughout the Morven South Boundary.

IEF	Importance	Justification
		Listed as a PMF. Listed on the SBL.
Norway pout	National	Spawning and nursery grounds are present within the Morven South Boundary. Listed as a PMF. Listed on the SBL.
Plaice	National	Spawning and nursery grounds are present throughout the Morven South Boundary. Listed on the SBL.
Sandeel	National	There are five species of sandeel found in Scottish waters lesser sandeel and greater sandeel being the most common. Important prey species for fish, birds and marine mammals. Spawning and nursery grounds are present throughout the Morven South Boundary. Identified as likely to be present in the Morven South Boundary based on historic data and habitat preference. Lesser sandeel and Raitt's sandeel are listed as PMFs and listed as protected features within the Turbot Bank MPA, which is within the Regional Fish and Shellfish Ecology Study Area. Listed on the SBL.
Saithe	National	Listed as a PMF. Nursery grounds present within the Regional Fish and Shellfish Ecology Study Area.
Sprat	Regional	Important prey species for larger fish, birds and marine mammals. Spawning and nursery grounds are present throughout the Morven South Boundary.
Whiting	National	Spawning and nursery grounds are present throughout the Morven South Boundary. Listed as a PMF. Listed on the SBL.
Other flatfish species	Local	Other flatfish species including dab and long rough dab are likely to occur within the Regional Fish and Shellfish Ecology Study Area.
Elasmobranchs		
Basking shark	International	Listed under Appendix II of the Bern Convention Protected under the Bonn Convention and CITES. Basking shark are also protected under the Wildlife and Countryside Act 1981. Listed on the OSPAR List of Threatened and/or Declining Species.

IEF	Importance	Justification
		Listed on the SBL. Listed as a PMF. This species has an IUCN Status of "Endangered".
Common skate	National	There are nursery grounds for this species overlapping and in the vicinity of the Morven South Boundary. Listed on the SBL. Listed as a PMF. This species is also listed on the OSPAR List of Threatened and/or Declining Species.
Spurdog	International	Protected under the Bonn Convention. Listed on the SBL. Listed as a PMF. This species is also listed on the OSPAR List of Threatened and/or Declining Species and has an IUCN Status of "Vulnerable". There are nursery grounds for this species overlapping with the Morven South Boundary.
Rays	Regional	Ray species including cuckoo ray, spotted ray and thornback ray. These species either have low intensity nursery grounds or no known nursery grounds overlapping with the Morven South Boundary.
Small spotted catshark	Local	This species is common throughout Scottish waters but forms a component of the fish assemblages in the Regional Fish and Shellfish Ecology Study Area.
Thorny skate	Local	This species is common throughout Scottish waters but forms a component of the fish assemblages in the Regional Fish and Shellfish Ecology Study Area.
Tope shark	International	Protected under the Bonn Convention. Listed on the SBL. This species has an IUCN Status of "Critically Endangered". There are nursery grounds for this species overlapping and in the vicinity of the Morven South Boundary.
Diadromous fish		
Allis and twaite shad	International	Listed under Annex II of the Habitats Regulations but not as a qualifying feature of any SACs within the Regional Fish and Shellfish Ecology Study Area. Appendix III of the Bern Convention. Protected under national legislation, such as the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003 and the Wildlife and Countryside Act 1981. Listed on the SBL.

IEF	Importance	Justification
Atlantic salmon	International	Listed under Annex II of the Habitats Regulations and as a qualifying feature of SACs within the Regional Fish and Shellfish Ecology Study Area. Appendix III of the Bern Convention. Protected under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. Listed on the SBL. Listed as a PMF.
European eel	International	Listed under Appendix II of CITES and the Bonn Convention. Protected under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. Listed on the SBL. Listed as a PMF. This species has an IUCN status of 'Critically Endangered'.
Freshwater pearl mussel	International	Listed under Annex II of the Habitats Regulations and as a qualifying feature of SACs within the Regional Fish and Shellfish Ecology Study Area. Freshwater pearl mussel are also listed under Appendix III of the Bern Convention and under the Wildlife and Countryside Act 1981. Listed on the SBL. This species has an IUCN status of 'Critically Endangered'.
Sea lamprey	International	Listed under Annex II of the Habitats Regulations and as a qualifying feature of SACs within the Regional Fish and Shellfish Ecology Study Area. Listed under Appendix III of the Bern Convention. Protected under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. Listed on the SBL. Listed as a PMF. Listed on the OSPAR list of Threatened and/or Declining Species.
Sea trout	National	Protected under the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. Listed on the SBL. Listed as a PMF.
Shellfish		
Edible crab	Regional	Commercially important species. Identified as being likely to be present within the Morven South Boundary.

IEF	Importance	Justification
European lobster	Regional	Commercially important species. Identified as being likely to be present within the Morven South Boundary.
King scallop	Regional	Commercially important species. Identified as being likely to be present within the Morven South Boundary.
Nephrops	Regional	Commercially important species. Identified as unlikely to be present in the Morven South Boundary based on habitat preference. Spawning and nursery grounds present throughout the Regional Fish and Shellfish Ecology Study Area but not overlapping within the Morven South Boundary.
Queen scallop	Regional	Commercially important species. Identified as being likely to be present within the Morven South Boundary.
Velvet swimming crab	Regional	Commercially important species. Identified as being likely to be present within the Morven South Boundary.
Other shellfish	Local	Other shellfish including shrimps, whelk, razor clams, and cephalopods have been identified as being likely to occur within the Morven South Boundary. Within the Regional Fish and Shellfish Ecology Study Area, these species are of relatively low commercial importance when compared to species such as Nephrops.

9.7.5 Future baseline scenario

9.7.5.1 The EIA Regulations (The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Marine Works (Environmental Impact Assessment) Regulations 2007 require the following to be included within the EIA Report: "a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without development as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge. In the event that Morven South does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

9.7.5.2 The fish and shellfish baseline is not static and may experience natural changes over time, even if Morven South does not come forward. Changes could arise due to naturally occurring cycles and processes, such as altered spawning behaviour, primary production, and marine food webs. In addition to these potential natural changes, potential effects on the marine environment could also occur due to climate change. Variability and long-term changes on physical processes, ocean acidification, stratification, and water temperature could result in direct and indirect changes to the fish and shellfish baseline in the mid to long-term future.

9.7.5.3 For example, increased sea surface temperatures have been predicted to occur due to climate change and will likely have an effect on fish and shellfish species at all biological levels (cellular, individual, population, species, community and ecosystem) both directly and indirectly. As sea temperatures rise, species adapted to cold water (such as those within the North Sea) may spawn earlier in the year and/or demonstrate earlier larval development (McQueen and Marshall, 2017, Weigel *et al.*, 2021). In addition, species may migrate further north towards cooler waters, while species adapted to warm water may become more established in their absence (Dahms and Killen, 2023, Hastings *et al.*, 2020). Changes in weather patterns under climate change could alter the stratification of water columns and primary production (Morison *et al.*, 2019). This could subsequently impact fish and shellfish species due to altered prey availability throughout trophic levels. Overall, climate change presents many uncertainties about the future fish and shellfish baseline.

9.7.5.4 In addition to natural and climatic effects, changes in fisheries management may also affect the fish and shellfish ecology baseline. For example, in an attempt to conserve seabird populations who rely on sandeels as a key prey resource, the Sandeel (Prohibition of Fishing) (Scotland) Order 2024 introduced a ban on sandeel fishing from March 2024 within the Scottish zone (i.e. the sea adjacent to Scotland out to 200nm), with similar measures in the English waters of the North Sea. However, this order was appealed by the European Union (EU) during a tribunal in late 2024 and into 2025. The results of this tribunal were published in May 2025, with the ban on sandeel fishing retained in both Scottish and English waters of the North Sea. It is anticipated that the closure of sandeel fisheries in the North Sea will provide wider direct benefits to sandeel populations (through reduction of pressures from fishing) and indirect benefits to a wide range of fish, seabird and marine mammal species that prey upon them.

9.7.6 Data limitations and assumptions

9.7.6.1 The most recent publicly available data sources at the time of writing as specified in Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report, have been used to characterise the baseline. These data sources were agreed upon during consultation (see Section 9.4). However, it should be noted that some datasets are now somewhat dated, such as Coull *et al.* (1998) and Ellis *et al.* (2012). These are industry-standard datasets and have been included and assessed with the caveat that they are now quite dated. In addition, long-term data series, such as the IBTS and International Herring Larvae Survey (IHLS), have demonstrated the continued validity of these legacy datasets, with spawning and nursery grounds continuing to remain broadly consistent with these earlier studies.

9.7.6.2 Given the rich species diversity and wide range of habitats within the North Sea, it is always possible that not all potential fish and shellfish species within the Regional Fish and Shellfish Ecology Study Area have been identified. However, given the detailed desktop study completed, and the precautionary approach adopted, which has included the identification of a broad Regional Fish and Shellfish Ecology Study Area, it is unlikely that any key species have been omitted from the baseline characterisation and the assessment presented in this chapter.

9.7.6.3 Any data limitations are not considered to have implications for the conclusions of the assessment presented in this chapter, based on the rationale provided in the previous two paragraphs.

9.8 Methodology for assessment of effects

9.8.1 Overview

9.8.1.1 The fish and shellfish ecology assessment of effects has followed the methodology set out in Volume 1, Chapter 6: EIA Methodology. Relevant guidance is presented in Section 9.6.2. In addition, the fish and shellfish ecology assessment of effects has considered the legislative framework as defined in Section 9.3.

9.8.2 Assessment criteria

9.8.2.1 The approach for determining the significance of effects is a two-stage process that involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in Volume 1, Chapter 6: EIA Methodology.

9.8.2.2 The criteria for defining magnitude in this chapter are outlined in Table 9.16 below.

Table 9.16: Definition of terms relating to the magnitude

Magnitude of impact	Definition
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements.
Medium	Loss of resource but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements.
Low	Some measurable change in attributes, quality or vulnerability, minor loss or, or alteration to, one (maybe more) key characteristics, features or elements.
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements.

9.8.2.3 The criteria for defining sensitivity in this chapter are outlined in Table 9.17 below. These include the recoverability and importance of a receptor in IEF terms, alongside the vulnerability of the receptor to a given impact.

Table 9.17: Definition of terms relating to the sensitivity of the receptor

Value (sensitivity of the receptor)	Description
High	High importance and rarity, international and/or national receptor and limited potential for recovery.
Medium	High or medium importance and rarity, regional receptor, and potential for recovery.
Low	Low or medium importance and rarity, local receptor and high potential for recovery.
Negligible	Very low importance and rarity, local receptor and very high potential for recovery.

9.8.2.4 The significance of the effect upon fish and shellfish ecology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 9.18. This involves a consideration of spatial extent, duration, intermittent or continuous nature of the impact, reversibility, and if the impact will directly or indirectly affect a receptor.

9.8.2.5 In cases where a range is suggested for the significance of effect, there remains the possibility that this may span the significance threshold (i.e. the range is given as minor to moderate). In such cases the final significance is based upon the expert's professional judgement as to which outcome delineates the most likely effect, with an explanation as to why this is the case.

9.8.2.6 For the purposes of this assessment:

- a level of effect of moderate or more will be considered a 'significant' effect in terms of the EIA Regulations;
- a level of effect of minor or less will be considered 'not significant' in terms of the EIA Regulations.

9.8.2.7 Effects of moderate significance or above are therefore considered important in the decision-making process, whilst effects of minor significance or less warrant little, if any, weight in the decision-making process.

Table 9.18: Matrix used for the assessment of the significance of the effect

Sensitivity of receptor	Magnitude of impact			
	Negligible	Low	Medium	High
Negligible	Negligible	Negligible to minor	Negligible to minor	Minor
Low	Negligible to minor	Negligible to minor	Minor	Minor to moderate
Medium	Negligible to minor	Minor	Moderate	Moderate to major
High	Minor	Minor to moderate	Moderate to major	Major
Very high	Minor	Moderate to major	Major	Major

9.8.3 Designated sites

9.8.3.1 Where Natura 2000 sites (i.e. nature conservation sites in Europe designated under the Habitats or Birds Directives) or sites in the UK that comprise the National Site Network (collectively termed "European sites") are considered, this chapter makes an assessment of the likely significant effects in EIA terms on the qualifying interest feature(s) of the European sites described within Section 9.7.3 of this chapter. The full assessment of the potential impacts on the site is deferred to the Morven South RIAA.

9.8.3.2 With respect to locally designated sites and national designations (other than European sites), where these sites fall within the boundaries of a European site and where qualifying interest features are the same, only the European site has been taken forward for assessment. This is because potential impacts on the integrity and conservation status of the locally or nationally designated site are assumed to be inherent within the assessment of the European site (i.e. a separate assessment for the local or national site is not undertaken). However, where a local or nationally designated site falls outside the boundaries of a European site, but within the Regional Fish and Shellfish Ecology Study Area, an assessment of the likely significant effects on the overall site is made in this chapter using the EIA methodology.

9.9 Parameters for assessment

9.9.1 Maximum Design Scenario

9.9.1.1 The Maximum Design Scenarios (MDSs) identified in Table 9.19 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in Volume 1, Chapter 3: Project Description. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within Volume 1, Chapter 3: Project Description (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

Table 9.19: Maximum Design Scenario considered for the assessment of potential impacts on fish and shellfish ecology

C= construction, O= O&M, D= decommissioning phases

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
Temporary habitat loss and disturbance	✓	✓	✓	**Construction phase** Up to 62,596,300m^2 of subtidal habitat loss/disturbance in total across Morven South. Maximum duration of the offshore construction phase is up to five years. • Jack-up events: up to 1,939,200m^2 of disturbance from the use of jack-up vessels during foundation installation, with up to three jack-up events at each of 95 wind turbines and three jack-up events at each of five Offshore Substation Platforms (OSPs). • Cable installation (including sandwave clearance and pre-lay preparation including boulder and debris clearance): up to 13,680,000m^2 of disturbance comprising: – Inter-array cables sandwave clearance: up to 1,260,000m^2 disturbance from installation of up to 420km of inter-array cables (assumes 15% requires sandwave clearance with a 20m width of disturbance). – Inter-array cables boulder clearance: up to 7,140,000m^2 disturbance from installation of up to 420km of inter-array cables (assumes 85% requires boulder clearance with a 20m width of disturbance). – Interconnector cables sandwave clearance: up to 792,000m^2 disturbance from installation of up to 264km of interconnector cables (assumes 15% requires sandwave clearance with a 20m width of disturbance). – Interconnector cables boulder clearance: up to 4,488,000m^2 disturbance from installation of up to 264km of inter-	<u>Construction phase:</u> The MDS is based on the maximum footprint which would be affected during the construction phase. The MDS assumes 100% of all cables are buried. The MDS assumes that the width of disturbance for sandwave and pre-lay preparation (boulder and debris clearance) also includes subsequent burial. For the purposes of the MDS, and to avoid double counting of disturbance associated with site preparation activities (i.e. between boulder clearance and sandwave clearance), the MDS assumes 80% of inter-array and interconnector cables will be subject to pre-lay preparation (boulder and debris clearance) only. The MDS assumes that the remainder of the cables will be subject to sandwave clearance. The area of seabed affected by the placement of sandwave clearance material has been calculated based on the maximum volume of sediment to be placed on the seabed, assuming all this sediment is coarse material (i.e. is not dispersed through tidal currents; see "Increased SSCs" impact assessment below). The total footprint of seabed affected has been calculated, for the purposes of the MDS, assuming a mound of uniform thickness of

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
				connector cables (assumes 85% requires boulder clearance with a 20m width of disturbance). • Sandwave clearance material deposition: Up to 46,239,000m² of habitat disturbance associated with the deposition of sandwave clearance material comprising: – 26,539,800m² from deposition of 13,269,900m³ of sandwave clearance material associated with seabed preparation for wind turbine and OSP foundations. – 19,699,200m² from deposition of 9,849,600m³ of sandwave clearance material associated with seabed preparation for inter-array and interconnector cables. • Anchor placements: up to 684,000m² of habitat disturbance from 500m² anchor sets (5 anchors per set) every 500m per inter-array/interconnector cable link during installation. • Cable removal: Up to 100,000m² from the removal of 5,000m of disused cables with a width of disturbance of 20m. • UXO removal: potential for high order clearance of up to 15 UXOs across Morven South ranging from 25kg up to 554kg with 132kg the most likely (common) maximum. **O&M phase** Up to 7,967,400m² of temporary subtidal habitat disturbance in total across Morven South. O&M phase up to 35 years. • Up to 777,000m² of temporary habitat disturbance due to jack-ups at wind turbines and OSPs over the lifetime of Morven South for the following: – Up to 75 major component replacements for wind turbines; – Up to 48 major component replacements (one every three years over the lifetime per OSP) for OSPs;	0.5m height. The MDS assumes temporary loss of seabed habitat is beneath this. The area of seabed affected by the placement of sandwave clearance material arising from seabed preparation for wind turbine and OSP foundations has been calculated based on the maximum volume of sediment which is associated with 3-legged suction bucket jacket foundations for wind turbines and 6-legged gravity base foundations for OSPs. Maximum number and maximum size of UXOs encountered within the Morven South Boundary. Due to uncertainties in size of UXOs the assessment presents a range, highlighting the most likely size (common) to be encountered. **O&M phase** The MDS is based on the maximum footprint which would be affected during the O&M phase. This is related to the number of O&M activities including component replacements, inter-array and interconnector cable maintenance. Decommissioning phase: Parameters for decommissioning will be significantly lower than for the construction phase as sandwave clearance and pre-lay preparation will not be required in advance of cable and cable protection removal and scour protection will be left *in situ*.

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
				– 18 access ladder replacements and up to 70 modifications to/replacement of J-tubes for wind turbines; – 12 access ladder replacements and up to 147 modifications to/replacement of J-tubes for OSPs • Up to 5,152,000m^2 of temporary habitat disturbance due to inter-array cable maintenance associated with: – 2,352,000m^2 from 7 reburial events affecting up to 16,800m of cable per reburial event – 2,800,000m^2 from 14 repair events (two every five years) affecting up to 10,000m per cable repair event – Assuming 20m width seabed disturbance for repair and remedial burial. • Up to 2,038,400m^2 of temporary habitat disturbance due to inter-connector cable maintenance: – 1,478,400m^2 from 7 reburial events affecting up to 10,560m per reburial event – 560,000m^2 from 14 repair events (one event per inter-connector every 25 years) affecting up to 2,000m of cable per repair event – Assuming 20m width seabed disturbance for repair and remedial burial. **Decommissioning phase** Temporary subtidal habitat loss/disturbance due to: • Cable removal: disturbance from the removal of 420km of inter-array cables and 264km of inter-connector cables. • Anchor placements: habitat disturbance from anchor placements during cable removal.	The MDS assumes the complete removal of all wind turbine and OSP foundations and cables.

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• Jack- up events: disturbance from the use of jack-up vessels during foundation removal.	
Underwater sound impacting fish and shellfish receptors	✓	✗	✓	**Construction phase** Piling Concurrent piling with up to two vessels, at a minimum distance of 1km and a maximum distance of 27.65km, piling at 73 foundations comprising: • 67 wind turbines: – 16m diameter monopiles; – Maximum hammer energy of 6,600kJ; – Maximum duration of 24h piling per monopile, with a maximum of two foundations per day (concurrently); – Total of 34 days of concurrent piling. • Four AC collector OSPs: – 16m diameter monopiles; – Maximum hammer energy of 6,600kJ; – Maximum duration of 24h piling per monopile, with a maximum of two foundations per day (concurrently); – Total of two days of concurrent piling. • One bridge-linked HVDC converter OSP (treated as one location, with two foundations): – Two six-legged jacket foundations (bridge-linked); – 24 x 5m (modelled as 5.3m) diameter pin piles per foundation, which equals 48 piles for the two foundations; – Maximum hammer energy of 4,000kJ; – Maximum duration of 9h piling per pin pile, with an average of two piles per day. – Total of 12 days of piling (based on four piles per day)	**Construction phase** Piling The MDS assumes that concurrent piling of the largest diameter monopiles (16m) using the greatest hammer energy (6,600kJ) would lead to the largest spatial extent of ensonification at any one time. The MDS assumes the maximum number of piles would be installed per day. Minimum spacing between concurrent piling (1km) represents the highest risk of injury to animals as sound from adjacent foundations could combine to produce a greater radius of effect compared to a single piling event. Maximum spacing between concurrent piling (27.65km) represents the highest risk of behavioural effects to fish and shellfish receptors as a larger area would be ensonified at any one time. UXO Clearance Maximum number and maximum realistic size of UXOs encountered is based on the UXO Hazard Assessment undertaken for Morven North. **Decommissioning** The approach for decommissioning is yet to be determined, however, for the purposes of the MDS it is assumed there will be a range of decommissioning activities such as removal of foundations, cables and cable protection.

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
				Total duration of piling = 34 + 2 + 12 = 48 days UXO clearance • Clearance of up to 15 UXOs within the site boundary; • maximum charge weight of 554kg Net Explosive Quantity (NEQ); • most likely charge weight of 132kg NEQ; • maximum of one detonation within 24 hours; • total duration of UXO clearance campaign 15 days (excluding downtime for e.g. weather); • clearance during daylight hours only. **Decommissioning phase** • The MDS for the decommissioning phase assumes there will be a range of activities such as removal of foundations, cables and cable protection.	Details of these activities in the decommissioning phase are currently unavailable.
Increased SSCs and associated deposition	✓	✓	✓	**Construction phase** Site preparation foundations: • Sandwave clearance activities undertaken over an approximate fifteen month duration within the wider five year construction programme. • Wind turbines and OSP foundations: sandwave clearance has been calculated based on the assumption of clearance at up to 80% of locations. Spoil volume per location has been calculated on the basis of 58 locations supporting the three-legged suction bucket wind turbine foundations and 5 locations supporting gravity base OSP foundations. This equates to a total sandwave clearance area for Morven South of 3,753,226m^2 or 11,259,679m^3 based on sandwaves 3m in height. The single greatest sandwave clearance area may occur due to the bridge-linked High Voltage Direct Current (HVDC) converter substation OSP with gravity base	**Construction phase** Seabed Preparation • The volume of material to be cleared from individual sandwaves will vary according to the local dimensions of the sandwave (height, length, and shape) and the level to which the sandwave must be reduced. These details are not fully known at the time of writing, however based on the available data, it is anticipated that the sandwaves requiring clearance in the Morven South Boundary are likely to be circa 3m in height. • The MDS for sandwave clearance to allow the installation of wind turbines and OSPs and their associated scour protection has been selected in line with standard practice and based on the greatest potential volume

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
				foundations, with a clearance area up to 597,800m^2 or volume of up to 1,793,400m^3. Site Preparation Cabling: • Inter-array cables: sandwave clearance along 63.0km of cable length, with a base width of 20m, to an average depth of 3m. Total spoil volume of 6,048,000m^3. • Inter-connector cables: sandwave clearance along 39.6km of cable length, with a base width of 20m, to an average depth of 3m. Total spoil volume of 3,801,600m^3. • Total Cabling spoil volume of 9,849,600m^3, which assumes that 15% of total length of inter-array and interconnector cables will require sandwave clearance. • Removal of up to 5km of disused cables. Foundation installation: Undertaken over an approximate 21 month duration. • Wind turbines: installation of up to 34 monopiles of 16m diameter, drilled to a depth of 64m at a rate of up to 1.5m/h. Three monopiles installed concurrently. Spoil volume of 14,358m^3 per pile. • OSPs: installation of four High Voltage Alternating Current (HVAC) collector substation OSPs with foundations consisting of 16m diameter monopiles, drilled to a depth of 64m at a rate of up to 1.5m/h. Two monopiles installed concurrently. Spoil volume of 14,357m^3 per pile. • OSPs: installation of one bridge-linked HVDC converter substation OSP with two six-legged jacket foundations, each with a pile diameter of 5m, drilled to a depth of 80m at a rate of up to 1.45m/h. Three piles installed concurrently. Spoil volume of 1,888m^3 per pile.	of suspended sediments at an individual location, rather than over the Morven South Boundary. This is because for suspended sediments, it is the maximum concentrations of suspended sediments within the water column at a particular location at a particular time during a tidal cycle that are considered critical with regards to the maximum potential deposition on the seabed. Note that although sediment plumes from a sandwave clearance operation at an individual foundation may extend and interact with sediment plumes resulting from similar works at an adjacent turbine location, if these operations are undertaken simultaneously, sediment plumes will align with the tidal currents, with concentration rapidly diminishing with increasing distance from the works. Thus, selection of the MDS is based upon maximum concentrations and the maximum potential seabed deposition at any one location. • Similarly, the MDS for sandwave clearance to allow for the installation of cables and associated cable protection has been selected in line with standard practice, based on the greatest potential volume of suspended sediments at an individual location. However, as sandwave clearance width, proportion of cables requiring clearance and sandwave heights remain the same for all scenarios considered and the

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
				Cable installation: • Inter-array cables: Installation via trenching of up to 420km of cable, with a trench width of up to 3m and a depth of up to 3m. Total spoil volume of 1,890,000m^3 assuming triangular cross section of the trench. Installed over a period of one year. • Inter-connector cables: installation via trenching of up to 264km of cable, with a trench width of up to 3m and a depth of up to 3m. Total spoil volume of 1,188,000m^3 assuming triangular cross section of the trench. Installed over a period of one year. **O&M phase** • Project lifetime of 35 years • Inter-array cables: repair of up 10km of cable in two events every five years. Reburial of up to 17km of cable in a maximum of one event every five years. • Inter-connector cables: repair of up to 2km of cable in each of 10 events every 25 years. Reburial of up to 11km of cable in a maximum of one event every five years. **Decommissioning phase** • Inter-array and inter-connector cables will be removed where it is possible and appropriate to do so. The MDS will assess the removal of all cables.	selected MDS is also capable of producing the largest sandwave clearance areas and volumes over the Morven site as a whole. • Site clearance activities may be undertaken using a range of techniques, the suction hopper dredger will result in the greatest increase in suspended sediment and largest plume extent as material is released near the water surface during the disposal of material • Boulder clearance activities will result in minimal increases in SSCs and have therefore not been considered in the assessment. Foundation Installation: • Installation of foundations via augured (drilled) operations results in the release of the largest volume of sediment. The greatest volume of sediment disturbance by drilling at individual foundation locations and across the Morven site as a whole is associated with monopiles for wind turbines. The selected OSP scenario represents the greatest volume of sediment to be released for a drilling event. • The greatest drilling rate represents the maximum level of increase in SSCs. Maximum drilling rates are similar for all scenarios. Cable Installation: • Cable routes inevitably include a variety of seabed material and in some areas 3m

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
					depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route. The assessment therefore considers the upper bound in terms of suspended sediment and dispersion potential. • Cables may be buried by ploughing, trenching or jetting with trenching or jetting mobilising the greatest volume of material to increase SSCs. **O&M phase** • The greatest foreseeable number of cable reburial and repair events is considered to the MDS for sediment dispersion. **Decommissioning phase** • The removal of cables may be undertaken using similar techniques to those employed during installation, therefore the potential increases in SSC and deposition would be in line with the construction phase. Scour and cable protection are anticipated to remain *in-situ*.
Long-term habitat loss	✓	✓	✓	**Construction and O&M phase** Up to 1,820,664m^2 of long-term habitat loss/habitat alteration in total across Morven South. O&M phase up to 35 years.	**Construction and O&M phase** The MDS includes the wind turbine and OSP foundation type and associated scour protection option with the largest seabed footprint, maximum length of cable protection

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• Presence of foundations and scour protection: up to 1,107,864m² of habitat loss comprising: – Wind turbines: up to 796,529m² from the presence of up to 95 wind turbine foundations on suction bucket 3-legged jacket foundations with associated scour protection. – OSPs: up to 311,335m² from six OSPs on gravity base foundations and with associated scour protection. • Presence of cable protection for inter-array and inter-connector cables: up to 684,000m² of habitat loss comprising: – Inter-array cable protection: 420,000m² associated with up to 10% of 420km of inter-array cables requiring cable protection (10m width of cable protection) – Inter-connector cable protection: 264,000m² for up to 10% of 264km of inter-connector cables requiring cable protection (10m width of cable protection) • Presence of cable crossing protection: up to 28,800m² of habitat loss comprising: – Cable protection for cable crossings for inter-array cables: 14,400m² from five cable crossings (each up to 80m in length and 36m in width) – Cable protection for cable crossings for inter-connector cables: 14,400m² from five cable crossings (each up to 80m in length and 36m in width). **Decommissioning phase** Up to 1,649,807m² of permanent subtidal habitat loss due to scour, cable protection and cable crossings left *in situ* post decommissioning.	and cable crossings resulting in the greatest extent of habitat loss. **Decommissioning phase** The MDS for decommissioning and permanent habitat loss following decommissioning) assumes removal of the foundations, if any additional infrastructure is decommissioned, this will result in a reduced area of permanent habitat loss. Greatest amount of cable and scour protection resulting in the largest area of infrastructure to be left *in situ* after decommissioning.

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
Colonisation of hard structures and associated fish aggregation	✓	✓	✓	**Construction and O&M phase** Introduction of up to 3,074,239m^2 of hard structures across Morven South. These will be installed in the construction phase and persist over the O&M phase, and these phases have been combined for brevity. O&M up to 35 years. • Wind turbines and OSPs: Presence of up to 95 wind turbines 4-legged suction bucket jacket foundations and six OSPs on gravity base foundations. • Scour protection: Presence of scour protection for wind turbine foundations and OSP foundations • Cable protection: Presence of cable protection associated with up to 10% of 420km of inter-array cables and 10% of the 264km of interconnector cables • Cable crossing protection: Presence of cable protection for cable crossings, five cable crossings for inter-array cables (each up to 80m in length and 36m in width) and five cable crossings for interconnector cables (each up to 80m in length and 36m in width). Maintenance activities including the removal of marine growth from foundations or access ladders. **Decommissioning phase** Up to 1,649,807m^2 of artificial structures remaining post-decommissioning due to scour and cable protection and cable crossings being left *in situ* post-decommissioning.	**Construction and O&M phase** Maximum number of wind turbine and OSP foundations and associated scour protection, maximum length of cables and cable protection resulting in greatest surface area for colonisation. The estimate of area associated with the introduction of artificial structures from the presence of foundations has been calculated as if the foundations were a solid structure. This is, therefore, likely to be a conservative estimate of the introduction of artificial structures on the basis that the jacket foundations will have a lattice design rather than a solid surface. **Decommissioning phase** The MDS for decommissioning assumes removal of the foundations but that cable and scour protection could be left in situ after decommissioning.

Potential impact	Phase			Maximum Design Scenario	Justification
	C	O	D		
EMF from subsea electrical cables	×	✓	×	There will be a total of up to **684km** of subsea electrical cables, comprised of: • 420km of 66kV inter-array cables; • 264km of 275kV HVAC inter-connector cables. There will be a target burial depth of 1m, with a minimum and maximum burial depth of 0.5m and 3m, respectively. Up to 10% of the cables will require cable protection as opposed to burial, equating to 68.4km in total. The O&M phase will last up to 35 years.	**O&M phase** The MDS for this impact has been based on maximum length of potential cables at the seabed.

9.10 Designed-in measures and mitigation

9.10.1.1 As part of the project design process, a number of measures (primary and tertiary) have been adopted to reduce the potential for impacts on fish and shellfish ecology (see Table 9.20). For the purposes of the EIA process, the term 'designed-in measure' is used to include the following measures (adapted from the Institute of Environmental Management and Assessment (IEMA, 2016, 2024)):

- Measures included as part of the design of Morven South. These include modifications to the location or design of Morven South, which are integrated into the application for consent. These measures are considered standard industry practice for this type of development and are referred to as primary mitigation in IEMA (2016) and IEMA (2024).
- Measures required to meet legislative requirements, or actions that are generally standard practice used to manage commonly occurring environmental effects. These measures are secured through the conditions of the marine licences and referred to as tertiary mitigation in IEMA (2016) and IEMA (2024).

9.10.1.2 As there is a commitment to implementing these measures, they are considered inherently part of the design of Morven South and have therefore been considered in the assessment presented in Section 9.11 (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

9.10.1.3 The requirement for any additional mitigation measures is dependent on the significance of the effects on fish and shellfish ecology. Where significant effects have been identified, further mitigation measures (referred to as secondary mitigation in IEMA (2016) and IEMA (2024)) have been identified to reduce the significance of effect to acceptable levels following the initial assessment. These are measures that could further prevent, reduce and, where possible, offset any adverse effects on the environment. These measures are set out, where relevant, in Section 9.10.

9.10.1.4 All designed-in measures and secondary mitigation measures are detailed in Volume 3, Annex 6.4: EIA Commitments Register.

Table 9.20: Designed-in (primary and tertiary) measures adopted as part of Morven South

Reference number	Designed in measures adopted as part of Morven South	Justification	Primary or tertiary
MM-2	Development of and adherence to a Cable Plan which will include a Cable Burial Risk Assessment (CBRA) and cable burial and protection monitoring throughout the operational phase.	A Cable Plan will set out the approach to protection of cables during the project lifecycle. It will reduce the risks of vessel underwater allision with cable protection, anchor or fishing gear interaction with subsea cables and interference with magnetic position fixing equipment. The Cable plan will implement management and monitoring of cable protection (via burial or external protection where adequate burial depth, as identified via risk assessment, is not feasible) with any damage, destruction or decay of cables notified to Maritime and Coastguard Agency, Northern Lighthouse Board, Kingfisher and UK Hydrographic Office no later than 24 hours after discovered. This will reduce the probability of cables becoming unburied and impacting other sea users and marine ecology receptors. It will include the requirement of minimum burial depths of 0.5m or the use of cable protection around inter-array and interconnector cables and will include a Cable Burial Risk Assessment. Cable protection may be necessary in some locations where sufficient cable burial depth cannot be achieved or where cables become exposed during the lifetime of Morven South. The CBRA will consider relevant activities in the vicinity of inter-array and interconnector cables and confirm appropriate means of protection taking account of the final inter-array and interconnector cable. The CBRA will identify the appropriate target burial depth to ensure the cable remain buried, or appropriately protected, where target burial depths cannot be achieved, for the duration of the Morven South, to reduce the risk of interaction with other sea users or cable exposure.	Primary
MM-5	Development of and adherence to an INNSMP, and Biosecurity Plan.	To reduce the risk of introduction and spread of INNS during all phases of Morven South, as far as practicable. The Biosecurity Plan and an INNSMP will control invasive non-native species and their potential impact on marine ecology receptors.	Tertiary
MM-6	Development and adherence to a Marine Pollution Contingency Plan (MPCP).	To reduce the potential for release of pollutants from construction, operation and maintenance and decommissioning, a MPCP will be developed. The MPCP will include planning for accidental spills, addressing all potential contaminant releases and include key emergency details, and will be in line with appropriate regulations and guidelines.	Primary

Reference number	Designed in measures adopted as part of Morven South	Justification	Primary or tertiary
MM-16	UXO clearance using low order disposal techniques where technically feasible.	Where reasonably practical, low order techniques will be adopted as mitigation to reduce sound levels and thereby reduce injury and disturbance to sound-sensitive receptors during UXO clearance.	Primary
MM-32	Development of and adherence to an EMP.	The EMP will ensure appropriate environmental controls are in place for Morven South, and the agreed procedures to mitigation and potential risk to the receiving environment. Measures will cover a wide range of management measures including environmental awareness training, auditing, reporting procedures and waste management. It is expected that the EMP will include a MPCP and an INNSMP. The EMP is also expected to limit potential environmental damage from small quantities of drill fluids which may be released and as regulated by the UK Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulations.	Primary
MM-40	Development of and adherence to a piling strategy which will include a soft-start procedure (including low hammer initiation and ramp up) to be implemented for pile driving.	To reduce the likelihood of injury from elevated underwater noise to marine receptors in the immediate vicinity of piling operations as much as possible, allowing individuals to move away from the area before sound levels reach a level at which injury may occur.	Primary

9.11 Assessment of Significant Effects

9.11.1.1 The potential impacts arising from the construction, O&M and decommissioning phases of Morven South are listed in Table 9.19, along with the MDS against which each impact has been assessed.

9.11.1.2 An assessment of the likely significance of the effects of Morven South on fish and shellfish ecology receptors caused by each identified impact is given below.

9.11.2 Temporary habitat loss and disturbance

9.11.2.1 Temporary habitat loss and disturbance of seabed habitats within the Morven South Boundary will occur during the construction, O&M, and decommissioning phases. This temporary habitat loss and disturbance may result from a range of activities including boulder and debris clearance and site and seabed preparation activities, cable installation and repair and associated seabed clearance, UXO clearance, placement of spud-can legs from jack-up operations, anchor placements, and existing cable removal.

Construction phase

Magnitude of impact

9.11.2.2 The MDS accounts for up to a total of 62,596,300m^2 of temporary habitat loss and disturbance during the construction phase (Table 9.19). This represents 4.38% of the total Morven South Fish and Shellfish Ecology Study Area and 0.12% of the Regional Fish and Shellfish Ecology Study Area. The MDS has been based on the total temporary habitat loss and disturbance as a result of sandwave clearance, cable installation, jack-up events, anchor placements, cable removal, and UXO removal.

9.11.2.3 Sandwave clearance will account for up to 46,239,000m^2 of temporary habitat loss/disturbance. The mounds of cleared sediment material, which will be deposited within the Morven South Boundary, will erode over time, and this displaced material will rejoin the natural surrounding sedimentary environment, gradually reducing the size of these mounds of displaced material. The type of sediment deposited onto the seabed causing temporary habitat loss and disturbance will be similar in composition to that of the surrounding areas (consisting of fine to medium sand, see Volume 2, Chapter 8: Benthic Subtidal Ecology). Due to this similarity, displaced fish and shellfish communities would be anticipated to recolonise the disturbed areas in the short term.

9.11.2.4 The cable installation activities will account for up to 13,680,000m^2 of temporary habitat loss and disturbance (Table 9.19). Cable installation will also include the removal of disused existing cables, with this representing up to 100,000m^2 of temporary habitat loss and disturbance. The boulder clearance activities, which account for up to 7,140,000m^2 for the inter-array cables and up to 4,488,000km^2 for the interconnector cables, will likely involve moving any boulders directly to the side of the cable trench. The redistribution of boulders in the local area by these methods is unlikely to cause a notable shift in the baseline patchiness of boulder distribution on the surrounding seabed and it is not considered that it would act as a barrier to the recovery of disturbed epifaunal communities and the fish and shellfish species associated with them.

9.11.2.5 A recent study (RPS, 2019) reviewed the effects of cable installation on subtidal sediments and habitats, drawing on monitoring reports from over 20 UK wind projects. Following cable installation, sandy sediments were shown to recover to baseline conditions quickly, with little to no evidence of disturbance within two years of cable installation. The review presented evidence that remnant cable trenches through coarse and mixed sediments remained visible for several years following installation. However, these depressions were of limited depth (tens of centimetres) relative to the surrounding seabed, and these were spread over a horizontal distance of several metres and therefore did not represent a large shift from the baseline environment (RPS, 2019). In areas of muddy and muddy sandy seabed, evidence of trenches were observed after a number of years following cable installation, although these were found to be relatively shallow (tens of centimetres).

In addition, post-construction monitoring of the Block Island Offshore Wind Farm (off the coast of Rhode Island, United States of America (USA)) demonstrated that 62% of the trenches formed during export cable installation had recovered within four months post construction, and the remainder was partially recovered (BOEM, 2020), which further highlights the likely reversibility of this impact. As sediments within the Morven South Boundary are dominated by fine to medium sands with varying amounts of gravel and shell fragments (see Volume 2, Chapter 8: Benthic Subtidal Ecology), the results of the review indicate that disturbance to these sediments is likely to be reversible (RPS, 2019).

9.11.2.6 In addition to seabed disturbance from site preparation and cable trenching, jack-up events associated with foundation installation will result in compression of the seabed beneath spud-cans. The potential impact of this is up to 1,939,200km^2 of temporary habitat loss/disturbance in the form of depressions in the seabed. Also, anchor placements may cause up to 684,000m^2 of depressions during inter-array and inter-connector cable installation. The depressions formed by these activities are likely to infill over time, but may remain visible for a number of years after the end of construction (Barrow Offshore Windfarm Limited, 2008, RPS, 2019). Monitoring at the Barrow Offshore Windfarm showed that depressions were near fully infilled one year post construction (Barrow Offshore Windfarm Limited, 2008). Monitoring at the Lynn and Inner Dowsing OWF also showed some evidence of depression infilling, although at this site depressions were still visible four years following the end of construction (Centrica Energy Ltd, 2016).

9.11.2.7 The MDS accounts for the clearance of up to 15 UXOs within the Morven South Boundary ranging from 25kg to 554kg, with 132kg the most likely (common) maximum (Table 9.19). Studies undertaken for the Norfolk Vanguard OWF (Ordtek, 2018) and the Sheringham Shoal and Dudgeon OWF Extension Projects (Equinor, 2022) calculated likely crater sizes for a range of UXOs. Modelling showed that a high order detonation of a 150 kg UXO (the option most similar to the most likely (common) maximum) could produce a crater with an estimated diameter of 12.61m and a depth of 1.8m to 2.8m (Ordtek, 2018). Other modelling indicated that craters of up to a maximum of 21m in diameter could be created from high order UXO detonation of a similar magnitude, with a disturbed area of approximately 346m^2 per crater (Equinor, 2022). It is anticipated that the craters will infill over time, with displaced material rejoining the surrounding natural sedimentary environment.

9.11.2.8 The impact is predicted to be of local spatial extent, medium duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

Sensitivity of the receptor

9.11.2.9 The fish and shellfish IEFs may be indirectly affected by this impact due to temporary loss and disturbance of foraging habitat and associated prey items. However, since this impact is predicted to affect only a small proportion of seabed habitats within the Morven South Boundary at any one time (up to 4.38%), and that there are similar habitats (and prey species) occurring throughout the Regional Fish and Shellfish Ecology Study Area, these impacts are likely to be limited. Furthermore, temporary habitat disturbance will also expose benthic infaunal species from the sediment, potentially offering foraging opportunities to opportunistic scavenging species. The implications of changes in fish and shellfish prey species are also discussed for higher trophic level receptors (i.e. marine mammals and birds) in Volume 2, Chapter 10: Marine Mammals and Volume 2, Chapter 11: Offshore Ornithology.

Marine fish Important Ecological Features

9.11.2.10 As this impact involves loss and disturbance to seabed habitats, the most sensitive marine fish IEFs are likely to be those which live or spawn on or near the seabed (such as herring, sandeel and certain elasmobranch species). For other marine fish IEFs, adults are considered to be less vulnerable to this impact than larva or juveniles. This is because adults are more mobile than other life stages and can move away from impacted areas and recolonise once activities have ceased. However, demersal species, such as anglerfish and flatfish species, are not considered to be particularly vulnerable to this impact. For example, neither positive nor negative effects of construction and operation of the Block Island Wind Farm were observed for a range of north American flatfish species (Wilber *et al.*, 2018) suggesting a degree of resilience to this impact in flatfish, and an ability to move away from temporarily affected areas of the seabed.

9.11.2.11 As demersal spawners, temporary loss and disturbance to seabed habitats could lead to sandeel mortality if individuals cannot colonise their preferred sandy spawning habitats or where these habitats may be at carrying capacity (Wright *et al.*, 2000). FeAST reports sandeel species as having a medium sensitivity to the pressures of 'surface abrasion' and a high sensitivity to "physical removal (extraction of substratum)' and 'sub-surface abrasion/penetration" (NatureScot, 2025). Sandeel may also be particularly vulnerable during the winter when they are less mobile and remain buried in the seabed. The Regional Fish and Shellfish Ecology Study Area is located in an area of both high and low intensity spawning grounds for sandeel and a mix of marginal and unsuitable seabed habitat type. From desktop study, low intensity spawning grounds were identified to be present within the Morven South Boundary (i.e. the ZoI for temporary habitat loss and disturbance; Ellis et al., 2012); however, one sample location within the Morven South Boundary recorded a preferred sandeel habitat sediment classification during site specific surveys (Figure 9.4). Only a small proportion of the maximum footprint of temporary habitat loss and disturbance will be occurring at any one time during the construction phase, with recovery of sediments, and sandeel populations into them, following the cessation of activities. Construction activities are expected to be staggered both spatially and temporally throughout the construction phase.

9.11.2.12 Short and long-term monitoring studies of OWFs have reported that offshore wind farm construction (Jensen *et al.*, 2004, Stenberg *et al.*, 2011) and operation (Van Deurs *et al.*, 2012) did not lead to significant adverse effects on sandeel populations in the long-term, with some localised increases in abundance in the first year following construction. More recently, the results of a post-construction monitoring study at the Beatrice OWF showed that sandeel abundance either increased or remained at similar levels when comparing abundance from 2014 to 2020, with the offshore construction phase commencing in April 2017 (Beatrice OWF Limited, 2021b). This study reported no evidence that construction resulted in adverse impacts on the local sandeel population (Beatrice OWF Limited, 2021b). Substrate type is the primary driver for recoverability and rate of recovery of an area after large scale seabed disturbance, with some sandy and muddy habitats (such as those present with the Morven South Fish and Shellfish Ecology Study Area) recorded to return to baseline species abundance after one to two years (Desprez, 2000, Newell *et al.*, 1998). Thus, recovery of sandeel populations at Morven South would be expected, with the rate of recovery dependent on the recovery of sediments to a condition suitable for sandeel recolonisation. Recovery may also occur through larval recolonisation of suitable sandy sediments with larvae likely to be distributed during spring months following spawning in winter/spring (Ellis *et al.*, 2012).

9.11.2.13 The sandeel IEF is likely to be impacted by temporary habitat loss, although seabed habitats are expected to recover. The sandeel IEF is deemed to be of high vulnerability, medium to high recoverability and national value. The sensitivity of the receptor is therefore, considered to be medium.

9.11.2.14 Like sandeel, herring are also demersal spawners, with specific substrate requirements. Temporary habitat loss or disturbance may lead to mortality of herring if spawning habitats are lost or disturbed. Herring stocks have historically followed "boom and bust" cycles, with recolonisation of spawning grounds and subsequent population recovery not fully evidenced (Dickey-Collas *et al.*, 2010, Trochta *et al.*, 2020).

9.11.2.15 A site specific herring spawning habitat suitability assessment has been undertaken with the habitats present within the Morven South Boundary (and therefore the ZoI for temporary habitat loss) assigned as "unsuitable" for herring spawning (Figure 9.3). Therefore, it is unlikely that temporary habitat loss and disturbance within the Morven South Boundary will affect herring spawning grounds. Herring spawning grounds have been recorded elsewhere in the Regional Fish and Shellfish Ecology Study Area (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report), however there is not considered to be a pathway of potential impact due to no overlap with the ZoI.

9.11.2.16 The herring IEF is deemed to be of high vulnerability, high recoverability and of national value. However, given the limited habitat suitability within the Morven South Boundary (wherein the impacts will be isolated), herring spawning grounds are not likely to be impacted by temporary habitat loss and disturbance associated with Morven South. The sensitivity of the receptor is therefore, considered to be low.

9.11.2.17 For the remaining marine fish IEFs, spawning and/or nursery grounds have been identified within the Regional Fish and Shellfish Ecology Study Area (Table 9.11). These areas are largely widespread throughout the North Sea as a whole and are not unique to the Morven South Fish and Shellfish Ecology Study Area (wherein the ZoI will be located) (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report for more information). Further, as the remaining marine fish IEFs are highly mobile species (with some mainly occupying the pelagic zone, such as mackerel, sprat, and various elasmobranchs), they are likely to be able to move away from areas of disturbance and temporary habitat loss. This rationale has been used by FeAST and MarESA for the common skate IEF. Common skate was assessed as having medium sensitivity to “surface abrasion”, and no sensitivity to “sub-surface abrasion/penetration” on FeAST (NatureScot, 2025). The MarESA for common skate presents low sensitivity to “substratum loss” (Neal and Pizzolla, 2006). These sensitivities can reasonably be applied to the other marine fish IEFs, as they are all highly mobile and many either live and/or spawn in the pelagic zone.

9.11.2.18 Overall, the remaining marine fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Diadromous fish Important Ecological Features

9.11.2.19 As diadromous fish species are highly mobile and typically occupy the pelagic zone during their marine phase, therefore during migration they are unlikely to interact with the ZoI for temporary habitat loss and disturbance, which will be concentrated near the seabed in the offshore waters of the Morven South Boundary. Therefore, any temporary habitat loss and disturbance to the seabed is not likely to cause any direct impact upon diadromous fish IEFs, nor is it likely to represent a barrier to migration.

9.11.2.20 There is the potential for indirect impacts on the diadromous fish IEFs due to potential changes in prey and host species as a result of this impact. For example, adult sea lamprey are parasitic and known to attach to a wide range of larger fish and some cetacean species (Silva *et al.*, 2014). Like the marine fish IEFs, most large mobile host species are likely to be able to avoid any potential effects associated with temporary seabed habitat loss due to their mobility and would be able to return to the affected areas following cessation of construction activities.

9.11.2.21 Overall, the diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and of national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Shellfish Important Ecological Features

9.11.2.22 The shellfish IEFs largely live directly on the seabed and are typically less mobile than fish IEFs, and are, therefore, potentially be more vulnerable to this impact. A study on European lobster reported that 84% of berried females (females with eggs) remained within 500m of their release site (Agnalt *et al.*, 2007). Similarly, Smith *et al.* (2001) reported that tagged European lobsters did not appear to undertake extensive migrations, with 95% of recaptured European lobsters moving less than 4km from their original release positions over periods of up to 862 days. Finally, Øresland and Ulmestrand (2013) also demonstrated limited movement in this species, with only 58 out of 4,016 tagged individuals recaptured over 1km away from the release site. Similarly, Vigo *et al.* (2021) demonstrated that the home ranges of tagged Nephrops were approximately 17.75m^2 to 736.25m^2. Nephrops, European lobster, and the other larger crustacean IEFs are referred to as equilibrium species, meaning that they can only recolonise an area once the original substrate has recovered to baseline conditions (Newell *et al.*, 1998). The MarESA for Nephrops lists the species as having a medium sensitivity to 'substratum loss' and a low sensitivity to 'abrasion and physical disturbance' (Hill and Sabatini, 2008). Whilst there are Nephrops spawning and nursery habitats within the Regional Fish and Shellfish Ecology Study Area, these areas do not overlap with the Morven South Fish and Shellfish Ecology Study Area and the ZoI for temporary habitat loss and disturbance (Coull *et al.*, 1998). There is no MarESA for European lobster, however, a recent study at the Westermost Rough OWF reported that the size and abundance of European lobsters increased following temporary closure of the area for the construction of the OWF (Roach *et al.*, 2018) suggesting the wind farm construction activities did not impact European lobster populations.

9.11.2.23 Of the crab IEFs, there is a MarESA available for edible crab to help characterise its sensitivity (Neal and Wilson, 2008). This species was assessed as having high recoverability and low sensitivity to the pressure 'abrasion and physical disturbance' due the high potential for population recovery (Neal and Wilson, 2008). The edible crab IEF was assessed as having a moderate recoverability and sensitivity to 'substratum loss' as individuals will be able to move away from areas of disturbance and are likely to quickly recolonize in undisturbed areas (Neal and Wilson, 2008). Although not specific to edible crab, a capture-mark-recapture study at the Lillgrund OWF in Sweden found no evidence that the project had negative effects on common shore crab populations (Langhamer *et al.*, 2016).

9.11.2.24 The king and queen scallop IEFs, whilst predominantly sessile, can swim limited distances in the low tens of metres, typically as an escape response (Howell and Fraser, 1984, Marshall and Wilson, 2008). This species may have some resilience to habitat loss and disturbance, with the potential for individuals to flee localised areas of disturbance. Scallop larval distribution is reliant on relatively unpredictable hydrographic features (Delargy *et al.*, 2019), however evidence shows that larvae can disperse several tens of kilometres (Le Pennec *et al.*, 2003) and undertake vertical migrations within the water column to retain self-sustaining populations (Sinclair *et al.*, 1985). Nonetheless, the king and queen scallop IEFs are expected to continue spawning outwith the ZoI for temporary habitat loss and disturbance. As suitable settlement habitat will remain following cessation of construction activities, it is expected that king and queen scallop will continue to be recruited within the Morven South Fish and Shellfish Ecology Study Area, through larval transport. The king and queen scallop IEFs are therefore likely to recover well from this impact. This is supported by the MarESA (although only available for king scallop), which concluded that this king scallop has a high recovery potential against the pressure of 'substratum loss' (Marshall and Wilson, 2008).

9.11.2.25 The shellfish IEFs are deemed to be of medium vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

<u>Significance of the effect</u>

9.11.2.26 Overall, for the sandeel IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.2.27 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.2.28 There are no designated sites within the ZoI for temporary habitat loss and disturbance (i.e. the Morven South Boundary; Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, temporary seabed habitat loss and disturbance in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs (see paragraphs 9.11.2.19 and 9.11.2.20).

Secondary mitigation and residual effect

9.11.2.29 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

9.11.2.30 O&M activities will account for up to 7,967,400m^2 of temporary habitat loss and disturbance, from activities including jack-up events for component replacement and repair on wind turbines, and repair and reburial of inter-array and interconnector cables (Table 9.19). This represents 0.56% of the total Morven South Fish and Shellfish Ecology Study Area and 0.02% of the Regional Fish and Shellfish Ecology Study Area. It should also be noted that a small proportion of the total temporary habitat loss and disturbance is likely to occur at any one time over the 35 year operational lifetime and the ZoI associated with each individual maintenance activity will be localised to the immediate vicinity of the works.

9.11.2.31 The repair and reburial of subtidal export cables, and jack-up events, will affect seabed habitats in the immediate vicinity of these operations, with effects on seabed habitats and associated demersal fish and shellfish communities expected to be smaller than during the construction phase due to the reduced area of impact. There is, however, the potential for repeat disturbance to the habitats in the immediate vicinity of the cables through repeat activities over the operational phase of the windfarm, but this impact is likely to be minimal overall over the course of the 35 year operational lifetime.

9.11.2.32 The impact is predicted to be of local spatial extent, long-term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

Sensitivity of the receptor

9.11.2.33 The sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the construction phase and not repeated here.

Significance of the effect

9.11.2.34 Overall, for the sandeel IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.2.35 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.2.36 There are no designated sites within the ZoI for temporary habitat loss and disturbance (i.e. the Morven South Boundary; Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, temporary seabed habitat loss and disturbance in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs (see paragraphs 9.11.2.19 and 9.11.2.20).

Secondary mitigation and residual effect

9.11.2.37 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

9.11.2.38 Decommissioning activities will include the removal of foundations and cables where it is possible and appropriate to do so, with jack-up activities and anchor placements of associated vessels involved in decommissioning. It is proposed that the scour protection will be left *in situ*. Any direct impacts from jack-up vessels and anchor placements will be similar to the construction phase, with similar recovery periods. Overall the extent of temporary habitat disturbance that may occur as a result of decommissioning activities is predicted to be in line with that described for the construction phase in paragraphs 9.11.2.2 to 9.11.2.7 (i.e. up to 62,596,300m^2). On the basis that there will be no requirement for sandwave clearance or pre-lay preparation during decommissioning, the magnitude of the impact is likely to be lower than during construction.

9.11.2.39 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

Sensitivity of the receptor

9.11.2.40 The sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the construction phase and not repeated here.

Significance of the effect

9.11.2.41 Overall, for the sandeel IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.2.42 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.2.43 There are no designated sites within the ZoI for temporary habitat loss and disturbance (i.e. the Morven South Boundary; Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, temporary seabed habitat loss and disturbance in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs (see paragraphs 9.11.2.19 and 9.11.2.20).

Secondary mitigation and residual effect

9.11.2.44 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.11.3 Underwater sound impacting fish and shellfish receptors

Construction phase

Magnitude of impact

9.11.3.1 In the construction phase, underwater sound has the potential to impact fish and shellfish receptors from the following activities:

- Piling of wind turbine and OSP foundations;
- UXO clearance.

Magnitude of impact – piling

9.11.3.2 Piling during the construction phase of Morven South has the potential to result in higher levels of underwater sound when compared to background levels and could result in auditory injury and/or potential behavioural effects on fish and shellfish receptors.

9.11.3.3 The assessment of potential effects on fish and shellfish receptors from piling considered a spatial MDS (Table 9.19). Spatially the MDS assumes concurrent piling of 16m diameter monopile foundations, leading to the largest area of effect at any one time, for which underwater sound modelling was undertaken. The following assumptions were identified for concurrent piling, based on the parameters provided in Volume 1, Chapter 3: Project Description and site bathymetry (see Volume 3, Annex 10.2: Underwater Shared Sound Technical Report):

- minimum separation distance of 1km between concurrent piling events as the MDS for potential injury;
- maximum separation distance of up to 27.65km as the MDS for potential disturbance.

9.11.3.4 The MDS includes piling for the Wind Turbines (16m monopile foundations), OSP Option I (16m diameter monopile foundations) and the OSP Option II (represented as the 5.3m diameter pin pile foundations). A summary of the piling parameters for the MDS presented in Table 9.19 is shown below in Table 9.21. The underwater sound modelling presented in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report selected three conservative pile types to represent the suite of different options available; two of these pile types (16m monopiles and 5.3m pin pile) have been presented here, based on the MDS, as the basis of the assessment.

Table 9.21: Details of hammer and helmet weights in the modelling and representations of different foundation types/hammer energies presented in this chapter

Pile	Hammer model	Helmet weight (kN)	Hammer energy (kJ)	Foundation/ hammer represented	Justification
16m monopile	IQIP IQ6	4,400	6,600	16m monopile, 6,600kJ	16m monopile is the maximum adverse spatial for wind turbines and OSPs Option I
5.3m pin pile	IQIP IQ6	4,000	4,500	5.0m pin pile, 4.5m pin pile, 4,000kJ	The 5.3m pin pile was selected to capture the maximum ranges across all pin pile diameters (i.e. for the OSP Option 2) including the 5.0m and 4.5m.

9.11.3.5 As detailed in Table 9.20, the use of soft-starts (including low hammer initiation and ramping up to full hammer energy) during piling is considered to be a primary designed-in measure. This may allow time for mobile fish and shellfish receptors to flee the area prior to full power piling.

9.11.3.6 The underwater sound modelling presented in Volume 3: Annex 3.1 presented model outputs as Best Estimates (BE) and Upper Bound (UB) to represent the median and maximum geoacoustic profiles respectively. These are described in the underwater sound report as realistic and conservative for the BE and UB respectively. Effect ranges for cumulative Sound Exposure Level (SEL_{cum}) were given as the absolute maximum (R_{max}) and the maximum after removing the most distant 5% (i.e. the outliers) ($R_{95\%}$). For SPL_{pk}, four depths were modelled A-D, with A representing the shallowest and D representing the deepest depth for piling.

9.11.3.7 For the assessment of instantaneous injury (based on SPL_{pk}), the predicted ranges presented in the assessment were based on the conservation case (i.e. UB) and the depth which presented the largest potential range of injury for the scenario. For the assessment of injury (based on SEL_{cum}), predicted ranges presented in the assessment were based on the conservative case and Rmax predictions to provide a precautionary approach to the assessment of effect ranges. It is noted that this is a precautionary approach to the assessment and will likely overestimate the potential effects on fish and shellfish receptors above the likely realistic piling scenario. A summary of the metrics taken forward from the Underwater Sound Modelling (see Volume 3, Annex 3.1: Underwater Sound Shared Technical Report) for the fish and shellfish assessment is presented in Table 9.23.

Table 9.22 Summary of metrics taken forward from the underwater sound modelling to the fish and shellfish assessment

Metric	Application	Values taken forward	Justification
Unweighted Peak pressure (SPL_{pk})	Injury	Conservative Close proximity piles (NR) (separation distance of 1km) Depth: D for 16m monopiles and depth A for 5.3m pin piles	This is the absolute maximum which will determine the maximum injury or disturbance range at any location, based on the MDS. The use of the conservative scenario ensures a precautionary assessment has been undertaken.
	Disturbance	Conservative Far proximity piles (FAR) (separation distance of 27.65km) Depth: D for 16m monopiles and 5.3m pin piles	
Weighted cumulative Sound Exposure Level (SEL_{cum})	Injury	Conservative NR R_{max}	
	Disturbance	Conservative FAR R_{max}	

9.11.3.8 The results of the underwater sound modelling are discussed in Paragraph 9.11.3.14 *et seq* to define the “sensitivity of receptor” in relation to potential injury and behavioural impacts upon fish and shellfish receptors.

9.11.3.9 The impact is predicted to be of local spatial extent, short term duration (in terms of piling hours), intermittent over the construction phase and high reversibility, with the soundscape returning to near baseline conditions upon completion of piling. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

Magnitude of impact – Unexploded Ordnance clearance

9.11.3.10 UXO clearance (including detonation) has the potential to cause injury and disturbance to the fish and shellfish IEFs. UXO clearance will be completed prior to the construction activities. The MDS assumes clearance of up to 15 UXOs within the Site Boundary, with a maximum charge weight of 554kg NEQ, most likely charge weight of 132kg NEQ and a smaller hazard of 25kg (Table 9.19). The total duration of UXO clearance is estimated at up to 15 days (excluding downtime), with clearance during daytime hours only and a maximum of one detonation every 24 hours.

9.11.3.11 As detailed in Table 9.20, the use of low order disposal of UXOs (e.g. deflagration and clearance shots) where possible is a tertiary designed in measure adopted for Morven South. This will reduce underwater sound levels during UXO clearance and thereby reduce the potential for injury and disturbance to fish and shellfish receptors. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has also been considered in the assessment (e.g. high order clearance of the 554kg, 132kg, and 25kg masses as detailed in Paragraph 9.11.3.10). In addition, the implementation of soft start measures for UXO clearance is also a designed-in measure (Table 9.20). This may allow individuals to flee the area before sound levels reach a harmful threshold.

9.11.3.12 To understand the magnitude of sound emissions from UXO clearance, underwater sound modelling has been undertaken considering the key parameters summarised above; further detail on this modelling is provided in Volume 3, Annex 3.1: Underwater Sound Shared Technical Report. In addition, the implications of UXO clearance on fish (in terms of injury and disturbance) are discussed in Paragraph 9.11.3.53 *et seq* to define the 'sensitivity of receptor' in relation to potential injury and behavioural impacts upon fish and shellfish receptors. In comparison to piling activities, UXO clearance will consist of single, isolated events of very short duration.

9.11.3.13 The impact is predicted to be of local spatial extent (up to 15 clearances isolated within the Site Boundary), short term duration during the site preparation activities, intermittent and high reversibility, with the soundscape returning to near baseline conditions upon completion of UXO clearance. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

<u>Sensitivity of the receptor</u>

9.11.3.14 Underwater sound can potentially have an adverse impact on fish species ranging from physical injury and mortality to behavioural effects. Recent peer reviewed guidelines have been published by the Acoustical Society of America (ASA) and provide directions and recommendations for setting criteria (including injury and behavioural criteria) for fish. The Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.*, 2014) are considered most relevant and best available guidelines for impacts of underwater sound on fish species (Volume 3, Appendix 10.2: Underwater Sound Shared Technical Report).

9.11.3.15 The Popper *et al.* (2014) guidelines broadly group fish into the following categories according to the presence or absence of a swim bladder and on the potential for that swim bladder to improve the hearing sensitivity and range of hearing:

- Group 1: Fishes lacking swim bladders (e.g. elasmobranchs, flatfish and lampreys). These species are only sensitive to particle motion, not sound pressure and show sensitivity to only a narrow band of frequencies.
- Group 2: Fishes with a swim bladder but the swim bladder does not play a role in hearing (e.g. salmonids and some Scombridae). These species are considered more sensitive to particle motion than sound pressure and show sensitivity to only a narrow band of frequencies.
- Group 3: Fishes with swim bladders that are close, but not connected, to the ear (e.g. gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than Groups 1 and 2, extending to approximately 500Hz.
- Group 4: Fishes that have special structures mechanically linking the swim bladder to the ear (e.g. clupeids such as herring, sprat and shads). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3.
- Eggs and larvae: separated due to greater vulnerability and reduced mobility. Only few peer-reviewed studies report on the response of eggs and larvae to anthropogenic underwater sound.

9.11.3.16 The Popper *et al.* (2014) guidelines set out criteria for injury effects due to different sources of underwater sound. The criteria include a range of indices including SEL, rms and SPL_{pk}. Where insufficient data exist to determine a quantitative guideline value, the risk is categorised in relative terms as "high", "moderate" or "low" at three distances from the source: "near" (i.e. in the tens of metres), "intermediate" (i.e. in the hundreds of metres) or "far" (i.e. in the thousands of metres). It should be noted that these qualitative criteria cannot differentiate between exposures to different underwater sound levels and therefore all sources of underwater sound, no matter how loud, would theoretically elicit the same assessment result. However, because the qualitative risks are generally qualified as "low", with the exception of a moderate risk at "near" range (i.e. within tens of metres) for some types of hearing groups and impairment effects, this is not considered to be a significant issue with respect to determining the potential effect of underwater sound on fish.

9.11.3.17 Relatively few studies have been conducted on the potential impacts of underwater sound on invertebrates, including crustacean species, and little is known about the potential effects of anthropogenic underwater sound upon them (Hawkins and Popper, 2014, Morley *et al.*, 2014, Williams *et al.*, 2015). There are therefore no injury criteria that have been developed for shellfish (Hawkins and Popper, 2014); however, shellfish are expected to be less sensitive than fish species to underwater sound and therefore injury ranges of fish could be considered conservative estimates for shellfish species (risk of behavioural effects are discussed further below for shellfish).

9.11.3.18 An assessment of the potential for injury/mortality and behavioural effects to be experienced by fish and shellfish IEFs with reference to the sensitivity criteria described above is presented in turn below.

Sensitivity of the receptor – Piling

9.11.3.19 An assessment of the potential for injury/mortality and behavioural effects from piling on the fish and shellfish IEFs with reference to the Popper *et al.* (2014) fish hearing groups is presented in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, with the results summarised here and used to inform the assessment of this impact.

9.11.3.20 The injury threshold criteria used in the underwater sound modelling for impulsive piling are presented in Table 9.23. This includes parameters for both SEL and SPL_{pk}, both of which are unweighted (see paragraph 9.11.3.16). Physiological effects relating to injury criteria are as follows (Hawkins and Popper, 2014, Popper *et al.*, 2014):

- Mortality and potential mortal injury: either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g. a barotrauma) that death occurs sometime later due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity.
- Recoverable injury: Tissue and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.
- Temporary Threshold Shift (TTS): Short term changes in hearing sensitivity may, or may not, reduce fitness and survival. Temporary impairment of hearing may affect the ability of animals to capture prey and avoid predators and also cause deterioration in communication between individuals affecting growth, survival, and reproductive success. After termination of a sound that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of exposure.

Table 9.23: Criteria for the onset of injury to fish from impulsive piling (Popper *et al.*, 2014)

Hearing Group	Parameter	Mortality and Potential Moral Injury	Recoverable Injury	TTS
Group 1 Fish: no swim bladder (particle motion detection)	SEL, dB re 1 μPa^{2}s	>219	>216	>186
	SPL_{pk}, dB re 1 μPa	>213	>213	-
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	SEL, dB re 1 μPa^{2}s	210	203	>186
	SPL_{pk}, dB re 1 μPa	>207	>207	-
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	SEL, dB re 1 μPa^{2}s	207	203	186
	SPL_{pk}, dB re 1 μPa	>207	>207	-
Eggs and larvae	SEL, dB re 1 μPa^{2}s	>210	(Near) Moderate (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Low (Far) Low
	SPL_{pk}, dB re 1 μPa	>207		

9.11.3.21 Behavioural reactions of fish to underwater sound have been found to vary between species based on their hearing sensitivity. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish's body (see Volume 3, Appendix 10.2: Underwater Sound Shared Technical Report for further details). The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders. However, it should be noted that the presence of a swim bladder does not necessarily mean that the fish can detect pressure. Some fish have swim bladders that are not involved in the hearing mechanism and can only detect particle motion.

9.11.3.22 Highly sensitive species, such as herring, have elaborate specialisations of their auditory apparatus, known as an otic bulla, which is a gas filled sphere connected to the swim bladder, which enhances hearing ability. The gas filled swim bladder in species such as cod and Atlantic salmon may be involved in their hearing capabilities, so although there is no direct link to the inner ear, these species are able to detect lower sound frequencies and as such are considered to be of medium sensitivity to sound. All flatfish, lampreys, and elasmobranch species have no swim bladders and as such are considered to be relatively less sensitive to sound pressure.

9.11.3.23 Popper *et al.* (2014) sets out qualitative criteria for disturbance due to different sources of sound. The risk of behavioural effects is categorised in relative terms as "high", "moderate" or "low" at three distances from the source: "near", "intermediate" or "far" (see paragraph 9.11.3.16), as shown in Table 9.24. Since these criteria are qualitative not quantitative, an underwater sound source of a particular type (e.g. piling) would be predicted to result in the same potential impact, no matter the level of underwater sound produced or the propagation characteristics.

9.11.3.24 Criteria presented in the Washington State Department of Transport (WSDOT) Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011) have been used to inform other OWF underwater sound assessments for predicting the distances at which behavioural effects may occur due to underwater sound from impulsive piling (e.g. Ossian Offshore Windfarm Limited (Ossian OWFL, 2024)). This manual suggests an unweighted SPL of 150 dB re 1 μPa (rms) as the criterion for onset of behavioural effects, based on work by Hastings (2002). SPL in excess of 150 dB re 1 μPa (rms) are expected to cause temporary behavioural changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury but may indirectly affect the individual fish (such as by impairing predator detection). It is important to note that this threshold is for onset of potential effects, and not necessarily an 'adverse effect' threshold. Following consultation with NatureScot during the Scoping Workshop, it was agreed that the modelled sound contours at 160dB re 1μPa (SPL_{pk}) would be used as a guide for the potential for behavioural disturbance across all hearing groups. This value was based on a number of literature sources (McCauley *et al.*, 2000, Mueller-Blenkle *et al.*, 2010) and was deemed appropriate and proportionate for this assessment. As such, the modelled SPL_{pk} 160dB re 1μPa contours have been applied to the assessment of disturbance due to piling. It should be noted that this is highly precautionary for Group 1 and Group 2 species which are less sensitive to underwater sound than Group 3 and 4 species (upon which most literature sources focus on).

Table 9.24: Criteria for the onset of behavioural effects in fish (Popper *et al.*, 2014)

Hearing Group	Relative Risk of Behavioural Effects		
	Impulsive piling	Explosives	Non-impulsive sound
Group 1 Fish: no swim bladder (particle motion detection)	(Near) High (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) Moderate (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) High (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) High (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	(Near) High (Intermediate) High (Far) Moderate	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Eggs and larvae	(Near) Moderate (Intermediate) Low (Far) Low	(Near) High (Intermediate) Low (Far) Low	(Near) Moderate (Intermediate) Moderate (Far) Low

Marine and diadromous fish Important Ecological Features

9.11.3.25 For the different piling scenarios, the modelling using the SEL metric considers fish as static receptors, which is considered to be the most precautionary approach to the assessment. It should be noted that, in reality, most fish species are not likely to remain static for the duration of piling and therefore being modelled as static receptors is highly precautionary.

Injury and disturbance

9.11.3.26 The potential injury ranges for concurrent piling of wind turbine foundations are presented in Table 9.25 for fish modelled as static receptors using the SEL_{cum} metric; this is based on minimum spacing of 1km between 16m monopile operations. The potential disturbance range for all fish groups has been based on modelling the same piling operations, with maximum spacing between concurrent piling, due to this representing the largest potential area over which fish could experience behavioural effects.

9.11.3.27 The modelling results suggest that the thresholds for mortality will be exceeded for all hearing groups. For Group 1 fish, the modelling results show that mortality could occur out to a range of 2.92km and recoverable injury out to 4.11km, with higher ranges modelled for Groups 2, 3 and 4 fish (Table 9.25). TTS ranges were higher for all fish groups (range of 39.0km); however, these are reversible. For eggs and larvae, mortality was modelled out to 7.38km (Table 9.25).

Table 9.25: Potential Injury recoverable injury and Temporary Threshold Shift ranges for concurrent 16m wind turbine anchor monopile installation, based on the Cumulative Sound Exposure Level Metric for Static Fish

Hearing Group	Response	Threshold (SEL: db re 1 µPa2s)	Range (km)
Group 1 Fish	Mortality	219	2.92
	Recoverable injury	216	4.11
Group 2 Fish	Mortality	210	7.38
	Recoverable injury	203	14.0
Groups 3 and 4 Fish	Mortality	207	9.29
	Recoverable injury	203	14.0
Fish eggs and fish larvae	Mortality	210	7.38
All fish groups	TTS	186	37.1

9.11.3.28 The potential ensonified areas (km^2) over which injury could occur for concurrent piling of wind turbine foundations are presented in Table 9.26 for fish modelled as static receptors using the SPL_{pk} metric; this is based on 16m monopile operations with minimum spacing of 1km. The modelling results suggest that the thresholds for mortality will be exceeded for all hearing groups. The maximum ensonified area to the SPL threshold is presented for Groups 2, 3, 4 fish and fish eggs and fish larvae of 1.94km^2 (Table 9.28).

Table 9.26: Potential injury ranges for concurrent 16m wind turbine anchor monopile installation, based on the SPL_{pk} Metric

Hearing Group	Response	Threshold (SPL_{pk} db re 1 µPa)	Ensonified area to SPL threshold level(km^2)
Group 1 Fish	Mortality	213	0.27
	Recoverable injury	213	0.27
Groups 2, 3, 4 Fish eggs and fish larvae	Mortality	207	1.94
	Recoverable injury	207	1.94

9.11.3.29 The potential injury and disturbance ranges for concurrent piling of the HVDC converter OSP foundations are presented in Table 9.27 for fish modelled as static receptors using the SEL_{cum} metric; this is based on two 5.3m pin pile operations with minimum spacing of 1km. The modelling results suggest that the thresholds for mortality will be exceeded for all hearing groups. For Group 1 fish, the modelling results show that mortality could occur out to a range of 1.06km and recoverable injury out to 1.92km, with higher ranges modelled for Groups 2, 3 and 4 fish (Table 9.27). TTS ranges were higher for all fish groups (range of 39.3km); however, these are reversible. For eggs and larvae, mortality was modelled out to 4.11km (Table 9.27).

Table 9.27: Potential injury ranges for concurrent Offshore Substation Platform 5.3m pin pile foundation installation, based on the Cumulative Sound Exposure Level Metric for Static Fish

Hearing Group	Response	Threshold (SEL: db re 1 µPa2s)	Range (km)
Group 1 Fish	Mortality	219	1.06
	Recoverable injury	216	1.92
Group 2 Fish	Mortality	210	4.11
	Recoverable injury	203	8.97
Groups 3 and 4 Fish	Mortality	207	5.80
	Recoverable injury	203	8.97
Fish eggs and fish larvae	Mortality	210	4.11
All fish groups	TTS	186	37.4

9.11.3.30 The potential ensonified areas (km^2) over which injury could occur for concurrent piling of the OSP Option II foundation are presented in Table 9.28 for fish modelled as static receptors using the SPL_{pk} metric; this is based on two 5.3m pin pile operations with minimum spacing of 1km. The modelling results suggest that the thresholds for mortality will be exceeded for all hearing groups. The maximum ensonified area is presented for Groups 2, 3, 4 fish and fish eggs and fish larvae of 0.33km^2 (Table 9.28).

Table 9.28: Potential injury ranges for concurrent Offshore Substation Platform 5.3m pin pile foundation installation, based on the SPL_{pk} Metric

Hearing Group	Response	Threshold (SPL_{pk} db re 1 µPa)	Ensonified area to SPL threshold level (km^2)
Group 1 Fish	Mortality	213	0.11
	Recoverable injury	213	0.11
Groups 2, 3, 4 Fish eggs and fish larvae	Mortality	207	0.33
	Recoverable injury	207	0.33

Behavioural disturbance

9.11.3.31 Given that there is limited evidence of behavioural disturbance from underwater sound, TTS is often used as a proxy for behavioural disturbance in fish. This is because it can be assumed that individuals experiencing TTS will likely also experience some disturbance. The TTS ranges are greatest for concurrent piling of wind turbines (for static fish) (Table 9.25; as per the MDS presented in Table 9.19). TTS ranges for fish and shellfish receptors are presented below.

9.11.3.32 A range of 37.1km was modelled for concurrent piling of two 16m monopile operations with maximum separation distance, with fish modelled as static receptors based on the SEL_{cum} metric. (Table 9.25). Based on the same metric, A larger TTS range of 37.4km was modelled for concurrent piling of two 5.3m pin pile operations with maximum separation distance (Table 9.27). These results broadly align with qualitative thresholds for behavioural effects on fish as set out in Table 9.24, with moderate risk of behavioural effects in the range of hundreds of metres to thousands of metres from the piling activity.

9.11.3.33 Behavioural responses to underwater sound have been found to vary between species, based on their hearing sensitivity. There have been several studies on the behavioural effects of the sound pressure component of impulsive sound (which includes piling operations) on fish. For example, Mueller-Blenkle *et al.* (2010) demonstrated behavioural responses in cod and sole to underwater sound similar to that produced during piling, with variation noticed across individuals (i.e. depending on the age, sex, and condition of the fish, as well as the possible increased stress levels due to confinement in cages). Mueller-Blenkle *et al.* (2010) could not define a clear relationship between the level of exposure and the extent of the behavioural response, although an observable behavioural response was reported at 140 to 161 dB re 1 µPa (SPL_{pk}) for cod and 144 dB to 156 dB re 1 µPa (SPL_{pk}) for sole. Nonetheless, these thresholds have not be interpreted as the level at which an avoidance reaction will be elicited, as Mueller-Blenkle *et al.* (2010) were not able to show this.

9.11.3.34 In addition, Pearson *et al.* (1992) examined the effects of geophysical survey sound on caged rockfish Sebastes spp. and observed a startle or 'C-turn response' beginning at around 200 dB re 1 µPa (SPL_{pk}). However, this behavioural response was less common in larger fish. Similarly, McCauley *et al.* (2000) exposed various caged fish species to seismic airgun sound to assess behavioural, physiological and pathological changes. The study observed that:

- A general behavioural response in many fish was to move to the bottom of the cage during periods of high level exposure (around 156 to 161 dB re 1 µPa (rms); approximately equivalent to around 168 dB to 173 dB re 1 µPa (SPL_{pk}).
- A greater startle response was seen in small fish to the above levels than in larger fish.
- A return to normal behavioural patterns occurred between 14 to 30 minutes after airgun operations ceased.
- No significant increases in physiological stress were attributed to air gun exposure.

9.11.3.35 Some preliminary evidence of damage to the hair cells was noticed when fish were exposed to the highest underwater sound levels, although it was determined that such damage would only likely occur at short range from the source (McCauley *et al.*, 2000).

9.11.3.36 Behavioural disturbance due to piling can also be inferred from post-construction monitoring studies of other OWFs. For example, a post-construction monitoring study for cod at the Beatrice OWF recorded no change in the presence of spawning individuals between pre and post construction (although spawning intensity was found to be low across both surveys) (Beatrice OWF Limited, 2021a). Similarly, a sandeel monitoring study at the Beatrice OWF found no evidence of adverse impacts on sandeel populations between pre and post construction levels over a six year period (Beatrice OWF Limited, 2021b). Based on these results, it can be inferred that behavioural disturbance associated with piling and other construction sound from an OWF are likely to be temporary and that fish communities (specifically cod and sandeel in this case) show a higher degree of recoverability following construction. As cod are a Group 3 fish (with some of the highest sensitivity to underwater sound), these results could be extrapolated to other fish IEFs with similar, or lower, hearing sensitivities.

9.11.3.37 Regarding diadromous fish IEFs, a study by Harding *et al.* (2016) failed to produce physiological or behavioural responses in Atlantic salmon when subjected to sound similar to piling. However, the sound levels tested were estimated at <160 dB re 1μPa (rms), below the level at which injury or behavioural disturbance would be expected for Atlantic salmon (Harding *et al.,* 2016). Nedwell *et al.* (2006) compared behavioural responses to piling in sea trout and Atlantic salmon. This study found no significant behavioural response in both species (Nedwell *et al.,* 2006). Physical impacts on migrating salmonids exposed to piling sound of 218 dB re 1μPa^{2}s (SEL) were recorded by Bagočius (2015), although at these high sound levels, avoidance reactions would be expected, in order to avoid injury.

9.11.3.38 As there are no agreed thresholds for behavioural effects on fish from piling, a risk based approach has been undertaken using published literature. Based on these studies and agreed with stakeholders during consultation (see Paragraph 9.11.3.24) the 160 dB re 1 μPa (SPL_{pk}) sound contour has been mapped as a guide to assess behavioural responses in fish species in general. It is unlikely that species will experience behavioural disturbance beyond this sound contour, based on the described studies which demonstrated responses (including avoidance) at levels above this threshold. It's likely that the 160 dB re 1 μPa (SPL_{pk}) contour is over conservative, given that many fish IEFs (such as flatfish, elasmobranchs, lampreys, and salmonids) are at the lower end of the sensitivity spectrum (i.e. hearing Groups 1 and 2).

9.11.3.39 The 160 dB re 1 μPa (SPL_{pk}) contour is presented on Figure 9.6 which shows the following four piling scenarios, in line with the approach outlined above:

- conservative single piling of the maximum piling scenario for the 16m monopile foundation, at the deepest location (which represents the largest potential range of effects from Morven South);
- conservative single piling of the maximum piling scenario for the 5.3m pin pile foundation, at the deepest location (which represents the largest potential range of effects from Morven South);
- conservative concurrent piling of the maximum piling scenario for the 16m monopile foundation, at the deepest location, with the monopiles at furthest distance from each other (27.65km);
- conservative concurrent piling of the maximum piling scenario for the 5.3m pin pile foundation, at the deepest location, with the pin piles at furthest distance from each other (27.65km).

9.11.3.40 The extent of the 160 dB re 1 μPa (SPL_{pk}) contour should be noted, particularly in the context of its considerable distance offshore (approximately 86km) and its relatively small area of effect in terms of the availability of habitat in the Regional Fish and Shellfish Ecology Study Area.

9.11.3.41 Figure 9.7 and Figure 9.8 show the 160 dB re 1 μPa (SPL_{pk}) contour in relation to the habitat suitability for sandeel and spawning grounds of sandeel, respectively. These figures illustrate that behavioural disturbance could occur within the areas of sandeel preferred habitat and within low and high intensity sandeel spawning grounds for all piling scenarios. However, the maximum range of the 160 dB re 1 μPa (SPL_{pk}) contour (approximately 22km) and subsequent area covered is limited compared to the wider availability of sandeel spawning grounds within the Regional Fish and Shellfish Ecology Study Area (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report for more information on spawning grounds within the wider area). Therefore, the sandeel IEF is deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

9.11.3.42 Figure 9.9 and Figure 9.10 show the 160 dB re 1 μPa (SPL_{pk}) contour in relation to habitat suitability for herring spawning and known spawning grounds of herring, respectively. Figure 9.11 shows the 160 dB re 1 μPa (SPL_{pk}) contour in relation to the more recent IHLS cumulative larval densities for herring, which illustrates a herring spawning hotspot to the northwest of Morven South. These figures illustrate that behavioural disturbance could occur within areas of herring potential spawning habitat and marginal spawning habitat (based on substrate type) for all piling scenarios, with the exception of the single piling of the 5.3m pin pile (Figure 9.9). Figure 9.10 shows that behavioural disturbance could also occur within low to high intensity herring nursery grounds but outside of recorded herring spawning grounds (of undetermined intensity; Coull *et al.,* 1998) for all piling scenarios.

9.11.3.43 Furthermore, Figure 9.11 illustrates that the maximum range of the 160 dB re 1 μPa (SPL_{pk}) contour will not extend to the hotspot of herring larval density, located to the north-west of Morven South, for any piling scenario. Only the conservative unmitigated concurrent and single piling of the maximum piling scenario for the 16m monopile foundation is shown to overlap slightly with the herring spawning ground, in an area of low spawning intensity (between >0 and 30,000 larvae <10mm per square metre from IHLS datasets; Figure 9.11). The area of overlap is limited compared to the wider availability of their spawning grounds within the Regional Fish and Shellfish Ecology Study Area (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report) and will not extend to the hotspot for herring spawning as identified from IHLS (Boyle and New, 2018). Therefore, there is no potential for behavioural disturbance within the key areas of high intensity herring spawning. It is noted that the conservative single piling for the 16m monopile and 5.3m pin pile has been modelled from a central location and therefore does not show the largest potential overlap with herring spawning grounds for these scenarios. However, given the larger of these two contours (single 16m monopile) extends outwards to approximately 21km, the concurrent 16m monopile scenario is considered to represent the MDS for this species.

9.11.3.44 Therefore, the herring IEF is deemed to be of medium vulnerability, high recoverability, and national importance. The sensitivity of the receptor is, therefore considered to be medium.

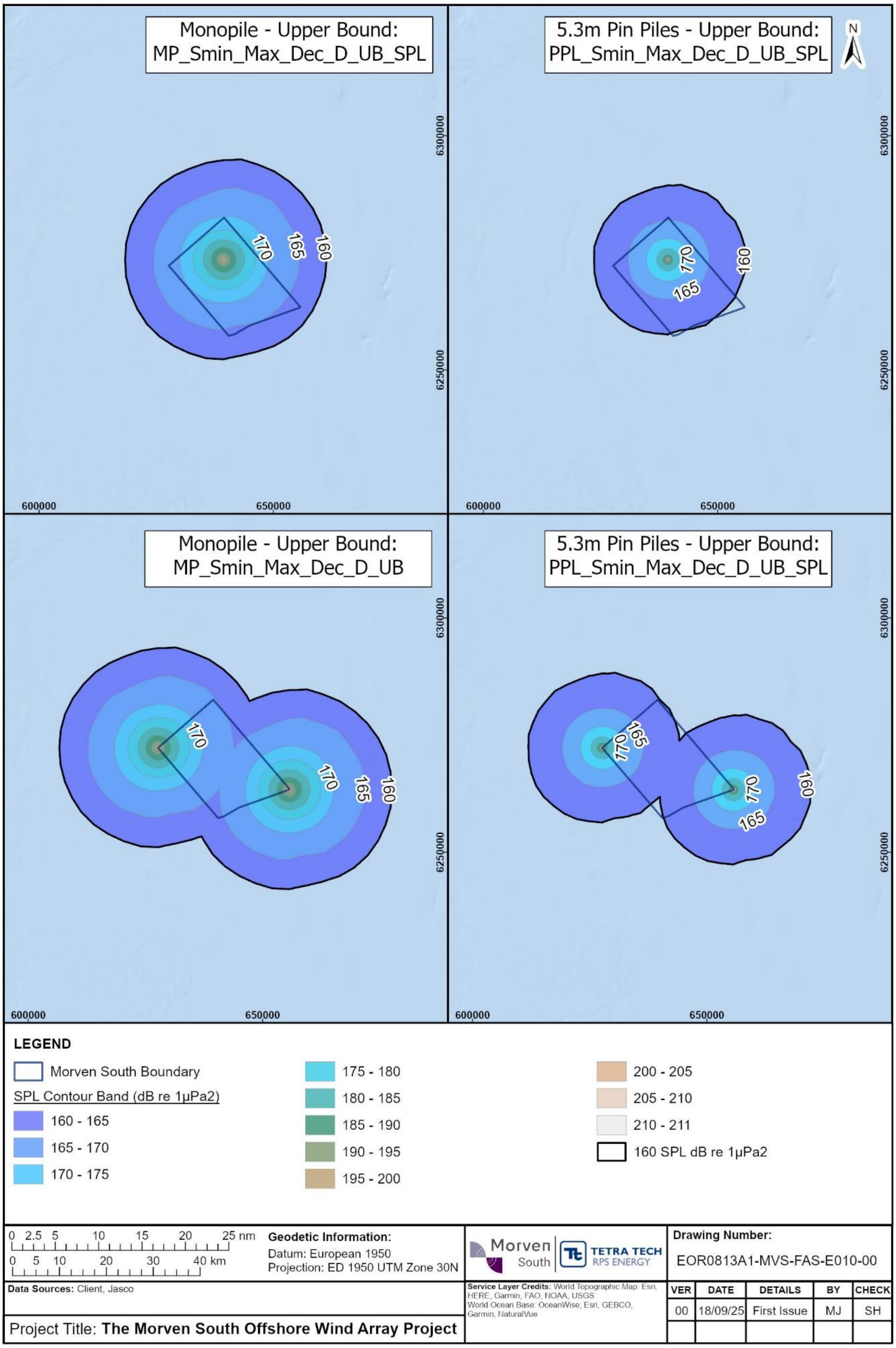

Figure 9.6: Modelled underwater sound contours (SPL_{pk} dB re 1 μPa) for single and concurrent piling of 16m monopiles and 5.3m pin piles for Morven South

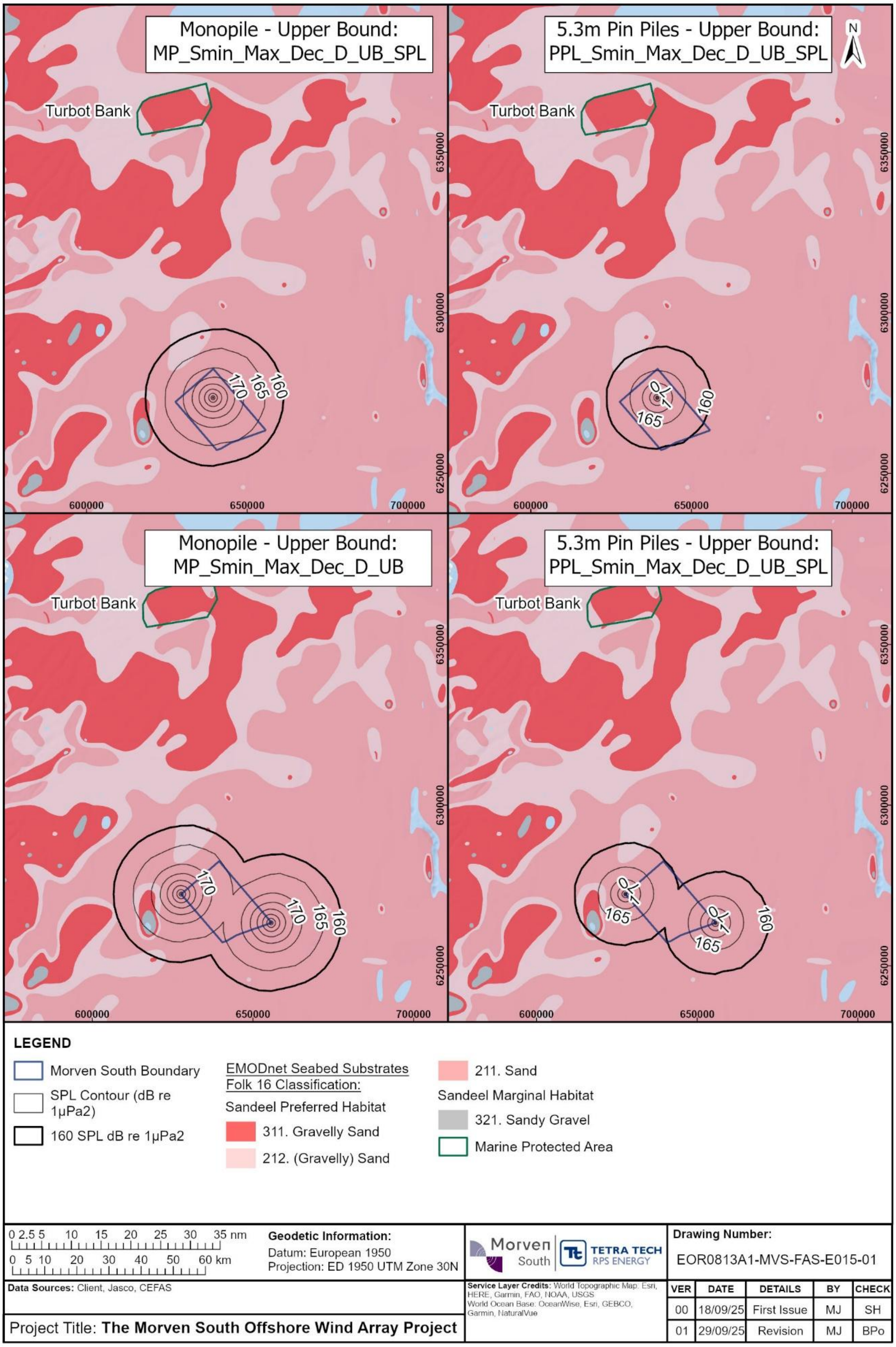

Figure 9.7: Modelled underwater sound contours (SPL_{pk} dB re 1 μPa) for single and concurrent piling of 16m monopiles and 5.3m pin piles and sandeel spawning habitat suitability

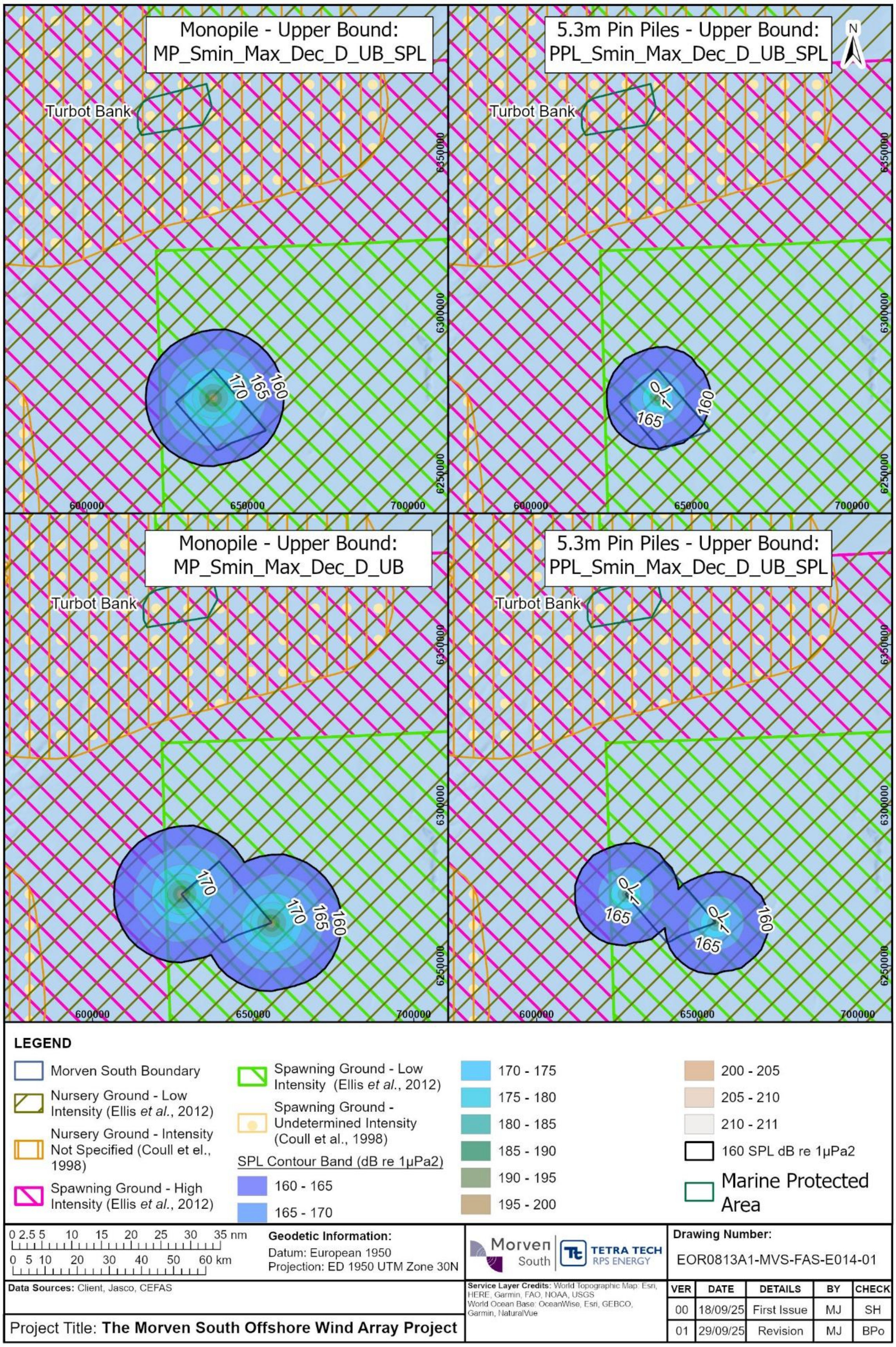

Figure 9.8: Modelled underwater sound contours (SPL_{pk} dB re 1 µPa) for Single and concurrent piling of 16m monopiles and 5.3m pin piles and sandeel spawning grounds

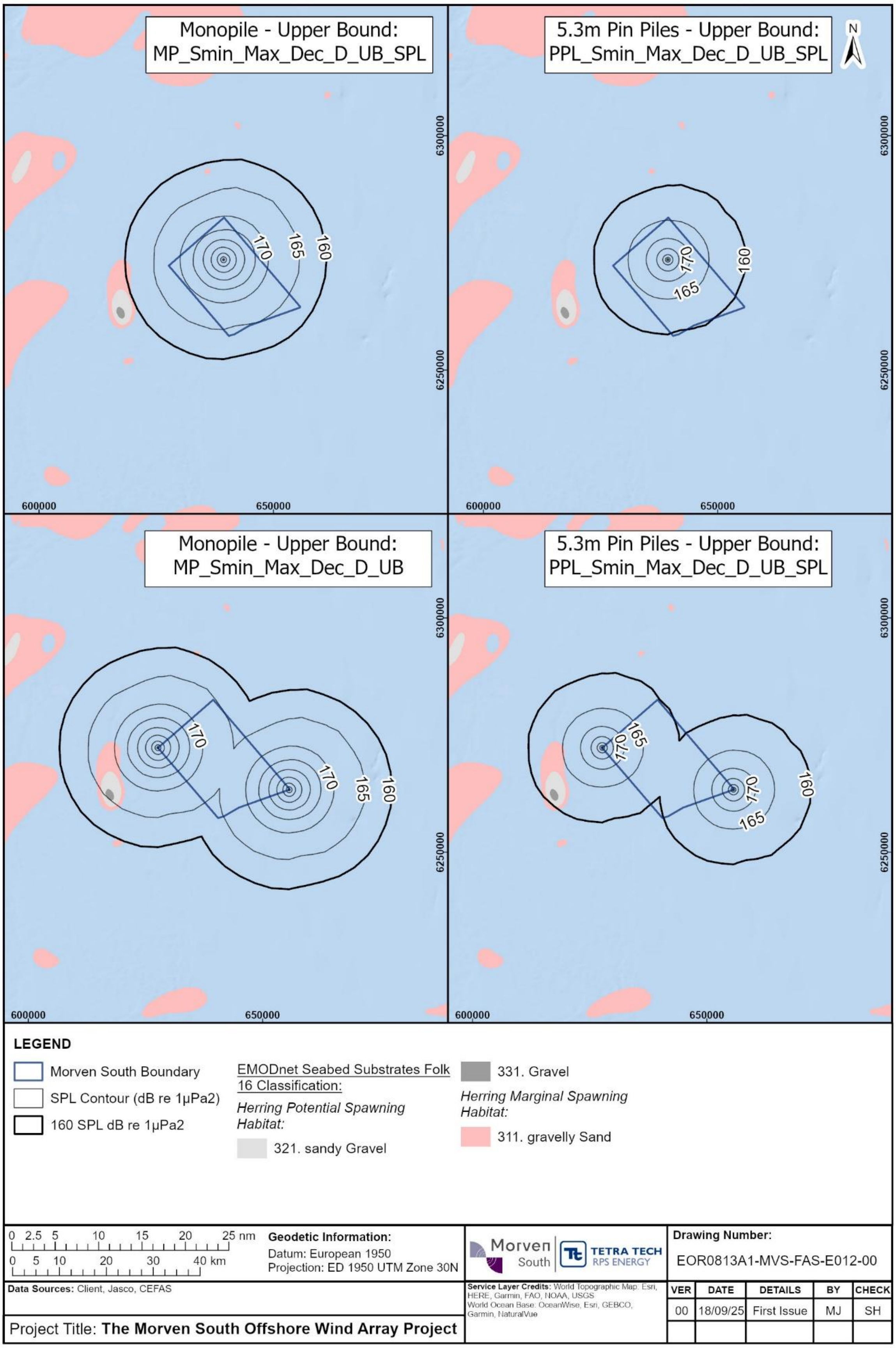

Figure 9.9: Modelled underwater sound contours (SPL_{pk} dB re 1 µPa) for single and concurrent piling of 16m monopiles and 5.3m pin piles and herring spawning habitat suitability

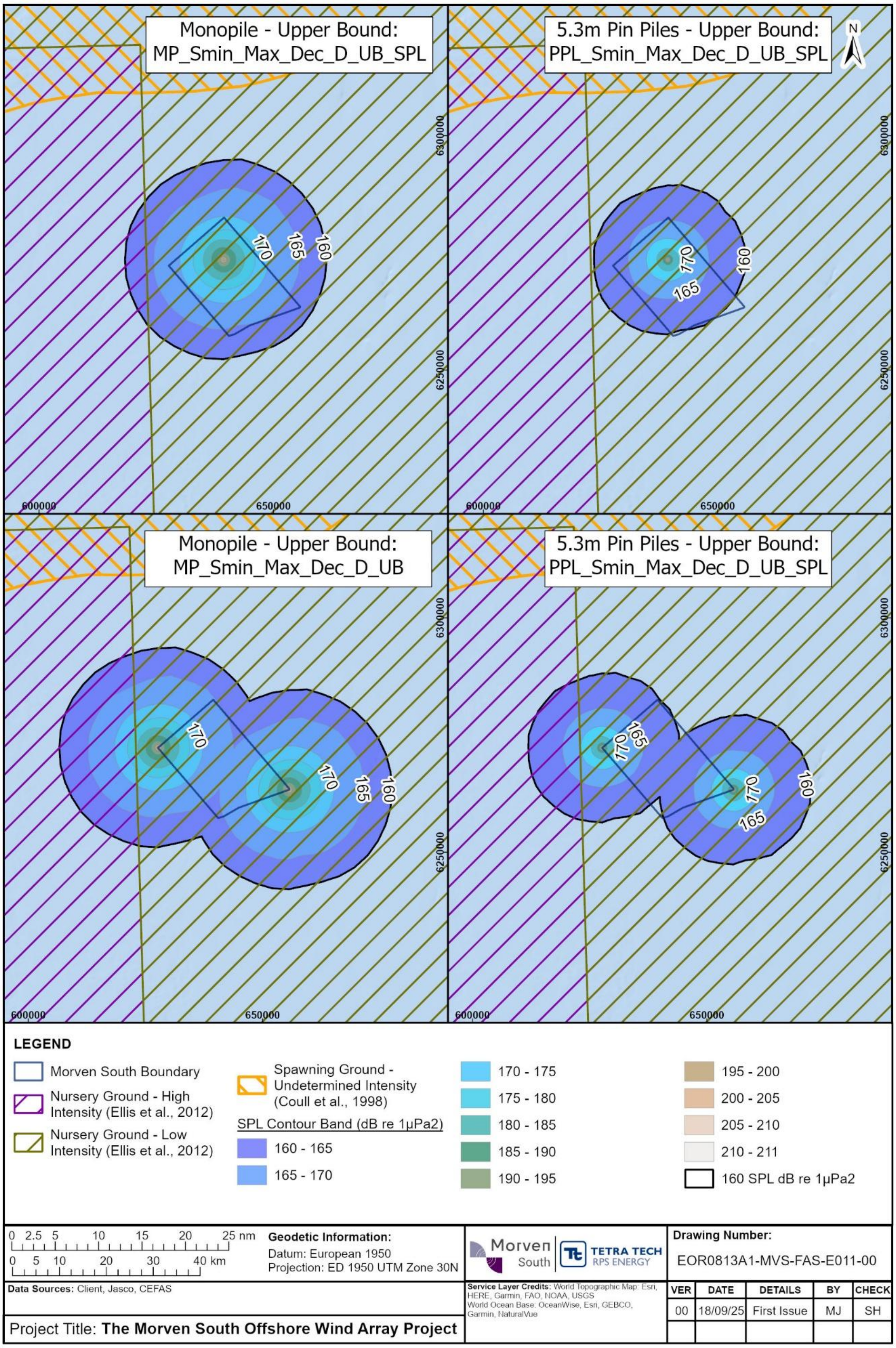

Figure 9.10: Modelled underwater sound contours (SPL_{pk} dB re 1 μPa) for single and concurrent piling of 16m monopiles and 5.3m pin piles and herring spawning grounds

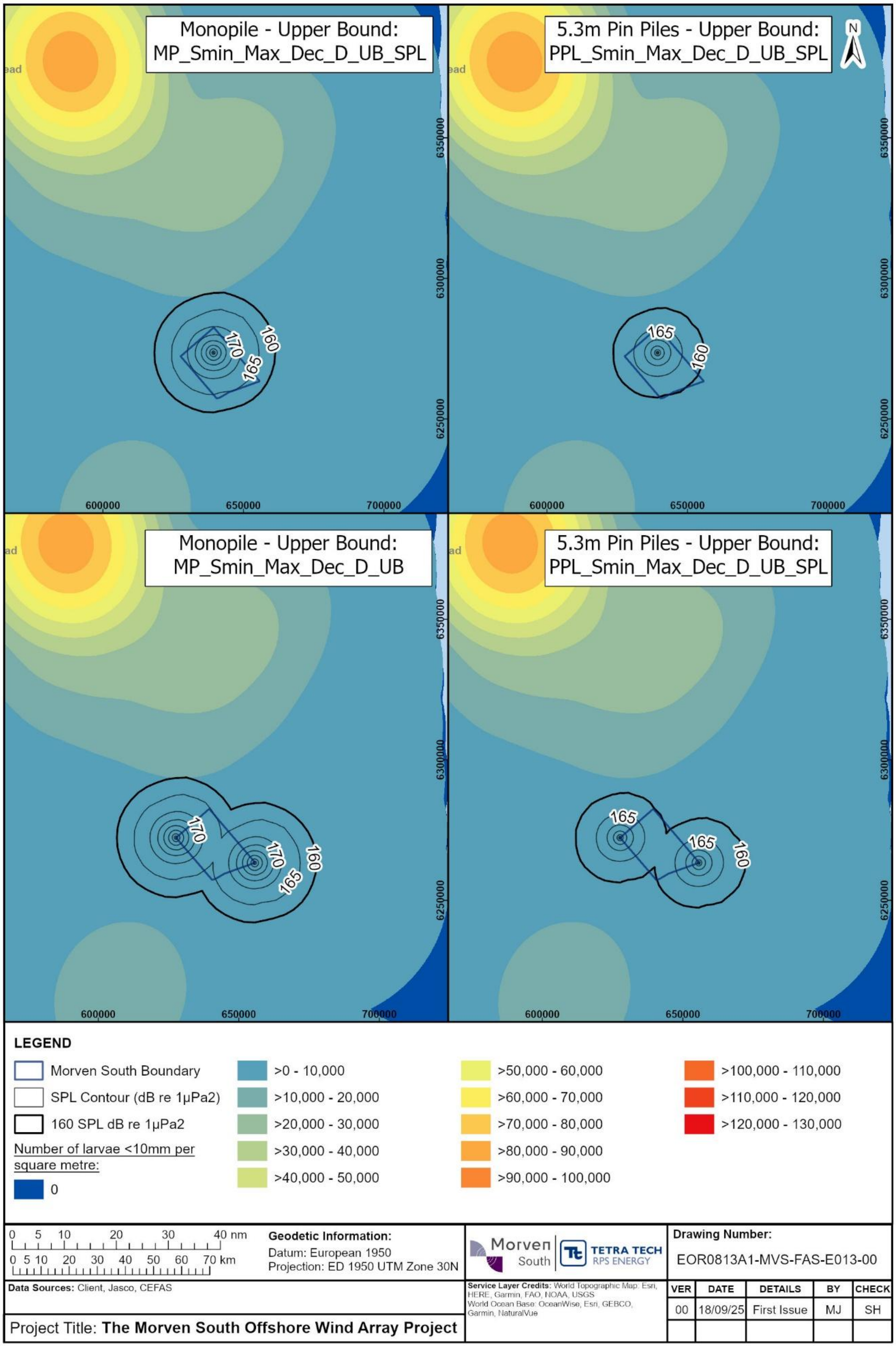

Figure 9.11: Modelled underwater sound contours (SPL_{pk} dB re 1 µPa) for single and concurrent piling of 16m monopiles and 5.3m pin piles and cumulative herring larval density from IHLS datasets (2007 to 2016)

9.11.3.45 These contours when compared to the distance to the Turbot Bank MPA (75.4km; Figure 9.7 and Figure 9.8) illustrate that behavioural disturbance is not likely to impact the sandeel feature of the Turbot Bank MPA. Due to the extent of the modelled contours offshore, any potential behavioural impacts are unlikely to cause barrier effects to diadromous species as they migrate along the east coast of Scotland, due to the relatively limited area around piling events where sound levels are high enough to cause behavioural responses in the context of the wider Fish and Shellfish Ecology Study Area. In addition, due to the extent of the modelled contours offshore, any potential behavioural impacts are unlikely to result in barrier effects to diadromous species as they migrate to and from rivers along the east coast of the UK. This is due to the relatively limited area modelled in comparison to the wider Regional Fish and Shellfish Ecology Study Area.

9.11.3.46 The remaining marine and diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Shellfish Important Ecological Features

9.11.3.47 Injury and disturbance criteria has not been developed for shellfish and, therefore, modelling could not be conducted for the shellfish IEFs. As the shellfish IEFs are expected to be less sensitive than fish species, the injury and disturbance ranges modelled for fish could be considered conservative overestimates for the shellfish IEFs. Nonetheless, an overview of literature available on shellfish sensitivity to underwater sound has been provided in the following paragraphs.

9.11.3.48 To date, no effect or influence of sound or vibrations has been reported on shellfish mortality rates or fisheries yields. Further, no studies have indicated a direct mortal effect of anthropogenic sound, either immediate or delayed (Scott *et al.*, 2020).

9.11.3.49 Of the shellfish IEFs identified, studies suggest that crustaceans such as European lobster, Norway lobster and various crab species are likely to be physiologically resilient to underwater sound due to the lack of gas within their bodies (Popper *et al.*, 2001). For example, a study by Christian *et al.* (2003) found no significant difference between acute effects of seismic airgun exposure (an impulsive high amplitude sound source similar to piling; >189 dB re 1 μPa (SPL_{pk}) at 1 m) upon adult snow crabs *Chionoecetes opilio.*

9.11.3.50 Sub-lethal physiological effects have been identified from anthropogenic underwater sound sources including bruised internal organs in snow crabs exposed to seismic survey sound emissions (at unspecified SPLs) (Chadwick, 2004), changes in serum biochemistry and hepatopancreatic cells in American lobster *Homarus americanus* (Payne *et al.*, 2007), and metabolic rate changes in green shore crab *Carcinus maenas* exposed to shipping sound (Wale *et al.*, 2013).

9.11.3.51 There is currently no evidence to suggest shellfish eggs and larvae are at risk of direct harm from underwater sound such as piling, although it should be noted that studies are limited (Edmonds *et al.*, 2016). Of the limited studies that have focussed on shellfish eggs and larvae, impaired embryonic development and mortality has been observed after playback of seismic survey sound among gastropods and bivalves (De Soto *et al.*, 2013, Nedelec *et al.*, 2014). There is limited information on the impact of impulsive sound upon crustacean eggs, and no research has been conducted on commercially exploited decapods around the UK. All studies focus on the impact of seismic sound, which has been demonstrated to delay the hatching of snow crab eggs, causing resultant larvae to be smaller than controls (Chadwick, 2004). However, Pearson *et al.* (1994) reported no statistically significant difference between the mortality and development rates of the free-swimming, planktonic larval stage of Dungeness crab *Metacarcinus magister* larvae exposed to single field-based discharges (231 dB re 1 μPa (SPL_{pk}) at 1 m) from a seismic airgun.

9.11.3.52 Therefore, the shellfish IEFs are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

Sensitivity of the receptor – Unexploded Ordnance clearance

9.11.3.53 The criteria used in the underwater sound modelling assessment for explosives (i.e. UXO clearance activities) for fish and shellfish receptors are given in Table 9.29.

Table 9.29: Criteria for the onset of injury to fish from explosives (Popper *et al.*, 2014)

Hearing Group	Parameter	Mortality and Potential Moral Injury	Recoverable Injury	TTS
Group 1 Fish: no swim bladder (particle motion detection)	SPL_{pk}, dB re 1µPa	229 - 234	(Near) High (Intermediate) Low (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	SPL_{pk}, dB re 1µPa	229 - 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) Moderate (Far) Low
Groups 3 and 4 Fish: where swim bladder is involved in hearing (primarily pressure detection)	SPL_{pk}, dB re 1µPa	229 - 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) High (Far) Low

9.11.3.54 The modelled scenarios presented in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report define the identified possible cases of UXO clearance in the region. Due to uncertainties in size of UXOs the assessment presents a range, highlighting the most likely size (common) to be encountered (132kg), a smaller hazard (25kg), as well as the maximum UXO size predicted (554kg).

9.11.3.55 As detailed in Table 9.20, the use of low order disposal techniques for UXOs (e.g. deflagration and clearance shots) will be used where possible as a mitigation measure to reduce sound levels. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has been assessed as the MDS (i.e. a maximum mass of 554kg NEQ). Details of the possible cases of UXO clearance in the region, including worst-case of estimate largest charge, detonated without mitigation, through to clearing through deflagration are shown in Table 9.30.

Table 9.30: Overview of the Unexploded Ordnance clearance scenarios

Modelled explosive mass (kg)	Description
554	Allied MK I Mine
132	500lb Allied Anti-submarine bomb
25	Smaller hazard
0.25	Deflagration donor charge

9.11.3.56 The modelled mortality and potential mortal injury ranges (using the SPL_{pk} metric) for low order and high order are presented in Table 9.31. All fish hearing groups are combined in this table as the Popper *et al*. (2014) thresholds are the same for Groups 1 to 4 (see Table 9.29). The criteria used in this underwater sound assessment for explosives are detailed in further detail in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report.

9.11.3.57 It should be noted that, due to a combination of dispersion (i.e. where the waveform elongates), multiple reflections from the sea surface and seabed and molecular absorption of high frequency energy, the underwater sound is unlikely to still be impulsive in character once it has propagated more than a few kilometres. Furthermore, the modelling assumes that the UXO acts like a charge suspended in open water whereas in reality it is likely to be partially buried in the sediment. In addition, it is possible that the explosive material will have deteriorated over time meaning that the predicted underwater sound levels are likely to be overestimated. In combination, these factors mean that the results should be treated as precautionary potential impact ranges which are likely to be significantly lower than predicted.

Table 9.31: Potential injury ranges for Unexploded Ordnance clearance activities, based on the Peak Sound Pressure Level metric (impact thresholds from Popper *et al.*, 2014)

Modelled explosive mass (kg) and Receptor Group	Threshold (dB re 1µPa SPL_{pk})	Impact Range (km)
554kg (high order detonation of the maximum size)		
Fish Hearing Groups 1 to 4	229	1.87
	234	0.80
132kg (high order detonation of the most likely size)		
Fish Hearing Groups 1 to 4	229	0.77
	234	0.51
25kg (high order detonation of the smaller hazard size)		
Fish Hearing Groups 1 to 4	229	0.44
	234	0.17
Deflagration of the UXO using a smaller donor charge of 0.25kg		
Fish Hearing Groups 1 to 4	229	Threshold not exceeded
	234	Threshold not exceeded

All Fish and Shellfish Important Ecological Features

9.11.3.58 Overall, the herring IEF is deemed to be of medium vulnerability, high recoverability, and national importance. The sensitivity of the receptor is, therefore, considered to be medium.

9.11.3.59 The remaining marine and diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

9.11.3.60 There are limited data on the sensitivity (if any) of shellfish species to underwater sound generated from UXO clearance. However, shellfish species have a lower sensitivity to underwater sound than the fish IEFs, so the results presented for the fish IEFs could be considered highly over precautionary estimates. Therefore, the shellfish IEFs are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect - Piling

9.11.3.61 Overall, for the herring IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.3.62 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

Significance of the effect – Unexploded Ordnance Clearance

9.11.3.63 Overall, for the herring IEF, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.3.64 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

Secondary mitigation and residual effect

9.11.3.65 For all fish and shellfish IEFs, no secondary mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

9.11.3.66 Underwater sound may be produced from decommissioning activities in this phase. The approach for decommissioning is yet to be determined, however, for the purposes of the MDS it is assumed there will be a range of decommissioning activities such as removal of foundations, cables and cable protection. Details of these activities in the decommissioning phase are currently unavailable, and so for the purpose of the assessment, the magnitude of impact in the decommissioning phase is expected to be of a lower extent to that detailed in Paragraphs 9.11.3.1 to 9.11.3.13 for the construction phase. The magnitude is assumed to be lower due to the lack of piling and UXO clearance in the decommissioning phase.

9.11.3.67 Therefore, the impact is predicted to be of very local spatial extent, short term duration, intermittent and high reversibility, with the soundscape returning to near baseline conditions upon completion of the decommissioning activities. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore considered to be low.

Sensitivity of the receptor

9.11.3.68 The sensitivity of the receptor provided in Paragraphs 9.11.3.14 to 9.11.3.60 for the construction phase is based on the underwater sound modelling results for piling and UXO clearance, which will not occur during the decommissioning phase. As decommissioning activities will produce lower underwater sound levels than those associated with piling and UXO clearance, the sensitivity of all fish and shellfish receptors has been reduced for the decommissioning phase. Therefore, all fish and shellfish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

9.11.3.69 Overall, for all fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

Secondary mitigation and residual effect

9.11.3.70 For all fish and shellfish IEFs, no secondary mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

9.11.4 Increased Suspended Sediment Concentrations and associated deposition

9.11.4.1 Increased SSCs and associated deposition are predicted to occur during the construction and decommissioning phases as a result of the installation/removal of foundations, sandwave clearance seabed preparation activities, the installation/removal of inter-array and inter-connector cables, and the removal of disused and out of service cables. Increased SSCs and associated deposition are also predicted to occur in the O&M phase from cable repair and reburial events. Volume 2, Annex 7.1: Physical Processes Technical Report, provides a full description of the physical processes assessment, including numerical modelling used to inform the predictions made with respect to increases in suspended sediment and subsequent deposition.

Construction phase

Magnitude of impact

9.11.4.2 The seabed preparation and activities and installation of infrastructure associated with Morven South may lead to increased SSCs and associated deposition. During the construction phase, these activities will include sandwave clearance and installation of wind turbines and OSPs, and sandwave clearance and installation of inter-array and inter-connector cables (Table 9.19).

9.11.4.3 For the wind turbines and OSPs, sandwave clearance has been calculated on the basis of 58 locations supporting three-legged suction bucket wind turbine foundations and five locations supporting gravity base OSP foundations requiring clearance of sandwaves of an average height of 3m. This is expected to result in a total sandwave clearance volume of 11,259,679m^3. Modelling was undertaken to quantify the potential increases in SSC and sedimentation by the use of a suction hopper dredger to remove material from the crest of sandwaves and deposit the material into an adjacent area. This modelling indicated increased concentrations of up to 17,200mg/l at the release site during disposal, with resuspension on the following slack tide resulting in concentrations of up to 500mg/l. On average, SSCs across the Morven South Boundary were modelled to be <1mg/l, with the sediment plume envelope limited to within 13km of the disposal activity, which falls within the Morven South Fish and Shellfish Ecology Study Area. Resuspension of deposited material would continue to occur on successive tides but would be fully incorporated into the background sediment transport regime soon following the cessation of sandwave clearance activities. activities. For further information, see Volume 2, Annex 7.1: Physical Processes Technical Report.

9.11.4.4 For the inter-array and interconnector cables, sandwave clearance will occur along a total of up to 15% of the length of both cables, resulting in a cable spoil volume of up to 9,849,600m^3. For cable sandwave clearance, modelling indicated SSCs of up to 650mg/l in the immediate vicinity of releases, with plumes of concentrations of 50mg/l extending up to 6.5km in a northeasterly direction within the Morven South Boundary. Average SSCs over the entire clearance campaign were typically <100mg/l, with average sedimentation of <20mm noted within the Morven South Boundary and rapidly reducing following the cessation of activity. For further information, see Volume 2, Annex 7.1: Physical Processes Technical Report.

9.11.4.5 For the foundation installation, up to 34 monopiles for wind turbines, up to four HVAC collector substation OSPs with 16m diameter monopile foundations, and one HVDC converter substation OSP with six 5m diameter jacket foundations may be installed. Modelling of drilling operations indicated average SSCs of <0.2mg/l at the discharge locations, rapidly decreasing within a short distance within the plume envelope. Instantaneous concentrations on the peak ebb and flood tides were modelled at <0.16mg/l within the plume envelope, with these levels localised and only persisting for a short period. For further information, see Volume 2, Annex 7.1: Physical Processes Technical Report.

9.11.4.6 For the inter-array and interconnector cable installation, activities may cause the production of up to 1,890,000m^3 and 1,188,000m^3 of spoil volume respectively. For the installation of these cables, the SSCs were modelled as larger than for pile installation, with resuspension giving rise to concentrations of up to 0.7mg/l in an amalgamated plume but only causing an average of <0.004mm of sedimentation. For further information, see Volume 2, Annex 7.1: Physical Processes Technical Report.

9.11.4.7 The impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

<u>Sensitivity of the receptor</u>

Marine Fish Important Ecological Features

9.11.4.8 Wenger *et al.* (2017) reviewed the effects of dredging on fish and considered the potential for increased SSCs at great length, with a wide range of responses recorded:

- 14 studies showed no effect of suspended sediment (although only 11 of these recorded an exposure time);
- 12 studies observed behavioural changes;
- 34 studies recorded physical damage and substantial behavioural changes;
- 37 studies measured physiological stress and sublethal responses;
- 49 studies recorded some level of mortality (Wenger *et al.*, 2017).

9.11.4.9 The fish species reviewed in this study displayed different tolerances to increased SSCs, with some species able to withstand concentrations up to 28,000 mg/l, while mortality occurring in others at 25mg/l (Wenger *et al.*, 2017). In addition, linear discriminant analysis indicated that increasing both the concentration and exposure time to elevated SSCs increased the severity of fish response, as per Newcombe and Macdonald (1991) and Newcombe and Jensen (1996).

9.11.4.10 For the marine fish IEFs in general, their eggs and larvae are the most susceptible life stage to this impact (Engell-Sørensen and Skyt, 2001, Yang *et al.*, 2019), as adults are typically highly mobile and can avoid areas with high sediment loads (Robertson *et al.*, 2006). For example, SSCs on the scale of mg/l can be lethal to eggs and larvae but only lethal to juveniles and adults on the scale of g/l. Although, this does not apply to herring, which are more sensitive to suspended sediment (Engell-Sørensen and Skyt, 2001). Eggs and larvae of species which are demersal spawners (such as herring and sandeel) are most likely to be affected by SSCs and associated deposition, given their proximity to the seabed wherein the ZoI will be located. This is evidenced by the medium and high sensitivities of sandeel to light and heavy siltation rate changes, respectively, on FeAST (NatureScot, 2025). The Regional Fish and Shellfish Ecology Study Area is located in an area of both high and low intensity spawning grounds for sandeel and a mix of marginal and unsuitable seabed habitat type. From desktop study, low intensity spawning grounds were identified to be present within the Morven South Boundary (i.e. the ZoI for temporary habitat loss and disturbance; Ellis et al., 2012); however, one sample location within the Morven South Boundary recorded a preferred sandeel habitat sediment classification during site specific surveys (Figure 9.4). Only a small proportion of the Morven South

Fish and Shellfish Ecology Study Area (which represents the ZoI) will experience increased SSCs at any one time during the construction phase, as activities will be staggered both spatially and temporally. However, modelled deposition levels are expected to be localised within the vicinity of activities and reduce in concentration on successive tides (see paragraphs 9.11.4.3 to 9.11.4.6 and Volume 3, Annex 7.1: Physical Processes Technical Report for further information). Therefore, the potential impact on sandeel spawning activity due to increased SSCs is predicted to be limited.

9.11.4.11 Furthermore, based on site specific herring spawning habitat suitability assessment undertaken, the habitats present within the Morven South Fish and Shellfish Ecology Study Area were all assigned as 'unsuitable' for herring spawning (Figure 9.3). Therefore, it is unlikely that herring populations (including their eggs and larvae) will be largely affected by this impact. Spawning grounds have been recorded in the Regional Fish and Shellfish Ecology Study Area (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report for more information), however there is not considered to be a pathway of potential impact due to no overlap with the ZoI for increased SSCs.

9.11.4.12 Increased SSCs could also impact pelagic eggs (which the majority of the marine fish IEFs produce), as their survival is dependent on their buoyancy within the water column. Suspended sediments can stick to pelagic eggs, causing them to become heavier and sink. Mortality can occur if eggs sink, primarily due to reduced oxygen levels, benthic predation, and mechanical or physiological stress (Engell-Sørensen and Skyt, 2001). Westerberg *et al.* (1996) showed that adhering sedimentation resulted in a loss of buoyancy in cod eggs that was proportional to the SSC levels and exposure time. Therefore, even relatively low SSCs over a longer exposure time could result in cod eggs sinking to the seabed (Westerberg *et al.*, 1996). The authors also reported increased mortality of cod yolk-sac larvae after exposure to SSCs of 10mg/l (Westerberg *et al.*, 1996). Modelling undertaken of SSCs associated with Morven South identified maximum increased concentrations of up to 17,200mg/l at the release site during sandwave clearance, with resuspension on the following slack tide resulting in concentrations of up to 500mg/l. On average, SSCs across the Morven South Boundary were modelled to be in the tens of mg/l to less than 1mg/l for a range of construction activities (see paragraphs 9.11.4.3 to 9.11.4.6 and Volume 3, Annex 7.1: Physical Processes Technical Report for further information). Resuspension of deposited material would continue to occur on successive tides but would be fully incorporated into the background sediment transport regime soon following the cessation of various construction activities. Therefore, it is unlikely that these SSCs will affect the development of eggs and larvae, and they are only expected to be present in the immediate vicinity of the construction activities, with dispersion continuing over successive tides.

9.11.4.13 The eggs of pelagic spawning IEFs could therefore be less vulnerable to the impact of increased SSCs as they may be high enough in the water column to avoid the ZoI associated with sedimentation at the seabed, particularly due to the offshore waters in which Morven South is located. Sinking and suffocating of eggs as detailed in the previous paragraph may then only effect eggs or larvae in close proximity to the construction works. Sediments are also expected to be rapidly dispersed (see paragraphs 9.11.4.3 to 9.11.4.6). Given that the IEFs are characteristic of the North Sea, they are expected to be tolerant to temporary increases in SSCs as a result of the strong currents naturally present within the region.

9.11.4.14 Adult fish are more mobile than eggs and larvae and therefore are likely to show greater avoidance behaviour within areas affected by increased SSCs. Westerberg *et al.* (1996) observed avoidance behaviour in adult herring and cod exposed to sediment plumes as low as 2mg/l. This increased mobility renders adults of these species less susceptible to physiological effects of this impact. Conversely, due to the reduced mobility and higher dependence on specific nursery habitats, juvenile fish are likely to be less able to avoid habitat disturbances due to increased SSCs and associated deposition. For example, laboratory studies on juvenile snapper and damselfish species demonstrated reduced foraging success, food acquisition, and body condition when exposed to increased SSCs (Lowe *et al.*, 2015, Wenger *et al.*, 2012). While there are limited studies on the effect of SSCs on juveniles of the marine fish IEFs in this assessment, the results observed by Wenger *et al.* (2012) and Lowe *et al.* (2015) may still be relevant. Although it should be noted that these were laboratory studies, with artificially manipulated SSC levels that are outwith those predicted to occur due to construction of Morven South (which are predicted to reduce to background levels following cessation of activities; see Volume 3, Appendix 7.1: Physical Processes Technical Report).

9.11.4.15 Juveniles of many of the marine fish IEFs could occur throughout the Regional Fish and Shellfish Ecology Study Area, with nursery habitats present for a range of species (see Table 9.11 and Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report for a full account). As the marine fish IEFs are characteristic of the North Sea, it is likely that juveniles are acclimatised to any natural fluctuations in SSCs that may occur within their nursery habitats. Therefore, it is proposed that most juveniles will be largely unaffected by the relatively low-level temporary increases in SSCs resulting from the construction phase, which are likely to be within the range of natural variability (generally at background levels) and occur intermittently and be dispersed on succeeding tides. Recoverability (i.e. fish returning to the area affected by this impact) is highly dependent on the recovery of the area to pre-disturbance conditions, the availability of alternative suitable habitat, and the ecological plasticity of that species (Wenger *et al.*, 2017). Due to the limited duration of SSCs associated with construction activities and due to the rapid succession on the following tides, juvenile habitats are expected to recover quickly from this impact. As a result, it is likely that there will be little impact upon juvenile marine fish IEFs with the ZoI associated with increased SSCs and associated deposition.

9.11.4.16 Adults of demersal species, such as the common skate, may have low sensitivity to this impact. For example, the MarESA for this species presents a low sensitivity to "smothering" and that the pressure of "increase in suspended sediment" is not relevant for this species (Neal and Pizzolla, 2006). The rationale behind this is that individuals will be mobile enough to move to unaffected areas, however it is noted that egg cases may be more sensitive to this impact (Neal and Pizzolla, 2006). Similarly, no sensitivity to "siltation rate changes (light)" and "water clarity changes" is presented for common skate on FeAST (NatureScot, 2025), citing high mobility as the reasoning. However, a medium sensitivity to "siltation rate changes (heavy)" is presented on FeAST for common skate egg cases, as large levels of siltation (between 12cm to 18cm) would bury egg cases and block their respiratory channels (NatureScot, 2025). Although nursery grounds for common skate overlap with the north of the Morven South Boundary, these grounds are extensive across the coast of the Regional Fish and Shellfish Ecology Study Area (Ellis *et al.* (2012); see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report). Given that the increased SSCs associated with Morven South are likely to be within the range of natural variability, occur intermittently and be dispersed on succeeding tides, it is likely that there will be little impact upon any common skate egg cases within the ZoI.

9.11.4.17 Based on the evidence summarised in the preceding paragraphs, it is considered that all marine fish IEFs (except herring and sandeel) are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

9.11.4.18 As a precaution, the herring and sandeel IEFs are deemed to be of medium vulnerability, medium recoverability, and national value. The sensitivity of the receptor is therefore, considered to be medium.

Diadromous fish Important Ecological Features

9.11.4.19 The diadromous fish IEFs are expected to have some tolerance to increased SSCs as their migration routes typically require them to travel through estuarine habitats, which naturally have considerably higher background SSCs than in the marine environment (Bash *et al.*, 2001). As temporary increases in SSCs associated with the construction of Morven South will be at levels lower than those naturally present in estuarine environments, it is predicted that the diadromous fish IEFs will be temporarily affected at most. It may be that certain species are not affected at all if their migration period does not overlap with the timing of activities associated with the Morven South. As detailed in Newcombe and Macdonald (1991) and Newcombe and Jensen (1996), the duration of exposure to increased SSCs is important when assessing the severity of effect.

9.11.4.20 Any potential effects on the diadromous fish IEFs are likely to be short term behavioural effects, (e.g. temporary changes swimming behaviour). For example, rainbow smelt (*Osmerus mordax)* (a diadromous species) were found to be significantly more active at SSCs equal to and greater than 10mg/l, which was interpreted as an alarm response (Chiasson, 1993). Berli *et al.* (2014) investigated the effects of increased SSCs on swimming ability of juvenile sea trout and rainbow trout (*Oncorhynchus mykiss*). Both species showed a decrease in swimming performance as turbidity increased, but rainbow trout were impaired to a greater extent (Berli *et al.*, 2014).

9.11.4.21 Avoidance response is another temporary behavioural effect that may occur due to increased SSCs. A laboratory study by Robertson *et al.* (2007) demonstrated that short-term increases in SSCs influenced the behaviour of juvenile Atlantic salmon. Foraging activity increased upon the initial introduction of SSCs of 20mg/l, which subsequently declined at sediment levels greater than 180mg/l (Robertson *et al.*, 2007). Avoidance responses were also demonstrated in early laboratory studies on juvenile Coho salmon (*Oncorhynchus kisutch*) (Bisson and Bilby, 1982). Other studies on Coho salmon (which shares life history traits with the diadromous fish IEFs) have illustrated that avoidance behaviour ceases post-disturbance or if the fish becomes acclimated (Berg, 1979, Berg and Northcote, 1985). Avoidance behaviour may occur at very low SSC levels (Wenger *et al.*, 2017), but may vary between species. For example, avoidance responses varied between six species of diadromous fish in New Zealand and suspended solid levels with three species showing no avoidance behaviour, even at the highest turbidity levels tested (Boubée *et al.*, 1997). Various other salmonid species have been demonstrated to exhibit avoidance reactions and move away from the vicinity of adverse sediment conditions, if refuge conditions are present (Bash *et al.*, 2001, Sigler *et al.*, 1984).

9.11.4.22 The evidence summarised in the preceding paragraphs is derived from laboratory based studies, and some do not cover the exact diadromous IEFs identified for this assessment, thus the potential for other responses does exist. However, the slight temporary behavioural responses detailed are likely to be similar for the diadromous fish IEFs, due to similar life histories, and natural turbidity of the estuarine environments within the Regional Fish and Shellfish Ecology Study Area. Information on the impact of increased SSCs on diadromous species in the offshore environment is limited (Kjelland *et al.*, 2015), although there is the potential for increased turbidity to improve the survival rates of Pacific salmon species (*Oncorhynchus* spp.) during migrations due to lower predation associated with reduced visibility (Gregory and Levings, 1998).

9.11.4.23 Overall, this impact is not expected to create a significant barrier to migration for the diadromous fish IEFs. The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel IEF with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Shellfish Important Ecological Features

9.11.4.24 Many shellfish species have high tolerances to increased SSCs and are able to tolerate increases in turbidity (Wilber and Clarke, 2001). This includes some of the crustacean IEFs, such as the edible crab and Nephrops which have been assessed as having low or no sensitivity to the pressure: ‘increase in suspended sediment’ on the MarESA (Hill and Sabatini, 2008, Neal and Wilson, 2008). These species also have very low to no sensitivity to the pressures ‘smothering’ and ‘increase in turbidity’, which can be associated with this impact (Hill and Sabatini, 2008, Neal and Wilson, 2008). The low to no sensitivity of these IEFs to pressures associated with increased SSCs is largely due to their high mobility levels and therefore their ability to relocate to unaffected areas. Egg bearing (e.g. ‘berried’) Nephrops and European lobster could be more vulnerable to this impact as the eggs they carry attached to their bodies required regular aeration. However, Nephrops inhabit large burrows, which can penetrate 20cm to 30cm into the sediment and be over a metre long (Rice and Chapman, 1971), and are therefore considered unlikely be affected by this impact. As lobsters are mobile, they can move to more suitable conditions during periods of increased SSCs associated with Morven South, which are not expected to be continuous and will only affect a small area at any one time (see ‘magnitude of impact’ in paragraphs 9.11.4.3 to 9.11.4.6, above). Further, spawning and nursery grounds for Nephrops are not located within the ZoI (i.e. the Morven South Fish and Shellfish Ecology Study Area). Therefore, the Nephrops IEF is unlikely to be impacted by increased SSCs and associated deposition. There is no MarESA available for European lobster, however this species inhabits unsheltered seabeds, rocky crevices, and in excavated burrows and is also highly mobile. Therefore, it is likely that any potential impact to this species will also be low.

9.11.4.25 Although far less mobile than the crustacean IEFs, the king scallop IEF was also assessed as having low sensitivity to increased suspended sediment and no sensitivity to increased turbidity in its MarESA (Marshall and Wilson, 2008). Whilst both king and queen scallop could potentially be buried due to sediment deposition, the sensitivity to smothering was still considered to be low on for king scallop on the MarESA (Marshall and Wilson, 2008). Although there is no MarESA for queen scallop, these sensitivities could also be applicable. For example, Hendrick *et al.* (2016) demonstrated that queen scallop had some ability to emerge after being buried under 2cm of sediment, but mortality occurred after several days of burial and under sediments over 5cm. The modelling of sediment plume movement and deposition have shown this is unlikely to occur in this case due to activities associated with Morven South (see Volume 3, Appendix 7.1: Physical Processes Technical Report for further information). The king scallop IEF appears to be more tolerant to burial than queen scallop, with high levels of emergence and low mortality recorded in coarse to medium grain sizes and depths of <3cm (Szostek *et al.*, 2013). However, similar to the study on queen scallop by Hendrick *et al.* (2016), emergence decreased and mortality increased in king scallops buried under fine sediment of increasing depths, up to 5cm (Szostek *et al.*, 2013). Within this study, king scallop also demonstrated increased clapping rate (e.g. quickly opening and closing their shell to clear unwanted particles) at SSCs of <100mg/l and up to 700mg/l, suggesting self-preservation behaviour in response (Szostek *et al.*, 2013). Scallop species may be able to visually detect the size and speed of moving particles (Speiser and Johnsen, 2008), and may therefore be able to avoid areas of increased SSCs. Further, both species have some mobility, with queen scallops believed to be more mobile that king scallop, although this is yet to be quantified (Howarth and Stewart, 2014). Given the relatively low level of SSCs and deposition modelled for Morven South, the potential for avoidance behaviour and re-emergence from light sediment deposition, king and queen scallop populations are not considered to be sensitive to this potential impact. The low to no sensitivity to the pressures associated with this impact on the king scallop MarESA (Marshall and Wilson, 2008) can reasonably be applied to queen scallop, given the similarity between the two species.

9.11.4.26 Overall, all shellfish IEFS are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

9.11.4.27 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.4.28 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.4.29 There are no designated sites within the ZoI for this impact (see Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, increased SSCs and associated deposition at the seabed in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs.

Secondary mitigation and residual effect

9.11.4.30 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

Operations and maintenance phase

Magnitude of impact

9.11.4.31 The repair and reburial of inter-array and inter-connector cables may lead to increased SSCs and associated deposition which could impact fish and shellfish IEFs.

9.11.4.32 The repair of up to 10km of inter-array cables in two events every five years and up to 2km of inter-connector cables in 10 events every 25 years may cause seabed disturbance which could create sediment plumes. Reburial of up to 17km of inter-array cables up to 11km of interconnector cables in a maximum of one event each in every five year period may also cause increased SSCs. These activities will utilise similar methods as cable installation, with the use of trenching or jetting in trenches of up to 3m depth and width (Table 9.19).

9.11.4.33 In each case the length of the repair or reburial activity may be up to 17km; therefore, the magnitude of the impacts would be a fraction of those for the construction phase, with events being undertaken over the duration of the 35 year project lifetime. The sediment plumes and sedimentation footprints would be dependent on which section of the cables is being repaired but would be smaller in magnitude than the construction phase in all cases.

9.11.4.34 The impact is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility. The magnitude is therefore considered to be negligible.

Sensitivity of the receptor

9.11.4.35 The sensitivity of the receptor is as provided in paragraphs 9.11.4.8 to 9.11.4.26 for the construction phase and not repeated here.

Significance of the effect

9.11.4.36 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of these IEFs (including PMF status; see Table 9.15).

9.11.4.37 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.4.38 There are no designated sites within the ZoI for this impact (see Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, increased SSCs and associated deposition at the seabed in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs.

Secondary mitigation and residual effect

9.11.4.39 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

9.11.4.40 During decommissioning, increases in SSCs and the potential impact on the fish and shellfish IEFs would be of lesser magnitude than the construction phase due to removal of the cables, with scour and cable protection remaining *in situ*. Increases in SSC due to the removal of inter-array and inter-connector cables would be similar or smaller to those experienced during the construction phase, as retrieval would be undertaken using similar techniques to installation. In the case of piled foundations, there is no significant disturbance of the seabed during decommissioning as piles are to be cut off. SSCs would increase temporarily if suction caissons were removed using overpressure to release. Decommissioning of gravity bases would involve the removal of ballast, which may release sediment into the water column. The increase in suspended sediments may persist during decommissioning, however they are likely to be temporary and localised in nature. Following decommissioning, changes in SSCs and associated deposition would return to baseline levels.

9.11.4.41 The impact is predicted to be of local spatial extent, short-term duration, intermittent and high reversibility. The magnitude is therefore considered to be negligible.

Sensitivity of the receptor

9.11.4.42 The sensitivity of the receptor is as provided in paragraphs 9.11.4.8 to 9.11.4.26 for the construction phase and not repeated here.

Significance of the effect

9.11.4.43 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of these IEFs (including PMF status; see Table 9.15).

9.11.4.44 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.4.45 There are no designated sites within the ZoI for this impact (see Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, increased SSCs and associated deposition at the seabed in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs.

Secondary mitigation and residual effect

9.11.4.46 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.11.5 Long-term habitat loss

9.11.5.1 Long-term habitat loss within the Morven South Boundary will begin during the construction phase as infrastructure is installed across the construction period, and will continue during the O&M phase, and during the decommissioning phase if infrastructure is left *in situ*. Long-term habitat loss will occur directly under all foundations, scour protection, cable protection, and cable crossing protection, and will lead to habitat alteration to another seabed type. The construction and O&M phases have been combined as the structures placed during construction will persist throughout the O&M phase. The potential impact of long-term habitat loss throughout the decommissioning phase has been considered due to the cable and scour protection being left *in situ* based on the MDS (Table 9.19).

Construction and operation and maintenance phases

Magnitude of impact

9.11.5.2 The presence of the Morven South infrastructure will result in up to 1,820,664m^2 of long-term habitat loss due to the installation of foundations and associated scour protection; cable protection on inter-array and inter-connector cables, and cable crossing protection (Table 9.19). This represents 0.13% of the total Morven South Fish and Shellfish Ecology Study Area and 0.004% of the Regional Fish and Shellfish Ecology Study Area.

9.11.5.3 Long-term habitat loss potential impacts will be introduced during the construction phase and will be continuously present throughout the 35 year O&M phase and will impact the seabed directly.

9.11.5.4 The impact is predicted to be of local spatial extent, long-term duration, continuous and low reversibility during the construction and O&M phases. It is predicted that the impact will affect the receptor directly and will only represent a small area of long-term habitat loss compared to similar nearby habitats which will remain unimpacted. The magnitude is therefore considered to be low.

Sensitivity of the receptor

9.11.5.5 Fish and shellfish species that rely on the presence of specific sediment and subtidal habitats would typically be the most vulnerable to this impact, depending on the availability of said habitats within the ZoI (i.e. the Morven South Boundary) and the Regional Fish and Shellfish Ecology Study Area. Long-term seabed habitat loss due to Morven South may reduce the area of suitable habitat and available food resources within the Morven South Boundary for the fish and shellfish communities associated with them. However, the total footprint of seabed potentially impacted represents a low percentage of the extensive subtidal habitats present within the Morven South Boundary and within the Regional Fish and Shellfish Ecology Study Area as a whole.

Marine fish Important Ecological Features

9.11.5.6 The Regional Fish and Shellfish Ecology Study Area coincides with spawning and nursery habitats for a range of marine fish IEFs, with several overlapping with the Morven South Boundary directly (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report). Sandeel and herring are the most vulnerable teleost fish IEFs to this impact due to their specific seabed habitat requirements for spawning. As detailed in Section 9.11.2 for the impact of temporary habitat loss and disturbance, these species lay their eggs on the seabed and require specific sediment composition in order to do so successfully. Some elasmobranchs, such as spotted ray, thornback ray, and common skate are also demersal spawners, as they lay egg cases in shallow nearshore nurseries. Low intensity nursery grounds for spotted ray and common skate were identified as overlapping with the Morven South Boundary and being present throughout the Regional Fish and Shellfish Ecology Study Area (see Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report). However, given that these habitats are low intensity and extensively spread, these species are unlikely to be significantly impacted by long-term habitat loss and disturbance that may overlap with these nursery grounds.

9.11.5.7 As described in Section 9.11.2 for the impact of temporary habitat loss and disturbance, long-term loss to seabed habitats could lead to sandeel mortality if individuals cannot colonise their preferred sandy spawning habitats in the immediate vicinity, or where these habitats may be at carrying capacity (Wright *et al.*, 2000). FeAST reports sandeel as having a high sensitivity to the pressures: "physical removal (extraction of substratum)" and "physical change (to another seabed type)"' (NatureScot, 2025). Sandeel may also be particularly vulnerable during their winter hibernation period when they are less mobile and remain buried in the seabed. The Regional Fish and Shellfish Ecology Study Area is located in an area of both high and low intensity spawning grounds for sandeel and a mix of marginal and unsuitable seabed habitat type. From desktop study, low intensity spawning grounds were identified to be present within the Morven South Boundary (i.e. the ZoI for temporary habitat loss and disturbance; Ellis et al., 2012); however, one sample location within the Morven South Boundary recorded a preferred sandeel habitat sediment classification during site specific surveys (Figure 9.4). Low intensity spawning grounds are present within the Morven South Boundary (i.e. the ZoI for temporary habitat loss and disturbance). The maximum footprint of long-term habitat loss will only make up a small proportion of the Morven South Fish and Shellfish Ecology Study Area as a whole (0.13%). Therefore, it is unlikely that long-term habitat loss associated with Morven South will affect sandeel at a population level. Furthermore, monitoring as the Horns Rev I OWF in Denmark has indicated that the presence of operational wind farm infrastructure has not caused significant adverse long-term effects on sandeel populations (Stenberg *et al.*, 2011, Van Deurs *et al.*, 2012). Similarly, the initial results of post-construction monitoring at the Beatrice OWF demonstrated no negative effects on sandeel populations (Beatrice OWF Limited, 2021b).

9.11.5.8 The sandeel IEF is deemed to be of high vulnerability, high recoverability and regional value. The sensitivity of the receptor is, however, precautionarily considered to be medium.

9.11.5.9 As described in Section 9.11.2 for the impact of temporary habitat loss and disturbance, herring also have very particular seabed spawning habitat preferences and could suffer if these habitats are lost or disturbed. However, based on site specific seabed habitat suitability assessment, the habitats present within the Morven South Boundary were all assigned as ‘unsuitable’ for herring spawning (Figure 9.3). Spawning grounds have been recorded in the wider Regional Fish and Shellfish Ecology Study Area (see Volume 3, Appendix 9.1: Fish and Shellfish Ecology Technical Report for more information), however these are outwith the ZoI for long-term habitat loss, which is confined to the Morven South Boundary. Overall, it is considered unlikely that herring populations will be largely affected by long-term habitat loss associated with Morven South.

9.11.5.10 The herring IEF is deemed to be of high vulnerability, medium recoverability, and of national value. The sensitivity of the receptor is, however, precautionarily considered to be medium.

9.11.5.11 For some of the remaining marine fish IEFS, there are spawning and/or nursery grounds overlapping with the Morven South Boundary (see Volume 3, Appendix 9.1: Fish and Shellfish Ecology Technical Report for more information). However, these are not unique to this area and are largely widespread throughout the Regional Fish and Shellfish Ecology Study Area as a whole. Further, as the remaining marine fish IEFs are highly mobile species (with some occupying the pelagic zone, such as mackerel, sprat, and various elasmobranchs), they could easily move away from long-term habitat loss and disturbance to the seabed (which does not represent a significant proportion of the Morven South Fish and Shellfish Ecology Study Area: 0.13%). This rationale has been used by FeAST and MarESA for the common skate IEF. On FeAST, common skate has been assessed as having low sensitivity to “physical change (to another seabed type)” due to its high mobility (NatureScot, 2025). This species was not assessed against the FeAST pressure “physical removal (extraction of substratum)”’ due to insufficient information on potential effects to rocky habitats in which their egg cases are typically laid (NatureScot, 2025). The MarESA for common skate presents a low sensitivity to “substratum loss”, again citing this species’ high mobility (Neal and Pizzolla, 2006).

9.11.5.12 Overall, the remaining marine fish IEFs are deemed to be of low vulnerability, high recoverability and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Diadromous Fish Important Ecological Features

9.11.5.13 As the diadromous fish IEFs are all highly mobile and not reliant on demersal offshore habitats for spawning or breeding, they are considered to be less susceptible to this impact, wherein the ZoI is restricted to the offshore seabed. Diadromous species are only likely to interact within the ZoI while migrating to and from rivers and freshwater habitats. Thus, this impact is unlikely to be of particular relevance for the diadromous fish IEFs as it will not present a barrier to migration or affect their ecology during their marine life stages.

9.11.5.14 Diadromous species may be indirectly affected due to altered prey availability offshore as a result of this impact. However, the majority of marine fish species are unlikely to be impacted by any long-term habitat loss and disturbance associated with the Proposed Development and population level effects are not likely to occur (see paragraphs 9.11.5.6 to 9.11.5.12).

9.11.5.15 Therefore, the diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Shellfish Important Ecological Features

9.11.5.16 As most of the shellfish IEFs are less mobile than the fish IEFs and are more reliant on the seabed, they could be more sensitive to this impact. The installation of infrastructure associated with the Morven South has the potential to directly alter the habitats inhabited by many of the shellfish IEFs. The potential for long-term habitat loss directly around Morven South represents a small proportion of habitat within the Morven South Fish and Shellfish Ecology Study Area and the wider Regional Fish and Shellfish Ecology Study Area and is unlikely to impact on the wider shellfish populations. Some species, such as the king scallop IEF (and the queen scallop IEF, by proxy) were assessed as having a high potential for recovery from the pressure "substratum loss" on the MarESA (Marshall and Wilson, 2008). In addition, the MarESA for the edible crab IEF conclude that this species was expected to have some recoverability to "substratum loss" (Neal and Wilson, 2008).

9.11.5.17 There are Nephrops spawning and nursery grounds within the Regional Fish and Shellfish Ecology Study Area, but they do not overlap with the ZoI (Coull *et al.*, 1998). Therefore, the potential for long-term habitat loss and disturbance (which is confined within the Morven South Boundary) will not directly impact their spawning and nursery areas in the wider Regional Fish and Shellfish Ecology Study Area. Given the wide range of available habitat throughout the Regional Fish and Shellfish Ecology Study Area and the low footprint of impact within the Morven South Fish and Shellfish Ecology Study Area (0.13%), and even lower footprint within the Regional Fish and Shellfish Ecology Study Area (0.004%), it is not likely that this impact will significantly reduce the available habitat for the shellfish IEFs.

9.11.5.18 The shellfish IEFs are deemed to be of low to medium vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

<u>Significance of the effect</u>

9.11.5.19 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.5.20 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.5.21 There are no designated sites within the ZoI for long-term habitat loss (i.e. the Morven South Boundary; Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, long-term seabed habitat loss in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs (see paragraphs 9.11.5.13 to 9.11.5.15).

Secondary mitigation and residual effect

9.11.5.22 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

9.11.5.23 Cable and scour protection which may remain *in situ* post-decommissioning may have a footprint of up to 1,649,807m^2 (Table 9.19). This represents 0.1% of the total Morven South Fish and Shellfish Ecology Study Area and 0.003% of the Regional Fish and Shellfish Ecology Study Area.

9.11.5.24 Some areas of cable protection may gradually become buried by sediment, which may facilitate some recolonisation of sedimentary species into these areas. However, this burial is not guaranteed and therefore the habitat will not return to soft sediments, and there will be no potential for recovery of sedimentary communities. Any cable or scour protection remaining after decommissioning which is not buried over time will provide an ongoing substrate for colonisation although the communities that develop and persist will be different from those originally found in the previously soft sediment environment. This will represent a permanent loss of the underlying sedimentary environment.

9.11.5.25 The impact is predicted to be of local spatial extent, long-term duration, continuous and low reversibility during the decommissioning phase. It is predicted that the impact will affect the receptor directly and will only represent a small area of long-term habitat loss compared to similar habitats within the Morven South Boundary which will remain unimpacted. The magnitude is therefore considered to be low.

Sensitivity of the receptor

9.11.5.26 The sensitivity of the receptor is as provided in paragraphs 9.11.5.5 to 9.11.5.18 for the construction and operation and maintenance phases and not repeated here.

Significance of the effect

9.11.5.27 Overall, for the herring and sandeel IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

9.11.5.28 Overall, for all other fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.5.29 There are no designated sites within the ZoI for long-term habitat loss (i.e. the Morven South Boundary; Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, long-term seabed habitat loss in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs (see paragraphs 9.11.5.13 to 9.11.5.15).

Secondary mitigation and residual effect

9.11.5.30 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.11.6 Colonisation of hard structures and associated fish aggregation

9.11.6.1 A range of hard infrastructure will be installed in the construction phase of Morven South and will persist into the O&M phase and into the decommissioning phase, if left *in situ.*

9.11.6.2 Hard structures in the marine environment (such as turbine and OSP foundations and scour protection) can attract many marine organisms including benthic and biofouling species. Additionally, anthropogenic structures may also have direct impacts on fish and shellfish communities through their potential to act as fish aggregation devices (Petersen and Malm, 2006). Volume 2, Chapter 8: Benthic Subtidal Ecology, examines this impact from the perspective of benthic colonisation and habitat creation, whereas this assessment looks at the subsequent consequences for fish and shellfish populations (with implications upon the wider marine food web).

All phases

Magnitude of impact

9.11.6.3 The MDS accounts for a total surface area of up to 3,074,239m^2 of hard structures installed throughout the construction phase and persisting into the up to 35 year O&M phase (Table 9.19). This represents 0.22% of the total Morven South Fish and Shellfish Ecology Study Area and 0.01% of the Regional Fish and Shellfish Ecology Study Area. The MDS is based on the introduction of artificial structures as a result of the installation of wind turbines, OSPs, scour protection, cable protection, and cable crossing protection. In the decommissioning phase, up to 1.,649,807m^2 of hard structures may remain permanently due to scour and cable protection being left *in situ* (Table 9.19). This represents 0.1% of the total Morven South Fish and Shellfish Ecology Study Area and 0.003% of the Regional Fish and Shellfish Ecology Study Area.

9.11.6.4 It is likely that the foundations, scour protection, and cable protection will become colonised by a range of marine organisms. Therefore, the permanent placement of infrastructure may be more accurately considered habitat alteration. This shift in baseline conditions from soft substrate areas (muds, sands, and gravels) to hard substrate has the potential to cause beneficial effects, such as local biodiversity increases and increased abundance of reef species, as observed on monopile foundations at the Lysekil research site for offshore wind-based research in Gothenburg, Sweden (Bender *et al.*, 2020). This was supported by (Lefaible *et al.*, 2023), which found increased species richness and abundance in the immediate vicinity of foundations (approximately 37m from foundations), but the effect was absent at a distance of 350m from the foundations.

9.11.6.5 The impact is predicted to be of local spatial extent, long-term duration, continuous, and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is considered to be low due to the wide availability of similar habitats within the Morven South Boundary and Regional Fish and shellfish Ecology Study Area.

Sensitivity of the receptor

Marine fish and shellfish Important Ecological Features

9.11.6.6 Artificial hard structures installed during the construction phase of Morven South could act as artificial reefs and provide habitat for a wide range of species, from lower trophic level biofouling species to higher predators, such as large fish, seabirds, and marine mammals (Degraer *et al.*, 2021, Degraer *et al.*, 2020, Fujii *et al.*, 2023). This impact has been considered from a benthic perspective in Volume 2, Chapter 9: Benthic Ecology. There are three types of species that could be attracted to the artificial hard structures associated with Morven South:

- species that predate the biofouling community for a prolonged period, such as gadoids;
- species that occasionally predate the biofouling community, such as horse mackerel;
- species such as mackerel that are attracted for non-trophic reasons, for example, to find shelter or to encounter other individuals of their species, which may lead to their creating larger

schools and thus increasing their safety and chances of finding food and mates (Degraer *et al.*, 2020).

9.11.6.7 Colonisation of hard structures can take place over several years following the initial construction, until a structured recolonised population is formed (Krone *et al.*, 2013). It is uncertain whether artificial reefs facilitate recruitment into the local population, or if these observations are simply a result of concentrating biomass from surrounding areas (Inger *et al.*, 2009). It has been suggested that the abundance of fish can be greater in the vicinity of turbine foundations than in the surrounding area, which supports the findings of Linley *et al.* (2007) that fish are likely to benefit from introduction of these hard structures. Studies of fish distributions before and after installation of OWFs have demonstrated that some species, such as cod, spend at least part of their life cycles closely associated with these artificial structures (Bergström *et al.*, 2013, Reubens *et al.*, 2014). Increased availability of prey species associated with artificial hard structures may enhance settlement, survival, and/or growth of their predators, such as cod and other gadoids, and allow them to conserve energy (Schwartzbach *et al.*, 2020). Artificial habitats associated with OWFs have also been recorded to act as refuges for cod (Lindeboom *et al.*, 2011, Winter *et al.*, 2010) and plaice (Buyse *et al.*, 2022), with these effects possibly applicable to some other marine fish IEFs. Key prey species, such as horse mackerel, mackerel, and sprat, have been reported to utilise artificial hard structures for spawning and/or predation on the newly developed community (Degraer *et al.*, 2020, Glarou *et al.*, 2020).

9.11.6.8 Some studies have also recorded increased abundance of small demersal fish species in the vicinity of OWF structures, most likely due to the increase in epifaunal communities and the resulting greater structural complexity of the habitat (Wilhelmsson *et al.*, 2006a, Wilhelmsson *et al.*, 2006b). Further, plaice abundance was found to be four times higher on sandy patches of scour protection compared to surrounding sand (Buyse *et al.*, 2022). The authors suggested that the configuration of the hard scour protection offered increased food and shelter opportunities, while the sandy patches in between facilitate the natural burrowing behaviour of plaice, resulting in increased abundances (Buyse *et al.*, 2022). Contrastingly, there have been post-construction studies that found no evidence of fish abundance being beneficially nor adversely affected by the presence of OWFs (Barrow Offshore Windfarm Limited, 2008, Walker *et al.*, 2010), although these studies are somewhat dated.

9.11.6.9 Overall, some colonisation is expected on the artificial hard structures associated with Morven South, and this impact is considered to have some form of a beneficial effect on the fish and shellfish IEFs and the wider ecosystem food web due to possible fish aggregation.

9.11.6.10 Crustacean species are likely to benefit from the introduction of hard structures due to the increased availability of refuge areas (Linley *et al.*, 2007). Where hard infrastructure is placed within areas of sandy and soft bottom sediments (i.e. the Morven South Boundary), this presents novel habitat and new potential sources of food in these areas. This could potentially extend the habitat range of shellfish species such as edible crab IEF, which has been shown to strongly associate with OWF foundations (Hooper and Austen, 2014). Evidence from post-construction monitoring surveys at the Horns Rev OWF in the North Sea suggest that hard structures are particularly suitable for edible crab hatchery and nursery grounds, as well as several other species (Vattenfall, 2006). These surveys also reported that crustacean larvae and juveniles could rapidly colonise the hard structures associated with the wind farm (Vattenfall, 2006).

9.11.6.11 The introduction of hard structures could lead to colonisation from INNS (see Volume 2, Chapter 9: Benthic Ecology, for an assessment of this impact) which could impact shellfish populations through competition or habitat loss. There is limited evidence within the literature on the effect of this potential impact on fish and shellfish communities within OWFs and their sensitivity to INNS colonisation. Given this, implementation of precautionary mitigation measures is recommended to reduce or prevent spread of INNS where possible (Baulaz *et al.*, 2023). The development and adherence to an EMP, which will include an INNSMP, is a designed-in measure adopted as part of Morven South. This will include measures for controlling INNS and their impact on fish and shellfish ecology receptors (see Table 9.20).

9.11.6.12 Overall, the marine fish IEFs and the shellfish IEFs are deemed to be of low vulnerability, low recoverability (due to the persistence of hard structures throughout the lifecycle of Morven South, however these could result in beneficial effects) and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Diadromous fish Important Ecological Features

9.11.6.13 As all of the hard infrastructure will be installed in the offshore waters of Morven South, the diadromous fish IEFs could only interact with them during the marine phases of their lifecycles. Given their typically pelagic migrations, it is expected that diadromous fish IEFs are unlikely to utilise offshore hard structures associated with Morven South for foraging or shelter opportunities as they pass through the Morven South Boundary. Sea lamprey parasitise a wide range of larger fish species and some cetacean species (Silva *et al.*, 2014), however there is not anticipated to be any potential impact to these host species (as set out in paragraphs 9.11.6.6 to 9.11.6.9 and in Volume 2, Chapter 10: Marine Mammals).

9.11.6.14 The diadromous fish IEFs could be impacted due to increased predation by marine mammals which are attracted to the fish aggregations around the hard infrastructure. A tagging study on harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) around OWFs in Dutch and UK waters presented evidence that the seals were utilising wind farm sites as foraging habitats, specifically targeting structures such as foundations (Russell *et al.*, 2014). Diadromous fish species could face increased predation risk from seal species as a result. However, other studies have shown there to be no change in seal behaviour (McConnell *et al.*, 2012), and these potential effects may be site specific. It is, however, unlikely that potential increased seal presence would result in significantly increased predation on solely diadromous species, with seals likely to forage on a range of fish species aggregating around the infrastructure. Research has shown that Atlantic salmon smolts spend little time in coastal waters, and actively swim away from natal rivers making their way to northern feeding grounds soon after maturation (Newton *et al.*, 2021, Newton *et al.*, 2019, Newton *et al.*, 2017). They are therefore at lower risk of potential impact from increased predation from seals and other predators in the Morven South Boundary as their presence within it is likely to be transitory.

9.11.6.15 The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

<u>Significance of the effect</u>

9.11.6.16 Overall, for all fish and shellfish IEFs, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.6.17 There are no designated sites within the ZoI (i.e. the Morven South Boundary; Figure 9.5), therefore this impact will not directly impede the conservation objectives of any sites designated for fish and shellfish receptors. Although there are some SACs designated for Annex II diadromous fish along the east coast of the UK, colonisation of hard structures and associated fish aggregation in the offshore waters of the Morven South Boundary will not cause a barrier for migration to and from these SACs (see paragraphs 9.11.5.13 to 9.11.5.15).

<u>Secondary mitigation and residual effect</u>

9.11.6.18 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.11.7 Electromagnetic fields from subsea electrical cables

9.11.7.1 EMFs from subsea electrical cables associated with the operation and maintenance phase of Morven South could impact the navigational abilities and predator/prey interactions of fish and shellfish receptors.

Operation and maintenance phase

Magnitude of impact

9.11.7.2 As detailed in Table 9.19, the MDS for this impact considered the maximum potential length of subsea cables associated with Morven South. There will be a total of up to 684km of subsea electrical cables associated with Morven South, comprised of:

- 420km of 66kV inter-array cables;
- 264km of 275kV inter-connector cables (Table 9.19).

9.11.7.3 There will be a target burial depth of 1m, with a minimum and maximum burial depth of 0.5m and 3m, respectively. Up to 10% of the cables will require cable protection as opposed to burial, equating to 68.4km in total.

9.11.7.4 As detailed in Table 9.20, there are several designed-in measures applicable to this impact, which will help mitigate the potential impact:

- Development and adherence to a CBRA.
- Use of minimal burial depths (0.5m) or cable protection around inter-array and inter-connector cables.
- Development of, and adherence to, an OMP.

9.11.7.5 EMFs are comprised of the following:

- electrical fields, measured in volts per metre (V/m);
- magnetic fields, measured in microtesla (μT), millitesla (mT), milligauss (mG) or gauss.

9.11.7.6 Within the North Sea (and thus the Regional Fish and Shellfish Ecology Study Area), background electric field levels of 25μV/m and magnetic field levels of 50μT have been approximated (Tasker *et al.*, 2010). Subsea power cables associated with offshore wind projects are constructed using magnetic outer sheathing materials. These partially block the emission of the direct electrical field, meaning that only the magnetic field and the resultant induced electrical field are emitted (Hervé, 2021). Similarly, both Alternating Current (AC) and Direct Current (DC) cables typically contain two to three conductor bundles which are superimposed and twisted around each other. This cable design feature results in a partial self-cancellation of the total magnetic field emitted (Hervé, 2021, Snyder *et al.*, 2019). Therefore, the design features of subsea cables themselves mitigate the EMF levels emitted into the marine environment.

9.11.7.7 In addition, the standard industry measure of cable burial (and cable protection where burial is not possible; both of which have been incorporated into the MDS, see Table 9.19) can further reduce the EMF levels emitted. This is because the strength of the magnetic field (and consequently, the induced electrical fields) decreases rapidly horizontally and vertically with distance from the cable and will attenuate to baseline levels within a few metres to few tens of metres (both horizontally and vertically) from the cable (Hutchison *et al.*, 2021). Cable burial and protection can, therefore, reduce EMF levels at the seabed as a result of field decay with distance of the seabed from the cable (Chapman *et al.*, 2023, Gill *et al.*, 2009, Snyder *et al.*, 2019). For example, Snyder *et al.* (2019) demonstrated that cables associated with OWFs buried between depths of 1m to 2m reduced the magnetic field at the seabed surface up to four times than unburied cables. Unburied cables protected by concrete mattresses or rock berms, the field levels were found to be similar to those of the buried cables (Snyder *et al.*, 2019). Magnetic field levels directly over live AC cables associated with offshore wind projects ranged between 65mG at the seabed and 5mG at 1m vertically from the seabed and between 10mG and <0.1mG horizontally at the seabed (Snyder *et al.*, 2019).Therefore, the commitments to cable burial and cable protection incorporated into the MDS further reduce the ZoI and potential for barrier effects associated with EMFs.

9.11.7.8 A minimum burial depth of 0.5m represents part of the MDS for this impact (Table 9.19). Although there was no EMF modelling conducted for Morven North, this has been undertaken for other offshore cable and OWF projects. For example, recent modelling for the Sea Link Subsea Power Cable in the southern North Sea reported that, irrespective of the burial depth, magnetic fields reduced rapidly with distance from the cables due to bundling of the cables. This was modelled for a minimum burial depth of 0.5m (National Grid, 2025a). Similarly, a recent EMF modelling study for the Seagreen OWF (within the Regional Fish and Shellfish Ecology Study Area) demonstrated that the magnetic field reduced to negligible levels within 5m horizontal distance from the cable when buried at a depth of 0.5m (Seagreen, 2023). In addition, at a minimum burial depth of 0.4m (which is lower than that associated with the MDS for Morven North), a value of 59μT was modelled at the surface, which is near background levels of approximately 50μT for the North Sea (Seagreen, 2023). Thus, it has been anticipated that EMF levels will still decrease rapidly to background levels within metres from subsea cables buried at the minimum depth of 0.5m.

9.11.7.9 Overall, the impact is predicted to be of local spatial extent (i.e. metres to tens of metres from cables), long-term duration, continuous and high reversibility (at the end of the operation and maintenance phase). It is predicted that the impact will affect the receptor directly. The magnitude is therefore considered to be low.

<u>Sensitivity of the receptor</u>

9.11.7.10 Many fish and shellfish species have the ability to detect EMFs, as electromagnetic sensing is involved in a variety of sensory systems (Hutchison *et al.*, 2020). For example, some species (particularly elasmobranchs) are electro-receptive and are able to detect weak electric fields in order to locate prey and predators, communicate, find mates and/or orientate themselves (Kim, 2007). Some species may also be able to respond to magnetic fields using electro and magneto-sensory apparatus (Anderson *et al.*, 2017). Magneto-receptive species respond to small changes in the inclination, intensity and/or direction of a magnetic field and may rely on a magnetic compass and/or magnetic map to navigate (Lohmann *et al.*, 2008a, Nordmann *et al.*, 2017).

Marine fish Important Ecological Features

9.11.7.11 There have been a range of studies undertaken on the effect of EMFs from subsea cables on marine fish behaviours. Limited evidence was found that EMFs from subsea cables affected marine fish assemblages for a range of species (Love *et al.*, 2016). In addition, EMFs from subsea cables were not observed to affect the size, morphology, or the cardiac functions of juvenile cod (Lorillard, 2023) nor the spatial distribution, swimming speed, acceleration, or distance moved by larvae of lesser sandeel and herring (Cresci *et al.*, 2020, 2022). While these latter studies cover larvae and juveniles of three key IEFs (cod, herring, and sandeel), the majority of the literature surrounding the impact of EMFs on marine fish focusses on elasmobranchs, which are the most electro-receptive of all fish species. Many elasmobranch species possess specialised electro-receptors which allow them to detect very weak voltage gradients (down to 0.5μV/m) which are naturally emitted from their prey (Kim, 2007). Research also suggests that embryonic elasmobranchs within their egg cases are able to modulate their own bioelectrical signals to reduce predation risk (Kempster *et al.*, 2013).

9.11.7.12 Both attraction and repulsion reactions to EMFs have been observed in studies on elasmobranchs. For example, spurdog (an IEF) has been demonstrated to avoid electrical fields at 10μV/cm, although it should be noted that this level was considerably higher than levels associated with offshore electrical cables (Gill and Taylor, 2001). A study on the small spotted catshark (*Scyliorhinus canicula*) and thornback ray (an IEF) demonstrated that they could respond to EMFs of the type and intensity associated with subsea power cables, although these responses were not predictable and did not always occur (Gill *et al.*, 2009). Similarly, a recent study on small spotted catshark exposed to realistic EMF gradients from subsea power cables (15μT AC and 19.6μT DC) reported that individuals did not alter their movement towards or away from the cables and crossed them as frequently as the controls, suggesting that reactions may vary by species (Hermans *et al.*, 2025). Recently, Hermans *et al.* (2024) concluded that there is a large uncertainty surrounding the risk of behavioural effects from subsea cables on elasmobranchs, and varies across life stages and species ecology. Therefore, species and stimulus-specific sensitivities to EMFs are likely to occur across the elasmobranch IEFs.

9.11.7.13 Of the marine fish IEFs, the only one with an assessment for pressures associated with EMFs on the MarESA and/or FeAST was common skate. There was no relevant pressure for EMFs presented on the MarESA for the common skate IEF, the FeAST for this species concluded a low sensitivity to 'electromagnetic changes' (NatureScot, 2025). The rationale behind this assessment stated that although skates use electro and/or magnetic sensors to detection, orient themselves, and find mates, local EMF changes will cause little impact to the common skate due to its mobility (NatureScot, 2025).

9.11.7.14 In general, the range over which the marine fish IEFs could detect EMFs associated with Morven South is limited to a scale of metres around the subsea cables (Bochert and Zettler, 2006, Hutchison *et al.*, 2021, Snyder *et al.*, 2019). Demersal marine fish IEFs (such as some gadoids, anglerfish, sandeels, flatfish, and some elasmobranchs) are more likely to come into the ZoI of the cables and thus encounter higher EMF levels when near them. Demersal species are also likely to be exposed for longer periods of time and could be more constrained in terms of lateral location than pelagic species. However, the rapid decay of the EMF with horizontal and vertical distance (i.e. within metres, see paragraph 9.11.7.7) reduces the extent of potential impacts.

9.11.7.15 Therefore, the marine fish IEFs are deemed to be of low vulnerability, high recoverability (by swimming away) and local to international value. The sensitivity of the receptor is therefore, considered to be low.

Diadromous fish Important Ecological Features

9.11.7.16 As introduced in paragraph 9.11.7.10, many species are able to detect the Earth's natural electric and magnetic fields (referred to as 'magnetoreception') and used them to navigate. Given their highly migratory life histories, accurate navigation is essential for the diadromous fish IEFs. Magnetoreception and/or the possession of magneto-receptive material has been demonstrated in salmonid species (Lohmann and Lohmann, 2019, Moore *et al.*, 1990, Naisbett-Jones *et al.*, 2020, Putman *et al.*, 2014) and European eels (Moore and Riley, 2009, Naisbett-Jones *et al.*, 2017). There is evidence of a response to electric and/or magnetic fields in the following diadromous fish IEFs: Atlantic salmon, European eel, sea lamprey, and sea trout (Chung-Davidson *et al.*, 2008, Gill and Bartlett, 2010, Gill *et al.*, 2005, Snyder *et al.*, 2019), with research focussed on salmonids and European eel. However, a recent review on EMFs and diadromous fish migration concluded that there is a need for further research on whether shads are sensitive to EMFs, as the literature is scarce for these species (Verhelst *et al.*, 2025). EMFs associated with subsea cables could therefore interfere with the navigational ability the diadromous IEFs.

9.11.7.17 Salmonids are thought to use chemical and olfactory signals in coastal waters to navigate to their natal rivers (Ueda, 2014) and magnetoreception during offshore migrations (Gill and Bartlett, 2010, Lohmann *et al.*, 2008b). As Atlantic salmon and sea trout are pelagic during their marine phase, the potential effects of EMF would mostly be perceived in shallower waters where they are closer to cables at the seabed than in the offshore waters associated with Morven South (Snyder *et al.*, 2019). Some research on the effects of subsea cables on salmonid species has illustrated no impact on migration patterns (Westerberg *et al.*, 2007, Wilhelmsson *et al.*, 2010) nor migration success (Kavet *et al.*, 2016). Further, Armstrong *et al.* (2015) investigated the effects of mains frequency (50Hz) magnetic fields on the behaviour of captive Atlantic salmon. This study found that large individuals (62cm to 85cm long) demonstrated no significant differences in approach, traverse or departure times associated with coils emitting a magnetic field of 95μT. In addition, there was no evidence that the numbers of post-smolts passing through the coils was related to the intensity of the magnetic fields. There were also no observations of unusual behaviours in association with magnetic fields tested (Armstrong *et al.*, 2015). A study specifically on EMFs generated by subsea cables on chinook salmon (*Oncorhynchus tshawytscha*) migration in San Francisco Bay, United States, resulted in mixed effects (Wyman *et al.*, 2018). Smolts were attracted to some cables but avoided others, and the authors concluded that there was no strong effect on smolt migration and no barrier effects were observed (Wyman *et al.*, 2018). Given the literature summarised in this paragraph, it is not likely that EMFs associated with subsea cables at the seabed will result in a barrier effect to migrating Atlantic salmon and sea trout.

9.11.7.18 European eel have also been suggested to use the earth's magnetic field for navigational purposes during migration (Cresci *et al.*, 2017, Gill and Bartlett, 2010, Moore and Riley, 2009, Snyder *et al.*, 2019). Westerberg and Lagenfelt (2008) demonstrated short term changes in European eel swimming speed during migration (i.e. tens of minutes) due to exposure to AC subsea cables, even though the overall direction remained unaffected. A literature review by Ohman *et al.* (2007) concluded that any delaying effects (i.e. on average 40 minutes) were not likely to impact individual fitness levels over the European eel's 7,000km migration route, with little to no impact on migratory behaviour noted beyond 500m from offshore wind infrastructure. A different review concluded that migrating European eel may interact with EMFs if they pass directly next to the cable (particularly in shallow waters) (Gill and Bartlett, 2010), however this is less likely to be an issue in the offshore waters of Morven South. This is because these are not shallow waters and migrating European eel will therefore not pass directly over buried cables associated with Morven South as individuals will be travelling higher in the water column. The research summarised in this paragraph indicates that behavioural effects in response to EMFs are limited both temporally and spatially and may not cause barriers to migration for European eel.

9.11.7.19 The literature reviewed in this section demonstrates that EMFs could result in altered behaviour in diadromous fish species, however, these changes are temporary and would be highly localised to within metres of the cable. Given that diadromous fish offshore may not come into contact with the ZoI associated with subsea cables at the seabed (within metres to low tens of metres, see paragraph 9.11.7.7), large-scale barriers to migration are unlikely. It should be noted that although there is limited information available in the literature on the impacts and sensitivities of shellfish species to EMFs (paragraphs 9.11.7.21 onwards), the freshwater pearl mussel IEF would not be directly impacted by EMFs produced by subsea cables associated with Morven South given that they are a freshwater resident species and there will be no subsea cables associated with Morven South in any freshwater habitats.

9.11.7.20 The diadromous fish IEFs are deemed to be of low vulnerability, high recoverability (by swimming away) and national to international value. The sensitivity of the receptor is therefore, considered to be low. Due to the obligate life history of freshwater pearl mussel with Atlantic salmon and sea trout, the sensitivity of the freshwater pearl mussel IEF is also considered to be low.

Shellfish Important Ecological Features

9.11.7.21 Some crustacean species, such as Caribbean spiny lobster (*Panulirus argus*), have been recorded to demonstrate a response to magnetic fields and may use magnetoreception for navigation (Lohmann *et al.*, 1995). Exposure to EMFs has also been suggested to affect physiological processes within crustaceans, such as moulting (Lee and Weis, 1980). More recently, however, a study in southern California reported no evidence to suggest that EMFs from buried or unburied subsea cables affected Dungeness crab (*Metacarcinus magister*) and red rock crab (*Cancer productus*) movement (Love *et al.*, 2017). A similar study on American lobster (*Homarus americanus*) found no significant change in distance or speed of travel over time when individuals were exposed to magnetic fields of 53μT to 65μT (Hutchison *et al.*, 2020). Similarly, AC and DC fields were not found to cause a barrier to movement or migration of American lobster (Hutchison *et al.*, 2018). In contrast, Scott *et al.* (2018) and Woodruff *et al.* (2012) reported behavioural changes in edible crab (an IEF) and Dungeness crab during exposure to increased EMF levels, with both species showing increased activity when not exposed. Therefore, sensitivity may vary between species and be influenced by other environmental factors.

9.11.7.22 With the exception of edible crab, the research presented in the preceding paragraph does not focus on shellfish IEFs relevant to this assessment. Scott (2019) demonstrated that EMF exposure could result in varying egg volumes for edible crab, compared to control conditions. Exposed larvae were significantly smaller, but there were no statistically significant differences in hatched larval numbers, deformities, mortalities, or fitness (Scott, 2019). More recently, the authors measured stress related parameters (l-Lactate, d-Glucose, total haemocyte count) in addition to behavioural and response parameters (shelter preference and time spent resting/roaming) in edible crab over 24 hour periods (Scott *et al.*, 2021). Although, EMF strengths of 250μT were recorded to have limited physiological and behavioural impacts, exposure to 500μT and 1,000μT were found to suggest a stress response in this species (Scott *et al.*, 2021). Individuals showed a clear attraction to shelters with a significant reduction in time spent roaming when exposed to EMFs of 500μT and 1,000μT, but not at 250μT, suggesting a threshold for tolerance (Scott *et al.*, 2021). Maximum magnetic fields of 78.27μT were recorded at an unburied subsea cable (Normandeau Associates Inc *et al.*, 2011). Therefore, as these physiological and behavioural impacts on edible crab did not occur at levels of 250μT (Scott *et al.*, 2021), it can be assumed that the magnetic fields generated by the subsea cables associated with Morven South will be lower than 250 μT, and therefore will not result in the adverse impacts recorded by Scott *et al.* (2021).

9.11.7.23 Limited research undertaken on the European lobster IEF demonstrated no neurological response to magnetic field strengths considerably higher than those expected directly over an average buried power cable (Normandeau Associates Inc *et al.*, 2011, Ueno *et al.*, 1986). However, a significant decrease in egg volume at later stages of egg development and more larval deformities were recorded in European lobster exposed to EMFs (Scott *et al.*, 2020). Similarly, Harsanyi *et al.* (2022) noted that chronic EMF exposure could cause physiological deformities and reduced swimming rates in European lobster and edible crab larvae. However, it should be noted that these deformities were in response to EMF levels of 2,800μT, and therefore are considerably higher than EMF effects expected for buried cables (Harsanyi *et al.*, 2022).

9.11.7.24 Regarding other shellfish IEFs, there is currently no evidence for electroreception or magnetic sensitivity in cephalopods (Williamson, 1995), with their excellent vision believed to be largely responsible for navigation (Pungor and Niell, 2023). There is minimal scientific literature about the potential sensitivity of the common whelk, king scallop, and queen scallop IEFs to EMFs. However, as these species are not migratory, it is less likely that magnetoreception could be impaired by EMFs generated by subsea power cables.

9.11.7.25 As with the sensitivity of marine fish IEFs and diadromous IEFs, the range over which the shellfish IEFS could be sensitive to EMFs is limited to within metres of the subsea cables and the rapid decay of the EMF with horizontal and vertical distance (see paragraph 9.11.7.7) reduces the potential for individuals to detect emitted EMFs.

9.11.7.26 The shellfish IEFs are deemed to be of low vulnerability, high recoverability and local value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

9.11.7.27 Overall, for all fish and shellfish IEF the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse,** which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).

9.11.7.28 Given that minor adverse significance was concluded for all fish and shellfish IEFs, this impact will not cause a barrier to migration for the Annex II diadromous fish features of the designated SACs illustrated in Figure 9.5. This is due to the distance from Morven South and these SACs (Table 9.13), alongside the literature detailed in paragraphs 9.11.7.17 and 9.11.7.19. An assessment of the potential for adverse effect on the integrity of these SAC's conservation objectives is provided in the (Chapter 2.1: Report to Inform Appropriate Assessment Part 2: SAC Assessments). Although the

Turbot Bank MPA falls within the Regional Fish and Shellfish Ecology Study Area, it is located at least 75.4km from Morven South and is designated for sandeels, which are a relatively immobile feature (Table 9.13). Therefore, the highly localised ZoI associated with EMFs at Morven South will not impact the sandeel feature of this MPA.

Secondary mitigation and residual effect

9.11.7.29 No mitigation measures for fish and shellfish ecology are considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.11.8 Proposed monitoring

9.11.8.1 Site specific monitoring is not proposed because the assessment concluded that Morven North would not give rise to significant effects for fish and shellfish ecology, either alone or when considered cumulatively with other plans, projects or activities. The Applicant will, however, continue to liaise with MD-LOT, NatureScot and other key stakeholders to help identify opportunities for proportionate, evidence led regional or strategic monitoring that can improve understanding of the environmental implications of offshore wind, particularly where recognised evidence gaps exist. This may include contributing to, or participating in, relevant ongoing initiatives under the ScotMER programme (Scottish Government, 2026).

9.12 Whole project assessment and Cumulative Effects Assessment Methodology

9.12.1 Methodology

9.12.1.1 The Morven Programme comprises four distinct projects: Morven South, Morven North, Morven Hawthorn Pit Grid Connection Project (MHPGC Project), and Morven Branxton Area Grid Connection Project (MBAGC Project).

9.12.1.2 The following assessment scenarios have been considered to identify the potential effects of Morven South in combination with other projects on the same receptor, as follows (and summarised in Table 9.32):

- Whole project assessment: to identify the potential impacts associated with Morven South together with each grid connection option in turn, (Scenario 1: MHPGC and Scenario 2: MBAGC Project), each of which would comprise a “Whole Project”;
- Morven Programme assessment: to identify potential impacts associated with all four components of the Morven Programme together with other relevant projects, plans and activities (Scenario 3);
- Cumulative effects assessment (CEA): to identify the potential impacts associated with Morven South together with other relevant projects, plans and activities including other components of the Morven Programme, using a tiered approach (Scenario 4).

9.12.1.3 The Whole Project assessment and CEA have been undertaken in accordance with the methodology described in Volume 1, Chapter 6: EIA methodology.

Table 9.32: Scenarios to be considered in the Morven South Whole Project assessment and Cumulative Effects Assessment for fish and shellfish ecology

Whole project assessment		Morven Programme assessment (Offshore Ornithology and Shipping and Navigation chapters only)	Cumulative effects assessment
Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
Morven South + MHPGC Project	Morven South + MBAGC Project	Morven North + Morven South + MHPGC Project + MBAGC Project	Morven South + Tier 1, Tier 2 and Tier 3 Plans/Projects screened in

9.12.1.4 For the purposes of this chapter, Scenarios 1, 2, and 4 have been taken forward for assessment; Scenario 3 has not been included as it is not applicable to this chapter. As discussed in Volume 1, Chapter 6: EIA Methodology, the Morven Programme assessment (Scenario 3) is only required for specific chapters to provide further context to, and to support, the conclusions of the CEA scenario (Scenario 4), in agreement with the relevant stakeholders for these topics. As Scenario 3 does not form the basis of the CEA conclusions, it is considered a supplementary assessment to the CEA scenario (Scenario 4) for these specific topics. The approach to cumulative effects assessment presented in this [topic] chapter complies with the requirements under the EIA Regulations to assess the LSE[1] on the environment arising from a project cumulatively with other relevant plans, projects and activities, and no supplementary assessment of the Morven Programme (Scenario 3) is required or has been requested by relevant stakeholders with regard to fish and shellfish ecology.

9.12.1.5 The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see Volume 3, Annex 6.2: Cumulative Effects Screening). Each project or plan has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

9.12.1.6 In undertaking the CEA for Morven South, it should be noted that other projects and plans under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside Morven South. Therefore, a tiered approach has been adopted, whereby all third-party projects and plans considered have been allocated into “tiers” reflecting their current stage within the planning and development process. This provides a framework for placing relative weight upon the potential for each project/plan included in the CEA to ultimately be realised, based upon the project/plan’s current stage of maturity and certainty in the project/plan’s parameters. The tiered approach utilised within the Morven South CEA employs the following tiers:

- Tier 1 assessment – Existing developments either built (operational) or under construction[2]; approved developments awaiting implementation; and permitted/submitted application(s) but not yet determined.

[2] Note that existing developments are included in Tier 1 CEA long list but are generally screened out of the CEA assessments, aside from the following exceptions:

1) Existing developments which were not present at the time of baseline characterisation, where a potential cumulative impact-receptor pathway has been identified.

2) Existing developments are screened into tier 1 assessments for specific topics where there is a large conceptual, temporal and spatial overlap between project impacts. In these instances, the potential for ongoing effects through cumulative impact-receptor pathways throughout project lifetime, across the development phases, means that they are considered within quantitative assessment for these topic CEAs (e.g. offshore ornithology assessments consider the cumulative effects of operational offshore wind farms).

- Tier 2 assessment – All plans/projects assessed under Tier 1, and plans/projects where a scoping report has been submitted and is in the public domain.
- Tier 3 assessment – All plans/projects assessed under Tier 1 and 2, plus plans/projects that are reasonably foreseeable (e.g. projects identified in development plans, projects in other plans and programmes, offshore renewable energy projects that have a Crown Estate Scotland Lease Option Agreement).

9.12.1.7 For the impact of underwater sound, a buffer of 100km around the Morven South Boundary (with an area of 38,827.15km^2) has been implemented to identify relevant projects and activities. This is standard practice, to account for the wider ranging ZoI for underwater sound, in comparison to all other potential impacts to fish and shellfish ecology. For the impact of increased SSCs and associated deposition, the CEA screening buffer used in Volume 2, Chapter 7: Physical Processes was used to identify relevant projects (two tidal excursions from the Morven South Boundary: 28km). This is because the assessment for this impact is based on that presented the CEA for physical processes. A spring tidal excursion is defined as the distance that suspended sediment is transported due to tidal currents before being carried back on the returning tide. Two spring tidal excursions represents where study areas for adjacent projects and developments, defined in a similar way, may intersect.

9.12.1.8 For all other impacts, a buffer of 50km (with an area of 12,046.65km^2) has been implemented, which is suitably precautionary given the localised nature of the impacts and the wide range of suitable habitats for fish and shellfish throughout the North Sea. These buffers are as presented within the Scoping Report (MvOWL, 2023) and consulted upon during the Scoping Opinion process (see Table 9.6). Using these buffers, the specific projects and plans scoped into the CEA for fish and shellfish ecology are outlined in Table 9.33. Those carried forward for further assessment in the CEA are illustrated in Figure 9.12.

9.12.1.9 All impacts considered for the Morven South alone assessment have been taken forward to the Whole Project and CEA assessment.

Table 9.33: List of other projects and plans considered within the Cumulative Effects Assessment for fish and shellfish ecology

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
Tier 1						
Energy projects and cables						
Morven North	Consenting/pre-construction	0	Proposed for up to 96 turbines with a capacity of up to 1,500MW.	2033 – 2042[3]	2038 – 2073 or 2043 to 2078[4]	Part of Scenario 4
Berwick Bank OWF	Consented	34	Berwick Bank OWF is proposed for up to 307 turbines with a capacity of up to 4,100MW.	2025 - 2032	2033 - 2068	The O&M phase of Berwick Bank OWF overlaps with the construction and O&M phases of Morven South.
Cambois Connection	Consented	34	Up to four HVDC offshore export cables bundled with up to four fibre optic cables up to 40km in length from up to two offshore convertor station	2025 - 2032	2033 - 2068	The O&M phase of the Cambois Connection overlaps with the construction and O&M phases of Morven South.

[3] At the time of writing, Morven North and Morven South could be constructed anywhere between 2033 to 2042, with both projects possibly being constructed concurrently or one after another. As a precaution, the widest possible construction phase of ten years has been used in the CEA.

[4] While Morven North and Morven South could be constructed anywhere between 2033 to 2042, the O&M phase has been assumed as commencing in 2038 as a precaution in the instance that one project is constructed first and operational while the other is still in its construction phase. The operational lifecycle of Morven North and Morven South is 35 years and could end in either 2073 (if operational in 2038) or in 2078 (if operational in 2043).

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
			platforms within the Berwick Bank OWF to the Scottish/English border.			
Muir Mhor OWF	Application submitted, awaiting decision	77	Muir Mhor OWF is proposed for a capacity of 798MW.	2030 – 2033	2034 - 2069	The construction phase of Muir Mhor OWF overlaps with that of Morven South for one year in 2033. As this project is outwith the 50km CEA screening buffer for all impacts except underwater sound, Muir Mhor OWF would only be screened in for the latter. Given that there is potential for cumulative piling and UXO clearance at Morven South and Muir Mhor OWF, this project is screened in for this impact only.
Ossian OWF	Application submitted	5	The Ossian OWF is proposed for up to 3,610MW capacity.	2029 – 2038	2039 - 2074	The construction and O&M phases (and possibly the decommissioning

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
						phase) of the Ossian OWF overlap with those of Morven South.
Seagreen 1 OWF	Operational	35	Seagreen 1 OWF consists of up to 114 wind turbines at a capacity of 1,075MW.	Currently operational	Present day to 2049	The O&M phase of the Seagreen 1 OWF overlaps with the construction and O&M phases of Morven South. The decommissioning phase overlaps with the O&M phase of Morven South.
Cables and pipelines						
Eastern Green Link 2 (EGL2)	Construction	16	High voltage electricity link between Scotland and England.	2025 – 2029	2030 onwards	The O&M phase of EGL2 overlaps with the construction and O&M phases of Morven South.
Eastern Green Link 3 (EGL 3)	Joint PEIR published	3	EGL3 and EGL4 are two offshore high voltage electricity links between Scotland and England, with converter stations and associated onshore infrastructure.	2028 - 2033	2034 onwards	The construction phase of EGL 3 and EGL4 overlaps with that of Morven South for one year in 2033. The O&M (and possibly the decommissioning phases) of EGL3 and EGL4 also overlap with those
Eastern Green Link 4 (EGL 4)		55				

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
						of Morven South. The decommissioning phase is currently unknown. Given that EGL 4 is outwith the 50km CEA Screening Buffer for all impacts except underwater sound, this project is only considered for the impact of cumulative underwater sound.
Tier 2						
Energy projects and cables						
MHPGC Project	Consenting/pre-construction	0	Part of Scenarios 1 and 4	Unknown	Unknown	Part of Scenarios 1 and 4
Bellrock OWF	Consenting/pre-construction	35	Bellrock Floating OWF is proposed for a capacity of 1,800MW and up to 132 turbines.	2027 – 2030	2031 onwards	The O&M phase of Bellrock OWF overlaps with the construction and O&M phases of Morven South. The decommissioning phase is currently unknown.
Bowdun OWF	Consenting/pre-construction	44	Bowdun OWF is proposed for up to 67 turbines at a	2029 – 2033	2034 onwards	The construction and O&M phases of the Bowdun OWF

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
			capacity of 1,008MW.			overlap with those of Morven South. The decommissioning phase is currently unknown.
Ossian OWF Export Cable	Consenting/pre-construction	5	Maximum of six offshore export cables, with no indicative construction start date or transmission capacity publicly available.	Unknown	Unknown	The timing of the construction and O&M phase of the Ossian OWF Export Cable are currently not available. As a precaution, it has been assumed that all phases of development could overlap with those of Morven South.
Cables and pipelines						
Eastern Green Link 5 (EGL 5)	Consenting/pre-construction	4	Scotland to England cable connector of up to 555km in length.	2030 – 2034	2034 onwards	The construction phase of EGL 5 may overlap with that of Morven South, alongside overlapping O&M phases of both projects.

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
Tier 3						
Energy projects and cables						
MHPGC Project	In planning	0	Part of Scenarios 2 and 4	Unknown	Unknown	Part of Scenarios 2 and 4
Innovation and Targeted Oil and Gas Leasing Round (INTOG): Flora	Consenting/pre-construction	94	INTOG site 4 is proposed for up to 50MW.	Unknown	Unknown	These INTOG projects are outwith the 50km screening buffer for all impact except underwater sound. As Tier 3 projects, the construction phases (in which underwater sound from piling and UXO clearance would be produced) are currently unknown. As a precaution, these projects have been included in the CEA for the impact of underwater sound only.
INTOG: Cedar	Consenting/pre-construction	85	INTOG site 10 is proposed for up to 1,008MW.	Unknown	Unknown	

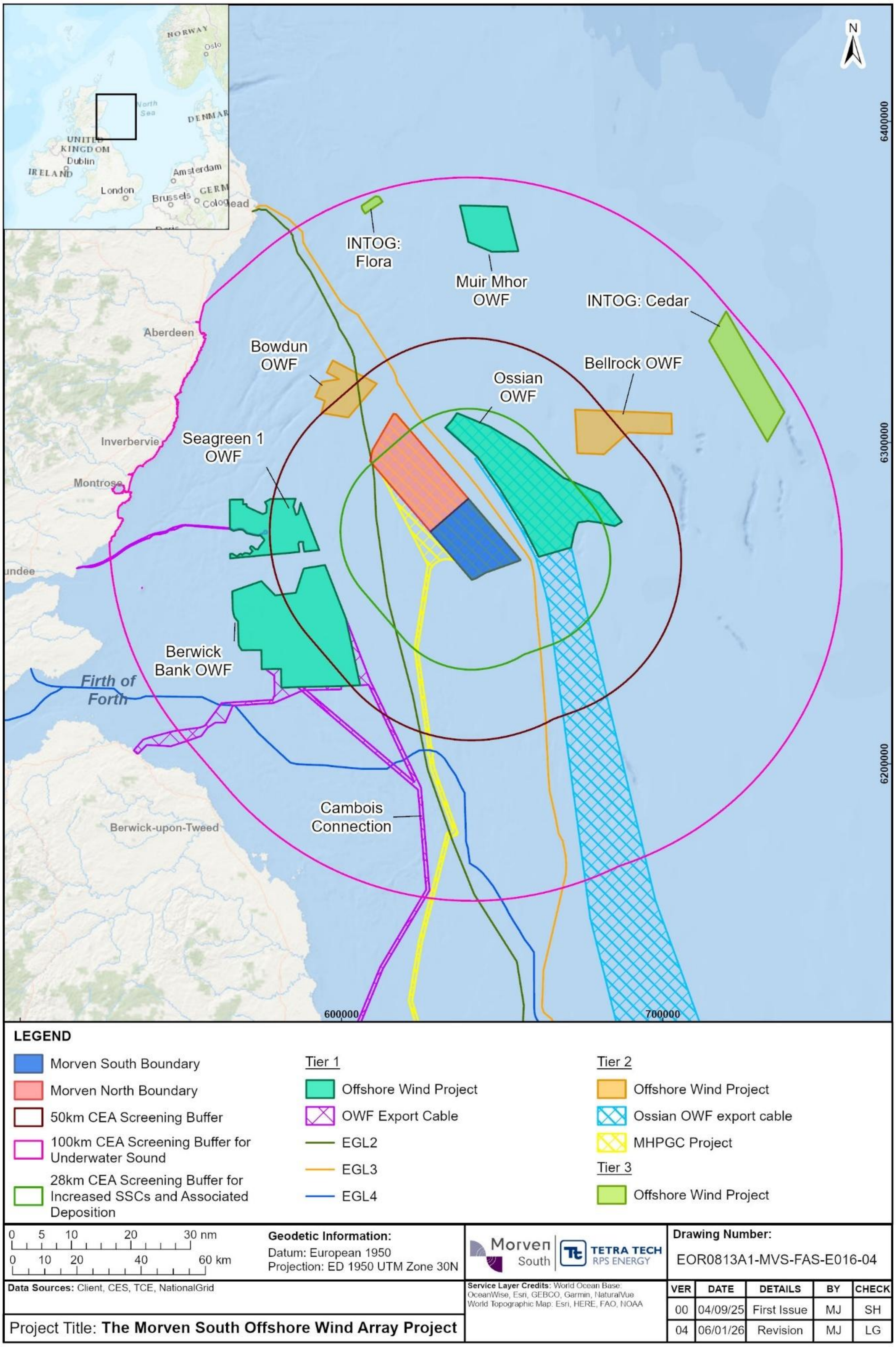

Figure 9.12: Other projects/plans screened into the Cumulative Effects Assessment for fish and shellfish ecology

9.12.2 Maximum Design Scenario

9.12.2.1 The cumulative MDSs identified in Table 9.34 have been selected as those having the potential to result in the greatest potential cumulative effect on an identified receptor or receptor group. The cumulative MDSs have been based on the Morven South alone assessment MDS (Table 9.19), the Morven North alone assessment MDS, the Project Description contained within the MHPGC Project Scoping Report and project information available for MBAGC Project, as well as publicly available information on other third party projects and plans that have been screened into the CEA (Table 9.33).

Table 9.34: Maximum Design Scenario considered for the assessment of potential Whole Project and cumulative effects on fish and shellfish ecology

C= Construction, O= Operations and maintenance, D= Decommissioning phases

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
Temporary habitat loss and disturbance	✓	×	×	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: Tier 1 • Morven North (in its construction phase); • Berwick Bank OWF and the Cambois Connection (in their O&M phases); • Ossian OWF (in its construction and O&M phases); • Seagreen 1 OWF (in its O&M phase); • EGL 2 (in its O&M phase); • EGL 3 (in its construction and O&M phases). Tier 2 • MHPGC Project (in its construction and O&M phases); • Bellrock OWF (in its O&M phase); • Bowdun OWF (in its construction and O&M phases);	A precautionary buffer of 50km was used to screen in plans and projects from the CEA long list into the assessment for this impact. The Scenario 4 projects detailed in the previous column have been screened in as they have the potential to cause temporary habitat loss and disturbance within their respective footprints and therefore require consideration at a cumulative scale.

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• Ossian OWF Export Cable (possibly in its construction and O&M phases); • EGL 5 (possibly in its construction and O&M phases). Tier 3 • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	
	×	✓	×	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: Tier 1 • Morven North (in their O&M phase); • Berwick Bank OWF and the Cambois Connection (in their O&M and decommissioning phases); • Ossian OWF (in its O&M phase); • Seagreen 1 OWF (in its O&M and decommissioning phases); • EGL 2 (in its O&M phase); • EGL 3 (in its O&M phase). Tier 2 • MHPGC Project (in its O&M phase);	

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• Bellrock OWF (in its O&M phase); • Bowdun OWF (in O&M phase); • Ossian OWF Export Cable (in its O&M phase); • EGL 5 (possibly in its O&M phase). Tier 3 • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	
	×	×	✓	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: **Tier 1** • Morven South (in its decommissioning phase); • Ossian OWF (in its decommissioning phase); • EGL 2 (possibly in its decommissioning phase, although this is not known); • EGL 3 (possibly in its decommissioning phase, although this is not known). **Tier 2** • MHPGC Project (possibly in its decommissioning phase);	

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• Bellrock OWF (possibly in its decommissioning phase, although this is not known); • Bowdun OWF (possibly in its decommissioning phase, although this is not known); • Ossian OWF Export Cable (possibly in its decommissioning phase, although this is not known); • EGL 5 (possibly in its decommissioning phase, although this is not known). **Tier 3** • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	
Underwater sound impacting fish and shellfish receptors	✓	×	×	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: **Tier 1** • Morven North (in its construction phase); • Muir Mhor OWF (in its construction phase); • Ossian OWF (in its construction phase); • EGL 3 and EGL 4 (in their construction phases).	A wider, but still precautionary, buffer of 100km was used to screen in plans and projects from the CEA long list into the assessment for this impact. The Scenario 4 projects detailed in the previous column have been screened in as they have the potential to generate underwater sound from piling and/or UXO clearance during their construction phases and therefore require consideration at a cumulative scale. Given the lack of piling and UXO clearance within the decommissioning phases of Morven South and the other projects included in the CEA, only the construction phase has been assessed at a cumulative level. This is due to the higher risk of impact associated with piling and UXO clearance and the lack of any specific underwater sound modelling available for the decommissioning phase of

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				Tier 2 • MHPGC Project (in its construction phase); • Bowdun OWF (in its construction phase); • Ossian OWF Export Cable (possibly in its construction phase); • EGL 5 (possibly in its construction phase). **Tier 3** • INTOG projects (Flora and Cedar) in their construction phases; • MBAGC Project (in its construction phase).	Morven South and the other projects available to undertake any form of assessment.
Increased SSCs and associated deposition	✓	×	×	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: **Tier 1** • Morven North (in its construction phase); • Ossian OWF (in its construction phase); • EGL 2 (in its O&M phase). **Tier 2** • MHPGC Project (in its construction phase); • Ossian OWF Export Cable (in its construction phase);	This impact was informed by Volume 2, Chapter 7: Physical Processes. Therefore, the projects included in the CEA for this impact include only those considered for the same impact in the CEA for physical processes. The screening buffer used was two spring tidal excursions. The Scenario 4 projects detailed in the previous column have been screened in as they have the potential to result in increased SSCs and associated deposition and therefore require consideration at a cumulative scale. Intermittent operations, such as the repair or reburial of offshore cables, have been included in the cumulative assessment. These activities, although potentially in their O&M phase, are not included within the background assessment (see Volume 2, Chapter 7: Physical Processes) as they are

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• EGL 3 (in its construction phase); • EGL 5 (in its construction phase). **Tier 3** • MBAGC Project (possibly in its construction phase).	not continual and therefore do not contribute to background conditions in a consistent manner.
	×	✓	×	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: **Tier 1** • Morven North (in its O&M phase); • Ossian OWF (in its O&M phase); • EGL 2 (in its O&M phase). **Tier 2** • MHPGC Project (in its O&M phase); • Ossian OWF Export Cable (in its O&M phase); • EGL 3 (in its O&M phase); • EGL 5 (in its O&M phase). **Tier 3** • MBAGC Project (possibly in its O&M phase).	

<table>
<tr><th rowspan="2">Potential Cumulative Effect</th><th colspan="3">Phase</th><th rowspan="2">Maximum Design Scenario</th><th rowspan="2">Justification</th></tr>
<tr><th>C</th><th>O</th><th>D</th></tr>
<tr><td></td><td>×</td><td>×</td><td>✓</td><td>Scenario 1
MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project.
Scenario 2
MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project.
Scenario 4
MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans:
Tier 1
• Morven North (in its O&M and decommissioning phase);
• Ossian (possibly in its decommissioning phase,);
• EGL 2 (possibly in its decommissioning phase).
Tier 2
• MHPGC Project (in its decommissioning phase);
• Ossian OWF Export Cable (possibly in its decommissioning phase, although this is not known);
• EGL 3 (possibly in its decommissioning phase, although this is not known);
• EGL 5 (possibly in its decommissioning phase, although this is not known).
Tier 3
• MBAGC Project (possibly in its decommissioning phase, although this is not known).</td><td></td></tr>
</table>

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
Long-term habitat loss	✓	✓	×	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with Morven North and the following other projects and plans: **Tier 1** • Morven North (in its construction and O&M phases); • Berwick Bank OWF and the Cambois Connection (in their O&M phases); • Ossian OWF (in its construction and O&M phases); • EGL 3 (in its construction and O&M phases). **Tier 2** • MHPGC project (in its construction an O&M phases); • Bellrock OWF (in its O&M and decommissioning phases); • Bowdun OWF (in O&M and decommissioning phases); • Ossian OWF Export Cable (in its O&M and decommissioning phases); • EGL 5 (possibly in its construction and O&M phases).	A precautionary buffer of 50km was used to screen in plans and projects from the CEA long list into the assessment for this impact. The Scenario 4 projects detailed in the previous column have been screened in as they have the potential to cause long-term habitat loss within their respective footprints and therefore require consideration at a cumulative scale.

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				Tier 3 • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	
	×	×	✓	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with Morven North and the following other projects and plans: **Tier 1** • Morven North (in its decommissioning phase); • Ossian OWF (in its decommissioning phase); • EGL 3 (possibly in its decommissioning phase, although this is not known). **Tier 2** • MHPGC Project (possibly in its decommissioning phase, although this is not known); • Bellrock OWF (possibly in its decommissioning phase, although this is not known); • Bowdun OWF (possibly in its decommissioning phase, although this is not known); • Ossian OWF Export Cable (possibly in its decommissioning phase, although this is not known);	

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• EGL 5 (possibly in its decommissioning phase, although this is not known). **Tier 3** • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	
Colonisation of hard structures and associated fish aggregation	✓	✓	✓	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: **Tier 1** • Morven North (in all phases); • Berwick Bank OWF and the Cambois Connection (in their O&M and decommissioning phases); • Ossian OWF (in all its phases); • EGL 3 (in its O&M phase and possibly in its decommissioning phases). **Tier 2** • MHPGC Project (in all phases); • Bellrock OWF (in its O&M and decommissioning phases); • Bowdun OWF (in O&M and decommissioning phases);	A precautionary buffer of 50km was used to screen in plans and projects from the CEA long list into the assessment for this impact. The Scenario 4 projects detailed in the previous column have been screened in as they have the potential to introduce artificial hard structures within their respective footprints and therefore require consideration at a cumulative scale.

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• Ossian OWF Export Cable (in its O&M and decommissioning phases); • EGL 5 (in its O&M phase and possibly in its decommissioning phases). **Tier 3** • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	
EMF from subsea electrical cables	×	✓	×	**Scenario 1** MDS as described for Morven South (Table 9.19), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 9.19), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 9.19), assessed cumulatively with the following other projects and plans: **Tier 1** • Morven North (in its O&M phase); • Berwick Bank OWF and the Cambois Connection (in their O&M phase); • Ossian OWF (in its O&M phase); • Seagreen 1 OWF (in its O&M phase); • EGL2 (in its O&M phase); • EGL 3 (in its O&M phase). **Tier 2** • MHPGC Project (in its O&M phase); • Bellrock OWF (in its O&M phase);	A precautionary buffer of 50km was used to screen in plans and projects from the CEA long list into the assessment for this impact. The Scenario 4 projects detailed in the previous column have been screened in as they have the potential to release EMFs and therefore require consideration at a cumulative scale.

Potential Cumulative Effect	Phase			Maximum Design Scenario	Justification
	C	O	D		
				• Bowdun OWF (in O&M phase); • Ossian OWF Export Cable (in its O&M phase); • EGL 5 (in its O&M phase). **Tier 3** • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	

9.13 Whole project assessment and Cumulative Effects Assessment

9.13.1 Overview

9.13.1.1 A description of the significance of Whole Project and cumulative effects upon fish and shellfish receptors arising from each identified impact is given below.

9.13.2 Temporary habit loss and disturbance

9.13.2.1 There is potential for temporary habitat loss and disturbance as a result of Morven South's construction, O&M and decommissioning activities alongside other projects screened in for this impact. The activities include seabed preparation, installation of wind turbines and OSP foundations, and the installation and/or maintenance of inter-array cables, inter-connector cables and offshore export cables.

9.13.2.2 The summary of the Whole Project assessment for temporary habitat loss and disturbance is presented in Table 9.35, and the CEA is presented in Table 9.39. A range of Tier 1 to 3 projects were screened into the CEA due to the potential for temporary habitat loss and disturbance in their own respective phases. Footprints of temporary habitat loss and disturbance associated with the Tier 1 projects (wherein quantitative data were available) are presented in Table 9.36 to Table 9.38 for the construction, O&M, and decommissioning phases of Morven South, respectively.

Table 9.35: Morven South Whole Project assessment for temporary habitat loss and disturbance

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Construction phase		
Magnitude of impact	The MDS for Morven South consists of up to 62,596,300m^2 of temporary habitat loss during the construction phase due to a range of activities (see Table 9.19). At the time of writing, it was not possible to calculate the area of temporary habitat loss associated with the MHPGC Project, however as per the assessment of Morven South Alone (Section 9.11.2), the footprints of temporary habitat loss associated with these projects will be distributed throughout their respective boundaries and not be located in one continuous area, thereby reducing the magnitude of impact. The footprint of temporary habitat loss associated with Morven South accounts for 0.52% of the 50km CEA Screening Buffer for this impact, and additional areas associated with the MHPGC Project are not expected to represent additional material impact to that defined for the assessment of Morven South alone. The Whole Project impact is predicted to be of local spatial extent, medium term duration (due to the potential for staggered construction periods between Morven South and the MHPGC Project), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the Whole Project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The Whole Project impact is predicted to be of local spatial extent, medium term duration (due to the potential for staggered construction periods between Morven South and the MBAGC Project), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.
Sensitivity of receptor	For the sandeel IEF, the sensitivity of the receptor is considered to be medium and is the same for both Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for both Scenario 1 and Scenario 2. Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the alone assessment and not repeated here.	
Significance of effect	The significance of effect is the same for both Scenario 1 and Scenario 2.	

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
	Overall, for the sandeel IEF, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	
Operations and maintenance phase		
Magnitude of impact	The MDS for Morven South consists of up to 7,967,400m^2 of temporary habitat loss during the O&M phase due to a range of activities (see Table 9.19). At the time of writing, it was not possible to calculate the area of temporary habitat loss associated with the MHPGC Project, however as per the assessment of Morven South Alone (Section 9.11.2), the footprints of temporary habitat loss associated with these projects will be distributed throughout their respective boundaries and not be located in one continuous area, thereby reducing the magnitude of impact. It should also be noted that only a very small proportion of the total temporary habitat loss and disturbance is likely to occur at any one time over the 35 year operational lifetime associated with Morven South, the MHPGC Project and each maintenance event will be highly localised. The footprint of temporary habitat loss associated with Morven South accounts for 0.07% of the 50km CEA Screening Buffer for this impact, and additional areas associated with the MHPGC Project are not expected to represent additional material impact to that defined for the assessment of Morven South alone. The Whole Project impact is predicted to be of local spatial extent, long-term duration, intermittent and high reversibility. It is predicted	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the Whole Project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The Whole Project impact is predicted to be of local spatial extent, long-term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	Scenario 2: Morven South + MBAGC Project
	that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.	
Sensitivity of receptor	For the sandeel IEF, the sensitivity of the receptor is considered to be medium and is the same for both Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for both Scenario 1 and Scenario 2. Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the alone assessment and not repeated here.	
Significance of effect	The significance of effect is the same for both Scenario 1 and Scenario 2. Overall, for the sandeel IEF, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	
Decommissioning phase		
Magnitude of impact	The MDS for Morven South consists of temporary habitat loss during the decommissioning phase due to a range of activities, however a footprint was not able to be quantified at the time of writing (see Table 9.19). Similarly, it was not possible to calculate the area of temporary habitat loss associated with the MHPGC Project. However as per the assessment of Morven South Alone (Section 9.11.2), the footprints of temporary habitat loss associated with these projects will be no greater than those calculated for the construction phase. The Whole Project impact is predicted to be of local spatial extent, short duration, intermittent and high reversibility. It is predicted that	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the Whole Project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The Whole Project impact is predicted to be of local spatial extent, short duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
	the impact will affect the receptor directly. The magnitude is therefore, considered to be low.	
Sensitivity of receptor	For the sandeel IEF, the sensitivity of the receptor is considered to be medium and is the same for both Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for both Scenario 1 and Scenario 2. Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the alone assessment and not repeated here.	
Significance of effect	The significance of effect is the same for both Scenario 1 and Scenario 2. Overall, for the sandeel IEF, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	

Table 9.36: Cumulative footprint of temporary habitat loss and disturbance for scenario 4 in the construction phase of Morven South

Project	MDS	Reference
Morven South	Construction: 62,596,300m^2	Table 9.19
Tier 1 Projects		
Morven North	Construction: 74,055,400m^2	Volume 2, Chapter 10: Fish and Shellfish Ecology, of the Morven North EIA Report
Berwick Bank OWF (in its O&M phase)	O&M: 989,000m^2[5]	SSE Renewables (2022b)
Cambois Connection (in its O&M phase)	O&M: Temporary habitat loss and disturbance could occur due to cable repair and reburial in the O&M phase; however the footprint of impact was not calculated.	SSE Renewables (2023a), (2023b)
Ossian OWF (in its construction and O&M phases)	Construction: 49,948,548m^2	Ossian OWFL (2024)
	O&M: 51,411,500m^2[6]	
Seagreen 1 OWF (in its O&M phase)	O&M: Temporary habitat loss and disturbance could occur due to anchors and jack-up vessel placements in the O&M phase; however, the footprint of impact was not calculated.	Seagreen Wind Energy Limited (2012)
EGL 2 (in its O&M phase)	O&M: Temporary habitat loss and disturbance could occur due to O&M activities; however, the footprint of impact was not calculated.	National Grid (2022)

[5] it should be noted that this value has been calculated for the entire O&M phase of this project, which does not fully overlap with the construction phases of the Morven North and Morven South, and thus the inclusion of this value is highly precautionary.

[6] it should be noted that this value has been calculated for the entire O&M phase of this project, which does not fully overlap with the construction phases of Morven North and Morven South, and thus the inclusion of this value is highly precautionary.

Project	MDS	Reference
EGL 3 (in its construction phase)	Construction: 13,200,000m^2	National Grid (2025b)
Total	**252,200,748m^2**	

Table 9.37: Cumulative footprint of temporary habitat loss and disturbance for scenario 4 in the operations and maintenance phase of Morven South

Project	MDS	Reference
Morven South	O&M: 7,967,400m^2	Table 9.19
Tier 1 Projects		
Morven North	O&M: 9,221,800m^2	Volume 2, Chapter 10: Fish and Shellfish Ecology, of the Morven North EIA Report
Berwick Bank OWF (in its O&M and decommissioning phases)	O&M: 989,000m^2	SSE Renewables (2022b)
	Decommissioning: 34,571,200m^2	
Cambois Connection (in its O&M and decommissioning phases)	O&M: Temporary habitat loss and disturbance could occur due to cable repair and reburial in the O&M phase; however, the footprint of impact was not calculated.	SSE Renewables (2023a), (2023b)
	Decommissioning: lesser than or equal to that calculated for the construction phase: 18,000,000m^2	
Ossian OWF (in its O&M phase)	O&M: 51,411,500m^2	Ossian OWFL (2024)
Seagreen 1 OWF (in its O&M and decommissioning phases)	O&M: temporary habitat loss and disturbance could occur due to anchors and jack-up vessel placements in the O&M phase; however, the footprint of impact was not calculated.	Seagreen Wind Energy Limited (2012)
	Decommissioning: lesser than or equal to that calculated for the construction phase: 3,752,700m^2	
EGL 2 (in its O&M phase)	O&M: Temporary habitat loss and disturbance could occur due to O&M activities, however the footprint of impact was not calculated.	National Grid (2022)

Project	MDS	Reference
EGL 3 (in its O&M phase)	O&M: Temporary habitat loss and disturbance could occur due to O&M activities, however in the PEIR for EGL3, the MDS for this phase was defined as 'to be confirmed at the EIA stage'.	National Grid (2025b)
Total	**74,631,100m^2,** although it should be noted that not all Tier 1 projects had footprints calculated for certain phases and that the O&M phase footprints were calculated over the entire life cycle of projects, which may not fully overlap with the O&M phase of Morven South in some cases.	

Table 9.38: Cumulative footprint of temporary habitat loss and disturbance for scenario 4 in the decommissioning phase of Morven South

Project	Maximum Design Scenario	Reference
Morven South	Decommissioning: Footprint not calculated, but assumed to be lesser than or similar to that of the construction phase (62,596,300m^2)	Table 9.19
Tier 1 Projects		
Morven North	Decommissioning: Footprint not calculated, but assumed to be lesser than or similar to that of the construction phase (74,055,400m^2)	Volume 2, Chapter 10: Fish and Shellfish Ecology, of the Morven North EIA Report
Ossian OWF (in its decommissioning phase)	Decommissioning: 43,200m^2	Ossian OWFL (2024)
EGL 2 (possibly in its decommissioning phase, although this is not known)	Decommissioning: lesser than or equal to that calculated for the construction phase: 15,200,000m^2	National Grid (2022)
EGL 3 (possibly in its decommissioning phase, although this is not known)	Decommissioning: lesser than or equal to that calculated for the construction phase: 13,200,000m^2	National Grid (2025b)
Total	**165,094,900m^2**	

Table 9.39: Morven South cumulative effects assessment for temporary habitat loss and disturbance

	Cumulative effects assessment
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
Construction phase	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North; • Berwick Bank OWF and the Cambois Connection; • Ossian OWF; • Seagreen 1 OWF; • EGL2; • EGL3. As detailed in Table 9.36, a maximum quantifiable area of up to 252,200,748m^2 of temporary habitat loss and disturbance may occur in the construction phase of Morven South cumulatively with other Tier 1 projects The footprint of temporary habitat loss and disturbance for the listed Tier 1 projects will be distributed throughout their respective boundaries and not be located in one continuous area, thereby reducing the magnitude of cumulative impact. The maximum area of temporary habitat loss and disturbance represents up to 2.09% of the 50km CEA screening buffer for fish and shellfish ecology during the construction phase of Morven South. However, in reality, it should be noted that some Tier 1 projects extend outwith this buffer (see Figure 9.12), and as such, the total calculated footprint may be spread out over a greater area. There will also be no spatial overlap between the Morven South Boundary and the majority of the Tier 1 projects (Figure 9.12). The magnitude of cumulative impact for Scenario 4, therefore, represents no additional material impact to that defined for the assessment for Morven South alone and for Scenarios 1 and 2. The magnitude of cumulative impact is predicted to be of local spatial extent, medium term duration (due to the potential for staggered construction periods), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

<table>
<tr><th></th><th>Cumulative effects assessment</th></tr>
<tr><th></th><th>Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects</th></tr>
<tr><td></td><td>Tier 2
The Tier 2 assessment includes Morven South, the Tier 1 projects and the following Tier 2 projects:
MHPGC Project;
Bellrock OWF;
Bowdun OWF;
Ossian OWF Export Cable;
EGL 5.
Given that these are Tier 2 projects, there were no project parameters publicly available to calculate a total area of temporary habitat loss and disturbance. It is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of temporary habitat loss and disturbance across the 50km CEA screening buffer for this impact. There will also be no spatial overlap between the Morven South Boundary and the Tier 2 projects (Figure 9.12). The magnitude of cumulative impact for Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2.
The magnitude of cumulative impact is predicted to be of local spatial extent, medium term duration (due to the potential for staggered construction periods), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Tier 3
Aside from the MBAGC Project, here were no Tier 3 projects identified for this impact. The Tier 3 assessment is therefore no different to the Tier 2 assessment as there are no further details about the MBAGC Project to quantify further.</td></tr>
<tr><td>Sensitivity of receptor</td><td>For the sandeel IEF, the sensitivity of the receptor is considered to be medium.
For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low.
Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the alone assessment and not repeated here.</td></tr>
<tr><td>Significance of effect</td><td>Overall, for the sandeel IEF, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of minor adverse significance, which is not significant in EIA terms.
Overall, for all other fish and shellfish IEFs, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance</td></tr>
</table>

	Cumulative effects assessment
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
	being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.
Operations and maintenance phase	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North; • Berwick Bank OWF and the Cambois Connection; • Ossian OWF; • Seagreen 1 OWF; • EGL2; • EGL3. As detailed in Table 9.37, a maximum quantifiable area of up to 74,631,100m^2 of temporary habitat loss and disturbance may occur in the O&M phase of Morven South cumulatively with the Tier 1 projects. The footprint of temporary habitat loss and disturbance for the Tier 1 projects will be distributed throughout their respective boundaries and not be located in one continuous area, thereby reducing the cumulative magnitude of impact. These footprints will also be distributed temporally over the 35 year lifecycle of Morven South and the lifecycles of the Tier 1 projects. The maximum area of temporary habitat loss and disturbance represents up to 0.62% of the 50km CEA screening buffer for fish and shellfish ecology during the O&M phase of Morven South. However, in reality, it should be noted that some Tier 1 projects extend outwith this buffer (see Figure 9.12), and as such, the total calculated footprint may be spread out over a greater area. There will also be no spatial overlap between the Morven South Boundary and the majority of the Tier 1 projects (Figure 9.12). The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2. The cumulative effect is predicted to be of local spatial extent, long-term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

<table>
<tr><th></th><th>Cumulative effects assessment</th></tr>
<tr><th></th><th>Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects</th></tr>
<tr><td></td><td>Tier 2
The Tier 2 assessment includes Morven South, the Tier 1 projects and the following Tier 2 projects:
• MHPGC Project;
• Bellrock OWF;
• Bowdun OWF;
• Ossian OWF Export Cable;
• EGL 5.
Given that these are Tier 2 projects, there were no project parameters publicly available to calculate a total area of temporary habitat loss and disturbance. It is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of temporary habitat loss and disturbance across the 50km CEA screening buffer for this impact. There will also be no spatial overlap between the Morven South Boundary and the Tier 2 projects (Figure 9.12). The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2.
The cumulative effect is predicted to be of local spatial extent, long-term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Tier 3
Aside from the MBAGC Project, here were no Tier 3 projects identified for this impact. The Tier 3 assessment is therefore no different to the Tier 2 assessment as there are no further details about the MBAGC Project to quantify further.</td></tr>
<tr><td>Sensitivity of receptor</td><td>For the sandeel IEF, the sensitivity of the receptor is considered to be medium.
For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low.
Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the alone assessment and not repeated here.</td></tr>
<tr><td>Significance of effect</td><td>Overall, for the sandeel IEF, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of minor adverse significance, which is not significant in EIA terms.
Overall, for all other fish and shellfish IEFs, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance being minor adverse, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).</td></tr>
</table>

	Cumulative effects assessment
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.
Decommissioning phase	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North • Ossian OWF; • EGL2; • EGL3. As detailed in Table 9.38, a maximum quantifiable area of up to 165,094,900m^2 of temporary habitat loss and disturbance may occur in decommissioning phase of Morven South cumulatively with the Tier 1 projects. The footprint of temporary habitat loss and disturbance for the listed Tier 1 projects will be distributed throughout their respective boundaries and not be located in one continuous area, thereby reducing the cumulative magnitude of impact. The maximum area of temporary habitat loss and disturbance represents up to 1.37% of the 50km CEA screening buffer for fish and shellfish ecology during the decommissioning phase of Morven South. However, in reality, it should be noted that some Tier 1 projects extend outwith this buffer (see Figure 9.12), and as such, the total calculated footprint may be spread out over a greater area. There will also be no spatial overlap between the Morven South Boundary and the majority of the Tier 1 projects (Figure 9.12). The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low. **Tier 2** The Tier 2 assessment includes Morven South, the Tier 1 projects and the following Tier 2 projects: • MHPGC Project; • Bellrock OWF;

	Cumulative effects assessment
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
	• Bowdun OWF; • Ossian OWF Export Cable; • EGL 5. Given that these are Tier 2 projects, there were no project parameters publicly available to calculate a total area of temporary habitat loss and disturbance. It is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of temporary habitat loss and disturbance across the 50km CEA screening buffer for this impact. There will also be no spatial overlap between the Morven South Boundary and the Tier 2 projects (Figure 9.12). The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2. The cumulative effect is predicted to be of local spatial extent, long-term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low. **Tier 3** Aside from the MBAGC Project, here were no Tier 3 projects identified for this impact. The Tier 3 assessment is therefore no different to the Tier 2 assessment as there are no further details about the MBAGC Project to quantify further.
Sensitivity of receptor	For the sandeel IEF, the sensitivity of the receptor is considered to be medium. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low. Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.2.9 to 9.11.2.25 for the alone assessment and not repeated here.
Significance of effect	Overall, for the sandeel IEF, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.13.3 Underwater sound impacting fish and shellfish receptors

9.13.3.1 There is potential for cumulative impact from underwater sound to be produced as a result of piling and UXO clearance in Morven South's construction phase alongside that associated with other projects screened in for this impact.

9.13.3.2 The summary of the Whole Project assessment for this impact is presented in Table 9.41, and the CEA is presented in Table 9.42. A range of Tier 1 to 3 projects were screened into the CEA due to the potential for underwater sound to be generated during piling and UXO in their construction phases. Results of underwater sound modelling from the Tier 1 projects (wherein quantitative data were available) are presented in Table 9.41 for the construction phase of Morven South.

Table 9.40: Morven South Whole Project assessment for underwater sound impacting fish and shellfish receptors

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Construction phase		
Magnitude of impact	Scenario 1 includes the piling and UXO clearance for Morven South and the MHPGC Project during their construction phases. There are no publicly available parameters or underwater sound modelling for the MHPGC Project, although it is unlikely that this project will involve any piling. While UXO clearance may be undertaken during the site preparation for the MHPGC Project, the underwater sound levels and associated injury and disturbance ranges for fish and shellfish would be lower than those associated with piling (as per the underwater sound modelling results detailed in Section 9.11.3 for Morven South alone). Compared to piling activities, UXO clearance will consist of single, isolated events of very short duration. As detailed for Morven South alone, the use of low order disposal of UXOs (e.g. deflagration and clearance shots) where possible is expected to be a designed in measure adopted for the MHPGC Project, as it is an industry standard practice. This will reduce underwater sound levels during UXO clearance at the MHPGC Project and thereby reduce the cumulative potential for injury and disturbance to fish and shellfish receptors. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility with the soundscape returning to near baseline conditions upon completion of cumulative UXO clearance. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the Whole Project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility with the soundscape returning to near baseline conditions upon completion of cumulative UXO clearance. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.
Sensitivity of receptor	For the herring IEF, the sensitivity of the receptor is considered to be medium and is the same for both Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for both Scenario 1 and Scenario 2.	

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	Scenario 2: Morven South + MBAGC Project
	Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.3.14 to 9.11.3.60 for the alone assessment and not repeated here.	
Significance of effect	The significance of effect is the same for both Scenario 1 and Scenario 2. Overall, for the herring IEF. the magnitude of the Whole Project impact is deemed to be low, and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs. the magnitude of the Whole Project impact is deemed to be low, and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	

Table 9.41: Cumulative potential for the generation of underwater sound during scenario 4 in the construction phase of Morven South

Project	Maximum Design Scenario	Reference
Morven South	Piling: The MDS considers concurrent piling of up to 67 wind turbines (16m monopiles) four AC collector OSPs and one bridge-linked HVDV converter OSP (two six-legged jacket foundations), on either monopiles or pin pile foundations. A maximum hammer energy of 6,600kJ represents the MDS for monopiles and 4,000kJ for pin piles. There is a potential for up to 48 days total piling. UXO Clearance: The MDS considers clearance of up to 15 UXO within the site boundary, over a number of potential charge weights and over a total of 15 days.	Table 9.19
Tier 1 Projects		
Morven North	Piling: The MDS considers concurrent piling of up to 68 wind turbines (16m monopiles) four AC collector OSPs and one bridge-linked HVDV converter OSP (two six-legged jacket foundations), on either monopiles or pin pile foundations. A maximum hammer energy of 6,600kJ represents the MDS for monopiles and 4,000kJ for pin piles. There is a potential for up to 48 days total piling. UXO Clearance: The MDS considers clearance of up to 15 UXO within the site boundary, over a number of potential charge weights and over a total of 15 days.	Volume 2, Chapter 9: Fish and Shellfish Ecology
Ossian OWF (in its construction phase)	Piling: The MDS considers concurrent piling of up to 265 semi-submersible floating wind turbine foundations (with up to six anchors per foundation and one 4.5m diameter pile per anchor; 1,590 piles) and concurrent piling of OSPs (up to three large and 12 small jacket foundations), with a maximum of 216 piles. A maximum hammer energy of 3,000kJ represents the MDS for floating wind turbine foundations and 4,400kJ for OSP foundations. There is a potential for up to 530 days piling (over a piling phase of 63 months, over a period of 7 years) for floating wind turbine foundations and up to 72 days piling (over a piling phase of 72 months, over a period of 8 years) for OSP foundations.	Ossian OWFL (2024)

Project	Maximum Design Scenario	Reference
	UXO Clearance: The MDS considers clearance of up to 15 UXO within the site boundary, over a number of potential charge weights and over a total of 8 days.	
Muir Mhor OWF (in its construction phase)	Piling: The MDS considers concurrent piling of up to 67 wind turbines (with up to nine anchors per wind turbine and one pile per anchor) and concurrent piling of two Offshore Electrical Platforms (OEPs) (with a maximum of 12 piles per platform. A maximum hammer energy of 2,400kJ represents the MDS for wind turbine anchors and 3,200kJ for OEP piles. There is a potential for up to 175 days total piling, with OEP piling between May and August 2030 and wind turbine piling between 2029 and 2031. UXO Clearance: No number UXOs requiring clearance is provided in the MDS but the MDS outlines that the primary method will be low-order deflagration, with high order assessed as the realistic worst-case scenario. UXO clearance will take place from the year prior to offshore construction commencing, potentially running concurrently with the first year of offshore construction.	Muir Mhòr Offshore Wind Farm (2024)
EGL 3 and EGL 4 (in their construction phase)	No MDS for underwater sound is presented for the joint PEIR for EGL 3 and EGL 4. With regard to underwater sound changes arising from these projects, it is assumed that UXO clearance will be undertaken under a separate Marine Licence application. In the assessment for underwater sound presented in the PEIR, there was consideration of sound arising from geophysical survey equipment and vessels and other equipment; however these have been scoped out of the assessment for Morven South and have not been considered further in the CEA.	National Grid (2025b)

Table 9.42: Morven South cumulative effects assessment for underwater sound impacting fish and shellfish receptors

	Cumulative effects assessment
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
Construction phase	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North • Muir Mhor OWF; • Ossian OWF; • EGL3; • EGL4. The piling and UXO clearance parameters included in the assessments for the Tier 1 projects are detailed in Table 9.41. As detailed in Table 9.41, the PEIR for EGL 3 and EGL 4 did not include an underwater sound modelling assessment for UXO clearance and there was no piling included in the scope (National Grid, 2025b). Therefore, there is not considered to be a potential for cumulative effect associated with this Tier 1 project. For the Muir Mhor OWF and the Ossian OWF, the potential for injury and disturbance associated with underwater sound from piling and UXO clearance associated was not concluded to be significant for the fish and shellfish species assessed in their individual EIAs (Muir Mhòr Offshore Wind Farm, 2024, Ossian OWFL, 2024). Given the location of the Tier 1 projects within the North Sea, the fish and shellfish species assessed are considered to be comparable to the fish and shellfish IEFs identified for the Morven South alone assessment. The underwater sound modelling undertaken for these projects was of a similar scale to that undertaken for Morven South and Morven North, with behavioural disturbance possible out to the low tens of kilometres, with far lower ranges predicted for injury (i.e. in the hundreds of metres to low kilometres) (Muir Mhòr Offshore Wind Farm, 2024, Ossian OWFL, 2024). Overall, the cumulative effect is predicted to be of local spatial extent, medium duration (over the construction phase), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low. **Tier 2** The Tier 2 assessment includes Morven South, the Tier 1 projects, and the following Tier 2 projects: • MHPGC Project; • Bowdun OWF; • Ossian OWF Export Cable;

	Cumulative effects assessment
	• EGL5. It is possible that the construction phases of the Tier 2 projects may overlap with that of Morven South, however there are no details available in the public domain on their construction programmes. For the MHPGC Project, impacts from underwater sound were scoped in during the construction phase for UXO clearance and pre-construction site investigation surveys (EnBW, 2024), however no specific details such as number of UXOs requiring clearance are currently available. It is likely that these will be of a similar scale to Morven South and while, there is some spatial overlap, it is not expected that cumulative underwater sound produced during UXO clearance along the MHPGC corridor will result in a significant impact as discussed in Table 9.40. For the Bowdun OWF, impacts of underwater sound were scoped in during the construction phase due to piling and UXO clearance, site investigation surveys and other construction activities (Bowdun OWF Limited, 2024). No specific details are currently available regarding underwater sound-producing parameters, such as maximum piling durations, maximum hammer energies, and number of UXOs requiring clearance, however these are likely to be of a similar scale to that of Morven South, given the similar scales of development and relative proximity between Morven South and Bowdun OWF. Given the extent of the possible ranges of behavioural disturbance associated with underwater sound modelled for Morven South alone (see Section 9.11.3) and that Bowdun OWF is 44km away, it is not likely that cumulative underwater sound produced during piling and UXO clearance at the Bowdun OWF will result in significant overlapping underwater sound contours with those modelled for Morven South alone. In contrast, in the Scoping Report for the Ossian OWF Export Cable, impacts of underwater sound were only scoped in for site investigation surveys in the construction phase (Ossian OWFL, 2025). Similarly, impacts of underwater sound were scoped out of the Scoping Report for EGL 5 due to insignificant effects that were predicted for a similar project (EGL 3, which is a Tier 1) (National Grid, 2025c), therefore the potential for cumulative effects associated with these Tier 2 projects are unlikely. Overall, the cumulative effect is predicted to be of local spatial extent, medium duration (over the construction phase), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low. **Tier 3** The Tier 3 assessment includes Morven North and Morven South, the Tier 1 and 2 projects, and the Tier 3 INTOG projects (Flora and Cedar) and the MBAGC Project. It is possible that the construction phases of the Tier 3 projects may overlap with that of Morven South, however there are no details on their construction programmes currently available in the public domain. Given their distance from Morven South to the two INTOG projects (94km and 85km), it is not likely that underwater sound contours associated with the Tier 3 projects would overlap with those associated with Morven South alone (see Section 9.11.3). Overall, the cumulative effect is predicted to be of local spatial extent, medium duration (over the construction phase), intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of impact is therefore, considered to be low.

	Cumulative effects assessment
Sensitivity of receptor	For the herring IEF, the sensitivity of the receptor is considered to be medium. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low. Information used to define the sensitivity of the receptor is as provided in paragraphs 9.11.3.14 to 9.11.3.60 for the alone assessment and not repeated here.
Significance of effect	Overall, for the herring IEF, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs, the cumulative magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.13.4 Increased Suspended Sediment Concentrations and associated deposition

9.13.4.1 There is potential for increased SSCs and associated deposition as a result of Morven South's construction, O&M and decommissioning activities alongside other projects screened in for this impact. The activities include seabed preparation, installation of wind turbines and OSP foundations, and the installation and/or maintenance of inter-array cables, inter-connector cables and offshore export cables.

9.13.4.2 The summary of the Whole Project assessment for increased SSCs and associated deposition is presented in Table 9.43, and the CEA is presented in Table 9.44.

Table 9.43: Morven South Whole Project assessment for increased SSCs and associated deposition

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Construction phase		
Magnitude of impact	The construction phase of the MHPGC Project may occur simultaneously with the construction phase of Morven South and is likely to include activities which will give rise to increased SSC namely, site preparation/sandwave clearance and export cable trenching. It is noted that the OSP and interconnector installation for Morven South alone have been included within the assessment presented in Section 9.11.4, therefore these elements are not included as part of the MHPGC Project. The O&M phase of the MHPGC Project may also occur simultaneously with the construction phase of Morven South and includes cable repair and reburial events. It is noted that the interconnector cable repair and reburial activities for Morven North alone have been included within the assessment presented in Section 9.11.4. The MHPGC Project site preparation and offshore export cable installation may be undertaken in close proximity to Morven South using similar parameters and techniques to those associated with the inter-array and interconnector cable installation, although there is potential for a larger magnitude of SSCs and associated deposition due to these activities compared to the activities associated with cables for Morven South. Similarly, MHPGC Project activities may be undertaken in close proximity to clearance and foundation installation activities for Morven South. Repair and reburial activities relating to the MHPGC Project during its O&M phase may yield a combined effect of lesser magnitude, compared to its construction phase. It is noted that given the relationship of these projects site preparation and installation of infrastructure would be phased and SSC increases would not occur concurrently from all activities.	Due to the similarities between the MHPGC Project and the MBAGC Project and the potentially similar project timelines, the assessment for Scenario 2 mirrors the assessment for Scenario 1, as presented in the column to the left. However, it is noted that due to the Tier 3 status of MBAGC Project, less information for assessment is available at this time. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
	However, should multiple operations be undertaken plumes would be advected on the tide and not towards one another. In the case of export cables and inter-array or interconnector cables these plumes may interact, however these activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each installation due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.	
Sensitivity of receptor	For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium and is the same for both Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for both Scenario 1 and Scenario 2. Information to define the sensitivity of the receptor is as in paragraphs 9.11.4.8 to 9.11.4.26 for the alone assessment and not repeated here.	
Significance of effect	The significance of effect is the same for both Scenario 1 and Scenario 2. Overall, for the herring and sandeel IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
residual significance		
O&M phase		
Magnitude of impact	The O&M phase of the MHPGC Project may occur simultaneously with the O&M phase of Morven South and includes cable repair and reburial events. It is noted that the interconnector cable repair and reburial activities for Morven South have been included within the assessment presented in Section 9.11.4. There is potential for a small proportion of the MHPGC Project export cable repair and reburial activities to be undertaken in close proximity to Morven South using similar parameters and techniques to those associated with the inter-array and interconnector cable maintenance activities for Morven South. It is noted that given the relationship of these projects, it is unlikely that concurrent repair and reburial events would be scheduled and would be of lesser magnitude than the combined activities for both projects during the construction phase. Should O&M activities be undertaken concurrently, there is potential for the plumes to interact, however these activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of cumulative impact is therefore, considered to be negligible.	The assessment is assumed to be the same as Scenario 1 for this impact and phase, as discussed in the column to the left, however it is noted that due to the Tier 3 status of MBAGC Project, less information for assessment is available at this time. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude of cumulative impact is therefore, considered to be negligible.

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	Scenario 2: Morven South + MBAGC Project
Sensitivity of receptor	For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium and is the same for both Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for both Scenario 1 and Scenario 2. Information to define the sensitivity of the receptor is as in paragraphs 9.11.4.8 to 9.11.4.26 for the alone assessment and not repeated here.	
Significance of effect	The significance of effect is the same for both Scenario 1 and Scenario 2. Overall, for the herring and sandeel IEFs, the magnitude of the Whole Project impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of these IEFs (including PMF status; see Table 9.15). Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	
Decommissioning phase		
Magnitude of impact	The decommissioning phase of the MHPGC Project may occur simultaneously with the decommissioning phase of Morven South. Due to the relationship of the projects, it has been assumed that the O&M phase of the MHPGC Project will not occur during the decommissioning phase of Morven South. There is the potential for MHPGC Project decommissioning activities to include cable removal, although it is anticipated that offshore cables and any offshore cable protection may be left *in situ,* to minimise environmental impacts associated with their	The assessment is assumed to be the same as Scenario 1 for this impact and phase, as discussed in the column to the left, however it is noted that due to the Tier 3 status of MBAGC Project, less information for assessment is available at this time. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be negligible.

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
	removal. It is noted that the inter-connector cable removal activities for Morven South have been included within the assessment presented in Section 9.11.4. The removal of export cables associated with the MHPGC Project may be undertaken in close proximity to Morven South using similar parameters and techniques to those associated with the inter-array and inter-connector cable decommissioning for Morven South. Should these removal activities be undertaken concurrently at Morven South and the MHPGC Project, there is potential for a negligible amount of remobilised and redistributed material to arise. This is not expected to be greater than any concurrent decommissioning activities for Morven South alone. Should decommissioning activities be undertaken concurrently, there is potential for any associated plumes to interact, however these activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. The Whole Project impact is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be negligible.	
Sensitivity of receptor	For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium and is the same for both Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for both Scenario 1 and Scenario 2. Information to define the sensitivity of the receptor is as in paragraphs 9.11.4.8 to 9.11.4.26 for the alone assessment and not repeated here.	

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	Scenario 2: Morven South + MBAGC Project
Significance of effect	The significance of effect is the same for both Scenario 1 and Scenario 2. Overall, for the herring and sandeel IEFs, the magnitude of the Whole Project impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of these IEFs (including PMF status; see Table 9.15). Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	

Table 9.44: Morven South cumulative effects assessment for increased SSCs and associated deposition

Cumulative effects assessment	
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
Construction phase	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North • Ossian OWF • EGL 2. The O&M phase of Ossian OWF and EGL 2, in addition to Morven North may occur simultaneously with the construction phase of Morven South and includes cable repair and reburial events. The construction phase of Ossian OWF may also occur simultaneously with the construction phase of Morven South and includes activities such as site preparation/sandwave clearance, and export cable trenching, which will give rise to increased SSCs. Morven North is located directly to the northwest of Morven South, with the Morven South Boundary and Morven North Boundary positioned adjacent to each other. Therefore, construction activities for Morven North may be undertaken in close proximity to Morven South, and should they be undertaken concurrently, there is potential for plumes to interact, however these activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Ossian is located 5km from the Morven South Boundary directly to the east and northeast and is proposed for up to 265 wind turbines. Given the orientation of the tides in a predominantly north northeast to south southwest direction, there would be opportunity for the amalgamation of sediment plumes from these projects. However, due to the intermittent nature of the associated activities, the likelihood of increased SSCs is low and would not persist for a long duration. The potential intermittent cable repair and reburial activities for Eastern Green Link 2 have a low percentage chance of occurring simultaneously and in a similar location to the construction activities of Morven South, however if there is the potential for plume interaction, it would likely be of a low magnitude and short duration. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

Cumulative effects assessment	
	Tier 2 The Tier 2 assessment includes Morven South, the Tier 1 Projects and the following Tier 2 projects: • MHPGC Project; • Ossian OWF Export Cable; • EGL 3; • EGL 5. The O&M phase of Ossian OWF Export Cable, Ossian OWF, Seagreen 1 OWF and EGL 3 and 5, in addition to the MHPGC Project and Morven North may occur simultaneously with the construction phase of Morven South and includes cable repair and reburial events. The construction phase of Ossian OWF Export Cable and Ossian OWF may also occur simultaneously with the construction phase of Morven South and includes activities such as site preparation/sandwave clearance, foundation installation, and export cable trenching, which will give rise to increased SSCs. Construction or O&M activities from Ossian OWF Export Cable or EGL 3 and 5 may be undertaken in close proximity to Morven South and should they be undertaken concurrently, there is potential for the amalgamation of plumes and increased deposition. These activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low. **Tier 3** The Tier 3 Assessment includes Morven North and Morven South, the Tier 1 and 2 projects and the Tier 3 MBAGC Project. There is uncertainty in the exact location of the potential cable route for the MBAGC Project, however as per other offshore cables, there is potential for short term plume interactions during the project's construction and O&M phases, coinciding with the construction phase of Morven South. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.
Sensitivity of receptor	For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low. Information to define the sensitivity of the receptor is as in paragraphs 9.11.4.8 to 9.11.4.26 for the alone assessment and not repeated here.

Cumulative effects assessment	
Significance of effect	Overall, for the herring and sandeel IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.
O&M phase	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North • Ossian OWF; • EGL 2. The O&M phase of Ossian OWF, and EGL 2, in addition to Morven North may occur simultaneously with the O&M phase of Morven South and includes cable repair and reburial events. The construction phase of Morven North may also occur simultaneously with the O&M phase of Morven South and includes activities such as site preparation/sandwave clearance, foundation installation and export cable trenching, which will give rise to increased SSCs. The decommissioning phases of Morven North, EGL 2 and Ossian also may align with the O&M phase of Morven South and may include cable removal. The construction phases of Morven North and Ossian are the most critical to the potential increase in SSCs and associated deposition. Project activities for Morven North would be undertaken in close proximity to Morven South, and should they be undertaken concurrently, there is potential for plumes to interact, however these activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. Given that the magnitude of the O&M activities will be negligible for Morven South alone, or Morven North alone, it is not anticipated that the cumulative magnitude of Morven North construction activities during the O&M phase of Morven South will be measurably higher than for Morven South or Morven North alone.

Cumulative effects assessment	
	Ossian is located 5km from the Morven South Boundary directly to the east and northeast. Given the orientation of the tides in a predominantly north northeast to south southwest direction, there is opportunity for the amalgamation of sediment plumes from these projects. It is noted that a limited increase in SSCs may occur due to the mooring lines interacting with the seabed as part of the Ossian Project, however any plume amalgamation is anticipated to be of low SSC, and any sedimentation consisting of native material. The potential intermittent cable repair and reburial activities for EGL 2 have a low chance of occurring simultaneously and in a similar location to the O&M activities of Morven South, however if there is the potential for plume interaction, it would likely be of a low magnitude and short duration. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low. **Tier 2** The Tier 2 assessment includes Morven South, the Tier 1 Projects and the following Tier 2 projects: • MHPGC Project; • Ossian OWF Export Cable; • EGL 3; • EGL 5. The O&M phase of Ossian OWF Export Cable, Ossian OWF, and EGL 2, in addition to the MHPGC Project and Morven North may occur simultaneously with the O&M phase of Morven South and includes cable repair and reburial events. The construction phase of Morven North and the Ossian OWF Export Cable may also occur simultaneously with the O&M phase of Morven South and includes activities such as site preparation/sandwave clearance, foundation installation, and export cable trenching, which will give rise to increased SSCs. The decommissioning phases of Ossian OWF Export Cable, Morven North, and Ossian OWF also may align with the O&M phase of Morven South and may include cable and foundation removal. Activities from Ossian OWF Export Cable and EGL 3 and 5 may be undertaken in close proximity to Morven South and should they be undertaken concurrently, there is potential for the amalgamation of plumes and increased deposition. These activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

<table>
<tr><th colspan="2">Cumulative effects assessment</th></tr>
<tr><td></td><td>Tier 3
The Tier 3 Assessment includes Morven North and Morven South, the Tier 1 and 2 projects and the Tier 3 MBAGC Project.
There is uncertainty in the exact location of the potential cable route for the MBAGC Project, however as per other offshore cables, there is potential for short term plume interactions during the project's construction, O&M and decommissioning phases, coinciding with the O&M phase of Morven South.
The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.</td></tr>
<tr><td>Sensitivity of receptor</td><td>For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium.
For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low.
Information to define the sensitivity of the receptor is as in paragraphs 9.11.4.8 to 9.11.4.26 for the alone assessment and not repeated here.</td></tr>
<tr><td>Significance of effect</td><td>Overall, for the herring and sandeel IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of minor adverse significance, which is not significant in EIA terms.
Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of negligible to minor adverse significance, with the overall significance being minor adverse, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).</td></tr>
<tr><td>Further mitigation and residual significance</td><td>No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.</td></tr>
<tr><td colspan="2">Decommissioning phase</td></tr>
<tr><td>Magnitude of impact</td><td>Tier 1
The Tier 1 assessment includes Morven South and the following Tier 1 projects:
Morven North;
Ossian OWF;
EGL 2.
The O&M phase of Ossian OWF and Morven North may occur simultaneously with the decommissioning phase of Morven South and includes cable repair and reburial events. The decommissioning phase of Ossian, and Morven North may also occur simultaneously with the decommissioning phase of Morven South and includes cable and foundation removal.</td></tr>
</table>

	Cumulative effects assessment
	Project activities from Morven North would be undertaken in close proximity to Morven South and should they be undertaken concurrently, there is potential for plumes to interact, however these activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time. Ossian is located 5km from the Morven South Boundary directly to the east and northeast. Given the orientation of the tides in a predominantly north northeast to south southwest direction, there would be opportunity for the amalgamation of sediment plumes from these projects. It is noted that a limited increases in SSCs may occur due to the mooring lines interacting with the seabed as part of the Ossian Project, however any plume amalgamation is anticipated to be of low SSC, and any sedimentation consisting of native material. The magnitude of the impact is considered less than during the standalone or cumulative Morven South construction phase, as it is unlikely concurrent activities from different projects would be undertaken in the same location and anticipated that some project infrastructure may be left *in-situ*. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be negligible. **Tier 2** The Tier 2 assessment includes Morven South, the Tier 1 Projects and the following Tier 2 projects: • MHPGC Project; • Ossian OWF Export Cable; • EGL 3; • EGL 5. The O&M and decommissioning phases of Ossian OEF Export Cable, Ossian, the MHPGC Project, Morven North and EGL 2, 3 and 5 may occur simultaneously with the decommissioning phase of Morven South and includes cable repair and reburial events or cable and foundation removal. Activities from the MHPGC Project, EGL 3 and 5 and Ossian OWF Export Cable may be undertaken in close proximity to Morven South and should they be undertaken concurrently, there is potential for the amalgamation of plumes and increased deposition. These activities would be of limited spatial extent and frequency and plume interactions likely of a low magnitude and short duration. The majority of sedimentation would occur within close proximity to each activity due to the low sediment transport rates in the area. Any changes to SSC would be reversible following cessation of the activities within a few tidal cycles, with deposited material returning to equilibrium over time.

Cumulative effects assessment	
	With no construction activities to consider under this phase, the magnitude of the impact is likely to be less than during the Morven South construction or O&M phases. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be negligible. **Tier 3** The Tier 3 assessment includes Morven North and Morven South, the Tier 1 and 2 projects and the Tier 3 MBAGC Project. There is uncertainty in the exact location of the potential cable route for the MBAGC Project, however as per other offshore cables, there is potential for short term plume interactions during the project's O&M and decommissioning phases, coinciding with the decommissioning phase of Morven South. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be negligible.
Sensitivity of receptor	For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low. Information to define the sensitivity of the receptor is as in paragraphs 9.11.4.8 to 9.11.4.26 for the alone assessment and not repeated here.
Significance of effect	Overall, for the herring and sandeel IEFs, the magnitude of the Whole Project impact is deemed to be negligible and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of these IEFs (including PMF status; see Table 9.15). Overall, for all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be negligible and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of **negligible to minor adverse** significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.13.5 Long-term habitat loss

9.13.5.1 There is potential for long-term habitat loss to occur under the footprints of infrastructure associated with Morven South and other projects. This could occur throughout the construction phase of Morven South and other projects as infrastructure is installed, throughout the O&M phase, and during and post-decommissioning under any infrastructure left *in situ*.

9.13.5.2 The summary of the Whole Project assessment for long-term habitat loss is presented in Table 9.45, and the CEA is presented in Table 9.47. A range of Tier 1 to 3 projects were screened into the CEA due to the potential for impact in their own respective phases. Footprints of long-term habitat loss associated with the Tier 1 projects (wherein quantitative data were available) are presented in Table 9.46 for all phases of Morven South.

Table 9.45: Morven South Whole Project assessment for long-term habitat loss

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
All phases		
Magnitude of impact	The MDS for Morven South consists of up to 1,820,664m^2 of long-term habitat loss due to infrastructure installed in the construction phase and persisting throughout the O&M phase with 1,649,807m^2 being left *in situ* after decommissioning. At the time of writing, it was not possible to calculate the area of hard infrastructure associated with the MHPGC Project, however as per the assessment of Morven South Alone (Section 9.11.5), the footprints of long-term habitat loss associated with it will be distributed throughout its boundary and not be located in one continuous area, thereby reducing the cumulative magnitude of impact. The footprint of long-term habitat loss associated with Morven South accounts for 0.02% and 0.01% of the 50km CEA Screening Buffer for this impact, and additional areas associated with the MHPGC Project are not expected to represent additional material impact to that defined for the assessment of Morven South alone. The Whole Project impact is predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide availability of similar habitats within the Regional Fish and Shellfish Ecology Study Area.	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the Whole Project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The Whole Project impact is predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide availability of similar habitats within the Regional Fish and Shellfish Ecology Study Area.
Sensitivity of receptor	For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium and is the same for Scenario 1 and Scenario 2. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for Scenario 1 and Scenario 2. Information to define the sensitivity of the receptor is as provided in paragraphs 9.11.5.5 to 9.11.5.18 for the alone assessment and not repeated here.	

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Significance of effect	The significance of effect is the same for Scenario 1 and Scenario 2. Overall, for the herring and sandeel IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The Whole Project effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For all other fish and shellfish IEFs, the magnitude of the Whole Project impact is deemed to be low and the sensitivity of the receptor is considered to be low. The Whole Project effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	

Table 9.46: Cumulative footprint of long-term habitat loss for scenario 4 in all phases of Morven South

Project	Maximum Design Scenario	Reference
Morven South	All phases: 3,074,239m^2 of infrastructure installed in the construction phase and persisting throughout the O&M phase, with up to 1,649,807m^2 being left *in situ* post-decommissioning	Table 9.19
Tier 1 Projects		
Morven North	All phases: 2,052,797m^2 of infrastructure installed in the construction phase and persisting throughout the O&M phase, with up to 1,881,338m^2 being left *in situ* post-decommissioning	Volume 2, Chapter 10: Fish and Shellfish Ecology, of the Morven North EIA Report
Berwick Bank OWF (in its O&M and decommissioning phases)	O&M: 7,798,856m^2	SSE Renewables (2022b)
	Decommissioning: 7,562,609m^2 being left *in situ*	
Cambois Connection (in its O&M and decommissioning phases)	O&M: 1,460,000m^2	SSE Renewables (2023a), (2023b)
	Decommissioning: as a precaution, it has been assumed that all structures (1,460,000m^2) will be left *in situ* in the decommissioning phase	
Ossian OWF (in its O&M and decommissioning phases)	O&M: 20,049,422m^2 (comprised of 19,270,958m^2 of long-term habitat loss and 778,464m^2 of long-term habitat disturbance)	Ossian OWFL (2024)
	Decommissioning: 6,786,162m^2 left *in situ*	
EGL 3 (in its O&M and decommissioning phases)	O&M: 915,000m^2	National Grid (2025b)
	Decommissioning: as a precaution, it has been assumed that all structures (915,000m^2) will be left *in situ* in the decommissioning phase	
Total	**35,350,314m^2** of long-term habitat loss in the construction and O&M phases of Morven South, with up to **20,254,916m^2** persisting after the decommissioning phase due to infrastructure left *in situ*	

Table 9.47: Morven South Cumulative Effects Assessment for long-term habitat loss

Cumulative effects assessment	
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
All phases	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North; • Berwick Bank OWF and the Cambois Connection; • Ossian OWF; • EGL3. As detailed in Table 9.46, a maximum quantifiable area of up to 35,350,314m^2 of long-term habitat loss may occur in the construction phases of Morven North and Morven South and the Tier 1 projects and persist throughout the O&M phase, with up to 20,254,916m^2 post-decommissioning due to infrastructure left *in situ*. As per the assessment of Morven South Alone (Section 9.11.5), the footprint of long-term habitat loss due to infrastructure installed at these projects will be distributed throughout their respective boundaries and not be located in one continuous area, thereby reducing the cumulative magnitude of impact. These maximum areas represent up to 0.29% of the 50km CEA screening buffer for fish and shellfish ecology during the construction and O&M phase and 0.17% in the decommissioning phase of Morven South. However, in reality, it should be noted that some Tier 1 projects extend outwith this buffer (see Figure 9.12), and as such, the total calculated footprint may be spread out over a greater area. There will also be no spatial overlap between the Morven South Boundary and the majority of the Tier 1 projects (Figure 9.12). The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1and 2. The cumulative effect predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide availability of similar habitats within the 50km CEA screening buffer for this impact. **Tier 2** The Tier 2 assessment includes Morven South, the Tier 1 projects and the following Tier 2 projects: • MHPGC Project; • Bellrock OWF;

Cumulative effects assessment	
	• Bowdun OWF; • Ossian OWF Export Cable; • ELG 5. Given that these are Tier 2 projects, there were no project parameters publicly available to calculate a total area of long-term habitat loss. It is important to note that the cumulative footprint will not be one continuous area but comprised of isolated areas of long-term habitat loss across the 50km CEA screening buffer for this impact. There will also be no spatial overlap between the Morven South Boundary and the Tier 2 projects (Figure 9.12). The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2. The cumulative effect predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide availability of similar habitats within the 50km CEA screening buffer for this impact. **Tier 3** The only Tier 3 project identified for this impact was the MBAGC Project. The Tier 3 assessment is therefore no different to the Tier 2 assessment as there are no further details about the MBAGC Project to quantify further.
Sensitivity of receptor	For the herring and sandeel IEFs, the sensitivity of the receptor is considered to be medium. For all other fish and shellfish IEFs, the sensitivity of the receptor is considered to be low. Information to define the sensitivity of the receptor is as provided in paragraphs 9.11.5.5 to 9.11.5.18 for the alone assessment and not repeated here.
Significance of effect	Overall, for the herring and sandeel IEFs, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be medium. The cumulative effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. For all other fish and shellfish IEFs, the magnitude of the cumulative impact is deemed to be low and the sensitivity of the receptor is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.13.6 Colonisation of hard structures and associated fish aggregation

9.13.6.1 There is potential for hard structures associated with Morven South and other projects to be colonised by a range of marine species and act as fish aggregation devices. This could occur throughout the construction phase of Morven South and other projects as infrastructure is installed, throughout the O&M phase, and during and post-decommissioning on any infrastructure left *in situ*.

9.13.6.2 The summary of the Whole Project assessment for colonisation of hard structures and associated fish aggregation is presented in Table 9.48, and the CEA is presented in Table 9.50. A range of Tier 1 to 3 projects were screened into the CEA due to the potential for impact in their own respective phases. Footprints of hard structures that could be colonised associated with the Tier 1 projects (wherein quantitative data were available) are presented in Table 9.49.

Table 9.48: Morven South Whole Project assessment for colonisation of hard structures and associated fish aggregation

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
All phases		
Magnitude of impact	The MDS for Morven South consists of up to 3,074,239m^2 of hard structures being installed in the construction phase and persisting throughout the O&M phase with 1,649,807m^2 being left *in situ* after decommissioning. At the time of writing, it was not possible to calculate the area of hard infrastructure associated with the MHPGC Project, however as per the assessment of Morven South Alone (Section 9.11.6), the footprint of hard infrastructure installed at this project will be distributed throughout its boundary and not be located in one continuous area, thereby reducing the cumulative magnitude of impact. The footprints of hard infrastructure associated with Morven South accounts for 0.03% and 0.01% of the 50km CEA Screening Buffer for this impact, and additional areas associated with the MHPGC Project are not expected to represent additional material impact to that defined for the assessment of Morven South alone. It is likely that the hard infrastructure associated with the MHPGC Project (such as cable protection and cable crossing protection) will become colonised by a range of marine organisms. As for the assessment of Morven South Alone (Section 9.11.6), this shift in baseline conditions from soft substrate areas (muds, sands, and gravels) to hard substrate has the potential to cause beneficial effects, such as local biodiversity increases and increased abundance of reef species. The Whole Project impact is predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the Whole Project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The Whole Project impact is predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide availability of similar habitats within the Regional Fish and Shellfish Ecology Study Area.

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
	availability of similar habitats within the Regional Fish and Shellfish Ecology Study Area.	
Sensitivity of receptor	For all fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for Scenario 1 and Scenario 2. Information to define the sensitivity of the receptor is as provided in paragraphs 9.11.6.6 to 9.11.6.15 for the alone assessment and not repeated here.	
Significance of effect	The significance of effect is the same for Scenario 1 and Scenario 2. Overall, magnitude of the Whole Project is deemed to be low and the sensitivity of all fish and shellfish IEFs is considered to be low. The Whole Project effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	

Table 9.49: Cumulative footprint of artificial hard structures for scenario 4 in all phases of Morven South

Project	MDS	Reference
Morven South	All phases: 3,074,239m^2 in the construction and O&M phases with 1,554,704m^2 being left *in situ* after decommissioning	Table 9.19
Tier 1 Projects		
Morven North	All phases: 3,139,362m^2 in the construction and O&M phases with 1,881,338m^2 being left *in situ* after decommissioning	Volume 2, Chapter 9: Fish and Shellfish Ecology, of the Morven North EIA Report
Berwick Bank OWF (in its O&M and decommissioning phases)	O&M: 10,198,971m^2	SSE Renewables (2022b)
	Decommissioning: 7,493,186m^2 being left *in situ*	
Cambois Connection (in its O&M and decommissioning phases)	O&M: 1,460,000m^2	SSE Renewables (2023a), (2023b)
	Decommissioning: as a precaution, it has been assumed that all structures (1,460,000m^2) will be left *in situ* in the decommissioning phase	
Ossian OWF (in its O&M and decommissioning phases)	O&M: 19,270,958m^2	Ossian OWFL (2024)
	Decommissioning: as a precaution, it has been assumed that all structures (19,270,958m^2) will be left *in situ* in the decommissioning phase	
EGL 3 (in its O&M phase and possibly in its decommissioning phase)	O&M: 915,000m^2	National Grid (2025b)
	Decommissioning: as a precaution, it has been assumed that all structures (915,000m^2) will be left *in situ* in the decommissioning phase.	
Total	**38,058,530m^2** installed in the construction phases of the Morven Programme and the Tier 1 projects and persisting throughout their O&M phases, with **32,575,186m^2** left *in situ* after decommissioning.	

Table 9.50: Morven South Cumulative Effects Assessment for colonisation of hard structures and associated fish aggregation

	Cumulative effects assessment
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
All phases	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North; • Berwick Bank OWF and the Cambois Connection; • Ossian OWF; • EGL3. As detailed in Table 9.49, a maximum quantifiable area of up to 38,058,530m^2 of hard infrastructure will be installed in the construction phases of Morven North and Morven South and the Tier 1 projects and persist throughout the O&M phase, with 32,575,186m^2 left *in situ* after decommissioning. As per the assessment of Morven South Alone (Section 9.11.6), the footprint of hard infrastructure installed at these projects will be distributed throughout their respective boundaries and not be located in one continuous area, thereby reducing the magnitude of cumulative impact. These maximum areas represent up to 0.31% of the 50km CEA screening buffer for fish and shellfish ecology during the construction and O&M phase and 0.27% in the decommissioning phase of Morven South. However, in reality, it should be noted that some Tier 1 projects extend outwith this buffer (see Figure 9.12), and as such, the total calculated footprint may be spread out over a greater area. There will be no spatial overlap between Morven South and the majority of Tier 1 projects (see Figure 9.12). Scenario 4 is therefore not expected to represent a material additional impact to that defined for the assessment of Morven South alone or for Scenarios 1 and 2. It is likely that the hard infrastructure associated with Scenario 4 will become colonised by a range of marine organisms. As for the assessment of Morven South Alone (Section 9.11.6), this shift in baseline conditions from soft substrate areas (muds, sands, and gravels) to hard substrate has the potential to cause beneficial effects, such as local biodiversity increases and increased abundance of reef species. The cumulative effect is predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide availability of similar habitats within the 50km CEA screening buffer for this impact. **Tier 2** The Tier 2 assessment includes Morven South, the Tier 1 projects and the following Tier 2 projects: • MHPGC Project;

	Cumulative effects assessment
	Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
	• Bellrock OWF; • Bowdun OWF; • Ossian OWF Export Cable; • EGL 5. Given that these are Tier 2 projects, there were no project parameters publicly available to calculate a total area of hard structures with the potential to be colonised. However, there will also be no spatial overlap between the Morven South Boundary and the Tier 2 projects (Figure 9.12). The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2. The cumulative effect predicted to be of local spatial extent, long-term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low due to the wide availability of similar habitats within the 50km CEA screening buffer for this impact. **Tier 3** The only Tier 3 project identified for this impact was the MBAGC Project. The Tier 3 assessment is therefore no different to the Tier 2 assessment as there are no further details about the MBAGC Project to quantify further.
Sensitivity of receptor	For all fish and shellfish IEFs, the sensitivity of the receptor is considered to be low. Information to define the sensitivity of the receptor is as provided in paragraphs 9.11.6.6 to 9.11.6.15 for the alone assessment and not repeated here.
Significance of effect	Overall, magnitude of the cumulative impact is deemed to be low and the sensitivity of all fish and shellfish IEFs is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.13.7 Electromagnetic fields from subsea electrical cables

9.13.7.1 There is potential for EMFs to be produced from subsea cables in the O&M phase of Morven South alongside the other projects screened in for this impact.

9.13.7.2 The summary of the Whole Project assessment for EMF from subsea electrical cables is presented in Table 9.51, and the CEA is presented in Table 9.53. A range of Tier 1 to 3 projects were screened into the CEA due to the potential for EMFs to be produced by cables associated with them. Additional information on the subsea cables associated with the Tier 1 projects (wherein quantitative data were available) are presented in Table 9.52.

Table 9.51: Morven South Whole Project assessment for electromagnetic fields from subsea cables

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
O&M phase		
Magnitude of impact	There will be a total length of 684km of subsea electrical cables associated with Morven South, comprised of 66kV inter-array cables and 275kV HVAC inter-connector cables. These will be buried to a target depth of 1m or protected where burial is not possible (Table 9.19). Although cable lengths and voltages are not currently available for the MHPGC Project, it is likely that cables associated with it will be buried to similar depths to that of the array and inter-connector cables for Morven South with cable protection used where minimum burial depths are not possible, as per industry standard practice. As for the assessment for Morven South alone (Section 9.11.7) the strength of magnetic fields (and consequently, the induced electrical fields) decreases rapidly horizontally and vertically with distance from a cable. This reduction in magnetic field (and consequent induced electrical fields) also occurs due to cable burial, which increases the distance between the cable and fish and shellfish receptors. Although Scenario 1 involves additional electrical cables within the marine environment than those associated with Morven South alone, effects of EMFs emitted by the additional cables are highly localised to metres to tens of metres from them (see the literature summarised in Section 9.11.7). Therefore, the Whole Project impact is predicted to be of local spatial extent, long-term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the Whole Project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. Therefore, the Whole Project impact is predicted to be of local spatial extent, long-term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.
Sensitivity of receptor	For all fish and shellfish IEFs, the sensitivity of the receptor is considered to be low and is the same for Scenario 1 and Scenario 2. Information to define the sensitivity of the receptor is as provided in paragraphs 9.11.7.10 to 9.11.7.26 for the alone assessment and not repeated here.	

	Whole project assessment	
	Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Significance of effect	The significance of effect is the same for Scenario 1 and Scenario 2. Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity all fish and shellfish receptors is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).	
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect of Scenario 1 and Scenario 2 in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.	

Table 9.52: Cumulative potential sources of electromagnetic fields for scenario 4 in the operations and maintenance phase of Morven South

Project	Maximum Design Scenario	Reference
Morven South	O&M: 684km of cables	Table 9.19
Tier 1 Projects		
Morven North	O&M: 908km of cables	Volume 2, Chapter 10: Fish and Shellfish Ecology, of the Morven North EIA Report
Berwick Bank OWF (in its O&M phase)	O&M: 2,097km of inter array and export cables	SSE Renewables (2022b)
Cambois Connection (in its O&M phase)	O&M: Presence of up to four 180km long HVDC cables in a 320kV symmetrical monopole arrangement or two 180km long HVDC cables as a bipole arrangement at 525kV. Therefore, a maximum length of 720km.	SSE Renewables (2023a), (2023b)
Ossian OWF (in its O&M phase)	O&M: 1,381km of cables at the seabed and 116km of floating cables within the water column	Ossian OWFL (2024)
Seagreen 1 OWF (in its O&M phase)	O&M: 355km of cables	Seagreen Wind Energy Limited (2012)
EGL 2 (in its O&M phase)	O&M: 486km of cables (although these are not all within the Fish and Shellfish Ecology Study Area). For the separated cables, EMF modelling showed that the magnetic field resulted in a combined field strength of 404μT at the seabed, reducing to slightly above the background level at 20m from the cables. The bundled cable had significantly lower magnetic fields due to cancellation of the magnetic fields between poles. EMF from a bundles cable reduced to the background geomagnetic field strength around 5m to 10m from the cable, having only a very localised effect.	National Grid (2022)
EGL 3 (in its O&M phase)	O&M: Length of cables not provided in the PEIR for EGL3.	National Grid (2025b)

Project	Maximum Design Scenario	Reference
Total	The total length of known project cables is up to **6,631km** of subsea cables at the seabed and **116km** within the water column	

Table 9.53: Morven South Cumulative Effects Assessment for electromagnetic fields from subsea cables

	Cumulative Effects Assessment
	Scenario 4: Morven South Tier 1, Tier 2 and Tier 3 Projects
O&M phase	
Magnitude of impact	**Tier 1** The Tier 1 assessment includes Morven South and the following projects: • Morven North • Berwick Bank OWF and the Cambois Connection; • Ossian OWF; • Seagreen 1 OWF; • EGL2; • EGL3. The maximum quantifiable total length of subsea cables associated with Tier 1 was up to 6,631km on the seabed and 116km within the water column (Table 9.52). It should be noted that not all of this will be within the Regional Fish and Shellfish Ecology Study Area, as projects such as EGL 2, EGL3, and EGL4 all extend outwith this area (see Figure 9.12). Given that cable type (HVAC or HVDC), voltages, burial depths, and protection methods varied between the projects, only a maximum length of cable was quantified. EMFs from subsea cables are influenced by a variety of design and installation factors, including distance between cable and cable sheathing. As for the assessment for Morven South alone (Section 9.11.7), the strength of magnetic fields (and consequently, the induced electrical fields) decreases rapidly horizontally and vertically with distance from a cable. Although an extensive network of subsea cables was identified across the Tier 1 projects, tangible effects associated with EMF are likely to be highly localised to within metres to tens of metres from cables. For example, an EMF modelling study undertaken for the Tier 1 EGL 2 project demonstrated that EMF levels would reduce to slightly above the background levels at 20m distance from the cables (see Table 9.52). The cumulative effect is, therefore, predicted to be of local spatial extent, long-term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low. **Tier 2** The Tier 2 assessment includes Morven North and Morven South, the Tier 1 projects and the following Tier 2 projects: • Bellrock OWF;

	Cumulative Effects Assessment
	• MHPGC Project; • Bowdun OWF; • Ossian OWF Export Cable; • EGL 5. As with the Tier 1 assessment, although an extensive network of subsea cables was identified across the Tier 2 projects, tangible effects associated with EMF are likely to be highly localised to within metres to tens of metres from cables. There will also be no spatial overlap between the Morven South Boundary and the Tier 2 projects, except from the MHPGC Project (Figure 9.12). While there may be some spatial overlap with the MHPGC Project boundary, it is unlikely that this will result in a significant cumulative effect as discussed in Table 9.51. The cumulative magnitude of impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2. The cumulative effect is predicted to be of local spatial extent, long-term duration, continuous and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low. **Tier 3** The only Tier 3 project identified for this impact was the MBAGC Project. The Tier 3 assessment is therefore no different to the Tier 2 assessment as there are no further details about the MBAGC Project to quantify further.
Sensitivity of receptor	For all fish and shellfish IEFs, the sensitivity of the receptor is considered to be low. Information to define the sensitivity of the receptor is as provided in paragraphs 9.11.7.10 to 9.11.7.26 for the alone assessment and not repeated here.
Significance of effect	Overall, the magnitude of the cumulative impact is deemed to be low and the sensitivity all fish and shellfish receptors is considered to be low. The cumulative effect will, therefore, be of negligible to minor adverse significance, with the overall significance being **minor adverse**, which is not significant in EIA terms. This, precautionary, minor adverse conclusion is due to the conservation designations of many of the fish and shellfish IEFs (including PMF status; see Table 9.15).
Further mitigation and residual significance	No mitigation measures for fish and shellfish ecology are considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the designed in measures outlined in Table 9.20), is not significant in EIA terms.

9.13.8 Proposed monitoring

9.13.8.1 Site specific monitoring is not proposed because the assessment concluded that Morven South would not give rise to significant effects for fish and shellfish ecology, either alone or when considered cumulatively with other plans, projects or activities. The Applicant will, however, continue to liaise with MD-LOT, NatureScot and other key stakeholders to help identify opportunities for proportionate, evidence led regional or strategic monitoring that can improve understanding of the environmental implications of offshore wind, particularly where recognised evidence gaps exist. This may include contributing to, or participating in, relevant ongoing initiatives under the ScotMER programme (Scottish Government, 2026).

9.14 Transboundary effects

9.14.1.1 A screening of transboundary impacts has been carried out (see Volume 3, Annex 6.3: Transboundary Screening). This has identified that no likely significant transboundary effects with regard to fish and shellfish ecology would result from Morven South upon the interests of other European Economic Area (EEA) States.

9.15 Inter-related effects

9.15.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of Morven South on the same receptor. Inter-related effects are considered to be either:

- Lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of Morven South (construction, O&M and decommissioning), to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three project stages (e.g. underwater sound effects from piling, operational turbines, vessels and decommissioning); or
- Receptor-led effects: Assessment of the scope for all effects to interact, spatially and temporally, to create inter-related effects on a receptor. All effects on fish and shellfish ecology may interact to produce a different, or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects may be short-term, temporary or transient effects, or incorporate longer-term effects.

9.15.1.2 A description of the likely inter-related effects arising from Morven South on fish and shellfish ecology is provided in Volume 2, Chapter 21: Inter-related and Ecosystem Effects.

9.15.1.3 For fish and shellfish ecology, the following potential impacts have been considered within the inter-related assessment:

- temporary habitat loss and disturbance;
- underwater sound impacting fish and shellfish receptors;
- increased SSCs and associated deposition;
- long-term habitat loss;
- colonisation of hard structures and associated fish aggregation;
- EMF from subsea electrical cables.

9.15.1.4 Table 9.54 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, O&M and decommissioning of Morven South and the inter-related effects (receptor-led effects) that are predicted to arise for fish and shellfish ecology receptors.

9.15.1.5 As noted above, effects on fish and shellfish ecology also have the potential to have secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:

- marine mammals;

  - changes to prey availability as a result of impacts associated with Morven South upon fish and shellfish ecology;
- offshore ornithology;
  - changes to prey availability as a result of impacts associated with Morven South upon fish and shellfish ecology;
- commercial fisheries;
  - changes to the commercial fisheries industry as a result of impacts associated with Morven South upon fish and shellfish ecology.

Table 9.54: Summary of likely significant inter-related effects on the environment from individual effects occurring across the construction, operations and maintenance and decommissioning phases of Morven South and from multiple effects interacting across all phases (receptor-led effects)

C= Construction, O= O&M, D= Decommissioning phases

Description of impact	Phase			Likely significant inter-related effect	Significance
	C	O	D		
Morven South lifetime effects					
Temporary habitat loss and disturbance	✓	✓	✓	If calculated across the construction, O&M, and decommissioning phases, the total footprint area of temporary habitat loss and disturbance would be larger than for each individual stage. However, it should be noted that across these three phases there is potential for the same areas to be repeatedly disturbed, as the footprints of impact are localised to the various infrastructure on the seabed. Therefore, a total footprint of impact across all three phases would likely be an overestimation, with overlap in footprints across phases. Further, the seabed habitats within the Morven South Boundary that may be temporarily disturbed are widespread across the Regional Fish and Shellfish Ecology Study Area. Therefore, project lifetime effects will be proportionally small in this wider context. This conclusion is supported further by the recoverability of temporarily disturbed seabed, and the high potential for fish and shellfish receptors to return to affected areas.	Therefore, across the lifetime of Morven South, the effects of this impact are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. minor adverse throughout). Overall, no likely significant inter-related effects are anticipated across the lifetime of Morven South.
Underwater sound impacting fish and shellfish receptors	✓	×	✓	As this impact is not scoped in for the O&M phase, it is unlikely that elevated underwater sound in the construction and decommissioning phases could interact in a way to result in inter-related effects of greater significance than the assessments presented for these phases individually. This is due to the substantial gap between scoped-in sound producing activities in the construction and decommissioning phase (i.e. the 35-year O&M phase).	Overall, no likely significant inter-related effects are anticipated across the lifetime of Morven South.

Description of impact	Phase			Likely significant inter-related effect	Significance
	C	O	D		
Increased SSCs and associated deposition	✓	✓	✓	Effects from increased SSCs and associated deposition in each phase of Morven South will be short lived and intermittent. Fish and shellfish receptors that may potentially be affected by this impact in each phase are likely to have recovered in the intervening period between the induvial activities resulting in increased SSCs (such as cable installation) and between phases of development. Further, the fish and shellfish IEFs were considered to be of low sensitivity and/or high recoverability to this impact.	Therefore, across the lifetime of Morven South, the effects of this impact are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. minor adverse throughout). Overall, no likely significant inter-related effects are anticipated across the lifetime of Morven South.
Long-term habitat loss	✓	✓	✓	The construction and O&M phases were combined as the infrastructure associated with Morven South resulting in long-term habitat loss will be installed throughout the construction phase and will persist into the O&M phase. The footprints of long-term habitat loss in the construction phase will, therefore, be in the same locations as in the O&M phase. The MDS for the decommissioning phase would be for the majority of the infrastructure to be left *in situ*, and the footprints of infrastructure left *in situ* will also be in the same locations as they were in the combined construction and O&M phases. Therefore, the footprint of long-term habitat loss will not differ if considered additively across the combined construction & O&M phase and the decommissioning phase (i.e. the total area of long-term habitat loss over all three phases will not be larger than within the individual phases). Further, the seabed habitats within the Morven South Boundary are widespread across the Regional Fish and Shellfish Ecology Study Area. Therefore, project lifetime effects will be proportionally small in this wider context.	Across the lifetime of Morven South, the effects of this impact are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for each individual phase (e.g. minor adverse throughout). Overall, no likely significant inter-related effects are anticipated across the lifetime of Morven South.

Description of impact	Phase			Likely significant inter-related effect	Significance
	C	O	D		
Colonisation of hard structures and associated fish aggregation	✓	✓	✓	As above for 'long-term habitat loss'.	
EMF from subsea electrical cables	×	✓	×	This impact will only occur during the O&M phase, and will not overlap with other phases, therefore no likely significant inter-related effects are anticipated across the lifetime of the Morven South.	
Receptor led effects					
There is potential for temporal and spatial interactions between the impacts listed in paragraph 9.15.1.3 across all phases of Morven South. However, these were assigned as minor adverse significance as standalone impacts. Although potential receptor-led effects may arise, it should be noted that the individual activities will not necessarily occur simultaneously or in the same physical areas of the Morven South Boundary. For example, the activities considered in the MDS for multiple impacts associated with the construction phase may not temporally overlap (such as UXO clearance, piling, and seabed preparation). Therefore, across the phases of Morven South, receptor-led effects are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for individual impacts in isolation (e.g. minor adverse throughout). Overall, no likely significant inter-related effects are anticipated across the lifetime of Morven South.					

9.16 Summary of impacts, mitigation, Likely Significant Effects and monitoring

9.16.1.1 Information on fish and shellfish ecology within the Morven South Fish and Shellfish Ecology Study Area was collected through a detailed desktop review and the results of site specific surveys.

9.16.1.2 Table 9.55 presents a summary of the potential impacts, mitigation measures and the conclusion of likely significant effects on fish and shellfish ecology in EIA terms. Overall, it is concluded that there will be no likely significant effects arising from Morven South during the construction, O&M or decommissioning phases.

9.16.1.3 Table 9.56 presents a summary of the potential cumulative impacts, mitigation measures and the conclusion of likely significant effects on fish and shellfish ecology in EIA terms. Overall, it is concluded that there will be no likely significant cumulative effects from Morven South alongside other projects/plans.

9.16.1.4 No likely significant transboundary effects have been identified in regard to effects of Morven South.

Table 9.55: Summary of Likely Significant Effects, mitigation and monitoring

C= Construction, O= Operations and Maintenance, D= Decommissioning phases

Description of impact	Phase			Designed in measures	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional mitigation measures	Significance of residual effect	Proposed monitoring
	C	O	D							
Temporary habitat loss and disturbance	✓	✓	✓	None	Low	Sandeel IEF: medium All other IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
Underwater sound impacting fish and shellfish receptors	✓	×	✓	Use of a soft-start procedure for piling and UXO, commitment to using low order UXO clearance techniques where possible, and the implementation of and Underwater Sound Management Strategy.	Low	Herring IEF: medium for the construction phase and low for the decommissioning phase All other IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
Increased SSCs and associated deposition	✓	✓	✓	None	Low for the construction phase and negligible for the O&M and decommissioning phases	Herring and sandeel IEFs: medium All other IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
Long-term habitat loss	✓	✓	✓	None	Low	Herring and sandeel IEFs: medium	All IEFs: minor adverse	None proposed	N/a	None proposed

Description of impact	Phase			Designed in measures	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional mitigation measures	Significance of residual effect	Proposed monitoring
	C	O	D							
						All other IEFs: low				
Colonisation of hard structures and associated fish aggregation	✓	✓	✓	None	Low	All IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
EMF from subsea electrical cables	×	✓	×	Development and adherence to a Cable Plan and the use of minimum cable burial depths (0.5m).	Low	All IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed

Table 9.56: Summary of likely significant cumulative effects, mitigation and monitoring

C= Construction, O= Operations and Maintenance, D= Decommissioning phases

Description of impact	Phase			Designed in measures	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Significance of residual effect	Proposed monitoring
	C	O	D							
Temporary habitat loss and disturbance	✓	✓	✓	None	Low	Sandeel IEF: medium All other IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
Underwater sound impacting fish and shellfish receptors	✓	×	×	Use of a soft-start procedure for piling and UXO, commitment to using low order UXO clearance techniques where possible, and the implementation of and Underwater Sound Management Strategy.	Low	Herring IEF: medium All other IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
Increased SSCs and associated deposition	✓	✓	✓	None	Low for the construction phase and negligible for the O&M and decommissioning phases	Herring and sandeel IEFs: medium All other IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed

Description of impact	Phase			Designed in measures	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Significance of residual effect	Proposed monitoring
	C	O	D							
Long-term habitat loss	✓	✓	✓	None	Low	Herring and sandeel IEFs: medium All other IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
Colonisation of hard structures and associated fish aggregation	✓	✓	✓	None	Low	All IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed
EMF from subsea electrical cables	×	✓	×	Development and adherence to a Cable Plan and the use of minimum cable burial depths (0.5m).	Low	All IEFs: low	All IEFs: minor adverse	None proposed	N/a	None proposed

9.17 References

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