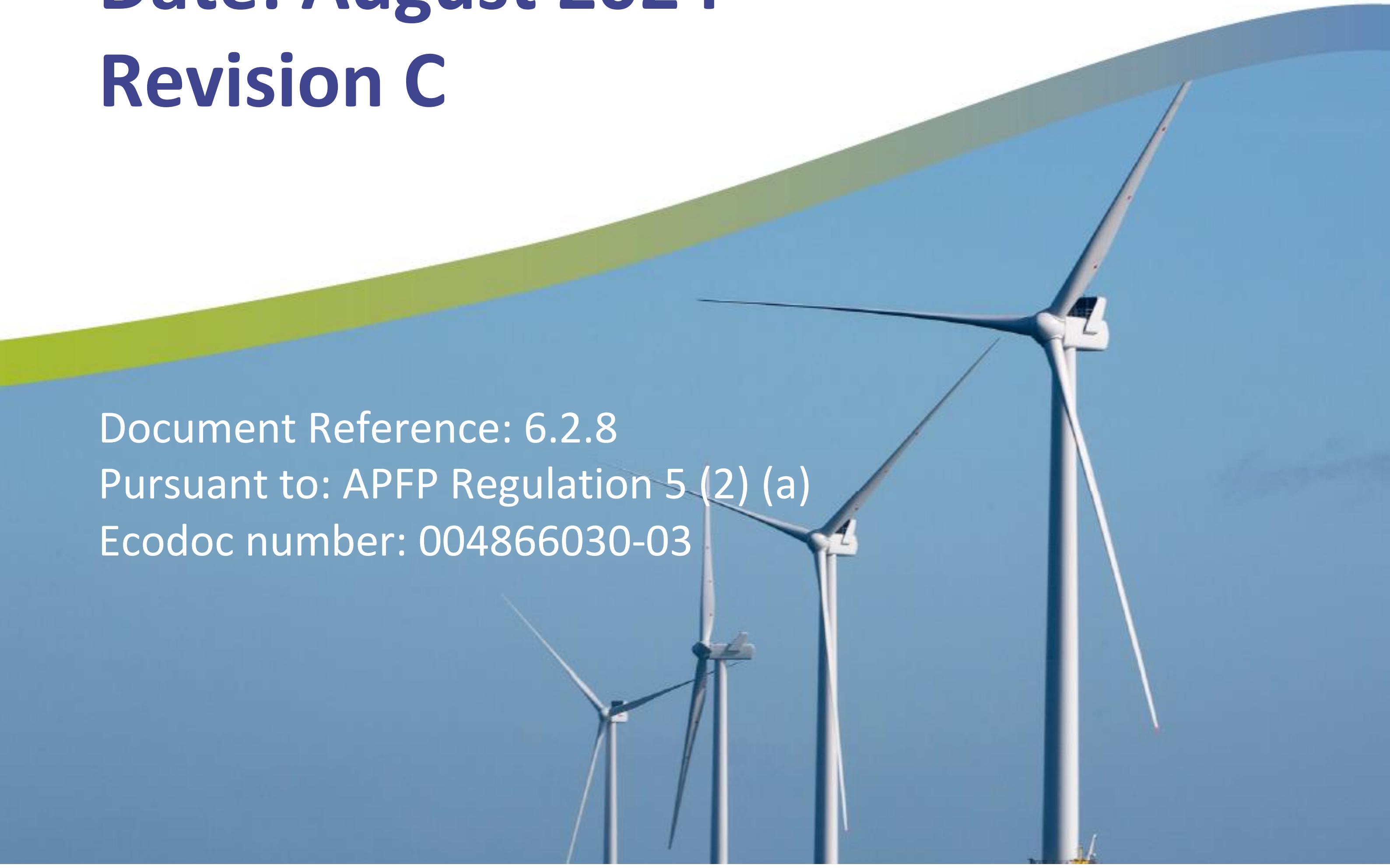
Rampion 2 Wind Farm

Category 6: Environmental Statement

Volume 2, Chapter 8: Fish and shellfish ecology (clean)

Date: August 2024

Revision C



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Executive Summary

This chapter of the Rampion 2 Environmental Statement (ES) examines the likely significant effects that may be experienced as a result of Rampion 2 on fish and shellfish ecology receptors.

A desk-based review of literature and existing datasets has been undertaken to establish a baseline (what exists in the area at the time of writing). This includes relevant historical geophysical and geotechnical data, including survey results for Rampion 1, and consultation with Expert Topic Groups (ETG). The characterisation of the baseline environment has been supported by site-specific geophysical and subtidal benthic survey data from the Study Area collected in 2020 and 2021. The geophysical survey data has provided important additional ground discrimination information and have been used to supplement several existing regional datasets on likely black seabream nesting locations in areas relevant to Rampion 2.

The fish and shellfish assemblages within the region are typical of the wider English Channel. Many species of fish and shellfish are known to either spawn or have nursery areas in relatively close proximity to or overlapping the Study Area. Notably, black seabream nesting areas are located within and adjacent to the Rampion 2 offshore export cable corridor. Various data sources and further details regarding the fish and shellfish baseline characterisation are provided in this chapter.

The assessment focuses on the construction, operational and decommissioning phases of Rampion 2, as at the Scoping stage of the Environmental Impact Assessment (EIA) it was agreed that there are likely to be impacts from activities associated with these phases on fish and shellfish ecology receptors. During the construction phase, temporary construction areas will be required for temporary construction activities associated with the array area, inter-array cables, offshore substations and export cable corridor.

The assessment concluded the potential for significant effects on black seabream from the following impacts:

- Construction phase:
  - underwater noise (the potential for recoverable injury and behavioural impacts only);
  - direct disturbance resulting from the installation of the export cable;
  - temporary increases in suspended sediment concentrations and smothering;
- Operation and maintenance phase:
  - Long-term loss of habitat and increased hard substrate and structural complexity due to the presence of turbine foundations, scour protection and cable protection; and
  - Direct disturbance resulting from maintenance within the array area and the offshore cable corridor.

The assessment also concluded the potential for significant effects on seahorse from the following impacts:

- Construction phase:
  - underwater noise (the potential for behavioural impacts only);

A range of environmental measures are embedded as part of the Rampion 2 design to remove or reduce any significant environmental effects on fish and shellfish ecology receptors, as far as possible. These include, but are not limited to, the following:

- Cable routeing design will be developed to ensure micrositing where possible to identify the shortest feasible path avoiding subtidal chalk and reef features, peat and clay exposures and areas considered to potentially support black seabream nesting;
- As part of the routeing design, a working separation distance (buffer) will be maintained wherever possible from sensitive features, notably black seabream nesting areas, as informed by the outputs of the physical processes assessment, to limit the potential for impacts to arise (direct or indirect);
- The offshore export cable routeing design will target areas of the seabed that enable maximising the potential for cables to be buried, thus providing for seabed habitat recovery in sediment areas and reducing the need for secondary protection and consequently minimising any potential for longer-term residual effects;
- Adoption of specialist offshore export cable laying and installation techniques will minimise the direct and indirect (secondary) seabed disturbance footprint to reduce impacts, which will provide mitigation of impacts to all seabed habitats, but particularly chalk and reef areas, peat and clay exposures as well as potential (unknown) black seabream nesting locations, where avoidance is not possible. The Applicant will seek to utilise the most appropriate technology available at the time of construction and operation, if required, to reduce the direct footprint impact from cutting machinery, where practicable;
- A seasonal restriction will be put in place to ensure offshore export cable corridor installation activities (including: construction and installation, preparatory works during cable installation, UXO clearance, preventive or scheduled maintenance, inspections and decommissioning) are undertaken outside the black seabream breeding period (March-July) to avoid any effects from installation works on black seabream nesting within or outside of the Kingmere MCZ. This does not apply to emergency work required to maintain the operation, safety and integrity of the infrastructure;
- Double big bubble curtains will be deployed as the minimum single offshore piling noise mitigation technology to deliver underwater noise attenuation for all foundation installations throughout the construction of the Proposed Development where percussive hammers are used in order to reduce predicted impacts to:
  - sensitive receptors at relevant Marine Conservation Zone (MCZ) sites and reduce the risk of significant residual effects on the designated features of these sites;
  - spawning herring;
  - and marine mammals.

- Commitment to no piling within the western part of the Rampion 2 offshore array closest to the Kingmere MCZ during the majority of the black seabream breeding period (March-June); and sequenced piling in the western part of the Offshore Array Area during July, in accordance with the zoning plan to be set out in the Final Sensitive Features Mitigation Plan, to reduce the risk of significant effects from installation works on breeding black seabream within or outside of the Kingmere MCZ;
- Commitment that no piling will occur in the piling exclusion zones during the seabream breeding period (March-July) which will be defined by the modelling in the Final Sensitive Features Mitigation Plan; and
- Commitment to commence piling at locations furthest from the Kingmere MCZ during the black seabream breeding period (March-July), to reduce the risk of significant effects from installation works on breeding black seabream within or outside of the Kingmere MCZ.

Following the implementation of embedded environmental measures, there are no residual significant effects predicted on all fish and shellfish receptors from the construction, operation and decommissioning of Rampion 2.

8. Fish and shellfish ecology

8.1 Introduction

8.1.1 This chapter of the Environmental Statement (ES) presents the results of the assessment of the likely significant effects of Rampion 2 with respect to fish and shellfish ecology. It should be read in conjunction with the project description provided in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference 6.2.4) and the relevant parts of the following chapters and appendices:

- **Chapter 6: Coastal processes, Volume 2** of the ES (Document Reference 6.2.6) due to the potential for changes to coastal process that could subsequently have the potential to impact fish and shellfish ecology receptors or habitats;
- **Chapter 9: Benthic subtidal and intertidal ecology, Volume 2** of the ES (Document Reference 6.2.9) due to the close association between key benthos and subtidal habitats for fish and shellfish species (e.g. key spawning grounds) there is therefore a degree of overlap between these aspects;
- **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference 6.2.10) as fish and shellfish species of commercial importance are also relevant to the assessment of fish and shellfish ecology, resulting in a degree of overlap between these aspects; and
- **Appendix 11.2: Underwater noise assessment report, Volume 4** of the ES (Document Reference 6.4.11.2) which provides details on modelled underwater noise levels arising from the Proposed Development and which has, therefore, been used to inform the fish and shellfish ecology assessment.

8.1.2 This technical chapter describes:

- the legislation, planning policy and other documentation that has informed the assessment (**Section 8.2: Relevant legislation, planning policy, and other relevant documentation**);
- the outcome of consultation and engagement that has been undertaken to date, including how matters relating to fish and shellfish ecology within the Statutory Consultation, have been addressed (**Section 8.3: Consultation and engagement**);
- the scope of the assessment for fish and shellfish ecology (**Section 8.4: Scope of the assessment**);
- the methods used for the baseline data gathering (**Section 8.5: Methodology for baseline data gathering**);
- the overall baseline (**Section 8.6: Baseline conditions**);

- embedded environmental measures relevant to fish and shellfish ecology and the relevant maximum design scenario (**Section 8.7: Basis for ES assessment**);
- the assessment methods used for the ES (**Section 8.8: Methodology for ES assessment**);
- the assessment of fish and shellfish ecology effects (**Section 8.9 – 8.11: Assessment of effects** and **Section 8.12: Assessment of cumulative effects**);
- consideration of transboundary effects (**Section 8.13: Transboundary effects**);
- inter-related effects (**Section 8.14: Inter-related effects**);
- a summary of residual effects for fish and shellfish ecology (**Section 8.15: Summary of residual effects**);
- a glossary of terms and abbreviations (**Section 8.16: Glossary of terms and abbreviations)**; and
- a references list (**Section 8.17: References)**.

8.1.3 The chapter is also supported by the following appendices:

- **Appendix 8.1 Herring annual heatmaps, Volume 4** of the ES (Document Reference 6.4.8.1);
- **Appendix 8.2 Black seabream nests, Volume 4** of the ES (Document Reference 6.4.8.2); and
- **Appendix 8.3 Underwater noise study for sea bream disturbance, Volume 4** of the ES (Document Reference 6.4.8.3)[1].

8.2 Relevant legislation, planning policy and other documentation

Introduction

8.2.1 This section identifies the legislation, policy and other documentation that has informed the assessment of effects with respect to fish and shellfish ecology. Further information on policies relevant to the Environmental Impact Assessment (EIA) and their status is provided in **Chapter 2: Policy and legislative context, Volume 2** of the ES (Document Reference 6.2.2) of this ES.

[1] **Appendix 8.3: Underwater noise study for sea bream disturbance, Volume 4** (Document Reference: 6.4.8.3) is a duplicate of the Underwater noise study for sea bream disturbance provided as **Appendix D** of the **Evidence Plan** (Document Reference: 7.21); it is provided as an Appendix to this Chapter for ease of reference.

Legislation and national planning policy

8.2.2 **Table 8-1** lists the legislation relevant to the assessment of the effects on fish and shellfish ecology receptors.

Table 8-1 Legislation relevant to fish and shellfish ecology

Legislation description	Relevance to assessment
EC Directive 92/43/EEC on Conservation of Natural Habitats and Wild Fauna and Flora, 1992 (the 'Habitats Directive')[2]	
The Habitats Directive requires Member States to take measures to maintain or restore natural habitats (listed on Annex I) and wild species (Annex II) at favourable conservation status by the designation of Special Areas of Conservation (SACs). The Conservation of Offshore Marine Habitats and Species Regulations 2017 implement the Habitats Directive in relation to marine areas where the UK has jurisdiction beyond territorial waters (broadly 12 nautical miles (nm) to 200nm). The Conservation of Habitats and Species Regulations 2017 (the Habitats Regulations) implement the Habitats Directive in relation to England and Wales as far as the limit of territorial waters (usually 12nm)	The Proposed Development could have potential effects on several Annex II and V migratory fish species, including sea lamprey (*Petromyzon marinus*) (Annex II only); Atlantic salmon (*Salmo salar*); allis shad (*Alosa alosa*); twaite shad (*Alosa fallax*). Under these regulations, these species that fall into specific categories are eligible for legal protection from activities that have the potential to damage them. The protection conferred to these fish species is accounted for within the scope of the assessment (see **Section 8.4**).
The Wildlife and Countryside Act 1981	
The Wildlife and Countryside Act 1981 protects several fish species found in the marine environment. Under the Variation of Schedule 5 (England) Order 2008. This protection means that it is an offence to intentionally or recklessly harm or disturb these species. Protection includes a prohibition of killing, injuring or taking, damage or destruction of their places of shelter, or disturbance while such animals are occupying places of shelter. The obligations of the Bern Convention on the Conservation of European Wildlife and	The Proposed Development could have potential effects on several fish species protected by The Wildlife and Countryside Act. This includes both short-snouted (*Hippocampus hippocampus*) and spiny/long-snouted (*Hippocampus guttulatus*) seahorses, and their habitats, which are fully protected out to the 12nm limit. Allis shad, twaite shad, basking shark (*Cetorhinus maximus*) and angel shark (*Squatina squatina*) are also protected. The protection conferred to these fish species is accounted for within the scope

[2] Habitats Directive as retained by the withdrawal act.

Legislation description	Relevance to assessment
Natural Habitats 1979 were transposed in UK law by means of the Wildlife and Countryside Act.	of the assessment (see **Section 8.4**) and the environmental measures embedded within the Proposed Development are detailed in **Section 8.7**.
Bern Convention on the Conservation of European Wildlife and Natural Habitats 1979	
The Bern Convention aims to ensure the conservation of wild flora and fauna species and their habitats. Particularly endangered and vulnerable species, including endangered and vulnerable migratory species. Annex II of the convention ensures special protection of Annex II species through particularly prohibiting deliberate killing, taking, disturbance, trade and possession.	The Proposed Development could have potential effects on several fish species protected by the Bern Convention. This includes Atlantic salmon, sea lamprey, twaite shad and allis shad under Annex III as protected fauna species. The short-snouted seahorse and basking shark are both protected under Annex II as strictly protected fauna species. The protection conferred to these fish species is accounted for within the scope of the assessment (see **Section 8.4**) and the environmental measures embedded within the Proposed Development is detailed in **Section 8.7**.
Marine and Coastal Access Act 2009	
The Marine and Coastal Access Act 2009 created a new type of Marine Protected Area (MPA) called a Marine Conservation Zone (MCZ), which are of national importance. MCZs are intended to protect areas that are important to conserve the diversity of rare, threatened and representative marine habitats, species, geology and geomorphology in UK waters and they, together with other types of MPAs, deliver the Government's objective for an ecologically coherent network of MPAs. As part of the MCZ process, so-called 'reference areas' will be designated, in which all extractive, depositional and/or disturbing and damaging activities are excluded.	There are two MCZs within the vicinity of the Proposed Development fish and shellfish Study Area, the Kingmere MCZ (protected feature includes black seabream (*Spondyliosoma cantharus*)) and the Selsey Bill and The Hounds MCZ (protected feature includes European native oyster (*Ostrea edulis*)). However, the proposed DCO Order Limits does not cross any MCZs.

8.2.3 **Table 8-2** lists the national planning policy relevant to the assessment of the effects on fish and shellfish ecology receptors.

Table 8-2 National planning policy relevant to fish and shellfish ecology

Policy description	Relevance to assessment
National Policy Statement for Energy (EN-1), (July 2011)	
Paragraph 5.3.3 "*Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the IPC consider thoroughly the potential effects of a proposed project.*" Paragraph 5.3.4 *"The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests."*	The potential effects of the Proposed Development have been assessed concerning international, national and local sites designated for ecological or geological features of conservation importance (see **Section 8.6**).
Paragraph 5.3.10 "*Many SSSIs are also designated as sites of international importance and will be protected accordingly. Those that are not, or those features of SSSIs not covered by an international designation, should be given a high degree of protection. All National Nature Reserves are notified as SSSIs.*" Paragraph 5.3.11 "*Where a proposed development on land within or outside an SSSI is likely to have an adverse effect on an SSSI (either individually or in combination with other developments), development consent should not normally be granted. Where an adverse effect, after mitigation, on the site's notified special interest features is likely, an exception should only be made where the benefits (including need) of the development at this site, clearly outweigh both the impacts that it is likely to have on the features of the site that make it of special scientific interest and any broader impacts on the national*	For SSSIs, where these are within European sites, the SSSI has been considered as part of that site in this environmental assessment. SSSIs within the region have been identified in **Section 8.6** and any potential impacts to features of SSSIs have been assessed in **Sections 8.9**, **8.10** and **8.11**.

Policy description	Relevance to assessment
network of SSSIs. The IPC should use requirements and/or planning".	
Paragraph 5.3.12 "*Marine Conservation Zones (MCZs) (Marine Protected Areas in Scotland), introduced under the Marine and Coastal Access Act 2009, are areas that have been designated for the purpose of conserving marine flora or fauna, marine habitats or types of marine habitat or features of geological or geomorphological interest. The protected feature or features and the conservation objectives for the MCZ are stated in the designation order for the MCZ, which provides statutory protection for these areas implemented by the MMO (see paragraph 1.2.2). As a public authority, the IPC is bound by the duties in relation to MCZs imposed by sections 125 and 126 of the Marine and Coastal Access Act 2009.*"	MCZs within the region have been identified in **Section 8.6** and any potential impacts to fish and shellfish features of the identified MCZs have been assessed in **Sections 8.9**, **8.10** and **8.11**. MCZs within the region have been identified in **Section 8.6** and any potential impacts to fish and shellfish features of the identified MCZs have been assessed in **Sections 8.9**, **8.10** and **8.11**. Although the proposed DCO Order Limits does not cross any MCZs.
National Policy Statement for renewable energy infrastructure (EN-3) (July 2011)	
Paragraph 2.6.64 *"Assessment of offshore ecology and biodiversity should be undertaken by the applicant for all stages of the lifespan of the proposed offshore wind farm and in accordance with the appropriate policy for offshore wind farm EIAs."*	The potential effects on offshore ecology and biodiversity associated with the construction, operation and maintenance and decommissioning phases of the Proposed Development have been assessed in **Section 8.9** to **8.11**.
Paragraph 2.6.65 "*Consultation on the assessment methodologies should be undertaken at early stages with the statutory consultees as appropriate.*"	Consultation with relevant statutory and non-statutory stakeholders has been carried out from the early stages of the Proposed Development. See **Section 8.3** for details on consultation in terms of fish and shellfish.
Paragraph 2.6.66 *"Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate".*	Relevant data collected as part of post-construction monitoring from the operational Rampion 1 offshore wind farm and any other offshore wind farm projects has informed the assessment of the Proposed Development (see **Section 8.9** to **8.11**).

Policy description	Relevance to assessment
Paragraph 2.6.67 *"The assessment should include the potential of the scheme to have both positive and negative effects on marine ecology and biodiversity."*	The assessment methodology includes the provision for assessment of both positive and negative effects (see **Section 8.8**).
Paragraph 2.6.72 *"Section 5.3 of EN-1 sets out the policy for the IPC in relation to generic biodiversity impacts and paragraphs 2.6.58 to 2.6.71 above set out offshore wind-specific biodiversity policy. The coastal change section at Section 5.5 of EN-1 may also be relevant. In addition, there are specific considerations which apply to the effect of offshore wind energy infrastructure proposals on fish as set out below."*	The Proposed Development assessment has considered all phases of the Proposed Development on fish and shellfish species with key life stages in the vicinity of the development (see **Section 8.9** and **Section 8.11**).
Paragraph 2.6.73 *"There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to interact with seabed sediments and therefore have the potential to impact fish communities, migration routes, spawning activities and nursery areas of particular species. In addition, there are potential noise impacts, which could affect fish during construction and decommissioning and to a lesser extent during operation."*	
Paragraph 2.6.74 "*The applicant should identify fish species that are the most likely receptors of impacts with respect to:* ***1)*** *spawning grounds;* ***2)*** *nursery grounds;* ***3)*** *feeding grounds;* ***4)*** *over-wintering areas for crustaceans; and* **5)** *migration routes.*	Particular attention has been given to impacts on fish species at key life stages such as during spawning or on known nursery habitats, and on features of protected sites (see **Section 8.6**).
Paragraph 2.6.76 "*EMF during operation may be mitigated by use of armoured cable for inter-array and export cables which should be buried at a sufficient depth. Some research has shown that where cables are buried at depths greater than 1.5m below the sea bed impacts are likely to be negligible. However sufficient*	Mitigation of EMF through cable burial and cable protection has been considered within the Proposed Development assessment (see Table 8-13).

Policy description	Relevance to assessment
depth to mitigate impacts will depend on the geology of the sea bed.."	
The Marine Policy Statement (MPS) (September 2011)	
Section 2.2 "*Living within environmental limits:* *1) Biodiversity is protected, conserved and where appropriate recovered and loss has been halted.* *2) Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems.* 3) *Our oceans support viable populations of representative, rare, vulnerable, and valued species*".	The Proposed Development embedded mitigation (as shown in **Table 8-13**) include measures designed to protect, and conserve fish and shellfish ecology features of ecological importance wherever possible.
UK Biodiversity Action Plan (BAP) Priority Species and Habitats	
The UK Biodiversity Action Plan (UK BAP) identified priority species and habitats as being the most threatened and requiring conservation action.	Environmental measures with the aim to protect and conserve UK BAP fish and shellfish species of relevance to the proposed DCO Order Limits are considered in **Section 8.7**.

8.2.4 **Table 8-3** lists the emerging national planning policy considerations relevant to the assessment of the effects on fish and shellfish receptors.

Table 8-3 Emerging national planning policy relevant to fish and shellfish

Policy description	Relevance to assessment
Draft National Policy Statement for Renewable Energy Infrastructure (EN-1), March 2023	
Paragraph 5.4.17 *"Where the development is subject to EIA the applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and*	The potential effects of the Proposed Development have been assessed concerning international, national and local sites designated for ecological or geological features of conservation importance (see **Section 8.6**).

Policy description	Relevance to assessment
other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats." Paragraph 5.4.18 *"The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the Secretary of State consider thoroughly the potential effects of a proposed project."*	
Paragraph 5.4.19 *"The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests."*	The Proposed Development embedded environmental measures (as shown in **Table 8-13**) include measures designed to protect and conserve fish and shellfish ecology features of ecological importance wherever possible.
Paragraph 5.4.20 *"Applicants should consider wider ecosystem services and benefits of natural capital when designing enhancement measures."*	
Paragraph 5.4.21 *"As set out in Section 4.6, the design process should embed opportunities for nature inclusive design. Energy infrastructure projects have the potential to deliver significant benefits and enhancements beyond Biodiversity Net Gain, which result in wider environmental gains (see Section 4.5 on Environmental and Biodiversity Net Gain). The scope of potential gains will be dependent on the type, scale, and location of each project."*	
Paragraph 5.4.22 "*The design of Energy NSIP proposals will need to consider the movement of mobile / migratory species such as birds, fish and marine and terrestrial mammals and their potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development."*	The Proposed Development assessment has considered all phases of the Proposed Development on fish and shellfish species with key life stages such as migration (see **Section 8.9** and **Section 8.11**). Potential transboundary effects have been assessed in **Section 8.13**.

Policy description	Relevance to assessment
Paragraph 5.4.23 *"Energy projects will need to ensure vessels used by the project follow existing regulations and guidelines to manage ballast water."*	Embedded environmental measures (as shown in **Table 8-13**) which include an **Outline Project Environmental Management Plan (PEMP)** (Document Reference 7.11). The Final PEMP will be developed post-consent and will incorporate a biosecurity plan which will ensure that the risk of potential introduction and spread of Marine INNS from increased vessel activity is minimised.
Paragraph 5.4.7 "*Many SSSIs are also designated as sites of international importance and will be protected accordingly. Those that are not, or those features of SSSIs not covered by an international designation, should be given a high degree of protection. Most National Nature Reserves are notified as SSSIs.* Paragraph 5.4.8 "*Development on land within or outside a SSSI, and which is likely to have an adverse effect on it (either individually or in combination with other developments), should not normally be permitted. The only exception is where the benefits (including need) of the development in the location proposed clearly outweigh both its likely impact on the features of the site that make it of special scientific interest, and any broader impacts on the national network of SSSIs.*".	For SSSIs, where these are within European sites, the SSSI has been considered as part of that site in this environmental assessment. SSSIs within the region have been identified in **Section 8.6** and any potential impacts to features of SSSIs have been assessed in **Sections 8.9**, **8.10** and **8.11**.
Paragraph 5.4.9 "*Marine Conservation Zones (MCZs) (Marine Protected Areas in Scotland), introduced under the Marine and Coastal Access Act 2009, are areas that have been designated for the purpose of conserving marine flora or fauna, marine habitats or types of marine habitat or features of geological or geomorphological interest. The protected feature or features and the conservation objectives for the MCZ are stated in the designation order for the MCZ.*"	MCZs within the region have been identified in **Section 8.6** and any potential impacts to fish and shellfish features of the identified MCZs have been assessed in **Sections 8.9**, **8.10** and **8.11**. MCZs within the region have been identified in **Section 8.6** and any potential impacts to fish and shellfish features of the identified MCZs have been assessed in **Sections 8.9**, **8.10** and **8.11**. Although the proposed DCO Order Limits does not cross any MCZs.
Draft National Policy Statement for renewable energy infrastructure (EN-3) (March 2023)	

Policy description	Relevance to assessment
Paragraph 3.8.115 *"Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for offshore wind farm EIAs, HRAs and MCZ assessments (See Sections 4.2 and 5.4 of EN-1)."*	The potential effects on offshore ecology and biodiversity associated with the construction, operation and maintenance and decommissioning phases of the Proposed Development have been assessed in **Section 8.9** to **8.11**.
Paragraph 3.8.118 "*Applicants should consult at an early stage of pre-application with relevant statutory consultees, as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken*."	Consultation with relevant statutory and non-statutory stakeholders has been carried out from the early stages of the Proposed Development. See **Section 8.3** for details on consultation in terms of fish and shellfish.
Paragraph 3.8.120 *"Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate."*	Relevant data collected as part of post-construction monitoring from the operational Rampion 1 offshore wind farm and any other offshore wind farm projects has informed the assessment of the Proposed Development (see **Section 8.9** to **8.11**).
Paragraph 3.8.117 *"Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity, as well as negative effects."*	The assessment methodology includes the provision for assessment of both positive and negative effects (see **Section 8.8**).
Paragraph 3.8.109 "*Generic biodiversity and ecology effects and receptors are covered in detail in Section 5.4 of EN-1*". Paragraph 3.8.110 *"The coastal change policy in Section 5.6 of EN-1 may also be relevant".* Paragraph 3.8.111 *"Impacts on the physical environment may have indirect effects on marine biodiversity."* *Paragraph 3.8.112 "In addition applicants should have regard to the specific ecological and biodiversity considerations*	The Proposed Development assessment has considered all phases of the Proposed Development on fish and shellfish species with key life stages in the vicinity of the development (see **Section 8.9** and **Section 8.11**).

Policy description	Relevance to assessment
that pertain to proposed offshore renewable energy infrastructure developments, namely: • *fish (see Section 2.8.129 of this NPS);* • *intertidal and subtidal seabed habitats and species (see Section 2.8.134 of this NPS);* • *marine mammals (see Section 2.8.139 of this NPS);* • *birds (see Section 2.8.149 of this NPS); and* • *wider ecosystem impacts and interactions (see Section 2.8.160 of this NPS).”*	
Paragraph 3.8.113 *“Evidence from existing offshore wind farms demonstrates that it has been possible to locate wind farms in ecologically sensitive areas where careful siting of turbines has been undertaken following appropriate ecological surveys and assessments.”*	The Proposed Development embedded environmental measures (as shown in **Table 8-13**) include measures designed to protect and conserve fish and shellfish ecology features of ecological importance wherever possible.
Paragraph 3.8.114 *“However, with increasing deployment of offshore wind to 2030 and beyond, with a likely focus on deployment of fixed offshore wind in the shallow waters of the North Sea, it is likely that the cumulative impact of multiple wind farms on the marine environment will increase impacts beyond identified thresholds for increasing numbers of species and habitats, leading to increased requirements for both mitigation and compensation for impacts to be acceptable.”*	Potential cumulative effects on fish and shellfish receptors from multiple wind farms in the marine environment have been assessed within **Section 8.12**.
Paragraph 3.8.130 “*There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to impact fish communities, migration routes, spawning activities and nursery areas of particular specie*s.” Paragraph 3.8.131 *“There are potential impacts associated with energy emissions*	The Proposed Development assessment has considered noise effects on fish and shellfish species arising from construction (piling) (see **Section 8.9)**. Noise impacts are further assessed in **Chapter 11: Marine mammals, Volume 2** of the ES (Document Reference 6.2.11) and **Appendix 11.3: Underwater noise assessment technical report, Volume 4** of the ES (Document Reference 6.4.11.3).

Policy description	Relevance to assessment
into the environment (e.g. noise or electromagnetic fields (EMF)), as well as potential interaction with seabed sediments."	
Paragraph 3.8.132 "*The applicant should identify fish species that are the most likely receptors of impacts with respect to:* ***1)*** *spawning grounds;* ***2)*** *nursery grounds;* ***3)*** *feeding grounds;* ***4)*** *over-wintering areas for crustaceans;* **5)** *migration routes; and* ***6)*** protected sites."	Particular attention has been given to impacts on fish species at key life stages such as during spawning or on known nursery habitats, and on features of protected sites (see **Section 8.6**).
Paragraph **3**.8.263 "*EMF in the water column during operation, is in the form of electric and magnetic fields, which are reduced by use of armoured cable for inter-array and export cables*." Paragraph 3.8.264 *"Burial of the cable increases the physical distance between the maximum EMF intensity and sensitive species. However, what constitutes sufficient depth to reduce impact will depend on the geology of the seabed."* *Paragraph 3.8.265 "Burial of the cable increases the physical distance between the maximum EMF intensity and sensitive species. However, what constitutes sufficient depth to reduce impact will depend on the geology of the seabed."* Paragraph 3.8.265 *"In the case of floating wind, the cables may hang freely in the water and thus potentially require alternative monitoring and mitigation.*" Paragraph 3.8.267 *"Construction of specific elements can also be timed to reduce impacts on spawning or migration. Underwater noise mitigation can also be used to prevent injury and death of fish species."*	Mitigation of EMF through cable burial and cable protection has been considered within the Proposed Development assessment (see **Table 8-13**).

Local planning policy

8.2.5 **Table 8-4** lists the local planning policy relevant to the assessment of the potential effects on fish and shellfish ecology receptors.

Table 8-4 Local planning policy relevant to fish and shellfish ecology

Policy description	Relevance to assessment
South Inshore and South Offshore Coast Marine Plan (July 2018)	
Policy Reference: S-MPA-1 "*Any impacts on the objectives of marine protected areas and the ecological coherence of the marine protected area network must be taken account of in strategic level measures and assessments, with due regard given to statutory advice on an ecologically coherent network*".	Designated nature conservation sites within the Rampion 2 fish and shellfish ecology Study Area have been described in **Section 8.6** and **Table 8-11**.
Policy Reference: S-FISH-4 "*Proposals that enhance essential fish habitat, including spawning, nursery and feeding grounds, and migratory routes should be supported. Proposals must demonstrate that they will, in order of preference: a) avoid, b) minimise, c) mitigate significant adverse impact on essential fish habitat, including, spawning, nursery, feeding grounds and migration routes*".	The Proposed Development has been through an iterative design process that has sought to avoid sensitive features wherever possible, however avoiding potential impacts on fish habitat may not be possible in all cases. Embedded environmental measures designed to protect, and conserve fish and shellfish ecology features of ecological importance are provided in **Section 8.7**.
Policy Reference: S-FISH-4-HER "*Proposals will consider herring (Clupea harengus) spawning mitigation in the area during the period 1 November to the last day of February annually*".	Consideration of herring spawning mitigation is provided in **Section 8.7**.
Sussex Biodiversity Action Plan (BAP)	
A BAP addresses threatened species and habitats, designed to protect and restore biological systems. The overall aim of the Sussex BAP is to conserve and enhance the biological diversity of Sussex and contribute to the conservation and enhancement of both national and international biodiversity. Marine fish species on the Sussex BAP comprise the undulate ray (*Raja undulata*),	Embedded environmental measures with the aim to protect and conserve all Sussex BAP fish and shellfish species of relevance to the proposed DCO Order Limits are considered in **Section 8.7**.

Policy description	Relevance to assessment
herring, plaice (*Pleuronectes platessa*), horse mackerel (*Trachurus trachurus*), mackerel (*Scomber scombrus*), Dover sole (*Solea solea*) and short-snouted seahorse. Anadromous fish species listed comprise allis shad, twaite shad, European eel (*Anguilla anguilla*), European smelt (*Osmerus eperlanus*), Atlantic salmon and sea trout (*Salmo trutta*). The European native oyster is also on the Sussex BAP.	

Other relevant information and guidance

8.2.6 A summary of other relevant information and guidance relevant to the assessment undertaken for fish and shellfish ecology is provided here:

- EIA Directive (11/92/EU) (as amended). Requires adequate characterisation of the receiving environment;
- The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. Requires a description of the relevant aspects of the current state of the environment (baseline scenario);
- The Marine Strategy Framework Directive (MSFD), adopted in July 2008, and transposed into law (The Marine Strategy Regulations 2010), has also been considered in the proposed DCO Order Limits for fish and shellfish ecology. The relevance of the MSFD to the Proposed Development is described in full in **Chapter 2: Policy and legislative context, Volume 2** of the ES (Document Reference 6.2.2). The overarching goal of the MSFD is to achieve 'Good Environmental Status' (GES) by 2020 across Europe's marine environment; and
- Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018).

8.2.7 In accordance with Cefas *et al*. (2004) guidance the assessment phase of the EIA will consider the following aspects of the fish and shellfish resource in the Study Area:

- spawning grounds;
- nursery grounds;
- feeding grounds;
- overwintering areas for crustaceans; and
- migration routes.

8.3 Consultation and engagement

Overview

8.3.1 This section describes the stakeholder engagement undertaken for Rampion 2. This consists of early engagement, the outcome of, and response to, the Scoping Opinion in relation to the fish and shellfish ecology assessment, the Evidence Plan Process (EPP), non-statutory consultation and Rampion 2's statutory consultation. An overview of engagement undertaken for Rampion 2 as a whole can be found in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference 6.2.5).

8.3.2 Given the social distancing restrictions which have been in place due to the COVID-19 pandemic, all technical consultation relating to fish and shellfish ecology has taken place online, primarily in the form of conference calls using Microsoft Teams.

Early engagement

8.3.3 Early engagement was undertaken with a number of prescribed consultation bodies in relation to fish and shellfish ecology, including Natural England (NE), the Marine Management Organisation (MMO) and Centre for Environment, Fisheries and Aquaculture Science (Cefas). This engagement was undertaken to introduce the Proposed Development and the proposed approach to scoping the EIA.

8.3.4 Rampion Extension Development Limited (RED) have engaged from the outset with NE, the MMO and Cefas who attended a consultation meeting on 18 February 2019. NE, the MMO and Cefas also attended a meeting on 6 May 2020 to discuss the methodological approach for black seabream.

Scoping Opinion

8.3.5 RED submitted a Scoping Report (RED, 2020) and request for a Scoping Opinion to the Secretary of State (administered by the Planning Inspectorate) on 2 July 2020. A Scoping Opinion was received on 11 August 2020. The Scoping Report set out the proposed fish and shellfish ecology assessment methodologies, an outline of the baseline data collected to date and proposed, and the scope of the assessment. **Table 8-5** sets out the comments received in Section 4 of the Planning Inspectorate Scoping Opinion 'Aspect based scoping tables – Offshore' and how these have been addressed in this ES. A full list of the Planning Inspectorate Scoping Opinion comments and responses is provided in **Appendix 5.2: Response to the Scoping Opinion, Volume 4** of the ES (Document Reference 6.4.5.2). Regard has also been given to other stakeholder comments that were received in relation to the Scoping Report.

Table 8-5 Planning Inspectorate Scoping Opinion responses – fish and shellfish ecology

Planning Inspectorate ID number	Scoping Opinion comment	How this is addressed in this ES
4.3.1	Although the Inspectorate notes the basis of the evidence provided to support the Applicant's proposed approach (Orpwood *et al*. (2015) and Armstrong *et al*. (2015)), the MMO and its technical advisors do not support these findings. In their view, significant uncertainties concerning electromagnetic effects remain. The Inspectorate therefore does not agree that likely significant effects upon fish receptors from operational EMF can be excluded at this stage and this matter should remain scoped into the ES.	The impacts of EMF on sensitive fish and shellfish species have been addressed in **Section 8.10** using available literature to undertake a precautionary assessment.
4.3.2	The Inspectorate agrees that, with the implementation of measures to limit any potential pollution incidents, any potential impacts on fish and shellfish are unlikely to result in significant effects and therefore further assessment is not required. However, the Inspectorate seeks assurances as to the detail of such measures that would be employed and how they would be secured and therefore considers that this detail should be presented within the ES.	This comment is acknowledged. Proposed environmental measures and how they will be secured are set out in **Section 8.7**.
4.3.3	The Inspectorate agrees on the basis of the evidence provided and the nature of the Proposed Development that direct and indirect impacts to the seabed resulting in the release of sediment contaminants during construction and decommissioning on fish and shellfish receptors can be scoped out of the ES.	This comment is acknowledged.

Planning Inspectorate ID number	Scoping Opinion comment	How this is addressed in this ES
4.3.4	**Paragraph 5.4.29** states that the proposed development may impact on less mobile species such as whelk, lobster and scallop. This stands at odds with **paragraph 5.4.44** which states "*Species present that will be subject to disturbance are likely to be mobile and can therefore move away from the construction activities*". In the absence of information such as evidence demonstrating clear agreement with relevant consultation bodies, the Inspectorate does not agree to scope this matter out. Accordingly, this should include an assessment of this matter where significant effects are likely.	The potential impact on these species is considered in **Section 8.9** to **8.12**.
4.3.5	The Inspectorate is content that there is unlikely to be significant effects from underwater noise during operation and therefore agrees that this matter can be scoped out of the fish and shellfish assessment.	This comment is acknowledged.
4.3.6	The Inspectorate does not consider there is sufficient information in the Scoping Report to support scoping out direct disturbance resulting from maintenance within the array area and the offshore export cable corridor during operation (e.g. frequency, duration and nature of such activities). Depending on the nature of the maintenance works and the species present in the area there could be a likely significant effect that should be assessed as part of the ES on the basis of the anticipated maintenance programme.	Potential impacts from direct disturbance resulting from maintenance within the array area and the offshore export cable corridor have been considered in **Section 8.10**.

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Planning Inspectorate ID number	Scoping Opinion comment	How this is addressed in this ES
4.3.7	The Inspectorate is content that there is unlikely to be significant effects from maintenance within the offshore cable corridor during operation and therefore agrees that this matter can be scoped out of the fish and shellfish assessment.	This comment is acknowledged.
4.3.8	The Inspectorate agrees that this matter can be scoped out of the ES on the basis that displacement is only expected to be short term in duration (construction phase) and of limited spatial extent as part of the wider Study Area. Relevant matters are considered as part of scope of the commercial fisheries section.	This comment is acknowledged.
4.3.9	It is noted that baseline section of the Scoping Report does not clearly identify the conservation status of the fish and shellfish species discussed. The ES should identify, value, and assess impacts on protected species and species of conservation concern, where significant effects are likely.	Species of conservation importance are identified in **Section 8.6**. Potential impacts on these species are considered in **Section 8.9** to **8.12**.
4.3.10	There are locally important populations of undulate ray in the vicinity of the Proposed Development, and as such, impacts to undulate ray nursery grounds should be assessed within the ES.	The potential impacts on elasmobranchs, including undulate ray is considered in, **Section 8.9** to **8.12**.
4.3.11	The Scoping Report does not propose any updated fish or shellfish surveys as there is intent to rely upon data collected for Rampion 1. As Rampion 1 was completed in 2018, it is considered that the fish and shellfish numbers or species may have changed during this time, and potentially as	Datasets used to inform the fish and shellfish ecology PEIR chapter are provided in **Section 8.5**. As part of the EPP, it was agreed with the fish and shellfish ETG that adequate information had been provided for the baseline characterisation, and with the exception of black seabream,

Planning Inspectorate ID number	Scoping Opinion comment	How this is addressed in this ES
	a direct result of the operation of Rampion 1. The Inspectorate does not specifically agree it is appropriate that no additional data collection is required based on the information presented in the Scoping Report. The Inspectorate considers the need for fish and shellfish surveys to be updated should be specifically considered as part of the EPP and reported in the ES. The ES should then justify the validity of the evidence base in informing a robust assessment of significant effects.	further fish and shellfish surveys were not considered necessary for the assessment. Site specific geophysical surveys were conducted across the entire proposed DCO Order Limits, which allows the consideration of likely distribution of black seabream nests, and nesting habitat potential outside the Kingmere MCZ based on seabed characteristics (**Section 8.6**, **paragraph 8.6.82** to **8.6.84**). The site-specific surveys complement long term black seabream nest distribution data collected within the export cable corridor, Kingmere MCZ and the nearfield Zone of Influence (ZOI) to inform licensing decisions for the aggregate industry, black seabream catch and release data, and regional geological data, the composite of which is described in this chapter and completes a comprehensive baseline characterisation fit for the purposes of EIA.

Post- Scoping Submissions

8.3.6 A **Fish and Shellfish Ecology Method Statement** (Appendix D, **Evidence Plan** (Document Reference 7.21)) was submitted to stakeholders on 23 December 2020, as a response to feedback provided within the Scoping Opinion, and consultee responses. The method statement set out the revised approach to characterise the baseline environment, and the scope of the assessment following stakeholder feedback. All comments on the Fish and Shellfish Method Statement as well as the benthic subtidal scope (as relevant to Black seabream nesting areas) were addressed as far as possible ahead of survey commencement.

Evidence Plan Process (EPP)

8.3.7 An EPP was instigated to provide a formal, non-legally binding, independently chaired forum to agree the scope of the EIA and Habitats Regulations Assessment (HRA), and the evidence required to support the DCO Application. The EPP commenced in January 2020 and has continued throughout the EIA helping to inform this ES.

8.3.8 For fish and shellfish ecology, detailed technical engagement has been undertaken via the EPP Coastal Processes, Water Quality, Benthic Ecology and Fish Ecology ETG Meetings. This ETG panel comprised a range of representatives, including Regulators (e.g. the MMO), Statutory Nature Conservation Bodies (SNCBs), local authorities, technical experts and interest groups. A summary of consultation undertaken between the receipt of the Scoping Opinion, and up to June 2022 is outlined in this section. Further information is provided in the **Evidence Plan** (Document Reference 7.21).

Physical Processes, Benthic Ecology and Fish Ecology ETG meeting, 17 September 2020

8.3.9 On 17 September 2020 the first Physical Processes, Benthic Ecology and Fish Ecology ETG meeting was held. Attendees were the MMO, Cefas, The Wildlife Trusts, Sussex Wildlife Trust, Sussex Inshore Fisheries and Conservation Authority (IFCA) and The Seahorse Trust. Apologies were sent by (NE).

8.3.10 The scope of the assessment relating to the Scoping Opinion was discussed, and the proposed methodology presented, including the characterisation of the baseline, the impacts identified by the Scoping Opinion, and the use of worst-case scenarios to inform the assessment. A brief discussion on the use of key datasets to inform the baseline characterisation was undertaken, and it was proposed by RED that no site-specific fish surveys were required, due to sufficient data coverage of the region. It was emphasised that geophysical surveys across the proposed DCO Order Limits will allow for a detailed assessment for Black seabream nesting outside of the Kingmere MCZ, from the seabed surface features identified from sides scan sonar (SSS) and multi-beam surveys. Addressing a key issue raised at Scoping in relation to capturing black seabream nesting outside the MCZ within areas potentially affected by the Proposed Development. The Seahorse Trust and the Environment Agency emphasised the usefulness of additional trawl surveys to inform the fish baseline characterisation.

8.3.11 The Seahorse Trust requested that data from the British Seahorse database is used to inform the baseline characterisation and confirmed that this data will be provided to RED in due course. RED provided an overview of the impacts proposed to be scoped out of the assessment. Cefas noted that an assessment is required if RED are to pursue the scoping-out of impacts from EMF. RED agreed this matter should be discussed further and suggested that initially it would be appropriate to agree the basis of the assessment, such as reaching agreement on the worst-case scenarios, including minimal cable burial depths and cable protection.

8.3.12 RED confirmed that underwater noise impacts from Unexploded Ordinance (UXO) clearance will be assessed within the fish and shellfish ecology chapter, and agreement was reached on UXO noise mitigation modelling being based on a source level reduction of circa 10dB.

ETG meeting – Catchup meeting with NE, MMO and Cefas, 21 October 2020

8.3.13 An additional 'progress meeting' ETG specific to fish and shellfish ecology was held on 21 October 2020, with NE, MMO and Cefas.

8.3.14 The proposed Study Area for fish and shellfish ecology was presented by RED, along with the methodology for the fish and shellfish ecology assessment and associated underwater noise modelling and there was a brief discussion of key datasets. NE agreed that seahorses (*Hippocampus* species) should be included within the assessments. NE queried the undertaking of drop-down video (DDV) surveys outside of the bream nesting season, identifying that as a result it was not currently comfortable to agree with any conclusions on the absence or extent of nesting black seabream based on the data presented by RED.

8.3.15 Cefas confirmed agreement that adequate information had been provided for the baseline characterisation, and that additional beam and otter trawls were not necessary.

Targeted meeting with NE, MMO and Cefas, 30 November 2020

8.3.16 The MMO agreed the sources of literature, data and publications presented were appropriate for fisheries and fish ecology for the purpose of the EIA. The MMO also agreed that no new fisheries surveys were required to inform the baseline characterisation. NE deferred to the MMO and Cefas on whether additional surveys are required. The MMO further agreed that the scoping in of effects from EMF on elasmobranch and electrosensitive species highlighted in the Scoping Opinion was appropriate.

8.3.17 NE noted that it would defer to MMO/Cefas on whether additional surveys were required to define the baseline for fish and shellfish ecology (excluding black seabream).

Physical Processes, Water Quality, Benthic Ecology and Fish Ecology ETG meeting, 24 March 2021

8.3.18 On 24 March 2021 the second Coastal Processes, Water Quality, Benthic Ecology and Fish Ecology ETG Meeting was held. With MMO, Cefas, NE (NE), EA, Sussex Wildlife trust, the wildlife trust, Sussex IFCA. Apologies were sent by East Sussex County Council.

8.3.19 The meeting presented a high-level summary of the baseline data gathered since the first ETG Meeting (17 September 2020). Discussions were held on the benthic indicative habitat model approach and on the comments received on the **Fish and Shellfish Ecology Method Statement** (see **paragraph 8.3.6**) (**Appendix D, Evidence Plan** (Document Reference 7.21))

8.3.20 In terms of the underwater noise modelling thresholds, the MMO considered the approach provided was sensible in relation to peak and single strike from piling location, which provided the MMO an appropriate indication of the likely sound levels, rather than a fixed threshold approach.

8.3.21 Cefas noted concern with the relatively limited spatial extent of aggregates data available, however noted their support in the use of the sediment habitat approach which was considered a potentially useful tool to help characterise black seabream habitat distribution in the vicinity of the proposed DCO Order Limits. Regarding the underwater noise assessment, Cefas noted for underwater noise that using different thresholds for different receptor is useful. No further agreements or disagreements were recorded at this meeting.

8.3.22 NE agreed with the precautionary approach to bream nesting, but also noted that it considered the area in and around the Kingmere MCZ as particularly important in relation to black seabream nesting with most nesting / spawning increasing closer to the MCZ itself as well as rock habitats in the vicinity of the MCZ. As such it was NE's opinion that these areas should be treated as sensitive locations and that these potential seabream nesting habitats should not be contextualised as a proportion of the extent of such habitat available in the region. RED confirmed that the Kingmere MCZ will be regarded as the most important feature in the assessment on account of its designation, and that for direct seabed disturbance, impacts to the MCZ would be avoided. NE welcomed a cable route being selected to avoid potential black seabream nesting habitat to ensure that impacts on this habitat are minimised to the extent possible.

8.3.23 Clarification was provided to The Wildlife Trusts and Sussex Wildlife Trust on comments made regarding underwater noise from piling, UXO clearance and operational noise raised in response to the submitted **Fish and Shellfish Ecology Method Statement** (**Appendix D, Evidence Plan** (Document Reference 7.21)). RED confirmed that no UXO clearance concurrent with piling will be undertaken at Rampion 2. Impacts of fishing and shipping will not be in cumulative assessment as those activities occur through the baseline.

8.3.24 Sussex IFCA provided details of the South Coast Regional Environmental Characterisation Report in relation to black seabream nest areas. Sussex IFCA stressed that site-specific fish and shellfish surveys were considered more appropriate than solely relying on desk-based studies to inform the baseline, but ultimately deferred to their statutory authority colleagues on this matter (MMO and Cefas). Agreement of no additional fish and shellfish surveys required for the Proposed Development was confirmed.

Physical Processes (Water Quality), Benthic Ecology & Fish Ecology ETG meeting, 3 November 2021

8.3.25 On 3 November 2021 the third Coastal Processes, Water Quality, Benthic Ecology and Fish Ecology ETG Meeting was held with the MMO, Cefas, NE, Environment Agency, Sussex Wildlife Trust (only a representative could attend this ETG), Zoological Society London Institute of Zoology and Sussex IFCA. Apologies were sent by the East Sussex County Council, and The Wildlife Trusts.

8.3.26 The meeting presented a selection of key issues raised by stakeholders, including Cefas, and an opportunity to discuss some of the issues raised including the addition of European seabass (*Dicentrarchus labrax*) to the underwater noise assessment. It was noted that the majority of the Section 42 comments received would be incorporated in the ES, any comments which could not be resolved at the ETG, will be discussed at targeted meetings. These include underwater noise mitigation for black seabream and the offshore export cable corridor route and its potential impacts to black seabream nests and reef features.

8.3.27 Discussions were also held with NE regarding the inclusion of seahorse data in the ES and the mapping of black seabream nests.

Targeted Meeting – Offshore Cable Corridor Issues (including black seabream nesting and reef features), 15 February 2022

8.3.28 In February 2022 a targeted meeting was undertaken with the MMO, Cefas, NE, the Environment Agency, Sussex Wildlife Trust and Sussex IFCA. Apologies were sent by The Wildlife Trusts. The aim of the meeting was to discuss offshore export cable corridor issues including black seabream nesting areas and reef features.

8.3.29 The targeted meeting detailed RED's proposed mitigation options for cable laying in the offshore export cable corridor. In preparation for the meeting a Technical Note was provided by RED, **Rampion 2 Technical Note: Cable Corridor area mitigation for sensitive feature** (**Appendix D, Evidence Plan** (Document Reference 7.21)). The paper included detailed routeing design combining survey and engineering data to avoid any direct interaction with sensitive features (for example chalk beds and areas with known or 'potential' suitability for black seabream nests) or, if this was not possible, to identify the shortest feasible path through any of these. Along with the proposed adoption of one or more of a range of different trenching methods to minimise any direct impact footprint within such seabed areas. These proposed mitigations were welcomed by the MMO, NE and Cefas. A seasonal restriction on export cable installation works was also proposed during the key breeding season for black seabream, following NE guidance. The MMO, NE and Cefas welcomed the seasonal restriction for black seabream, and formal agreement was noted.

8.3.30 NE raised concerns around recoverability of reef features and noted that where impacts would arise on such features, recoverability (or non-recoverability) should be appropriately presented in the assessment. NE also raised concerns with the proposed use of floatation pits for export cable installation close to shore. RED were able to confirm at the meeting on the 15 February that these would no longer be included in the Application. As an alternative measure to address the issues with shallow water and complex seabed that affects the cable vessel operations, RED committed to using rock filter bags (or similar) for seabed preparation purposes (noting that these will be removed after cable installation works have completed).

Targeted Meeting – Underwater Noise Mitigation, 24 February 2022

8.3.31 In February 2022 a targeted meeting was undertaken with the MMO, Cefas, NE, the Environment Agency, Sussex Wildlife Trust and Sussex IFCA. Apologies were sent by The Wildlife Trusts. The aim of the meeting was to discuss approaches to noise mitigation for black seabream.

8.3.32 The targeted meeting detailed RED's proposed mitigation options for underwater noise to enable construction activities to be undertaken through the year. The meeting discussed issues raised by stakeholders following review of the technical note submitted to stakeholders; **Rampion 2 Technical Note: Underwater noise mitigation for sensitive feature** (**Appendix D, Evidence Plan** (Document Reference 7.21)). Cefas suggested a more conservative approach should be taken by RED in relation to underwater noise and supported proposed mitigation across the entire site rather than zoning to address uncertainty. A recommendation was also made to make the proposed mitigation clearer in the Technical Note. In response RED provided a document containing additional modelling to stakeholders following the meeting **Rampion 2 Technical Note: Additional underwater noise modelling** (**Appendix D, Evidence Plan** (Document Reference 7.21)).

8.3.33 The Sussex Wildlife Trust requested the most precautionary approach should be taken where possible.

8.3.34 The Sussex IFCA noted that the movement of black seabream and the migration in should be considered. Particularly, vulnerable periods of migration inshore and the disturbance of those areas.

Advice note from Natural England, 20 May 2022

8.3.35 An advice note was submitted to RED from Natural England on 20 May 2022, providing advice on the two technical notes provided by RED for review; **Rampion 2 Technical Note: Underwater noise mitigation for sensitive features**, and **Rampion 2 Technical Note: Additional underwater noise modelling** (**Appendix D**, **Evidence Plan** (Document Reference 7.21)). In summary, Natural England expressed their concerns about the potential disturbance of breeding black seabream from underwater noise from the piling of the turbine foundations, in the absence of mitigation. Natural England expressed their view that a piling restriction during the entirety of the breeding season is the only approach that provides certainty that black seabream will not be subject to behavioural disturbance, and that the conservation objectives of the Kingmere MCZ are not hindered. Natural England also raised concerns about the behavioural noise thresholds for breeding black seabream as proposed by RED. Natural England confirmed that with the absence of a reliable behavioural disturbance threshold, they cannot comment on the suitability of any proposed mitigation measures, and therefore do not wish to advise RED to undertake additional work in this area, if ultimately there is not a suitable threshold.

8.3.36 Natural England also expressed their support for a commitment to adhere ‘to a seasonal restriction to ensure cable installation activities within the export cable area are undertaken outside the black seabream breeding period (March-July)’. Natural England however expressed that consideration needs to be given to the recoverability of suitable breeding habitats after the works. Natural England also recognised RED’s intention to microsite around known nesting sites to avoid direct impacts to these but stated that indirect impacts such as increased sediment deposition in nesting areas, which has the potential to persist after the works will also need to be considered. Natural England requested illustrative sediment plume modelling in relation to known nesting sites and also Kingmere MCZ, to understand the impacts on potential bream nesting areas. Natural England stated that in the event that known bream nesting areas cannot be avoided, then consideration would need to be given to whether rock directly impacted by trenching could recover to suitable nesting habitat.

8.3.37 Furthermore, in relation to the mapping of black bream nesting sites using historic desk studies and recent aggregates survey data, and geophysical survey data from Rampion 2, Natural England stated that the timings and spatial limitation of these surveys will need to be clearly recognised as a limitation to their use in identifying nesting sites within the ES. Natural England therefore confirmed that opportunities to enhance this data with suitably timed pre-construction surveys should be explored, whilst recognising this would not account for interannual variation.

8.3.38 Lastly Natural England expressed their support for the adoption of cable installation methodologies that minimise the footprint of impact and the amount of SSC/deposition. They stated however that consideration should be given in the first instance to the methodology available at the time of construction that minimises this as far as possible.

Targeted Meeting – Underwater Noise Black Seabream Survey Queries Meeting, 12 September 2022

8.3.39 On 12 September 2022 a targeted meeting was held with NE, the MMO, Sussex IFCA, and Cefas. The focus of the meeting was to discuss the establishment of a black seabream threshold and response upon which to inform mitigation. A dedicated survey of ambient noise levels was undertaken to provide contemporary data on noise levels at the Kingmere MCZ site and within surrounding areas whereby much of the black seabream nesting activity is focused. The purpose of the survey was to provide empirical data to establish the background noise levels to which resident seabream are already exposed within the relevant spawning season period, and therefore define a baseline for any new noise (such as from impact piling). The results of the survey and an assessment of the results are presented in **Appendix 8.3: Underwater noise study for black seabream disturbance, Volume 4** of the ES (Document Reference 6.4.8.3). The report was discussed at the focused meeting, with a more precautionary disturbance threshold put forward by RED than had previously been discussed, upon which to benchmark mitigation options (141dB SEL_{ss}). The MMO (as advised by Cefas) confirmed that it was comfortable with the use of this noise level to inform the impact assessment but advised that discussions with NE would be required regarding mitigation.

Advice note from Natural England, 2 November 2022

8.3.40 An advice note was submitted to RED from Natural England on 2 November 2022, providing advice on a technical note provided by RED for review; **Appendix 8.3: Underwater noise study for black bream disturbance, Volume 4** of the ES (Document Reference 6.4.8.3). Within this note Natural England expressed their concerns over the impacts from underwater noise from percussive piling of turbine foundations in the array area on breeding black seabream. Natural England welcomed the additional information provided in the technical note, but maintained their position that there is insufficient evidence to substantiate the proposed thresholds for behavioural disturbance to wild black seabream whilst in their reproductive phase. Specifically, Natural England stated that whilst the suggested thresholds for behavioural disturbance of proxy species represented physical similarity, they do not represent the reproductive behaviours which define the black seabream. Natural England also welcomed the collection of site-specific background noise evidence but stated that the dataset provided is severely limited, hindering its usefulness in establishing a baseline against which impacts can be assessed. Natural England confirmed that a piling restriction during the entirety of the breeding season is the only approach that provides sufficient certainty that long term exposure to underwater piling will not cause significant behavioural disturbance or physiological effects, and that the conservation objectives of the Kingmere MCZ will not be hindered.

Targeted meeting - Underwater Noise and Impacts on Fish Receptors, 30 March 2023

8.3.41 On 30 March 2023 a targeted meeting was held with NE, the MMO, Sussex IFCA, and Cefas. Prior to the meeting **The Rampion 2 Piling Noise and Black Bream Further Information and Response Paper** (**Appendix D, Evidence Plan** (Document Reference 7.21)) was distributed to attendees, responding to key points made in targeted meeting held on 12 September 2022, and any subsequent written feedback received. In addition, the report also provided further information on mitigation technique efficacy drawn from the Kaskasi II project monitoring in German waters. The key focus of the meeting was to discuss potential offshore piling mitigations and restrictions, to ensure there will be no significant effect arising on fish receptors (specifically black bream) from offshore piling activities associated with the construction of Rampion 2. A zoning exercise was proposed to be undertaken to recognise a spatial aspect (i.e. where piling works can be undertaken) to a mitigation plan in relation to the March-July black bream nesting period. RED stressed the importance of July during the construction period, due to reliable weather conditions, and proposed a zoned approach to mitigation whereby no piling on western site closest to the Kingmere MCZ from April-June inclusively is undertaken, and then a combination of spatial zoning and noise abatement techniques to be able to work on the eastern site during the sensitive period. Natural England stated that an agreement has not been made on the 141dB threshold, RED reiterated that when discussing the 141dB threshold, this is a stress response and using this as a target is worst-case scenario. RED confirmed that feedback will be taken from the meeting, and progress additional modelling, a zonation plan, and a temporal plan for Rampion 2, which will be presented prior to examination for discussion.

Non-statutory consultation

Overview

8.3.42 Non-statutory consultation captures all consultation and engagement outside of statutory consultation and has been ongoing with a number of prescribed and non-prescribed consultation bodies and local authorities in relation to fish and shellfish ecology. A summary of the non-statutory consultation undertaken since completion of the Rampion 2 Scoping Report (RED, 2020) is outlined in this section.

Non-statutory Consultation Exercise – January / February 2021

8.3.43 RED carried out a non-statutory consultation exercise for a period of four weeks from 14 January 2021 to 11 February 2021. This non-statutory consultation exercise aimed to engage with a range of stakeholders including the prescribed and non-prescribed consultation bodies, local authorities, Parish Councils and general public with a view to introducing the Proposed Development and seeking early feedback on the emerging designs.

8.3.44 The key themes emerging from the non-statutory consultation exercise in January 2021 relating to fish and shellfish ecology were:

- Concerns about the impacts to the local fishing industry from the installation of wind turbine generators (WTGs);
- Concerns about the effects of construction to the fish population and subsequent impacts on the fishing industry; and
- Suggestions to consider how we can minimise impacts to the fishing industry and shipping lane regarding the installation of the Offshore Export Cable Corridor.

8.3.45 Further detail about the results of the non-statutory consultation can be found in the **Consultation Report** (Document Reference 5.1).

Statutory consultation

8.3.46 Rampion 2's first Statutory Consultation exercise ran from 14 July to 16 September 2021, a period of nine weeks. The PEIR (RED, 2021) was published as part of Rampion 2's first statutory consultation exercise which provided preliminary information on shipping and navigation within Chapter 8: Fish and shellfish ecology (RED, 2021).

8.3.47 Following feedback to the Statutory Consultation exercise in 2021 it was identified that some coastal residents did not receive consultation leaflets as intended. Therefore, the first Statutory Consultation exercise was reopened between 7 February 2022 to 11 April 2022 for a further nine weeks. The original PEIR published as part of the first Statutory Consultation exercise in 2021 was unchanged and re-provided alongside the reopened Statutory Consultation exercise in early 2022.

8.3.48 The following statutory consultation exercises focussed on changes made to the onshore substation and cable route and did not consider offshore aspects of the Proposed Development.

8.3.49 The second Statutory Consultation exercise was undertaken from 18 October 2022 to 29 November 2022. This was a targeted consultation which focused on updates to the onshore cable route proposals which were being considered following feedback from consultation and further engineering and environmental works. As part of this second Statutory Consultation exercise, RED sought feedback on the potential changes to the onshore cable route proposals to inform the onshore design taken forward to DCO application.

8.3.50 The third Statutory Consultation exercise was undertaken from 24 February 2023 to 27 March 2023. This was a targeted consultation which focused on a further single onshore cable route alternative being considered following feedback from consultation and further engineering and environmental works. As part of this third Statutory Consultation exercise, RED sought feedback on the potential changes to the onshore cable route proposals to inform the onshore design taken forward to DCO Application.

8.3.51 The fourth Statutory Consultation exercise was undertaken from 28 April 2023 to 30 May 2023. This was a targeted consultation which focused on the proposed extension works to the existing National Grid Bolney substation to facilitate the connection of the Rampion 2 onshore cable route into the national grid electricity infrastructure. As part of this fourth Statutory Consultation exercise, RED sought feedback on the proposed substation extension works to inform the onshore design taken forward to the DCO Application.

8.1.1 **Table 8-6** provides a summary of the key themes of the feedback received in relation to fish and shellfish ecology and outlines how the feedback has been considered in this ES chapter. A full list of all comments received during the statutory consultation period and the responses to those comments are provided in the **Consultation Report** (Document Reference 5.1).

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Table 8-6 Statutory consultation feedback

Stakeholder	Comment ID	Theme	How this is addressed in this ES
NE	253/282	**Design Process.** Given that the cable channel chosen runs across known black seabream nesting habitat, it must be clearly demonstrated how Rampion has sought to avoid impacts via the design process to date. Have alternative cable routes been considered to minimise the impact on nesting black seabream?	To avoid impacting known sensitive features and identify the shortest feasible path, alternate cable routing to microsite around sensitive features will be undertaken (**Table 8-13**). This has involved detailed design work, using geodata and cable engineering expertise. Different trenching methods are also being considered (see **Rampion 2 Technical Note: Cable Corridor area mitigation for sensitive features** (**Evidence Plan** (Document Reference 7.21)).
	259/260/261/264/266	**Data collection** Concerns raised regarding the timing of site-specific surveys, which were undertaken outside of the optimum black seabream nesting period and reliance on old data Coull *et al.* (1998) and Ellis *et al.* (2010, 2012).	Black seabream nesting can occur in March to July (**paragraph 8.6.83**). The limitations and uncertainties of using these sources are addressed in **Section 8.5**. The baseline characterisation data has been agreed through the evidence plan process, in light of the proposed mitigations (**paragraph 8.3.16**).
	275/318	**Baseline data** NE request evidence that all salmon and sea trout swim in from the west/from the Atlantic. NE request values and figures to illustrate predicted plumes.	Current existing evidence supporting the predominant migratory paths of these species is provided within **paragraph 8.6.72**. **Table 8-12** presents the maximum design scenario associated with increases in suspended sediment concentrations

Stakeholder	Comment ID	Theme	How this is addressed in this ES
			(SSC) and deposition. For detailed information on sediment plumes see **Chapter 6: Coastal processes, Volume 2** of the ES (Document Reference 6.2.6).
	38/39/251/254/ 258/ 276/278/279/280/281/ 310/ 347	**Black seabream baseline data** Concerns that the assessment relies upon spatially discrete data and large data gaps exist. NE request further data on black seabream nesting habitats is collected to adequately characterise the Study Area for black seabream. NE request that potential and existing black seabream nesting habitats are clearly mapped.	RED has used the best available data to provide a representative characterisation of the receiving environment (**Table 8-10**). The combination of site-specific surveys, and published literature has allowed the characterising species to be noted. The site-specific survey data has included additional data presented in **paragraph 8.5.6**. Limitations of the data set are discussed within **paragraph 8.5.7** to **8.5.14**. Recognising the concerns around the potential for under-representation of bream nesting activity in the wider area, RED has made use of all existing information, including 20 years of regional data, as depicted in **Figures 8.14a** (Document Reference 6.3.8) **and 8.14b, Volume 3** (Document Reference 6.3.8), which illustrate the survey boxes showing the black seabream survey extents, and the historic and potential nesting areas. Site specific geophysical surveys have also been undertaken, informing the potential locations of nesting areas. Additionally, a precautionary assessment has been

Stakeholder	Comment ID	Theme	How this is addressed in this ES
			undertaken which assumes black seabream nests to be present. It should also be noted that cable routing has been undertaken to microsite the export cable corridor around sensitive features such as black seabream nesting areas, with a focus to route the cable through areas of deeper sediment and areas that have shown a lack of long-term changes to the seabed.
	249	**Noise modelling.** The worst-case scenario has not always been applied correctly in relation to the baseline data. It is unclear if the Applicant is planning on simultaneous piling. If this is the case, then it needs to be considered in all of the models undertaken.	Revised noise modelling has been undertaken to assess the worst-case scenario, which has been applied to the assessment throughout **Section 8.9**. RED confirm that simultaneous piling is being considered, and the worst-case scenario in relation to this has been assessed in **Section 8.9**. Details of underwater noise modelling are presented in **Appendix 11.3: Underwater noise assessment technical report Volume 4** of the ES (Document Reference 6.4.11.3).
	251/ 282/ 308/ 319/ 326	**Impacts to black seabream** Concerns raised regarding the impacts to black seabream nesting habitats outside of the MCZ. In	Impacts to black seabream arising from all of the noted sources (underwater noise, suspended sediment, direct disturbance,

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Stakeholder	Comment ID	Theme	How this is addressed in this ES
		relation to black seabream some of the key issues relate to the assessment of underwater noise, suspended sediment, direct disturbance, and long-term loss of nesting sites. NE disagree with the conclusion that the magnitude of disturbance would be moderate.	and long-term loss of habitat) are assessed in **Sections 8.9, 8.10, and 8.11**. Embedded mitigation to reduce the magnitude of impacts from underwater noise, suspended sediment, direct disturbance and habitat loss have been detailed in **Table 8-13**.
	311/ 327	**Black seabream mitigation** NE request further evidence on the success of reinstated chalk bedrock as a feasible mitigation measure. We are yet to see sufficient monitoring in relation to the floatation pits for Rampion 1. NE cannot agree that there is a high likelihood of successfully reducing the significant of impact to no significant levels at this stage.	Floatation pits will no longer be considered. Alternate measures have been proposed to eliminate the need for floatation pits (**paragraph 8.3.30**). Targeted meetings that discussed proposed mitigation options are detailed in **paragraph 8.3.39** et seq. Different trenching methods have been considered to minimise the footprint and identify the shortest feasible path through the chalk beds and presumed black seabream nests.
	40/251/ 257/ 274/ 314	**Impacts to Hippocampus species** Concern for underwater noise and suspended/deposited sediment impacts. Sensitivities to habitat structure changes, removal of substratum, visual disturbance and deoxygenation should be considered. The assessment should consider impacts to the species outside of designated sites. Additionally, seahorse species should be included here as a largely benthic species with slow swimming speeds, high conservation value and recorded presence within the locality.	Potential impacts from underwater noise, SSC and deposition, changes to habitats and direct disturbance of seahorses have been assessed within **Sections 8.9, 8.10** and **8.11** with sensitivities and magnitudes updated as appropriate. In addition, RED have provided mitigation options in the ‘'Rampion 2 Technical Note: Underwater noise mitigation for sensitive feature'' which highlights the use of primary

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Stakeholder	Comment ID	Theme	How this is addressed in this ES
			and secondary mitigation, to reduce or avoid the effects on seahorse.
	41/251/ 325	**Impacts to Herring (*Clupea harengus*)** Concerns about the impacts from suspended/deposit sediment and from underwater noise on herring the proximity of the spawning area to the southeast of the array.	Herring have been considered throughout the assessment in **Sections 8.9, 8.10** and **8.11** with the sensitivities and magnitudes of impact updated as appropriate. A Technical Note provided by RED, ''Rampion 2 Technical Note: Underwater noise mitigation for sensitive feature'' noted the use of primary and secondary mitigation, to reduce or avoid the effects of underwater noise impacts on herring, based on underwater noise modelling to determine the worst-case ranges for potential impact on spawning herring.
	332	**EMF Impacts** NE request studies of EMF effects relevant to sparid fish to assess sensitivity.	The assessment has been updated based on the most recent available information as presented in **Section 8.10.**
	263/271/272/273	**Assessment Impacts** NE recommend species, Atlantic salmon, sea lamprey and European native oyster to be included in the assessment. NE recommend an assessment of increased SSC and deposition impact on sandeel.	All recommended species have been included in the assessments throughout **Sections 8.9** to **8.10**. Sandeel have been considered throughout **Sections 8.9, 8.10** and **8.11** and additional data from JNCC (2021) has been added to support the statement made in **paragraph 8.6.28.**

Stakeholder	Comment ID	Theme	How this is addressed in this ES
	335-336	**Decommissioning** If cable protection is left in situ in relation to black seabream this has the potential to make any nesting habitat loss permanent. Potential for suspended sediment is highly dependent on the final scope of the decommissioning works. The worst case for suspended sediment should be considered here.	RED notes that the approach to decommissioning will be detailed in the Decommissioning Plan as detailed within **paragraph 8.11.14**. Furthermore, potential impacts from the decommissioning of Rampion 2 have been assessed in **Section 8.11**.
	345	**Transboundary Impacts** NE note Downs herring spawning is likely to have transboundary effects.	Transboundary effects, including consideration of the Downs herring spawning stock within **Section 8.13**.
	346	**Inter-related effects** Concerns raised regarding potential impacts from inter-related effects on nesting black seabream from directed disturbance, SSC and sediment deposition, and underwater noise.	RED confirms that all Proposed Development lifetime effects are assessed in **Chapter 30: Inter-related effects, Volume 2** of the ES (Document Reference 6.2.30).
MMO/Cefas	66/68	**Receptors requiring assessment** MMO requested that native oyster and blue mussel be included as a receptor for the fish and shellfish ecology assessment and cuttlefish as a species of commercial importance in the assessment. Direct and indirect seabed disturbance leading to the release of sediment contaminants as an impact on demersal spawners should extend to include filter feeding species.	Native oyster, blue mussel and cuttlefish have been included as receptors in **Table 8-7**. Impacts from direct and indirect disturbances leading to the release of sediment contaminants on King Scallop, Blue Mussel and Native Oyster have been considered in **Sections 8.9** and **8.11.**

Stakeholder	Comment ID	Theme	How this is addressed in this ES
	76/88	**Underwater noise assessment.** MMO recommend seabass should be included in the underwater noise assessment. MMO state if sandeel are to be included in the assessment, when other fish species with spawning grounds in the area have not been included e.g. sole, cod, lemon sole, then this should be justified by also highlighting their benthic spawning nature and close affiliation with the seabed.	Seabass have been considered within the assessment (**Sections 8.9** to **8.11**) as well as 'other fish receptors' including species such as cod, lemon sole, sprat and whiting. Sandeel are considered separately within the assessment due to their demersal spawning behaviours and close affiliation to the seabed.
		Modelling thresholds. Concerns were raised regarding the appropriateness of McCauley *et al* . (2000) for use in the assessment of behavioural impacts of underwater noise on fish during topic group meetings in 2020. It was noted that RED has committed to undertake a qualitative assessment of behavioural effects on fish in line with that described in Popper *et al* . (2014), where quantification is not possible. The MMO notes that the McCauley *et al* . (2000) threshold has been included in the modelling for the PEIR. However, in addition, the Hawkins *et al*. (2014) threshold has also been used in the modelling, which the MMO supports.	RED noted that whilst following stakeholder discussions there remained disagreements on a definitive disturbance threshold specifically for black seabream, a threshold of 141dB re 1μPa SELss as defined by Kastelein et al. (2017) has been used and potential behavioural impacts on black seabream from underwater noise have been assessed on this basis in **Sections 8.9** and **8.11**. Where a quantifiable assessment was not possible, a qualitative assessment of behavioural effects on fish and shellfish receptors has been undertaken.
	82/83	**Data Limitations.** MMO note the importance of recognising the limitations of data from site specific geophysical survey to supplement existing data on black seabream nesting locations and other limitations such as the age of data, seasonal variations in	Data limitations of the geophysical survey are presented in **Section 8.5**.

Stakeholder	Comment ID	Theme	How this is addressed in this ES
		species presence or abundance, and fishing methods used to collect data.	
	89/92/93	**Data collection.** MMO notes that the discussion on black seabream nesting sites fails to demonstrate how data collected are representative despite being conducted outside of the spawning and nesting season. If aggregate industry nest site monitoring improves the level of confidence in the data, this should be demonstrated with figures. MMO request a figure to demonstrate the black seabream nest site results identified during the Gardline survey of July/August 2020.	The survey was completed outside of the optimal period however nesting has been observed to the east in Kimmeridge Bay on the Matt Doggett black seabream project in late June to early July (2015). The 20-year composite dataset used for historic black seabream nesting is taken from the aggregates industry from 2002 to present, which highlights black seabream nest locations predominately within the Kingmere MCZ but also within the cable corridor (**Figures 8.14a** (Document Reference 6.3.8) and **8.14b,** (Document Reference 6.3.8) **Volume 3** of the ES)**.** The combination of the long term and site-specific surveys leads to the conclusion that nests are likely to be present within the export cable corridor (**Paragraphs 8.6.27 to 8.6.89**). **Appendix 9.4: Rampion 2 geophysical survey, Volume 4** of the ES (Document Reference 6.4.9.1) presents potential nesting areas as detailed in the Gardline survey (see Chart 7 in **Appendix 9.4, Volume 4** of the ES (Document Reference 6.4.9.4)).

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Stakeholder	Comment ID	Theme	How this is addressed in this ES
	94/98/100-104/109/110	**Mitigation.** Concerns that construction will result in significant adverse effects on black seabream and herring during their spawning and nesting seasons. MMO require close examination of embedded environmental measures and recommends early engagement prior submission. The MMO believes that piling restrictions during the black seabream spawning and nesting season and the Downs herring spawning season may be required.	Targeted meetings with appropriate stakeholders discussing the technical notes 'Underwater noise mitigation for sensitive features' and 'Cable Corridor area mitigation for sensitive features' occurred in February 2022. Embedded environmental measures are discussed throughout **Sections 8.9** to **8.11**.
	106	**Cumulative Impact Assessment.** The MMO expect black seabream to be afforded a species-specific cumulative impact assessment within the EIA.	The cumulative effects from other activities are considered at the community scale in **Section 8.12** in line with standard practice and the agreed approach during scoping. Black seabream has not therefore been afforded a species-specific cumulative assessment.
Mulberry Marine Experience	14	Concerns raised about the impact of noise and sediment on elasmobranchs and invertebrates, including undulate and thornback rays and scallops.	The impacts from underwater noise, direct disturbance and sediment suspension and deposition on elasmobranchs and invertebrates have been assessed in **Sections 8.9, 8.10** and **8.11.**
	15	Mulberry Marine Experience noted Spiny and Short-Snouted seahorse sightings within the Selsey Bill and the Hounds MCZ and in areas adjacent to the MCZ towards Pagham recorded on iRecord.	These sightings have been incorporated into the current baseline (**Section 8.6**).

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Stakeholder	Comment ID	Theme	How this is addressed in this ES
Fishing Organisations/ Fishermen	23	Concern that all elasmobranch species, cephalopods, some gastropod species and most cetaceans are all detrimentally affected by sub-sea noise, vibration and EMF produced around cabling.	The effects of underwater noise and vibration and EMF are assessed in **Sections 8.9, 8.10** and **8.11.**

8.4 Scope of the assessment

Overview

8.4.1 This section sets out the scope of the ES assessment for fish and shellfish ecology. This scope has been developed as Rampion 2 design has evolved and responds to feedback received to-date as set out in **Section 8.3**.

Spatial scope and Study Area

8.4.2 The spatial scope of the fish and shellfish ecology assessment is defined as Rampion 2 fish and shellfish Study Area, as defined by the secondary impact ZOI.

8.4.3 The secondary ZOI has been informed by the tidal excursion extent and coastal processes modelling undertaken to inform the previous Rampion 1 offshore wind farm EIA (ABPmer, 2012) and the likely extent of potential sediment plume impacts described by the tidal excursion buffer as described in **Chapter 6: Coastal processes, Volume 2** of the ES (Document Reference 6.2.6). The secondary ZOI buffer encompasses the proposed DCO Order Limits (area that encompasses all planned infrastructure of Rampion 2) and the area over which suspended sediments may travel following disturbance from the Proposed Development activities. This buffer was increased from the case assessed at PEIR following Section 42 consultation to include an extent of 16km in order to capture the full potential maximum sediment plume excursion distance during spring tides (**Figure 8.1, Volume 3** (Document Reference 6.3.8)). This ZOI buffer has formed the basis of the Study Area described in this section.

8.4.4 References to both the fish and shellfish Study Area and the proposed DCO Order Limits are made throughout the assessment, as applicable to the assessed impacts. For example, direct disturbance impacts have a discrete spatial extent, and therefore reference to the proposed DCO Order Limits may be more applicable. When assessing impacts regarding sediment dispersion, references to the Study Area are more appropriate.

8.4.5 It is also recognised that noise propagation (e.g. from piling) is likely to extend beyond this buffer and therefore the potential impact risk defined by underwater noise modelling has also defined the area for assessment of underwater noise impacts.

Temporal scope

8.4.6 The temporal scope of the assessment of fish and shellfish ecology is the entire lifetime of Rampion 2, which therefore covers the construction, operation and maintenance (of around 30-years), and decommissioning phases as described in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference 6.2.4).

Potential receptors

8.4.7 The spatial and temporal scope of the assessment enables the identification of receptors which may experience a change as a result of Rampion 2. The receptors identified that may experience likely significant effects for fish and shellfish ecology are outlined in **Table 8-7**.

Table 8-7 Receptors requiring assessment for fish and shellfish ecology

Receptor group	Receptors included within group
Mobile fish species	Herring (*Clupea harengus*), black seabream (*Spondyliosoma cantharus*), sandeel (*Ammodytes tobianus*, *Hyperoplus lanceolatus*), plaice (*Pleuronectes platessa*), Dover sole (*Solea solea*), lemon sole (*Microstomus kitt*), cod (*Gadus morhua*), sprat (*Sprattus sprattus*), mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), European seabass (*Dicentrarchus labrax*), cuttlefish (*Sepia officinalis*), spiny/long-snouted seahorse (*Hippocampus guttulatus)* and short-snouted seahorse (*Hippocampus hippocampus*)
Elasmobranch	Undulate ray (*Raja undulata*), thornback ray (*Raja clavata*), spurdog (*Squalus acanthias*), porbeagle shark (*Lamna nasus*), shortfin mako (*Isurus oxyrinchus*), tope (*Galeorhinus galeus*), blue shark (Prionace glauca) and basking shark (Cetorhinus maximus)
Migratory species	European eel (*Anguilla anguilla*), sea lamprey (*Petromyzon marinus*), Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), European smelt (*Osmerus eperlanus*), allis shad (*Alosa alosa*) and twaite shad (*Alosa fallax*)
Shellfish	Brown crab (*Cancer pagurus*), European lobster (*Homarus gammarus*), king scallop (*Pecten maximus*), queen scallop (*Aequipecten opercularis*), whelks (*Buccinum undatum*), European native oyster (*Ostrea edulis*) and blue mussel (*Mytilus edulis*).

Potential effects

8.4.8 Potential effects on fish and shellfish ecology receptors that have been scoped in for assessment are summarised in **Table 8-8**.

Table 8-8 Potential effects on fish and shellfish ecology receptors scoped in for further assessment

Receptor	Activity or impact	Potential effect
Construction		
Fish and shellfish ecology: Sandeel, herring, cod, plaice, cuttlefish, Dover sole, black seabream, European seabass, seahorse, undulate ray and thornback ray Shellfish – eggs and larvae	Mortality, injury, behavioural changes and auditory masking arising from noise and vibration	Potential for a significant effect on fish and shellfish ecology through temporary underwater noise disturbance (**Section 8.9**).
Fish and shellfish ecology: Demersal spawners – sandeel, herring, black seabream, undulate ray and thornback ray Seahorse Shellfish – brown crab, European lobster, king scallop, whelk, blue mussel and European native oyster	Direct disturbance resulting from the installation of the export cable	Potential for a significant effect on fish and shellfish ecology resource through temporary and direct habitat disturbance (**Section 8.9**).
Fish and shellfish ecology: Demersal spawners – sandeel, herring, black seabream, undulate ray and thornback ray Seahorse Shellfish – brown crab, European lobster, king scallop, whelk, blue mussel and European native oyster	Direct disturbance resulting from construction within the array	Potential for a significant effect on fish and shellfish ecology resource through temporary and direct habitat disturbance (**Section 8.9**).
Fish and shellfish ecology: Demersal spawners – black seabream, herring, sandeel, undulate ray and thornback ray Seahorse Shellfish – brown crab, European lobster, scallop, blue mussel and European native oyster	Temporary and localised increases in suspended sediment concentrations (SSC) and smothering	Potential for significant effect through smothering of important habitat to fish and shellfish, such as spawning areas (**Section 8.9**).
Fish and shellfish ecology:	Direct and indirect seabed disturbances	Potentially for significant effect through the release

Receptor	Activity or impact	Potential effect
Demersal spawners – black seabream and sandeel Shellfish species – scallop, blue mussel and European native oyster	leading to the release of sediment contaminants	of sediment-bound contaminants into the water column (**Section 8.9**).
Operation and maintenance		
Fish and shellfish ecology: Demersal spawners – black seabream, herring, sandeel and undulate ray Seahorse Shellfish species – European lobster and brown crab	Long-term loss of habitat and increased hard substrate and structural complexity due to the presence of turbine foundations scour protection and cable protection	Potential for significant effect through the loss of suitable substrate or sensitive habitat and potential impact on fish and shellfish ecology biodiversity due to the introduction of hard substrates (**Section 8.10**).
Fish and shellfish ecology: Elasmobranch species, migratory fish species and shellfish species	Electromagnetic field (EMF) impacts arising from cables	Potential for significant negative impact on fish and shellfish ecology (**Section 8.10**).
Fish and shellfish ecology: Demersal spawners – black seabream and sandeel Shellfish species – European lobster and brown crab	Direct disturbance resulting from maintenance within the array area and the offshore export cable corridor	Potential for a significant effect on fish and shellfish ecology resource through temporary and direct habitat disturbance (**Section 8.10**).
Decommissioning		
Fish and shellfish ecology: Sandeel, herring, cod, plaice, cuttlefish, Dover sole, black seabream, seahorse, undulate ray and thornback ray Shellfish – eggs and larvae	Mortality, injury, behavioural changes and auditory masking arising from noise and vibration	Potential for a significant effect on fish and shellfish ecology through temporary underwater noise disturbance (**Section 8.11**).
Fish and shellfish ecology: Demersal spawners – sandeel, herring, black seabream, undulate ray and thornback ray Seahorse	Direct disturbance resulting from the removal of the export cable	Potential for a significant effect on fish and shellfish ecology resource through temporary and direct

Receptor	Activity or impact	Potential effect
Shellfish – brown crab, European lobster, king scallop, whelk, blue mussel and European native oyster		habitat disturbance (**Section 8.11**).
Fish and shellfish ecology: Demersal spawners – sandeel, herring, black seabream, undulate ray and thornback ray Seahorse Shellfish – brown crab, European lobster, king scallop, whelk, blue mussel and European native oyster	Direct disturbance resulting from decommissioning within the array	Potential for a significant effect on fish and shellfish ecology resource through temporary and direct habitat disturbance (**Section 8.11**).
Fish and shellfish ecology: Demersal spawners – black seabream, herring, sandeel, undulate ray and thornback ray Seahorse Shellfish – European lobster, brown crab scallop, blue mussel and European native oyster	Temporary and localised increases in SSC and smothering	Potential for significant effect through smothering of important habitat to fish and shellfish, such as spawning areas (**Section 8.11**).
Fish and shellfish ecology: Demersal spawners – black seabream and sandeel Shellfish species – scallop, blue mussel and European native oyster	Direct and indirect seabed disturbances leading to the release of sediment contaminants	Potential for significant effect through the release of sediment-bound contaminants into the water column (**Section 8.11**).

Activities or impacts scoped out of assessment

8.4.9 A number of potential effects have been scoped out from further assessment, resulting from a conclusion of no likely significant effect. These conclusions have been made based on the knowledge of the baseline environment, the nature of planned works and the wealth of evidence on the potential for impact from such projects more widely. The conclusions follow (in a site-based context) existing best practice. Each scoped out activity or impact is considered in turn in **Table 8-9**.

Table 8-9 Activities or impacts scoped out of assessment

Activity or impact	Rationale for scoping out
Accidental pollution impacts during the construction phase resulting in potential effects on fish and shellfish receptors (Construction and Decommissioning)	Accidental pollution events are not considered to result in a significant effect on benthic subtidal and intertidal (and therefore fish and shellfish) receptors. The magnitude of an accidental spill will be limited by the size of chemical or oil inventory on construction vessels. In addition, released hydrocarbons will be subject to rapid dilution, weathering and dispersion and will be unlikely to persist in the marine environment. The likelihood of an incident will be reduced by the implementation of an **Outline Project Environmental Management Plan (PEMP)** (Document Reference 7.11) and **Outline Marine Pollution Contingency Plan (MPCP)** (Appendix A of the **Outline PEMP**) (embedded measure C-53, **Table 8-13**), which will be approved by the relevant stakeholders and secured through the DCO. The Planning Inspectorate agreed any potential impacts on fish and shellfish are unlikely to result in significant effects with the implementation of measures to limit any potential pollution incidents. The Planning Inspectorate agreed that no further assessment is required (The Planning Inspectorate, 2020).
Underwater noise as a result of operational WTGs (Operation)	The Planning Inspectorate agreed that underwater noise during operation can be scoped out of the fish and shellfish assessment in the Scoping Opinion (Planning Inspectorate, 2020). The MMO is content that that justification has been provided and to support scoping out the potential effects of underwater noise as a result of operational WTGs (The Planning Inspectorate, 2020). It was noted by the MMO (2021) that the cumulative contribution to the soundscape from multiple WTGs within a wind farm should not be ignored. However, given the anticipated localised extent of the operational noise, and the agreement to scope the impact out by the Planning Inspectorate and MMO, operational noise has not been assessed. As a cumulative assessment of underwater noise from operational WTG will give no meaningful contribution, it has not been assessed further.
Potentially reduced fishing pressure within the Rampion 2 array area and increased fishing pressure outside the array area due to displacement (Operation)	The Planning Inspectorate agreed that this matter can be scoped out of the EIA in the Scoping Opinion (Planning Inspectorate, 2020).

8.5 Methodology for baseline data gathering

Overview

8.5.1 Baseline data collection has been undertaken to obtain information over the Study Areas described in **Section 8.4: Scope of the assessment**. The current baseline conditions presented in **Section 8.6: Baseline conditions** sets out data currently available information from the Study Area.

8.5.2 Additional fish and shellfish surveys were not undertaken for the Proposed Development as existing site-specific data from the Rampion 1 offshore wind farm EIA, and from wider studies within the region (see **Table 8-10**), were considered sufficient in describing fish and shellfish receptors within Rampion 2 fish and shellfish ecology Study Area for the purposes of undertaking an EIA (as agreed with Cefas, the MMO and Sussex IFCA (see **Section 8.3**).

8.5.3 At this stage discussion has been held with ETG members and through the scoping process, and it is considered that the composite of data available adequately characterise the receiving environment with regards broad nursery and spawning areas for fish species, and specific regional species such as black seabream. The combined methods used for data collection align with existing best practice.

Desk study

8.5.4 A detailed desktop review was carried out to establish the baseline of information available on fish and shellfish populations in the fish and shellfish ecology Study Area from proposed DCO Order Limits. Information was sought on fish shellfish ecology in general, spawning and nursery activity and on black seabream. The baseline characterisation utilises a broad combination of datasets providing a robust temporal analysis and validation of the site-specific and regional monitoring datasets. The data presented provide a characterisation that is appropriate and adequate for the purpose of undertaking an EIA and complies with existing policy and guidance provided within **Table 8-2**. The data sources that have been collected and used to inform this fish and shellfish ecology assessment are summarised in **Table 8-10**.

8.5.5 As agreed with stakeholders through the EIA EPP, sufficient information exists to enable a robust characterisation of the receiving environment and identification of relevant valued ecological receptors for the purposes of assessment. As such it has been agreed that further fish and shellfish surveys are not required for the Proposed Development EIA. The data sources described in this section allow a robust conclusion to be drawn that further survey would not be likely to identify additional receptors or materially alter the findings of the assessment with regards to the likely magnitude of impact, the receptor species considered or the need or otherwise for appropriate mitigation.

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Table 8-10 Data sources used to inform the fish and shellfish ecology ES assessment

Source	Date	Summary	Coverage of Study Area
Fisheries Sensitivity Maps in British Waters (Coull *et al* , 1998)	1998	Fisheries sensitivity maps showing spawning and nursery areas of commercially important fish and shellfish species	Coverage of UK waters
Spawning and nursery grounds of selected fish species in UK waters (Ellis *et al* , 2010)	2010	Maps indicating the main spawning and nursery grounds for 14 commercially important species	Coverage of UK waters
Modelled distributions of ten demersal elasmobranchs of the eastern English Channel in relation to the environment (Martin *et al* , 2012)	2012	Modelled distributions of elasmobranch populations within the eastern English Channel	Coverage across the eastern English Channel
Distribution of skates and sharks in the North Sea: 112 years of change (Sguotti *et al* , 2016)	2012	Distributions of elasmobranch populations in the North Sea	Coverage of the North Sea
Assessing the status of demersal elasmobranchs in UK waters: a review (Ellis *et al* , 2005)	2005	Status of elasmobranch populations in UK waters	Coverage of UK waters
The International Herring Larvae Surveys (IHLS) (ICES, 1967-2019)	1967 to 2020	Herring larvae surveys conducted in the North Sea and adjacent areas, to provide quantitative estimates of herring larval abundance, used as a relative index of changes of the herring spawning-stock biomass	Coverage across the North Sea and the English Channel
UK sea fisheries annual statistics	2015 to 2020	Information on landings of the UK fishing fleet,	Full coverage of the Study Area.

Source	Date	Summary	Coverage of Study Area
report (MMO, 2020; 2021)		and the status of commercial fish stocks over the last six years (2015-2020)	
Rampion offshore wind farm Environmental Statement (E.ON, 2012a)	2012	Site-specific fish and shellfish surveys undertaken to inform the existing Rampion 1 offshore wind farm	Site-specific data across the existing Rampion 1 offshore wind farm
Rampion Offshore Wind Farm Preconstruction Fish and Shellfish Monitoring Report (Natural Power, 2017)	2017	Site-specific pre-construction fish and shellfish otter and beam trawl surveys undertaken to inform the existing Rampion 1 offshore wind farm ES	Site-specific data across the existing Rampion 1 offshore wind farm
Rampion Offshore Wind Farm Year 1 Post-Construction Fish Monitoring Report (OEL, 2020a)	2019 to 2020	Site-specific post-construction fish and shellfish otter and beam trawl surveys undertaken within the array area, export cable route and in reference areas outside the Rampion 1 offshore wind farm	Site-specific data across the existing Rampion 1 offshore wind farm
North Owers Black seabream Monitoring report (GoBe, 2015)	2015	Black seabream monitoring report for North Owers marine aggregate extraction area	Regional and partial site-specific (nearshore export cable) context of black seabream populations
Area 435/396, Area 453 and Area 488 Annual Monitoring Reports (EMU Limited, 2009; Fugro EMU Ltd. 2013 and 2014)	2009 to 2014	Environmental monitoring reports for marine aggregate extraction areas (Area 435/ 396, Area 453 and Area 488) within the region	Regional and partial site-specific (nearshore export cable) context of black seabream populations
A study of the Black seabream Spawning Ground at Littlehampton	1995	Black seabream spawning ground monitoring study	Regional context

Source	Date	Summary	Coverage of Study Area
(Southern Science Ltd., 1995)			
Black seabream tagging survey (Sussex IFCA, 2016)	2016	Black seabream monitoring data from tagging surveys have been used to further complement the baseline characterisation of black seabream distribution within the Study Area.	Regional context
Black seabream in the English Channel off the Sussex coast (EMU Limited, 2012a)	2012	Monitoring report of black seabream in the English Channel	Regional context
ICES Fish Map (ICES, 2006)	2006	North Sea fish species distribution maps	Coverage of UK waters
Offshore beam trawl surveys (ICES, 2019)	1987 to 2011	Offshore beam trawl surveys providing species distribution data	Coverage across the southern North Sea and the English Channel
North Sea International Bottom Trawl Survey (ICES, 2020)	1965 to 2011	Bottom trawl surveys providing species distribution data across the North Sea	Coverage across the English Channel
Marine Aggregates Regional Environmental Assessment (MAREA) (EMU Limited, 2010)	2010	Fisheries activity survey data, and sediment transport data across the English Channel	Coverage across the English Channel
Marine Aggregate Levy Sustainability Fund (MALSF) synthesis study in the central and eastern English Channel (James *et al*, 2011)	2011	Fisheries activity survey data, and sediment transport data across the English Channel	Coverage across the English Channel

Source	Date	Summary	Coverage of Study Area
Sussex Inshore Fisheries and Conservation Authority (IFCA)	N/A	Fisheries monitoring reports and research report	Regional context
Licence areas 453 CEMEX UK Marine Ltd. (CMX) and 488 Tarmac Marine Ltd., Aggregate black seabream monitoring data	2017 to 2019	Data covering seven survey boxes and two transects in and around the Kingmere MCZ	Coverage within and outwith the Kingmere MCZ and partial coverage of the export cable corridor
UKSeaMap	2018	EUNIS Level 4 model, detailing biological zone and substrate	Complete modelled coverage up to Mean High Water Springs (MHWS)
British Geological Survey (BGS) Marine Bedrock and Quaternary Deposit Thickness	2020	Maps detailing the type and location of marine bedrock and the thickness of deposits on the seabed	Coverage of UK waters

Site surveys

8.5.6 As detailed in **paragraph 8.5.2**, no additional fish and shellfish surveys were deemed to be required for the Proposed Development EIA, however, other site-specific surveys undertaken for Rampion 2 have provided important additional ground discrimination information and interpretation, which has been used to refine habitat mapping across the Study Area. A site-specific geophysical survey was undertaken between July and August 2020 across the offshore proposed DCO Order Limits. The survey employed single-beam and multi-beam echo sounders (SBES and MBES), side scan sonar (SSS), magnetometer and a sub-bottom profiler (SBP) (Gardline, 2020 (**Appendix 9.4: Rampion 2 geophysical survey, Volume 4** of the ES (Document Reference 6.4.9.4))). Site-specific benthic grab and drop-down video (DDV) surveys were also undertaken between December 2020 and February 2021 to ground-truth locations within the Study Area (**Appendix 9.3: Rampion 2 offshore wind farm subtidal benthic characterisation survey report, Volume 4** of the ES (Document Reference 6.4.9.3)). The geophysical survey data, combined with the information provided by the seabed ecological surveys, have provided important additional ground discrimination information relevant to the fish and shellfish ecology assessment, with interpreted outputs used to refine habitat mapping for the entire proposed DCO Order Limits. Notably, the results of the survey have been used to supplement existing data on likely black seabream nesting locations in areas relevant to the Proposed Development, but outside of areas previously subject to targeted survey (principally within the Kingmere MCZ). The geophysical data supplement several regional datasets already identified which focus specifically on the distribution of black seabream nests within the Study Area, the composite has been agreed as adequate for the purpose of characterising the receiving environment and informing the EIA as part of the EPP (**paragraph 8.3.16**).

Data limitations

8.5.7 It is acknowledged that the site-specific black seabream nest survey was conducted outwith the optimum nesting period, and whilst there is evidence of nest longevity and persistence there remains uncertainty with regards the dataset potentially underestimating nest coverage as nests may be affected by sediment movement once the male fish have ceased to actively maintain them once the eggs have hatched. The uncertainty has been addressed through the composite of the 20-year dataset referred to in the following section (**paragraph 8.6.76** to **paragraph 8.6.89**), which allows a conclusion to be drawn that nests are likely to be present across a discrete area of the export cable corridor, and as such demonstrates the data to be representative and robust for the purposes of EIA. Notwithstanding that the assessment takes a precautionary approach.

8.5.8 Coull *et al.* (1998) and Ellis *et al.* (2010, 2012) are considered the key references for providing broad scale overviews of the potential spatial extent of spawning grounds and the relative intensity and duration of spawning. Even so, the limitations of Coull *et al*. (1998) and Ellis *et al*. (2010, 2012), are recognised. These publications provide an indication of the general location of spawning and nursery grounds; they do not define precise boundaries of spawning and nursery grounds. Both Coull *et al*. (1998) and Ellis *et al*. (2010, 2012) are based on a collection of various data sources. Many of the conclusions drawn by Coull *et al*. (1998), are based on historic research and may fail to account for more recent changes in fish distributions and spawning behaviour. Ellis *et al*. (2010, 2012) also faces limitations due to the wide scale distribution of sampling sites used for the annual international larval survey data, consequently resulting in broad scale grids of spawning and nursery grounds. Similarly, the spawning times given in these publications represent the maximum duration of spawning on a species/stock basis. In some cases, the duration of spawning may be much more contracted, on a site-specific basis, than reported in Coull *et al*. (1998) and Ellis *et al*. (2010; 2012). It is also notable that both reference sources were published some years ago and as one might assume some variation due to changes in seabed characteristics at the local scale over time and spawning and nursery distributions may have altered, however gross changes in seabed character over the wider scale encompassed within these papers would not be anticipated. Therefore, where available, additional research publications have also been reviewed to provide site-specific information and where possible address uncertainty associated with these data sources. This includes, for example, the use of the International Herring Larvae Survey (IHLS) data, which have been used to complement the Ellis et al. (2012) and Coull *et al*. (1998) papers, providing a composite of interannual variation from 2007/2008 – 2021/2022 (**Appendix 8.1 Herring annual heatmaps, Volume 4** of the ES (Document Reference 6.4.8.1).

8.5.9 Mobile species such as fish, exhibit varying spatial and temporal patterns. All surveys, including the site-specific surveys for Rampion 1 offshore wind farm, were undertaken to provide semi-seasonal description of the fish and shellfish assemblages within the fish and shellfish Study Area. These datasets represent snapshots of the fish and shellfish assemblage at the time of sampling and the fish and shellfish assemblages may vary both seasonally and annually.

8.5.10 Furthermore, the efficiency of the survey methods employed at collecting species will vary depending on the nature of the survey methods deployed and the species recorded. Several survey sample stations during the Rampion 1 offshore wind farm post-construction survey had to be abandoned in the field either as a result of very hard ground and significant risk posed to the sampling gear and vessel or due to there being fishing gear in the target area. This included survey station 4 (spring 2020, otter trawl), station 7 (autumn 2019 beam trawl and spring 2020 beam and otter trawl), station 13 (autumn 2019 beam trawl and spring 2020 beam and otter trawl). Due to lack of data in these survey sample stations, it is difficult to compare variations between pre-and post-construction surveys at these stations, however they are considered fit for the purpose of characterisation for this EIA. In addition, any results from the post-construction monitoring represent one years' worth of monitoring and cannot be fully compared at this early stage until the full monitoring period is complete. Moreover, the use of non-shellfish specific survey methods (beam and otter trawls) to determine abundance of shellfish species will not be accurately represented and can only be recorded for presence/absence data. Shellfish abundance can only be accurately represented when using shellfish specific survey methods such as potting surveys or scallop dredging surveys.

8.5.11 It is important to note, however, that although some of the data used in the characterisation of the fish and shellfish baseline conditions at the Proposed Development site were published over a decade ago, the information presented represents a long-term dataset, which increases confidence in the baseline definition for this EIA, allowing for a detailed overview of the fish and shellfish species characterising the Study Area. The diversity and abundance of many species, particularly demersal fish species, is linked to habitat types, which have remained relatively constant in the Study Area (EMU Limited, 2009, 2011, 2012b; E.ON, 2012b; Gardline, 2020; GoBe, 2015; MMO, 2020, 2021; OEL, 2021). As the habitat conditions have remained essentially stable over time, no major shift in the fish and shellfish communities would be expected over the time period of the data used in this ES.

8.5.12 The baseline dataset for black seabream is based on a combination of aggregates survey data of known nesting sites within and in proximity to Kingmere MCZ, and black seabream nesting habitat identified from the Rampion 2 site specific geophysical survey (Gardline, 2020 (**Appendix 9.4: Rampion 2 geophysical survey, Volume 4** of the ES **Chart 7** (Document Reference 6.4.9.4). Although the data allow an assessment to be undertaken which assumes the presence of black seabream nests within the proposed DCO Order Limits, the exact locations/knowledge of nesting sites within the proposed DCO Order Limits requires further survey following consent. The post consent survey, undertaken as part of a suite of pre-construction surveys, will allow a determination to made as to the extent of the nesting area, and specifically the key nesting areas, in order to identify the best cable route, minimising interaction with key sensitive features where practical, prior to offshore export cable installation.

8.5.13 The EUNIS and Folk (1954) (Stephens and Diesing, 2015) broadscale marine habitat data used to identify preferred sandeel and herring spawning habitats are limited by the broadscale nature of the data since it does not account for small-scale, localised differences in seabed sediments, unlike the data obtained from site-specific grab sampling. In this case, it is important to review all datasets presented, to develop a clear overview of preferred sandeel and herring habitat.

8.5.14 It should also be noted that the use of particle size analysis (PSA) data and broadscale habitat mapping only provides a proxy for the presence of sandeel and herring in these locations (based on suitability of habitats; i.e. the potential for spawning rather than actual contemporary spawning activity); therefore, these data should be reviewed alongside other datasets presented in this chapter in determining the location and relative importance of spawning habitats.

8.6 Baseline conditions

Current baseline

Overview

8.6.1 A detailed literature review was undertaken to describe the use of the area by fish and shellfish species in relation to key life stages, spawning and juvenile behaviour and migratory pathways. The literature review was informed by the existing Rampion 1 offshore wind farm ES (E.ON, 2012a), and broader surveys across the English Channel and its coastal waters. The two fishing techniques utilised during the survey produced very different types of catches. The otter trawl survey produced the bigger catches, with a relatively even mix of fish and shellfish species, whereas the beam trawl survey captured more invertebrate species.

Rampion 1 characterisation surveys: beam trawls

8.6.2 Rampion 1 offshore wind farm conducted several fish and shellfish characterisation surveys using 2m scientific beam trawls. A commercial beam trawl survey was also conducted in April 2012 to specifically sample flatfish, as commercial beam trawling catches relatively slow-moving fish that live on (or close to) the seabed.

8.6.3 A total of 21 fish species were recorded in July 2011 beam trawl survey, of which the most abundant fish species included gobies (*Gobiidae* species), dragonet (*Callionymus* species), solenette (*Buglossidium luteum*) and weever (*Trachinidae* species). The most common commercial fish was plaice, with smaller numbers of Dover sole, lemon sole, thornback and spotted rays (E.ON, 2012a).

8.6.4 An additional survey conducted from October to November 2011, recorded similar fish species to that of the July 2011 survey. The majority of fish were small non-commercial teleosts, predominately sand goby (*Pomatoschistus minutus*), which made up over 70% of the fish recorded. The only commercial species recorded where two lemon sole and a single black seabream, plaice and John Dory, all within the Rampion 1 offshore wind farm project site. No elasmobranch species were recorded. A single short-snouted seahorse was recorded at a depth of approximately 29m in the north-eastern part of the Rampion 1 offshore wind farm

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site (Brown and May, 2012a). As noted in the Rampion 1 offshore wind farm ES (E.ON, 2012a), this area is predominately sandy flat substrate.

8.6.5 A further survey was conducted in February 2012, which also identified small non-commercial species as the most frequently recorded species. The only commercial fish species recorded were three plaice and a single specimen each of Dover sole and lemon sole, all of which were caught in the Rampion 1 offshore wind farm site. As with the survey in October to November no elasmobranch species were recorded. Three short-snouted seahorses were recorded, all within the Rampion 1 offshore wind farm site, one was caught in the same location as the seahorse recorded in the October to November survey. The two remaining seahorses were caught in water depths between 31 and 33m within the western part of the Rampion 1 offshore wind farm site. As with the previous survey, these seahorses were caught from an area of sandy gravel.

8.6.6 In April 2012, a commercial beam trawl was carried out and 2,638 individuals were recorded. Approximately 39% of the individuals record were plaice, with lemon sole, black seabream and Dover sole also recorded. Non-commercial species included bib (*Trisopterus luscus*), dab (*Limanda limanda*), lesser weever (*Echiichthys vipera*) and common dragonet (*Callionymus lyra*).

Rampion 1 characterisation surveys: otter trawls

8.6.7 Rampion 1 offshore wind farm conducted several fish and shellfish characterisation surveys using a commercial otter trawl. In the October to November 2011 survey 2,024 individuals were recorded, with 25% of individuals recorded were whiting (*Merlangius merlangus*). Other commercial species included plaice, black seabream (both contributed to 6% of individuals caught), with smaller abundances of lemon sole, bass and cod. Non-commercial species included horse mackerel and dab. Elasmobranch species recorded included the lesser spotted dogfish (*Scyliorhinus canicula*), tope, smooth hound (*Mustelus* species) and rays (thornback, undulate, blonde (*Raja brachyura*), spotted (*Raja montagui*) and cuckoo (*Leucoraja naevus*)). Shellfish species recorded included long-finned squid (*Loligo forbesi*), which comprised of 20% of the individuals caught, king scallop, queen scallop, cuttlefish, whelk and brown crab were all caught within the Rampion 1 offshore wind farm site.

8.6.8 A further survey was conducted in February 2012, where a total of 4,197 individuals were recorded. As found with the October to November 2011 survey, whiting were the most abundant species comprising of approximately 58% of individuals. Other commercial species recorded included herring, plaice and lemon sole. Non-commercial species included flounder, dab and sprat comprising of around 20% of all individuals. However, in this survey no black seabream were recorded, with limited number of shellfish species captured. Elasmobranch species included the lesser spotted dogfish, which was the most commonly recorded, followed by low numbers of smooth hound and rays (spotted, blonde, cuckoo, thornback and undulate). A single twaite shad was recorded within the Rampion 1 offshore wind farm site. Whelks dominated the shellfish individuals recorded (60%), with smaller numbers of king scallop, cuttlefish, queen scallop and European native oyster.

Pre-construction monitoring survey of Rampion 1

8.6.9 Pre-construction surveys were carried out in September/October 2015 and May 2016. The aim of these surveys was to determine the type and distribution of fish as well as shellfish species in and around the site of the Rampion 1 offshore wind farm. The surveys were performed using a commercial otter trawl and a 2m epibenthic scientific beam trawl.

8.6.10 Otter trawl surveys sampling demersal species undertaken to inform pre-construction fish and shellfish monitoring for Rampion 1 offshore wind farm were dominated numerically by lesser spotted dogfish, plaice, whiting and thornback ray, with smaller quantities of dab and red gurnard (*Chelidonichthys cuculus*) also recorded (E.ON, 2012a). The most abundant commercial species in the otter trawl were plaice, whiting and squid *(Loligo* species), with queen scallop also present. Seasonal variation in trawls was driven by increased abundances of dab, whiting, bib and starry smooth hound *(Mustelus asterias*) captured during the May survey, and greater numbers of spotted ray and red gurnards captured during the September/October survey (Natural Power, 2017).

8.6.11 Beam trawl surveys targeting epibenthic and demersal species were also undertaken as part of the existing Rampion 1 offshore wind farm pre-construction monitoring. The beam trawl used a smaller mesh compared to the otter trawl and was towed at a slower rate, allowing larger fish to avoid capture. This enabled the tow to focus on small or juvenile fish. The trawls were dominated numerically by lesser weever, gobies, Dover sole and common dragonet. The most abundant commercial species recorded in the beam trawl surveys was Dover sole, with queen scallop and common whelk also present. Seasonal variation within the beam trawl surveys was driven by the dominance of juvenile Dover sole during the May surveys, whereas in September thornback rays were captured at greater abundance. Variation in catches of invertebrates were attributed to larger catches of green sea urchin (*Psammechinus miliaris*), European squid (*Loligo vulgaris*), and queen scallop in the September/October survey, with the May survey dominated by brittle stars (*Ophiuroidea* species) in May (E.ON, 2012a, Natural Power, 2017).

8.6.12 The results from the pre-construction monitoring of the existing Rampion 1 offshore wind farm largely reflect surveys undertaken on a broader scale across the English Channel. Offshore beam trawl surveys (ICES, 2019) in the English Channel were dominated in plaice, Dover sole, poor cod (*Trisopterus minutus*), common dragonet, thornback ray and lesser spotted dogfish with European spider crab (*Maja squinado*) also present. Surveys conducted in July 2020 within the Eastern English Channel and the southern North Sea collected data on several species including, cod, whiting, dab, lemon sole, plaice and sole (ICES, 2021b). Bottom trawls undertaken across the English Channel to inform the North Sea International Bottom Trawl Surveys (ICES, 2020) were dominated in whiting, European squid, dab, herring, plaice, lesser spotted dogfish, sprat and poor cod (Natural Power, 2017). A survey was scheduled to be conducted in the East English Channel in 2020, however due to delays due to the COVID-19 pandemic, only the French side of the English Channel could be surveyed (ICES, 2021a).

8.6.13 These surveys undertaken for Rampion 1 offshore wind farm have enabled a picture of the usage of fish and shellfish populations in the area of the Rampion 2 fish and shellfish Study Area. The area supports a diverse assemblage of commercially and non-commercially important fish and shellfish species, all of which are typical of this eastern English Channel. In general, the fish species captured reflected those that will be expected from examining the commercial fishing information from this area.

Post-construction monitoring survey of Rampion 1

8.6.14 Year one post-construction fish and shellfish monitoring surveys were carried out in autumn (November) 2019 and spring (May) 2020 by OEL to provide an assessment of any long-term changes in the fish and shellfish communities within and adjacent to the areas of potential impact resulting from the construction of Rampion 1 offshore wind farm. The survey formed a repeat of the pre-construction surveys undertaken in autumn 2015 and spring 2016. These surveys involved the collection of commercial otter trawl and scientific beam trawl samples from 15 stations across the offshore wind farm, cable route and reference areas which are control areas located outwith the Rampion 1 offshore wind farm. These reference areas are located within the proposed DCO Order Limits. Sampling positions were consistent with those agreed previously with the MMO and as per the previous pre-construction baseline surveys.

8.6.15 During the post-construction otter trawl surveys, a total of 27 fish species and five commercial invertebrate species were recorded. Commercial fish species sampled were dominated by European seabass, plaice, and horse mackerel. Elasmobranch communities were characterised by the presence of lesser spotted dogfish and thornback ray. European squid and queen scallop were the most numerous invertebrates. The community was dominated by lesser spotted dogfish, plaice and whiting during pre-construction, while the dominant species were lesser spotted dogfish, thornback ray and European seabass during post-construction. There was also a reduction in other, less abundant, species between pre- and post-construction surveys, most notably queen scallop and common whelk. Conversely, several other species including black seabream, horse mackerel, squid and lemon sole increased in abundance between pre- and post-construction surveys.

8.6.16 A total of 11 species of conservation interest have been recorded during the Rampion 1 offshore wind farm pre- and post-construction (Year 1) otter trawl monitoring surveys. Of these the allis shad, and Atlantic mackerel (*Scomber scrombrus*), were only sampled during the post-construction surveys while herring, monkfish (*Lophius piscatorius*) and European native oyster, were only recorded during the pre-construction survey. Black seabream were also noted during both monitoring periods, with five individuals recorded in the pre-construction survey and 18 recorded in the post-construction survey.

8.6.17 A total of 31 fish species were captured in the post-construction beam trawl surveys. The fish samples were dominated by gobies (*Gobiidae* species), solenette and gadoides (*Gadidae* species), while squid and queen scallops were the most abundant invertebrates sampled. The community was dominated by gobies, lesser weever, common dragonet and solenette. Although the community remained broadly comparable across years, a reduction in whiting was apparent between pre- and post-construction surveys. Conversely, juvenile gadoids, and the two-spotted cling fish (*Diplecogaster bimaculata*) appeared to have increased in abundance during post-construction.

8.6.18 A total of nine species of conservation interest have been recorded during the Rampion 1 offshore wind farm pre- and post-construction (year 1) beam trawl monitoring surveys. This included the short-snouted seahorse, which was noted in three separate trawl samples during the autumn post-construction survey but did not occur during the 2015/2016 pre-construction survey (OEL, 2020a. However, four short-snouted seahorses were recorded during the characterisation 2m scientific beam trawl 2011/2012 surveys at Rampion 1 offshore wind farm (E.ON, 2012a) (a single seahorse was found in the survey between 7 to 8 November 2011 (Brown and May, 2012a), the other three were found in the survey between 20 and 23 February 2012 (Brown and May, 2012b)). Two species deemed as non-native and invasive were also sampled including the American-slipper limpet (*Crepidula fornicata*), and the leathery sea squirt (*Styela clava*).

8.6.19 Significant changes were observed in the abundance of fish and shellfish between pre- and post-construction surveys, seasons, and treatment areas. Variations in the relative abundance of pouting (*Trisopterus luscus*), lesser spotted dogfish, European seabass, scallop, and squid drove the observed differences between construction period, season, and treatment areas. This trend corresponds to previous studies which have associated offshore wind farms and the introduction of artificial hard substrata with increased fish abundance, particularly of pouting and lesser spotted dogfish (Griffin *et al*., 2016; Reubens *et al*., 2013; Wilhelmsson *et al*., 2006), as observed in these surveys. A higher abundance of black seabream characterised the fish community during post-construction when compared to pre-construction surveys. Similarly, the population of undulate ray increased between pre- and post-construction surveys, as well as the abundance of other elasmobranchs including lesser spotted dogfish and thornback ray.

8.6.20 However, these changes were either reflected in reference area stations (control areas taken outwith the Rampion 1 offshore wind farm area), where no impact from Rampion 1 was expected or were in line with expected natural variability. Additionally, significant differences in the fish and shellfish communities were also found between the pre-construction survey and EIA characterisation, both carried out prior to construction of Rampion 1 offshore wind farm. This implies that naturally occurring temporal changes are to be expected and the observed changes in the composition and abundance of fish and shellfish communities with the English Channel can likely be attributed to natural variability rather than an effect of the operational Rampion 1 offshore wind farm.

8.6.21 Results from this first post-construction surveys indicate that no significant reduction in the abundance of commercially important fish species, elasmobranchs, or black seabream was observed due to the construction and operation of Rampion 1 offshore wind farm. Additionally, a number of species of conservation interest were sampled during the surveys across Rampion 1 offshore wind farm including the short-snouted seahorse and several commercial fish species of protected status under various national and international legislations.

Spawning and nursery grounds

8.6.22 Many species of fish and shellfish are known to either spawn or have nursery areas in relatively close proximity to, or potentially overlapping with the proposed DCO Order Limits. Information on spawning and nursery grounds is based on data from Coull *et al*. (1998) and supported by data sources from Ellis *et al*. (2010; 2012). Nursery and spawning habitats within the Rampion 2 fish and shellfish ecology Study Area were categorised by Ellis *et al*. (2012) as either high or low intensity, dependant on the level of spawning activity or abundance of juveniles recorded within these habitats. Coull *et al*. (1998) does not provide this level of detail but has been used for species where spawning activity data is scarce, and where the link between spawning grounds and sediment (a key component of the Coull *et al*. (1998) approach, remains valid.

8.6.23 The Proposed Development lies within spawning grounds for lemon sole, grounds for which stretch widely across the eastern English Channel (**Figure 8.2, Volume 3** of the ES (Document Reference 6.3.8)). Spawning grounds for plaice cross the Rampion 2 array area and extend across the eastern English Channel (**Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8)). Whiting spawning grounds also clip the eastern extent of the Proposed Development Study Area, with areas of spawning activity present across the English Channel and into the southern North Sea (**Figure 8.4, Volume 3** of the ES (Document Reference 6.3.8)).

8.6.24 In a wider context, the Study Area for the Proposed Development, has a spatially limited interaction with a small portion of the overall spawning sites for sprat, cod, Dover sole, lemon sole, plaice, whiting and sandeel (Coull *et al*., 1998; Ellis *et al*., 2010, 2012; Hufnagl *et al*., 2013; Randon *et al*., 2021; Righton *et al*., 2007). With Ellis *et al*. (2010) data recording low intensity spawning grounds for sandeel, cod and plaice, with high intensity spawning grounds for Dover sole. Black seabream are also known to spawn in the eastern English Channel; spawning occurs in inshore areas where suitable substratum occurs. The nearest black seabream spawning ground to the proposed DCO Order Limits lies along the 10m depth contour between Bognor and Worthing, and within the Kingmere MCZ (Southern Science 1995, EMU, 2008, Collins and Mallinson, 2012) (see **Figures 8.14a and 814b, Volume 3** of the ES (Document Reference 6.3.8)).

8.6.25 Potential spawning grounds for herring and sandeel are considered in further detail in **paragraph 8.6.31** to **paragraph 8.6.33** (herring) and in **paragraph 8.6.34** to **paragraph 8.6.37** (sandeel).

8.6.26 Nursery grounds for lemon sole overlap the proposed offshore export cable corridor and array area, extending across the eastern English Channel and along most UK coastlines (**Figure 8.5, Volume 3** of the ES (Document Reference 6.3.8)). Nursery grounds for whiting occur across the majority of the Study Area in the nearshore, and follow most of the UK coastlines, and cover most of the North Sea (**Figure 8.7, Volume 3** of the ES (Document Reference 6.3.8)). Nursery areas for sandeel and mackerel both clip the eastern extent of the Study Area, approximately 12km, and 1.8km from the Rampion 2 array area respectively (see Coull *et al*., 1998 data; **Figure 8.6, Volume 3** of the ES (Document Reference 6.3.8)).

8.6.27 Nursery grounds for both thornback ray and undulate ray also cross the offshore export cable corridor and the array area, with both nursery grounds also extending along much of the Sussex coastline (**Figure 8.7, Volume 3** of the ES (Document Reference 6.3.8)). Thornback ray are one of the most dominant ray species within the English Channel (Ellis *et al*., 2005). They migrate to inshore waters to breed and lay eggs on the seabed with spawning occurs between February and September (Fowler and Cavanagh, 2005) with a peak in May and June. Spawning data on thornback ray are insufficient, although should broadly overlap with nursery grounds (Ellis *et al*., 2010). The nursery grounds are reported to overlap the Rampion 2 fish and shellfish Study Area in low intensity (Ellis *et al*., 2010, 2012). Martin *et al*. (2012) found low densities of juvenile thornback ray in inshore areas of the English Channel, where sediments comprised of mud, sand and gravel however noted thornback rays preferred habitat is gravel and pebbled sediments, which occur within the central part of the channel. A historical study in the North Sea noted similar habitat preference (Sguotti *et al*., 2016). The undulate ray is commonly encountered in the English Channel from the Channel Islands to the Solent and coast of Sussex with nursery grounds identified in these areas (Ellis *et al*., 2012). Ellis *et al*. (2012) suggests that due to the lack of data on spawning grounds that they may broadly overlap nursery grounds. Coelho and Erzini (2006) reported that undulate ray may spawn in the winter on sandy or muddy flats. Juvenile undulate ray tended to occur in the coastal fringe of the English Channel, with the Channel Islands the site of the most regular occurrence of juveniles (Ellis *et al*., 2010). Martin *et al*. (2012) noted suitable habitat in both inshore and offshore regions, with undulate ray being similar to thornback ray in recorded preference for gravel and pebbled sediment habitats.

8.6.28 The key sensitive receptors with spawning or nursery grounds in the fish and shellfish Study Area comprise sandeel, herring, cod, black seabream, Dover sole, plaice, undulate ray and thornback ray. These species have been taken through for further consideration in the fish and shellfish assessment (see **Table 8-8** for the key receptors scoped in for each potential impact). Black seabream are considered sensitive to increased SSC and subsequent sediment deposition due to the demersal nature of their spawning behaviours, as well as spawning habitat loss. Herring, although a species that displays substrate dependant spawning behaviours, is not considered a concern in relation to potential impacts to spawning grounds due to the limited extent of potential impacts arising from the Proposed Development and the separation distance of grounds from the proposed DCO Order Limits (the nearest herring spawning ground is approximately 47km from the Proposed Development) (**Figure 8.8, Volume 3** of the ES (Document Reference 6.3.8)). However, herring have been included throughout the ES assessment as they are vulnerable to habitat loss (JNCC, 2021) (see **Table 8-8**). Whilst sandeel also display demersal spawning behaviours, they are not considered sensitive to the effects of increased SSC and deposition; specifically, the regional assessment for sandeel concluded that the effects of smothering of individuals through deposition from sediment plumes and sediment mobilisation will not result in significant effects in the Regional Cumulative Impact Assessments for sandeel (MarineSpace Ltd *et al*., 2013a). However, a report by the JNCC (2021), suggests sandeel are sensitive to seabed disturbance and are vulnerable to habitat loss. Therefore, they have also been included throughout the ES assessment (see **Table 8-8**).

8.6.29 In accordance with the Popper *et al*. (2014) noise sensitivity classifications for fish species, several species with spawning grounds of relevance to the proposed development have been considered as noise sensitive receptors and have therefore been screened into the underwater noise assessment as set out in **Table 8-8**. These comprise sandeel (due to their demersal spawning habit and close affiliation to the seabed), herring, cod, plaice, Dover sole, black seabream, undulate ray and thornback ray. It should be noted that although herring spawning grounds are located at distance beyond the Rampion 2 fish and shellfish Study Area, herring are screened in on a precautionary basis as informed by the underwater noise propagation modelling.

Potential herring and sandeel habitats

Overview

8.6.30 The Rampion 2 fish and shellfish ecology Study Area is considered to be of low importance for herring (the determining receptor with regards noise sensitivity and the associated ZOI for consideration of underwater noise impacts on fish generally) on the basis of existing information. It is, however, relevant to consider whether there is the potential for herring spawning to occur in the future, or for the area to be of importance in the future. Sandeel and herring are of particular relevance when considering impacts to spawning areas as they are demersal spawners and therefore lay demersal eggs. As such, they have specific requirements in terms of spawning grounds, with seabed sediment being the primary determinant (Maravelias *et al*., 2000).

Herring

8.6.31 As well as being a UK BAP priority species, herring are important ecologically and form an important component of the diets of larger predators such as other fish, birds and marine mammals. Coull *et al*. (1998) identified two spawning areas in the eastern English Channel; one in French waters (Baie de Seine) and one due south of the Sussex coast. Herring stock in the eastern Channel and southern North Sea is known as the Downs stock (Vause and Clark, 2011). This large herring spawning ground lies approximately 47km offshore of the fish and shellfish Study Area, in the eastern English Channel. Although Coull *et al*. (1998) cites spawning to occur from November to February, an extensive literature review by Boyle and New (2018), suggests spawning occurs in December and January only. Herring are reported to spawn on well-oxygenated gravel and sandy gravel with little fine material (Ellis *et al*., 2012). The IHLS (1967-2020) identifies that herring are present in the fourth quarter of the year in ICES rectangle 30E9 but not at high densities.

8.6.32 The preferred sediment habitat for herring spawning is gravel, with some tolerance of more sandy sediments, although these are primarily on the edge of any spawning grounds (Stratoudakis *et al*., 1998). Atlantic herring spawning beds are typically discrete, localised features. Actual spawning habitat, or habitat that could be used for spawning activity, likely comprises relatively small seabed features, with discrete spatial extents, although these may be spread across a wide area of suitable seabed spawning habitat at a regional scale (e.g., spawning grounds (MarineSpace *et al*., 2013a)). Eggs are laid on the seabed, usually in water

10-80m deep, in areas of gravel, or similar coarse habitats (e.g., coarse sand, shell and maerl), with well-oxygenated waters (Aneer, 1989; Bowers, 1980; de Groot, 1980; Ellis *et al*., 2012; Rakine, 1986; Stratoudakis *et al*., 1998).

8.6.33 Herring spawning areas were identified using the IHLS dataset (ICES, 2007-2020), showing areas of high intensity spawning to the south-east of the Rampion 2 fish and shellfish Study Area (**Figure 8.8, Volume 3** of the ES (Document Reference 6.3.8)). The data largely reflect patterns shown by PSA data (data from EUNIS and Folk, 1954; Stephens and Diesing, 2015; UKSeaMap, 2018) and the predicted habitat model as developed by OEL (2020). The PSA data were processed according to the methodologies described in Reach *et al*. (2013), which allowed the classification of 'preferred', 'marginal' and 'unsuitable' herring habitats in the fish and shellfish ecology Study Area (**Figure 8.10, Volume 3** of the ES (Document Reference 6.3.8)). Whilst preferred habitat is illustrated in **Figure 8.10, Volume 3** of the ES (Document Reference 6.3.8), there is no evidence of herring spawning in the area. Data of high confidence is based on IHLS data overlaid with Coull *et al*. (1998) spawning, with sediment data assessed as low to medium confidence, as the BGS data may overrepresent the potential herring spawning grounds (MarineSpace Ltd *et al*., 2013b).

Sandeel

8.6.34 A large low intensity sandeel spawning ground lies to the east of the Study Area, lying approximately 13km from the Rampion 2 array area (see Coull *et al*., 1998 data; **Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8)), in a broader context the spawning ground also stretches across the eastern English Channel and much of the North Sea. Sandeel are highly abundant and a key prey species to larger fish, seabirds and marine mammals. Sandeel swim actively in the water column and are often associated with sandy substrates, into which they deposit their eggs and burrow into when threatened.

8.6.35 Sandeel also spawn in coarse sediments, though as their name suggests, their preferred spawning habitats are sandier than those of herring. Sandeel prefer habitats composed of sand to gravelly sand but will tolerate sandy gravels as a marginal spawning habitat. The proposed DCO Order Limits is located within a low intensity sandeel spawning grounds identified across the English Channel (Ellis *et al*., 2010).

8.6.36 Sandeel are highly substrate specific (Wright *et al*., 2000); after an initial larval dispersal period, sandeel display a degree of site fidelity (Jensen *et al*., 2011) so their settled distribution reflects the distribution of preferred habitat. Sandeel rarely occur in sediments where the silt content (particle size <0.63μm) is greater than >4%, and they are absent in substrates with a silt content greater than 10% (Holland *et al*., 2005; Wright *et al*., 2000).

8.6.37 Potential sandeel habitats were mapped using PSA data (using data from EUNIS and Folk, 1954; Stephens and Diesing, 2015; UKSeaMap, 2018) and the predicted habitat model as developed by OEL (2020), which were processed according to the methodologies described by Latto *et al*. (2013). This analysis allowed for identification of 'preferred', 'marginal' and 'unsuitable' sandeel habitat in the Rampion 2 fish and shellfish ecology Study Area (**Figure 8.9, Volume 3** of the ES (Document Reference 6.3.8)).

Sediment contamination

8.6.38 As part of the benthic ecology baseline characterisation at Rampion 1 offshore wind farm, surface sediments were tested for a range of contaminants. EMU Limited (2011) undertook the benthic subtidal and intertidal surveys and the results revealed that the levels of contaminants within the sediments were generally low, suggesting sediment across Rampion 1 offshore wind farm will not present any concern for seabed disturbance. However, eleven of the sites sampled supported levels of contaminants in excess of Action Level 1 (AL1) for arsenic, and Chromium at four of the sites, prior to construction of Rampion 1 offshore wind farm (EMU Limited, 2011).

8.6.39 Site specific sediment contaminant data has been collected within the benthic subtidal ecology Study Area. OEL (2021) collected a total of seven chemical samples (Trace Metals and Hydrocarbons) were collected across the Study Area. Chemical samples were unable to be obtained from eight further stations during the survey due to the coarse sediment (pebbles/cobbles/bedrock) present at the target location. Concentrations of arsenic were recorded at levels that exceeded AL1 at five stations, with no metals recorded exceeding Action Level 2 (AL2). Concentrations of arsenic above the Threshold Effect Level were recorded at all seven stations and above Probable Effect Level at one station located in north-east of the array area. All remaining metals were below the Threshold Effect Level or Probable Effect Level limits (see **Table 11, Appendix 9.3: Rampion 2 offshore wind farm subtidal benthic characterisation survey report, Volume 4** of the ES (Document Reference 6.4.9.3)).

8.6.40 The results of the sediment contaminant survey that has been undertaken across proposed DCO Order Limits (see **Appendix 9.3: Rampion 2 offshore wind farm subtidal benthic characterisation survey report, Volume 4** of the ES (Document Reference 6.4.9.3)). A total of eight heavy and trace metals were analysed from sediments taken at each of the seven stations. These were arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Concentrations of arsenic were recorded at levels that exceeded Cefas AL1 at five stations, with no metals recording in excess of Cefas AL2. Metal concentrations significantly below the OSPAR Background Assessment Concentration (BAC) are considered to be near background levels, with concentrations below the Effect Range Low (ERL) rarely causing adverse effects in marine organisms. All stations exceeded ERL levels for arsenic. In addition, six stations exceeded BAC levels for chromium, but did not exceed ERL levels (see **Table 11** of **Appendix 9.3: Rampion 2 offshore wind farm subtidal benthic characterisation survey report, Volume 4** of the ES (Document Reference 6.4.9.3)). All remaining metals were below ERL or BAC levels. For the Canadian sediment quality guideline (CSQG), levels above the Threshold Effect Level (TEL) adverse effects may occasionally occur, whilst at levels above the Probable Effect Level (PEL) adverse effects may occur frequently. Concentrations of arsenic above TEL were recorded at all seven stations and above PEL at one station (ST051). All remaining metals fell below TEL and PEL limits (see **Table 11** of **Appendix 9.3: Rampion 2 offshore wind farm subtidal benthic characterisation survey report, Volume 4** of the ES (Document Reference 6.4.9.3)). All remaining metals were below TEL or PEL limits.

8.6.41 Polycyclic Aromatic Hydrocarbons (PAH) were tested for all seven samples collected. With the exception of Phenanthrene (ST020) and Pyrene (ST030), all PAHs were recorded below limits of detection across all seven sampling stations. At the two stations where PAHs were detected, reference levels were not exceeded (see **Table 12** of **Appendix 9.3: Rampion 2 offshore wind farm subtidal benthic characterisation survey report, Volume 4** of the ES (Document Reference 6.4.9.3)).

Species of commercial importance

Overview

8.6.42 Detailed information on species of commercial importance is provided in **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference 6.2.10) aspect of the ES. On a regional basis, whelk, Dover sole, horse mackerel, mackerel, herring, sea bass, sole, plaice, whiting, turbot, black seabream, dogfish, European lobster, scallop, cuttlefish and brown crab are noted as comprising species of commercial importance to the region.

8.6.43 Of these species, whelk, brown crab, European lobster, and scallop are considered to be characterising shellfish receptors in relation to the Proposed Development. These species have therefore been screened in on the basis of commercial importance. European seabass and cuttlefish are also considered to have the potential to be sensitive to noise impacts from percussive piling. These species will therefore be taken forward into the fish and shellfish assessment, with the following sub-sections describing the species of commercial importance that occur within the Study Area.

Fish

8.6.44 Sea bass are of high value for both commercial and recreational fishing. Sea bass are found around the UK and are often associated with seabed features such as reefs. They spawn directly into the water column and have nursery areas in estuaries and natural harbours, which can be designated and protected from fishing activity under The Bass (Specified Areas) (Prohibition of Fishing) (Variation) Order 1999. The nearest designated bass nursery to the proposed DCO Order Limits is in Chichester harbour (Southern Inshore Fisheries and Conservation Authority, 2022) approximately 26km west of the Proposed Development. Pawson *et al*. (2007) noted pre-spawning and spawning bass that gather in winter offshore in the western English Channel, the Bay of Biscay, and the eastern Celtic Sea.

8.6.45 Similarly, Dover sole are recognised as a high value commercial species. Sole are usually found on sandy and muddy seabed and estuarine waters; distribution within the Study Area is therefore considered to be lower than in other key spawning areas such as the Thames estuary. Within the region Dover sole are subject to IFCA byelaws for minimum landing size but are not currently subject to any specific fisheries measures.

8.6.46 Horse mackerel and black seabream have a comparatively lower commercial value within the region, however UK and French demersal trawlers do target these species, alongside whiting and mackerel in the region, noting though that minimal landings of black seabream have been recorded from the Study Area since 2018 (less than 0.3 tonnes per year) (**Chapter 10: Commercial Fisheries, Volume 2** of the ES (Document Reference 6.2.10)). The Sussex IFCA, in an attempt to manage horse mackerel and other pelagic species, have sought to prohibit the use of pair trawling within the nearshore (6nm) but horse mackerel are not subject to any species-specific management measures, or measures in the area beyond the 6nm.

Shellfish

8.6.47 Brown crab can inhabit a variety of habitats, from the rocky intertidal to deeper shelf waters as adults. While both sexes can be found under boulders, some research suggests males prefer rocky habitat with females more abundant on sand and gravel. Mating occurs inshore in spring. Females initially store sperm, before moving offshore in late summer where the eggs are fertilized. The females then remain largely stationary (often buried in sediment) through the winter, incubating their eggs. In late spring, the larvae are released, which settle onto the seabed after two months in the plankton. Juveniles remain in shallow intertidal waters for around three years, before moving into deeper water (Vause and Clarke, 2011). Brown crab are also a commercial important species with an annual average landing weight of 2.4 tonnes (between 2015 to 2019) from ICES rectangle 30E9 (MMO, 2020).

8.6.48 Lobsters inhabit holes and crevices in or under rocks and artificial structures. Rocky substrates are abundant in ICES rectangle 30E9 (Sussex IFCA, 2020), this is reflected in commercial landings with some of the highest landings for lobster occurring in this rectangle between 2015 to 2020 (MMO, 2020; 2021a). Studies have shown lobsters are largely sedentary and do not undertake significant migrations. Lobster breed in the summer, and berried females release planktonic larvae in the following spring, which settle to the seabed after about three weeks (Vause and Clarke, 2011).

8.6.49 Sussex IFCA (2020) identified the greatest fishing effort for lobster and brown crab occurred between Chichester harbour to Littlehampton and Shoreham to Eastbourne.

Molluscs

8.6.50 Gastropods include the commercially harvested whelk and a number of smaller species. Whelks are an important commercial species with some of the highest landings within the inshore rectangle 30E9 between 2015 to 2020 (MMO, 2020; 2021a). Whelk potting is one of the most valuable fisheries in Sussex, with fishing effort occurring between Chichester Harbour and Shoreham and Newhaven and Hastings (Sussex IFCA, 2020). Whelks are occasionally found intertidally but are mainly subtidal and prefer muddy sand, gravel and rock. They lay masses of egg capsules which are attached to solid substrates such as rocks, seaweed or seagrass (Ager, 2008) from around November to April; the young do not have a planktonic phase and emerge as fully formed whelks in February and March (Vause and Clarke, 2011).

8.6.51 Commercial bivalve species include those that are attached to the seabed when adult (such as blue mussel and the European native oyster), or with limited mobility (using a predator-avoidance ‘swimming’), such as the king scallop and queen scallop. All of these bivalve species spawn directly into the water column, with planktonic larvae. King scallop spawn in the spring (April/May), and possibly also in the autumn (late August). King scallop larvae settle to the seabed within about one month and attach themselves to the seabed until they are around 4 to 13 millimetre (mm) in length, after which they settle on the seabed (Vause and Clarke, 2011). The average annual landing weight for scallops within ICES rectangle 30E9 is 3.6 tonnes between 2015 to 2019 (MMO, 2020), with this average increasing 3.86 tonnes between 2016 and 2020 (MMO, 2021). The MMO (2021a) landing data also notes that European native oysters have not been landed from 30E9 since 2018, with an average of 2.16 tonnes between 2016 to 2018.

8.6.52 Cephalopods in the Study Area include the highly mobile cuttlefish, which is regularly commercially exploited off the coast of Sussex. Cuttlefish adhesive eggs can be found attached to a range of substrates from algae (including *Zostera marina* and *Chorda filum*), sessile animals and man-made objects (such as mooring lines or fishing pots) but are most commonly located on sandy bottoms, at depths of less than 40m (Bloor, 2013; Irving, 1998; Pawson, 1995). Cuttlefish spend the winter in the western English Channel, and move into shallow Sussex waters to breed, laying eggs from February to May (peaking from mid-April to mid-May) (Vause and Clarke, 2011). The eggs hatch after approximately three months and juveniles are thought to remain in shallow waters until around October when they move offshore. After the first winter, juvenile cuttlefish again move inshore (spring to autumn), before another winter offshore, after which they are fully mature; in the following spring they return inshore, breed, and die (Sussex IFCA, 2020; Vause and Clarke, 2011). The English Channel cuttlefish stock is the most commercially important cephalopod stock exploited in the Northeast Atlantic (Pierce *et al*., 2010). The fishing effort for cuttlefish in Sussex from 2015 to 2019 occurred between Pagham to Shoreham and Eastbourne to Hastings (Sussex IFCA, 2020). The MMO (2020) recorded an average annual landing weight of two tonnes for ICES rectangle 30E9, however this average dropped to 1.56 tonnes between 2016 and 2020 (MMO, 2021).

Species of conservation importance

Overview

8.6.53 The following species of conservation importance are considered to be sensitive receptors to the Proposed Development. Priority Species within the UK BAP include elasmobranch species that have the potential to occur within the Rampion 2 fish and shellfish ecology Study Area. These include undulate ray, spurdog, porbeagle shark, shortfin mako, basking shark, tope and blue shark.

8.6.54 Other species of conservation importance that have the potential to occur in the Rampion 2 fish and shellfish ecology Study Area include, black seabream, European smelt, sea trout, European eel, allis shad, twaite shad, Atlantic salmon and sea lamprey. In UK waters both the short-snouted and spiny/long-snouted seahorses are of conservation importance and have been recorded in the English Channel.

8.6.55 Several species of conservation importance have been recorded on occasion within the eastern English Channel region. There are records of several marine and estuarine species protected under national, European and international legislation.

8.6.56 A review was undertaken to identify designated sites in the Study Area which are either designated for fish and shellfish interest or habitats/species which are dependent on or associated with fish or shellfish (**Figure 8.11, Volume 3** of the ES (Document Reference 6.3.8) and **Figure 8.12** (Document Reference 6.3.8)**, Volume 3** of the ES). The sites are presented in **Table 8-11** below.

8.6.57 It should be noted that National and International designated sites are covered in more detail within the **Report to Inform Appropriate Assessment (RIAA)** (Document Reference 5.9). On account of the presence of nature conservation designations within the Study Area, and the potential presence of features of interest of which the sites are designated for short-snouted seahorse, European native oyster, blue mussel beds and black seabream have been taken into consideration in the fish and shellfish assessment. The Fish and Shellfish Ecology Method Statement (see **paragraph 8.3.6**, was submitted to stakeholders (23 December 2020) and agreed through the EIA EPP, and the inclusion of the following nature conservation designations have been incorporated into the ES.

Table 8-11 Marine nature conservation designations with relevance to fish and shellfish ecology

Designated site	Location relevant to the proposed DCO Order Limits	Features or description
Kingmere MCZ	Lies adjacent to the eastern boundary of the offshore export cable corridor	Nesting black seabream are a protected feature of this MCZ
Selsey Bill and the Hounds MCZ	12km north-west of the array area	Short-snouted seahorse are a protected feature of this MCZ
Beachy Head West MCZ	18km north-east of the array	Short-snouted seahorse, European native oyster and blue mussel beds are protected features of this MCZ
Bembridge MCZ	24km north-east of the array	Short-snouted seahorse, European native oyster and stalked jellyfish (*Calvadosia campanulata*, *Haliclystus* sp.) are protected features of this MCZ
Beachy Head East MCZ	30km north-east of the array	Short-snouted seahorse are a protected feature of this MCZ

Designated site	Location relevant to the proposed DCO Order Limits	Features or description
Solent and Dorset Coast SPA	1km west of the offshore export cable corridor	Designated for common tern, sandwich tern and little tern of which sandeel are a key prey species
River Itchen SAC	61km west of the array area	Qualifying feature of the SAC includes Atlantic salmon.

8.6.58 The following sections describe the species of conservation importance occurring generally within the Study Area, and specifically in the context of the regional designated sites. Sandeel have been previously described within the baseline and that information is not therefore repeated here.

Shellfish

8.6.59 Shellfish of conservation importance that have the potential to occur within fish and shellfish Study Area including the European native oyster. European native oysters are known to be present in the inshore areas of the UK coast and are features of the Beachy Head West MCZ and Bembridge MCZ.

Elasmobranch

8.6.60 Elasmobranch species that have been included as ‘Priority Species’ on the UK BAP that have the potential to occur within the Rampion 2 fish and shellfish Study Area include undulate ray, spurdog, porbeagle shark, shortfin mako, basking shark, tope and blue shark.

8.6.61 Elasmobranchs are cartilaginous fish including sharks, skates and rays that reproduce either by laying eggs on the seabed (dogfish and rays) or giving birth to live young (spurdog; tope). Elasmobranchs are also notable in that they have a highly developed ability to detect EMFs, which they use in hunting prey.

8.6.62 Using data collected from Cefas groundfish surveys, Ellis *et al*. (2005) noted twelve demersal elasmobranch species were recorded from beam trawl surveys within the eastern English Channel. Undulate ray were primarily caught within the English Channel, with juveniles dominating the catches. Species commonly found in the Study Area include thornback ray, undulate ray, tope, spurdog.

8.6.63 Larger, highly mobile shark species, including porbeagle, shortfin mako, tope and blue shark may also occur within the fish and shellfish Study Area. A study by Sguotti *et al*. (2016) of historical surveys between 1902 and 2013 found tope and spurdog to be the predominant demersal shark species. Spurdog were the most common (recorded in 13.3% of the hauls) followed by tope (recorded in 4.2% of the hauls) in the early hauls, however both species numbers were declining in hauls following the 1970s. Between 2010 and 2013 spurdog were recorded in only 2.2% of hauls. Overall distributions of tope and spurdog were associated with either fishing pressure within the North Sea or an increase in sea surface temperature within the region resulted in distribution changes. The preferred habitat of tope was recorded as regions of gravel and pebbled sediment within the English Channel (Martin *et al*., 2012). Sguotti *et al*. (2016) recorded a depth preference of <50m, however the study did not identify a habitat preference for tope. The same study identified a change in depth preference for spurdog with the species more associated with cooler deeper waters.

8.6.64 Around the UK in the summer months, basking shark can often be observed near the surface although the English Channel is not thought to be an important area for this species.

Teleost

8.6.65 Teleosts of conservation importance that have the potential to occur within fish and shellfish Study Area include seahorse, black seabream (see **paragraph 8.6.76** to **paragraph 8.6.89** for further details) sea trout, European eel, European smelt, allis shad and twaite shad (see **paragraph 8.6.69** to **paragraph 8.6.75**). Of these species, black seabream was recorded in high numbers in pre-construction and post-construction otter trawl surveys conducted to inform the Rampion 1 offshore wind farm baseline and potential impact following construction and is a feature of conservation importance for the Kingmere MCZ.

Seahorse

8.6.66 Both short-snouted and spiny/long-snouted seahorses are of conservation importance in UK waters and are protected under Schedule 5 of the Wildlife and Countryside Act, 1981 and therefore they have been taken into account in the ES assessment given they are known to be present in the area from pre / post-construction surveys conducted for Rampion 1. The species have been recorded in the English Channel and within the Rampion 1 pre- and post-monitoring surveys, with the Proposed Development Study Area also being a potential overwintering area for both seahorse species. Seahorses can be found in a variety of habitats, including sand and soft sediment, seagrass meadows, rock and algae and artificial habitats (such as marinas) (Woodall *et al*., 2018). Research suggests that seahorses are present in shallower waters during summer months for breeding (short-snouted and spiny/long-snouted seahorses breed between April to October and March to October respectively) and migrate to deeper water during winter months (usually around October to April) to avoid storms (The Seahorse Trust, 2013). Garrick-Maidment (1998), also notes seahorse species move out to deeper water in winter, with Sabatini *et al*. (2021), noting that habitat preference may be linked to seasonal migration. During the breading season (spring to autumn) male seahorse can be pregnant on average five times within a single breeding season, with each pregnancy lasting around a month (Garrick-Maidment, 2011).

8.6.67 Globally ecological data on seahorses is lacking, due to their apparent patchy distribution and low density, as well as their cryptic nature (Foster and Vincent, 2004; Garrick-Maidment *et al*., 2010). A study by Garrick-Maidment *et al*. (2010) found an average home range for seahorse of approximately 167m^2. This range is considerably larger than previous studies with Foster and Vincent (2004) noting smaller home ranges of 7.8m^2 for short-snouted seahorse and 12.1m^2 for spiny/long-snouted seahorse, suggesting seahorses have small home ranges during the breeding season. A further study on the spiny/long-snouted seahorse in Portugal by Curtis and Vincent (2006) found a broadly similar mean home range of 19.9m^2 during breeding seasons and also noted adult spiny/long-snouted seahorse maintained a small home ranges over multiple years and probably had low emigration rates.

8.6.68 Both spiny/long-snouted and short-snouted seahorses are known to frequent the south coast of England; however, they do not appear in any commercial landings data. Existing numbers are limited and often based on the result of sightings. As detailed in **paragraph 8.6.18**, four short-snouted seahorses were recorded during surveys at Rampion 1 offshore wind farm (E.ON, 2012a) which confirms their presence in the wider area. With three short-snorted seahorses recorded during the post-construction survey (OEL, 2020a). A relatively small number of short-snorted seahorse observations have been recorded in the region of West and East Sussex and the Isle of Wight by Seasearch, Sussex IFCA and the Marine Biological Society, the most recent of which was a single observation south-east of Brighton Marina in July 2020 (National Biodiversity Network (NBN) Atlas, 2021a; Sussex Biodiversity Record Centre (BRC), 2021). Observations of spiny/long-snouted seahorse are limited in the region with a single spiny/long-snouted seahorse observation recorded near Brighton by Seasearch in 2019 (NBN Atlas, 2021b) As well as several unverified records submitted by the public from stranding and captures in the area (British Marine Life Study Society, 2020). The Bembridge MCZ and Selsey Bill and The Hounds MCZs are located at approximately 20.4km and 10km from the Proposed Development, respectively. Both of these sites are designated for short-snouted seahorses (see **Table 8-11** above), however, the protection from the Wildlife and Countryside Act, 1981, will require seahorse to be considered outside the designated sites and within the Proposed Development Study Area. Records collected by Sussex BRC (2021) noted nine recordings of short-snouted seahorse off the coast of Selsey; six in July 2019 and three records in May 2020, with a total of 16 snort-snouted seahorse recorded in the region since 2004.

Migratory species

8.6.69 Migratory species are diadromous fish that spend part of their life cycle in freshwater and part in seawater. Fish which spawn in freshwater and feed at sea are anadromous and include Atlantic salmon and sea trout. Fish which spawn at sea and feed in freshwater are catadromous, such as the European eel.

8.6.70 A number of migratory fish species have the potential to occur in the Rampion 2 fish and shellfish Study Area, migrating to and from rivers and other freshwater bodies in the area which these species use either for spawning habitat (e.g. sea lamprey, twaite shad, allis shad, Atlantic salmon and sea trout), or growth and development to the adult phase with spawning occurring at sea (i.e. European eel).

8.6.71 The European smelt is a migratory species typically found inshore and in estuaries, which moves into rivers between February and April to spawn (Barnes, 2008). It is generally found on the east coast of the UK and western Scotland (Barnes, 2008) and rarely found far from the shore (English Nature, 2003). Although shoals have been seen off the Sussex coast, records in the Ouse and

Adur are not known (English Nature, 2003) and their population status in the area requires further research (Ellis *et al*., 2010; English Nature, 2003).

8.6.72 Salmonids such as Atlantic salmon and sea trout are anadromous fish, which spend much of their life at sea but ascend rivers in summer to spawn on gravel beds in winter. While Atlantic salmon and sea trout are not generally captured in great numbers in commercial landings, the location of the River Itchen SAC (where Atlantic salmon are a qualifying feature) suggest this species may be in proximity to the proposed DCO Order Limits during their migration (adult and smolt) to and from this river, though it is noted that the migratory route to and from the River Itchen is considered to be from the west, migrating in and to the North Atlantic Coastal Zone (Gilbey *et al*., 2021), and therefore unlikely to interact with the construction of the Proposed Development. Sea trout are known to spawn in rivers (including Arun, Adur and Ouse) that discharge into the sea within the fish and shellfish Study Area. Preliminary results from the SAMARCH (Salmonid Management Round the Channel) Project, show sea trout travelling to the North Sea or remaining in the English Channel from the River Bresle in France. Unfortunately, the River Frome, which travels into the English Channel had the lowest migration success and data is yet to show the migration route (Whelan *et al*., 2019).

8.6.73 Shad (*Alosa* species) are members of the herring family, which ascend rivers to spawn, using the coastal shelf for nursery grounds and migration, are known to be present in the marine environment off the coast of Sussex; however, it is not known how these populations relate to rivers in the region (E.ON, 2012a). Landing data obtained from the MMO (2020) for fish caught in areas surrounding proposed DCO Order Limits show some of the highest landings by weight for the inshore ICES rectangle 30E9 (average of 0.04 tonnes between 2015 to 2019 landings). Surveys for the operational Rampion 1 offshore wind farm, confirm the presence of both the allis shad and twaite shad, where one specimen of each was captured (E.ON, 2012a).

8.6.74 Sea lamprey are a migratory species with adults travelling upstream into rivers to spawn in May or June on stony or gravely riverbed (Maitland, 2003). Following hatching lamprey will remain within the nursery area of the river for several years before metamorphosis into an adult, at which point they will then migrate downstream. Sea lamprey are rarely observed in UK coastal waters, estuaries and accessible rivers, with poor water quality considered a factor (JNCC, 2019). However, sea lamprey have been recorded within the River Arun catchment (Environment Agency, 2013), although very little is known about them after they have migrated to the sea (Maitland, 2003).

8.6.75 On account of the conservation importance of these species to the region, all species listed above are considered to be sensitive receptors to the Proposed Development, and therefore potential impacts to these species from the Proposed Development have been taken into consideration in the Rampion 2 fish and shellfish ecology assessment. The potential likely significant effects on black seabream as a designated feature of the Kingmere MCZ have been considered within the EIA, in the context of the EIA Regulations 2017, and in this Chapter of the ES.

Black seabream

8.6.76 Whilst not forming a species of conservation importance, black seabream are recognised as a significant interest to commercial and recreational fishers with spawning grounds within the region that are considered important within regional Marine Plan Policies and Kingmere MCZ being designated in part to protect areas of spawning importance. The stock which occupies the English Channel overwinters in water depths of between 50 to 100m, prior to migrating inshore to breed between May and June in suitable habitats (Vause and Clark, 2011). Black seabream are known to nest in areas around the south coast of the UK with extensive nesting grounds off the West Sussex coast to the Isle of Wight and Dorset (Collins and Mallinson, 2012; EMU Limited, 2009; Fugro EMU, 2015; Southern IFCA, 2014). Black seabream specific studies identified black seabream nest areas off the coast of Littlehampton to Bogner Regis (EMU Limited, 2009), to Shoreham harbour in the east and to the north of Kingmere MCZ (EMU Limited, 2012a).

8.6.77 Historical analysis of black seabream monitoring data identified black seabream nesting areas tend to correspond to shallow waters (<10m) with thin layers of coarse sediments (10 to 30cm deep) overlying bedrock within the general vicinity of rocky outcrops (GoBe, 2015). BGS data identified areas of chalk beds within the intertidal area of the offshore export cable corridor and within the north-eastern tip of the array area (see **Figure 8.13, Volume 3** of the ES (Document Reference 6.3.8)).

8.6.78 Black seabream arrive on the south coast in early spring and construct nests on the seafloor into which eggs are laid. Preferred spawning substrates are open gravel areas, gravel areas adjacent to chalk reefs, sandstone reefs and ships wreckage (Vause and Clark, 2011; Southern Science, 1995). A study by James *et al*. (2011) detailed the presence of underwater chalk features in the central and eastern English Channel. After fertilizing the eggs, males remain in close proximity to the nests protecting them from predators and keeping them clean from excessive siltation. After hatching, juveniles remain in the vicinity of the nests until they reach a length of 7 to 8cm, they then remain in the inshore area for a further two to three years (Vause and Clark, 2011). It is expected that the bream exhibit site fidelity, perhaps returning to the same sites to spawn annually (James *et al*., 2011; Sussex IFCA, 2018).

8.6.79 The broader nearshore area, both within the proposed offshore export cable corridor and outwith the proposed DCO Order Limits , is of noted importance for black seabream, with a significant body of evidence compiled by Sussex IFCA (Fugro EMA, 2015; Sussex IFCA, 2016) the marine aggregate industry (via the MALSF and site-specific monitoring) contributing to the understanding of black seabream spawning within the area. Black seabream is a designated feature of the Kingmere MCZ which lies to the north of the Rampion 2 array area off the coast of Worthing, and adjacent to the Rampion 2 offshore export cable corridor. Further afield, angling records note regular catches of black seabream along the coast of the English Channel from Eastbourne in the East, through to Devon and Alderney in the West, inclusive of inshore areas such as Kingmere Rocks and Swanage Bay, and mid-channel wrecks. Despite this range it is recognised that the core area for black seabream nesting appears to be from Shoreham harbour through to Swanage Bay.

8.6.80 In 2014, Sussex IFCA conducted SSS survey and underwater video surveys of Kingmere MCZ in collaboration with Cefas and Eastern IFCA to map seabed habitats and investigate the extent of black seabream nest locations and densities. In 2015, Sussex IFCA used this information to collect SSS data at known black seabream nest locations outside of repeat monitoring areas being re-surveyed the same year. Sussex IFCA data indicated that the majority of black seabream nest areas in 2014 fell outside of the repeat monitoring areas conducted by the aggregates industry biennially and were located in the north/north-east of the site (Fugro EMU, 2015).

8.6.81 During the period 2002 onwards, site-specific studies have been undertaken to inform the characterisation and monitoring of predicted effects for a cluster of marine aggregate dredging sites (Licence Areas 453, 488, 396 and 435) in close proximity to the Rampion 2 offshore export cable corridor. The data have been collected specifically to understand the potential changes associated with aggregate extraction at Area 435 and 396 (for which seasonal restrictions were not required), and the characterisation and monitoring of impacts associated with the extraction at Area 488 (for which a seasonal restriction on activities was required for the period April to June inclusive). All licensed activities must not be undertaken in the Eastern Section of Area 453 (Zone B) between 1st April and 31st July inclusive, and in the Western Section of Area 453 (Zone A) between 1st April and 30th June. The following sections provide a summary of the conclusions drawn from the data, commencing with the most recent datasets which provide an overview of activities undertaken since designation of the Kingmere MCZ (within which 453 and 488 are located) and commencement of extraction in 2017.

8.6.82 Geophysical and DDV surveys were conducted by ABPmer between May and July 2020 for Tarmac Marine Ltd and CEMEX Marine Ltd, in relation to aggregate Areas 453 and 488. These surveys were to determine whether there had been any changes in black seabream nest density and distribution at the seven survey sites, since previous surveys in 2019, 2017 and during the period 2002 to 2013. In addition, two transect sites were surveyed to determine any changes in black seabream nest activity compared to previous surveys in 2019 and 2017 (note that data for the two additional (2017 and 2019) transect areas was not available in preceding years for comparison). Following the geophysical survey, and in line with previous surveys used to characterise the MCZ, black seabream nests were characterised into three distinct groups (dense nests, less dense nests and small patches of nests).

8.6.83 The comparisons within the 2020 report, appear to show an increase in black seabream nests within the majority of the Study Area, with the additional 2020 transects showing an increase in nest density in comparison to both 2019 and 2017 data (ABPmer, 2020a). DDV data were collected to ground truth the geophysical survey data. The video and photographic data from the DDV surveys were assessed for the distribution and abundance of black seabream nests, the presence of black seabream eggs during the spawning season, and to determine the seasonal extent of black seabream spawning (known breeding season in 2020 was April to June, this has since been updated in 2021 to reflect a breeding season between March to July (NE, 2021)). On 2 June 2020, 272 black seabream nests were identified, with 172 nests recorded on 30 July 2020 using high-resolution video and stills photography within seven monitoring areas, two within the Rampion 2 offshore export cable corridor (survey Area 1 and 2) and five within the Kingmere MCZ, as well as two transect areas located within the Kingmere MCZ (ABPmer, 2020b).

8.6.84 Survey Area 1 and Area 2 are located within the Rampion 2 offshore export cable corridor. The 2020 data identified a small area of dense nests in the east of Survey Area 1; however, the area of nests appears to have decreased in size since 2019 (ABPmer, 2020b). Nests were present within areas of exposed chalk bedrock, with nest distribution running north and east of the rocky outcrop. Dense black seabream nests were observed across Survey Area 2 (which lies closest to the western extent of Kingmere MCZ), being located north of the rocky outcrops and extending across the full width of the survey area (ABPmer, 2020b). To the south, two further areas of 'dense nests' were recorded as well as narrow bands of less dense/patchy nests. Dense black seabream nests were recorded in areas containing exposed chalk bedrock features. It is notable that both the spatial extent and density of nests appear to have increased since the original 2002 survey (ABPmer, 2020b).

8.6.85 Seven Tenths Ecology Ltd. (7TE) analysed the images and data collected during the ABPmer 2020 survey (2020b). 7TE noted black seabream nests were identified in each of the DDV surveys completed between early June and late July 2020 (7TE, 2021). In total, 245 different black seabream nests were identified from the high-resolution images, during the 2 June 2020 survey; 64% of these were classified as either tended or potentially tended nests. Analysis undertaken by 7TE (2021) also recorded 4,005 black seabream nests in video footage obtained across all transects in June of which 89.4% of nests observed were classified as being tended by male black seabream, 0.1% potentially tended and 10.5% as untended. 7TE (2021) flagged that the tended nests did not necessarily contain eggs but were comparatively (to untended nests) free from colonising taxa (particularly those that might predate eggs) and had very little or no surface silt or larger sediment fractions present. The 10 July 2020 survey recorded approximately 5% of black seabream nests were potentially tended by male black seabream, with zero nests recorded as tended. This was supported by video footage taken during the survey which identified 1,796 nests and confirmed the presence of eggs on just two nests along one transect. Overall, the video data indicated a similar percentage (approximately 4%) of tended or potentially tended nests as the still image data. Untended nests accounted for approximately 96% of those observed from the video data. In the 30 July 2020 survey only one potentially tended nest was recorded out of 170 black seabream nests across all transects, with 100% of the 2,389 nests analysed from the video footage showing untended nests.

8.6.86 When considered in the context of previous studies these data demonstrate that the region, from Kimmeridge to Shoreham, is of importance to black seabream nesting.

8.6.87 As noted previously during the period 2002 to 2013 a number of monitoring studies were undertaken in compliance with the marine licence conditions for regional marine aggregates areas, and in support of the now licenced marine aggregate extraction areas 453 and 488. The areas surveyed focus primarily on discrete areas in and around Kingmere Rocks, and the subsequently designated Kingmere MCZ, with two areas (Area 1 and Area 2) corresponding with the eastern segment of the export cable corridor adjacent to Kingmere MCZ

(**Figures 8.14a** (Document Reference 6.3.8) and **8.14b, Volume 3** of the ES (Document Reference 6.3.8)). The monitoring confirms that nests exist to the west of the Kingmere MCZ, within a discrete section of the proposed offshore export cable corridor. During the period 2002 to 2013, and subsequently, in the period 2015 to 2020, there is a significant body of data available to confirm the distribution of black seabream nests during the critical spawning season. The data (2002, 2009, 2011, 2017, 2018, 2019, 2020) demonstrate that nests are present annually, within a discrete spatial area of the surveyed areas, within the offshore export cable corridor (**Figure 8.14a** (Document Reference 6.3.8) and **8.14b,** (Document Reference 6.3.8) **Volume 3** of the ES).Site specific data indicate that the area surveyed as part of the aggregate extraction monitoring is likely to represent a discrete area of sediment veneer that does not extend across the full export cable corridor. This conclusion is drawn from the consistent line of nests in each data set, which although vary in density each year, consistently bisect the overall survey 'box' in an approximately NWN-ESE direction with other areas in the survey box consistently not having nests recorded, however for the purposes of this assessment consideration will be given to the risk of direct impacts occurring on areas of spawning potential.

8.6.88 Sussex IFCA catch and release black seabream data (**Figure 8.15, Volume 3** of the ES (Document Reference 6.3.8)) illustrate higher site fidelity to areas within the Kingmere MCZ (in this context this is assumed as recapture points).The data further demonstrate that within the offshore export cable corridor itself, nests are present in a discrete area, with bream captured in greater densities across Kingmere Rocks, and to the west of the Rampion 2 offshore export cable corridor, in addition to within the export cable corridor itself. The data appear to indicate capture of black seabream occur along a ridge feature with discrete areas of greatest focus – the Kingmere Rocks, an area within the proposed export cable corridor, and areas to the west of the proposed export cable corridor. **Figure 8.13, Volume 3** of the ES (Document Reference 6.3.8) supports this assertion by illustrating the presence of thin veneer Quaternary sediments over a narrow band of sandstone and rock running broadly parallel to the coast in a west to east direction.

8.6.89 For the purposes of understanding potential effect-receptor pathways, these data provide appropriate information to inform the EIA and confirm that there is a risk of direct disturbance to areas of nesting and / or nesting potential that may not be avoidable. Whilst a specific environmental measure has not been embedded within the design of the Proposed Development at this stage, there are a suite of measures available to reduce the magnitude, and therefore significance of direct disturbance (see RED, 2022).

Future baseline

8.6.90 From the point of assessment, over the course of the development and operational lifetime of the Proposed Development (operational lifetime anticipated to be approximately 30 years from first power), long-term trends indicate that the condition of the baseline environment is expected to evolve. This section provides a qualitative description of the evolution of the baseline environment, on the assumption that the Proposed Development is not constructed, using available information and scientific knowledge of fish and shellfish ecology.

8.6.91 An assessment of the future baseline conditions in the absence of the Proposed Development has been carried out and is described within this section. The baseline environment is not static and will exhibit some degree of natural change over time, with or without the Proposed Development in place, due to naturally occurring cycles and processes. Therefore, when undertaking the impact assessment, it is necessary to place any potential impacts in the context of the envelope of change that might occur naturally over the timescale of the Proposed Development.

8.6.92 Recent research has suggested that there have been substantial changes in the fish communities in the northeast Atlantic over several decades as a result of a number of factors including climate change and fishing activities (DECC, 2016). These communities consist of species that have complex interactions with one another and the natural environment. Fish and shellfish populations are subject to natural variation in population size and distributions, largely as a result of year-to-year variation in recruitment success and these population trends will be influenced by broad-scale climatic and hydrological variations, as well as anthropogenic activities such as climate change and overfishing.

8.6.93 Fish and shellfish play a pivotal role in the transfer of energy from some of the lowest to the highest trophic levels within the ecosystem and serve to recycle nutrients from higher levels through the consumption of detritus. Consequently, their populations will be determined by both top-down factors, such as ocean climate and plankton abundance, and bottom-up factors, such as predation. Fish and shellfish are important prey items for top marine predators including elasmobranchs, seabirds, cetaceans and humans, and small planktivorous species such as sandeel and herring act as important links between zooplankton and top predators (Frederiksen *et al*., 2006).

8.6.94 Climate change may influence fish distribution and abundance, affecting growth rates, recruitment, behaviour, survival and response to changes of other trophic levels. Over the past 30 years, warming has been most pronounced to the north of Scotland and in the North Sea, with sea-surface temperature increasing by up to 0.24°C per decade (MCCIP, 2020). Within the English Channel and the southern North Sea, increased sea surface temperatures may lead to an increase in the relative abundance of species associated with more southerly areas. For example, data on herring and sardine (*Sardina* sp.) landings at ports in the English Channel and the southern North Sea showed that higher herring landings were correlated with colder winters, while warm winters were associated with large catches of sardine (Alheit and Hagen, 1997). Studies have shown that anchovy (*Engraulis encrasicolus*) have extended their distribution throughout the North Sea, from which they were largely absent until the mid-1990s (Alheit *et al*., 2012) becoming more established within the English Channel. Moreover, a study on black seabream stocks within the English Channel found the mean annual frequency of occurrence of black seabream off Plymouth has increased with rising sea temperature between 1913 and 2003 (Arkley and Caslake, 2004). MCCIP (2020) suggest the warming of UK shelf seas is projected to continue over the coming century, with most models suggesting an increase of between 0.25°C and 0.4°C per decade. Warming is expected to be greatest in the English Channel and the North Sea, with smaller increases in the outer UK shelf regions (MCCIP, 2020).

8.6.95 A potential effect of increased sea surface temperatures is the distribution of some fish species will extend into deeper, colder waters. In these cases, however, habitat requirements are likely to play an important role, as some shallow water species will have specific habitat requirements found in shallow water areas which are not available in deeper areas. For example, due to the specific habitat requirements for coarse sandy sediment, sandeel are less likely to be able to adapt to increasing temperatures; declining recruitment in sandeel in parts of the UK has been correlated with increasing temperature (Heath *et al*., 2012). Climate change may also affect key life history stages of fish and shellfish species, including the timing of spawning migrations (Department for Business, Energy and Industrial Strategy (BEIS), 2016). For example, warming temperatures has led to earlier spawning for sole, with warming and associated oxygen solubility appears to be affecting the age at maturation, growth rates, and the maximum size fish can attain (MCCIP, 2020). However, climate change effects on marine fish populations are difficult to predict and the evidence is not easy to interpret, therefore it is difficult to make accurate estimations of the future baseline scenario for the entire lifetime of the Proposed Development (approximately 30 years).

8.6.96 The Proposed Development will offset greenhouse gas emissions and increase the security of electricity supply, thereby assisting with the delivery of Government policy and the meeting of renewable energy targets.

8.6.97 In addition to climate change, overfishing subjects many fish species to considerable pressure, reducing the biomass of commercially valuable species, and non-target species (by-catch). Overfishing can reduce the resilience of fish and shellfish populations to other pressures, including climate change and other anthropogenic impacts. For example, a study on cod in an area where trawl fishing has been banned since 1932 indicated that this population was significantly more resilient to environmental change (including climate change) than populations in neighbouring fished areas (Lindegren *et al*., 2010). Conversely modelling by Beggs *et al*. (2013) indicated that cod may be more sensitive to climate variability during periods of low spawning stock biomass. There are indications that overfishing in UK waters is reducing to some degree, with declines in fishing mortality estimates in recent years for crustacean, demersal and benthic stock groups. ICES advice also suggests that some of the stocks (benthic and demersal) have shown signs of recovery since 2000. Similar, but less dramatic, changes are also evident for pelagic species (ICES, 2018). OSPAR's Quality Status Report (OSPAR, 2010) concluded that many fish stocks are still outside safe biological limits, although there have been some improvements in some stocks. Should these improvements continue, this may not result in significant changes in the species assemblage in the English Channel fish and shellfish Study Area, although may result in increased abundances of the characterising species present in the area.

8.6.98 Moreover, the Sussex IFCA introduced the Nearshore Trawling Byelaw 2019 which came into effect on the 22 March 2021. This byelaw updates a previous trawling exclusion byelaw, which incorporated a seasonal trawling ban in inshore IFCA waters. The Nearshore Trawling Byelaw 2019 bans trawling along a large area of the Sussex inshore coastline out to 4km between Selsey and Shoreham-by-Sea and encompasses Selsey Bill and the Hounds MCZ. The aim of this byelaw is to protect essential fish habitat and encourage the regeneration of marine habitats – particularly kelp forests – that act as nursery and feeding

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grounds for fish species, and prevent damage to sensitive marine habitats (Sussex IFCA, 2021).

8.6.99 Further to natural variation, significant work is being undertaken in the region to protect and restore kelp. The Sussex Kelp Restoration Project was launched in 2021 and will support and enhance the kelp communities within Sussex, with the aim of restoring 300km^2 of kelp along the Sussex coast. The restoration of this habitat will likely result in an increase in biodiversity and ecosystem services, including carbon sequestration and reducing coastal erosion (Rewilding Britain, 2022).

8.6.100 Therefore, the Proposed Development fish and shellfish baseline characterisation described in the preceding sections represents a ‘snapshot’ of the present fish and shellfish assemblages of the English Channel, within a gradual and continuously changing environment. Any changes that may occur during the lifetime of the Proposed Development (including construction, operation and maintenance and decommissioning) should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment, and the changes that would be expected to occur naturally in the absence of the Proposed Development.

8.7 Basis for ES assessment

Maximum design scenario

8.7.1 Assessing using a parameter-based design envelope approach means that the assessment considers a maximum design scenario whilst allowing the flexibility to make improvements in the future in ways that cannot be predicted at the time of submission of the DCO Application. The assessment of the maximum design scenario for each receptor establishes the maximum potential adverse impact and as a result impacts of greater adverse significance will not arise should any other development scenario (as described in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference 6.2.4)) to that assessed within this Chapter be taken forward in the final scheme design.

8.7.2 The maximum parameters and assessment assumptions that have been identified to be relevant to fish and shellfish ecology are outlined in **Table 8-12** and are in line with the Project Design Envelope (**Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference 6.2.4)).

Table 8-12 Maximum parameters and assessment assumptions for impacts on fish and shellfish ecology[3]

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
Construction			
Mortality, injury, behavioural changes and auditory masking arising from noise and vibration	**Monopile turbine parameters** Up to 90 monopiles (smaller turbines, 10m diameter) Or Up to 65 monopiles (larger turbines, 13.5m diameter) **Multi-leg turbine parameters** Up to 90 multileg foundations (smaller turbines, 3.5m pin pile diameter) (4 legs per foundation, 4 pin piles per multi-leg foundation) Or	**Maximum design scenario (monopiles)** Sequential installation of 2 13.5m diameter monopiles at two separate locations simultaneously - 4 monopiles within a 24-hour period Maximum hammer energy 4,400kJ 4 monopiles per day, 4.5-hour piling duration per pile **Maximum design scenario (multileg foundations)**: Sequential piling of multileg foundations (4.5m diameter piles) at two separate locations simultaneously – 4 pin piles at each location - 8	The maximum spatial design scenario equates to the greatest effect from subsea noise at any one-time during piling. In terms of simultaneous (concurrent) piling, for stationary receptors, this scenario assumes the sequential installation the piles of a multileg foundation (4 pin piles) at two locations simultaneously (total of 8 pin piles installed in a 24-hour period), with a hammer energy of 2,500kJ. When the receptor is presumed to remain stationary, this will create a total area of ensonification that is greater than the simultaneous piling of monopile foundations (despite the fact that the installation of monopiles requires a higher hammer energy). For fleeing receptors, the worst-case scenario assumes the sequential

[3] Please note: hearing category group 4 is not in Popper et al. (2014), but is considered to be a suitable category for this species.

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Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
	Up to 65 multileg foundations (larger turbines, 4.5m pin pile diameter) (4 legs per foundation, 4 pin piles per multi-leg foundation) **Offshore substation parameters (monopile foundations)** Up to 3 offshore substations 13.5m diameter monopile foundations (larger turbines) **Offshore substation parameters (multileg foundations)** Up to 3 offshore substations Up to 6 legs per substation Up to 12 pin piles per substation (up to 4.5m diameter)	pin piles within a 24-hour period Maximum hammer energy 2,500kJ 8 pin piles per day (4.5 hours piling per pin pile) 30-minute soft-start ramp up. **WTG foundation installation:** Crew transport vessels; 400 trips - assuming 4 visits per foundation for bolting and finalising purposes from local construction harbour The total number of vessel return trips made during construction = 2,473	installation of monopile foundations (2 monopiles) at two locations simultaneously (total of 4 monopiles installed in a 24-hour period) with a higher hammer energy (4,400kJ). The installation of monopile foundations introduces more sound to the water more quickly, while the receptor remains relatively close to the pile. Whilst when compared to the installation of pin piles for multileg foundations, by the time the third or fourth pin piles are driven, the fleeing receptor is much further from the pile, and so the additional exposure this causes to the total is small. The maximum temporal design scenario represents the longest duration of effects from subsea noise. This scenario assumes pin-pile foundations, which could result in a longer duration of piling per foundation due to the additional number of pin piles required.

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
Direct disturbance resulting from the installation of the export cable	**Export cable assessment parameters:** Total length- 170km	**Total habitat disturbance:** 8,970,000m^2 **Boulder clearance in the offshore export cable corridor:** Total clearance impact area - Pre-lay Plough/ Pre-lay grapnel = 1,700,000m^2 Total clearance impact area - subsea grab = 1,020,000m^2 **Offshore export cable installation:** Total seabed disturbance = 6,250,000m^2	The maximum design scenario for offshore export cable installation is defined by the largest area of disturbance as a result of installation and clearance of boulders within the offshore export cable area of search during construction.
Direct disturbance resulting from construction within the array	**Maximum offshore interconnector cable parameters:** Total cable length – 40km	**Boulder clearance in the array area:** Total clearance impact area - Pre-lay Plough/ pre-lay grapnel for cables (based on array cables, interconnector	The maximum design scenario for seabed preparation with the array area is defined by the largest area of disturbance as a result of installation and clearance of boulders within the array area during construction.

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
	Array cable installation assessment parameters Up to 4 cable crossings Impact area for cable/pipeline crossings (array) = 10,000m^2	cables and export cables in the array area) = 8,800,000m^2 Total clearance impact area - subsea grab for cables (based on array cables and export cables in the array area) = 5,280,000m^2 Total clearance impact area - Foundations and Jack-up legs (based on number of WTG, jack-up legs with a 15m buffer) = 1,313,000m^2 **Sandwave clearance in the array area** Total sandwave clearance area = 600,000 m^2 Construction vessel anchorage footprint = 334,000m^2 **Interconnector cable installation** Total seabed disturbance = 1,000,000m^2 **Array cable installation**	

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		Total seabed disturbance = 6,250,000m^2	
Temporary and localised increases in SSC and smothering	**Maximum offshore interconnector cable parameters:** Total cable length – 40km **Export cable assessment parameters:** Total length- 170km	**Total volume disturbed:** 2,614,005m^3 **Sandwave clearance** Total sandwave clearance volume in array area = 1,375,000m^3 (including up to 475,000m^3 for foundations, and up to 900,000m^3 for cables) **WTG foundations spoil volume:** Spoil volume per WTG foundation from drill arising (larger WTG type monopile: 8,588.33 m^3 x 33 (50% of 65) monopiles = 283,414.85m^3. **Spoil volume for offshore substation foundations:** Spoil volume per offshore substation foundation (multileg with pin piles foundations) from drilling	The maximum design scenario for foundation installation results from largest volume suspended from seabed preparation (suction bucket multileg) or the largest volume suspended from potential drilling of foundations (monopiles) as these are mutually exclusive, both with the maximum number of foundations) and using sandwave clearance techniques that liberate the maximum amount of suspended material. For cable installation, the maximum design scenario results from the greatest volume from sandwave clearance and installation. This also assumes the largest number of cables and the greatest burial depth.

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		arisings (if drilling required) = 11,451m^3 11,451m^3x 3 offshore substations = 34,353m^3. **Export cable installation** Burial spoil (ploughing/mass flow excavation/trenching) = 340,000m^3 Total HDD exit pit excavated material volume = 1,248m^3 fluid (99,840kg bentonite) Maximum volume and mass of drilling fluid released for all four HDD conduits: 1,248m^3 fluid (99,840kg bentonite) Burial spoil (ploughing/mass flow excavation/trenching) = 340,000m^3 **Interconnector cable installation** Burial spoil (ploughing/mass flow excavation/trenching) = 80,000m^3 **Array cable installation**	

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Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		Burial spoil (ploughing and jetting/mass flow excavation) = 500,000m^3	
Direct and indirect seabed disturbances leading to the release of sediment contaminants	Seabed disturbance arising from installation of foundations and cables as described above in '*Temporary and localised increases in SSC and smothering*'.		This represents the maximum design scenario for the Proposed Development and therefore the maximum volume of contaminated sediment that may be released into the water column during construction activities.
Operation and Maintenance			
Long-term loss of habitat and increased hard substrate and structural complexity due to the presence of turbine foundations, scour protection and cable protection	**Maximum WTG multi-leg foundation with suction buckets foundation assessment parameters** Number of legs per foundation: 4 Number of pin piles per foundation: 4 **Offshore substation parameters** Up to 6 legs per substation Up to 12 pin piles per substation (up to 4.5m diameter)	**Total habitat loss/change:** 1,390,900m^2 **WTG and substation foundations:** WTG footprint (based on 65 WTG scenario) with scour protection = 6,000m^2 (per multi-leg foundation with suction buckets). 6,000m^2 x 65 monopiles = 390,000m^2 Offshore substation footprint (multileg with pin piles	The maximum design scenario is defined by the maximum area of seabed lost as a result of the placement of structures, scour protection and cable protection. Habitat loss from drilling and drill arisings will occur within the same footprint of the infrastructure and scour protection.

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
	Maximum offshore interconnector cable parameters: Total cable length – 40km **Export cable assessment parameters:** Total length- 170km	foundation) with scour protection = 7,300m^2 (per substation). **Offshore substation footprint with scour protection - 3 offshore substations** 7,300m^2 x 3 multileg foundations = 21,900m^2. **Array and interconnector cables** Maximum rock protection area for array cable crossings: 10,000m^2 Maximum rock protection area for array cables (based on 20% of 250km cable requiring protection) = 300,000m^2 Maximum rock protection area for interconnector cables (based on 20% of 40km cable requiring protection) = 122,000m^2	

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		Offshore export cable corridor Maximum rock protection area for export cables (based on 20% of 170km cable requiring protection) = 517,000m^2	
Electromagnetic field (EMF) impacts arising from cables	**Turbine parameters** Up to 90 WTGs (smaller turbines) **Maximum offshore interconnector cable parameters:** Total cable length – 40km **Export cable assessment parameters:** Total length- 170km	**WTGs** 90 WTGs **Array Cables** Up to 250km of array cable operating at a maximum of 132kV. Target cable depth = 1m **Interconnector Cables** Up to 50km of interconnector cable (two cables approximately 25km in length), operating up to 275kV. Target cable depth = 1m **Offshore Export Cables**	The maximum design scenario is associated with the greatest length of inter-array cable and four export cables as this results in the longest total length of export cable

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		Length of cable corridor 170km operating up to 275kV. Target cable depth = 1.5m	
Direct disturbance resulting from maintenance within the array area and the offshore cable corridor		**Total direct disturbance to seabed:** 4,334,900m^2 The calculations for maintenance are as follows: **WTG maintenance** *Major WTG component replacement* Maximum of 4 events per WTG over the lifetime of the Proposed Development = 350. The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%) 350 events x 1,100m^2 footprint = 385,000m^2 *WTG access ladder replacement*	Defined by the maximum number of jack-up vessel operations and maintenance activities that could have an interaction with the seabed anticipated during operation.

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		Maximum of 450 ladder replacement events. The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%) 450 events x 1,100m^2 footprint = 506,000m^2 *Wind WTG anode replacement* Maximum of 450 anode replacement events. The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%) 450 events x 1,100m^2 footprint = 506,000m^2 *WTG J-tube replacement or modification* Maximum of 180 J-tube replacement or modification. The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%)	

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		180 events x 1,100m^2 footprint = 198,000m^2 **Offshore substation and accommodation** *Offshore substation platform major component replacement* Maximum of 27 exchange events (9 per platform). The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%) 27 events x 1,100m^2 footprint = 29,700m^2 *Offshore platform access ladder replacement* Maximum of 30 ladder replacement events (assumes 3 platforms, 2 ladders per platform). The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%)	

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Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		30 events x 1,100m^2 footprint = 33,000m^2 *Offshore platform anode replacement* Maximum of 60 anode replacement events (assumes 4 legs on each of 3 platforms). The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%). 60 events x 1,100m^2 footprint = 66,200m^2 *Offshore platform J-Tube replacement* Maximum of 60 J-tube replacement or modification (assumes 2 per J-Tube over lifetime). The footprint of seabed disturbance for all events via jacking-up activities = 1,100m^2 (+ 10%) 60 events x 1,100m^2 footprint = 66,000m^2 **Array cables**	

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
		Total footprint of seabed disturbance for all array remedial burial events = 2,800,000m^2 (14 events x 200,000m^2) Total footprint of seabed disturbance for array cable repairs = 6,600m^2 (6 events x 1,100m^2). **Export cables** The maximum temporary footprint of seabed disturbance for all export cable corridor remedial burial events = 240,000m^2 (3 events per cable (4 cables) x 20,000m^2) Total footprint of seabed disturbance for all export cable repairs via jacking-up activities = 4,400m^2 (4 events x 1,100m^2).	

Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
Decommissioning[4]			
Mortality, injury, behavioural changes and auditory masking arising from noise and vibration	Maximum levels of underwater noise during decommissioning will be from underwater cutting required to remove structures. This is much less than that arising during the construction (pile installation) phase and therefore impacts will be less than (well within) the case assessed during the construction phase. Piled foundations will likely be cut approximately 1m below the seabed.		This will result in the maximum potential disturbance associated with noise associated with decommissioning activities including foundation decommissioning.
Direct disturbance resulting from the removal of the export cable	Removal of all cables and rock protection leading to a temporary loss/change.	**Offshore export cable** Total seabed disturbance = 4,250,000m^2 Maximum rock protection area for export cables = 517,000m^2 **Total seabed disturbance:** = 4,250,000m^2	Maximum design scenario is assumed to be similar to the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables and rock protection is considered the maximum design scenario, however the necessity to remove cables and rock protection will be reviewed at the time of decommissioning.

[4] The approach to decommissioning will be detailed in the Decommissioning Plan, which will be developed to cover the decommissioning phase as required under Chapter 3 of the Energy Act 2004. It is noted that Decommissioning Plan will be subject to best practice at the time of decommissioning and surveys conducted to assess the quality of the communities established and a decision on infrastructure removal made in conjunction with the statutory authorities and key stakeholders.

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Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
			Removal will be subject to agreement with key stakeholders as part of the decommissioning plan.
Direct disturbance resulting from decommissioning within the array	**Maximum offshore interconnector cable parameters:** Total cable length – 40km **Array cable installation assessment parameters** Up to 4 cable crossings Impact area for cable/pipeline crossings (array) = 10,000m^2	**Interconnector cable** Total seabed disturbance = 1,000,000m^2 **Array cable** Total seabed disturbance = 6,250,000m^2 **Array and interconnector cables** Maximum rock protection area for array cable crossing = 10,000m^2. Maximum rock protection area for array cables (based on 20% of cable requiring protection) = 300,000m^2 Maximum rock protection area for interconnector cables (based on 20% of cable requiring protection) = 122,000m^2	Maximum design scenario is assumed to be similar to the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables and rock protection is considered the maximum design scenario, however the necessity to remove cables and rock protection will be reviewed at the time of decommissioning. Removal will be subject to agreement with key stakeholders as part of the decommissioning plan.

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Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
Temporary and localised increases in SSC and smothering	The impacts are expected to be equivalent to construction apart from the structures that may remain (e.g., cable protection measures to be removed but not cables)[5]		Maximum design scenario is assumed to be as per the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables is considered the maximum design scenario, however the necessity to remove cables will be reviewed at the time of decommissioning. Removal will be subject to agreement with key stakeholders as part of the decommissioning plan. The removal of cables is considered the Maximum design scenario, however the necessity to remove cables will be reviewed at the time of decommissioning. Removal will be subject to agreement with key stakeholders as part of the decommissioning plan.
Direct and indirect seabed disturbances leading to the	As above for construction impacts.		This scenario represents the maximum total seabed disturbance and therefore the maximum amount of contaminated sediment that may be released into the

[5] It is noted that this will be subject to best practice at the time of decommissioning and surveys conducted to assess the quality of the communities established and a decision on their removal made in conjunction with the statutory authorities.

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Project phase and activity/impact	Maximum parameters	Maximum assessment assumptions	Justification
release of sediment contaminants			water column. Maximum design scenario as per the construction phase and assumes the removal of all foundations and buried subtidal and intertidal cables.

Embedded environmental measures

8.7.3 As part of the Rampion 2 design process, a number of embedded environmental measures have been adopted to reduce the potential for impacts on fish and shellfish ecology. These embedded environmental measures have evolved over the development process as the EIA has progressed and in response to consultation.

8.7.4 These measures also include those that have been identified as good or standard practice and include actions that would be undertaken to meet existing legislation requirements. As there is a commitment to implementing these embedded environmental measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of Rampion 2 and are set out in this ES.

8.7.5 **Table 8-13** sets out the relevant embedded environmental measures within the design and how these affect the fish and shellfish ecology assessment.

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Table 8-13 Relevant fish and shellfish ecology embedded environmental measures

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
C-38	The selection of the foundation type will primarily be based upon the site conditions combined with the wind turbine generator (WTG) that is selected. The following foundation types are being considered: Monopile and Multi-leg.	Scoping	DCO requirements or deemed Marine Licence (dML) conditions.	These measures will ensure that the correct site and foundation selected will have the least effect on fish and shellfish ecology.
C-40	There will be up to three offshore substations installed to serve the Proposed Development. The exact locations, design and visual appearance will be subject to a structural study and electrical design, which is expected to be completed post consent. The offshore substations will be installed on multi-leg or monopile foundations, similar to those described for the wind turbine generators (WTGs) themselves.	Scoping	DCO requirements or deemed Marine Licence (dML) conditions.	These measures will ensure that the correct site and foundation selected will have the least effect on fish and shellfish ecology.
C-41	The subsea interarray cables will typically be buried at a target burial depth of 1m below the seabed surface. The final depth of the cables will be dependent on the seabed geological conditions and the risks to the cable (e.g. from anchor drag damage).	Scoping	Deemed Marine Licence (dML) conditions.	This measure will reduce the risk of EMF impacts on sensitive receptors and requirements for cable protection, therefore minimising any long-term habitat loss.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
C-42	The subsea inter-array cables and the subsea export cables will be installed using one or a combination of the three methods: ploughing, trenching or jetting. It is likely that a combination of these methods will be adopted for localised areas depending on seabed conditions. The installation methods will be selected during detailed design and tendering phases.	Scoping	DCO requirements or dML conditions.	These measures will ensure that cable installation will have the least effect on seabed habitats, which will minimise impacts on substrates of key importance to demersal spawning fish receptors.
C-44	An **Outline Scour Protection and Cable Protection Plan** (Document Reference 7.12) has been submitted with this application, and includes details of the need, type, quantity and installation methods for scour protection. A Final Scour Protection and Cable Protection Plan will be completed prior to construction commencing and submitted to the Marine Management Organisation (MMO) for approval.	Scoping	DCO requirements or dML conditions.	This measure will minimise where possible long-term habitat loss, which will minimise impacts on substrates of key importance to demersal spawning fish receptors..
C-45	Where possible, subsea cable burial will be the preferred option for cable protection. Cable burial will be informed by the cable burial risk assessment and detailed within the Cable Specification and Installation Plan.	Scoping	DCO requirements or dML conditions	This measure will reduce the risk of EMF impacts on sensitive receptors,

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
				and minimise the potential for long term habitat loss which will minimise impacts on substrates of key importance to demersal spawning fish receptors.
C-52	A piling Marine Mammal Mitigation Protocol (MMMP) will be implemented during construction and will be developed in accordance with Joint Nature Conservation Committee (JNCC, 2010) guidance and with the latest relevant guidance and information and in consultation with stakeholders. The piling MMMP will include details of soft starts to be used during piling operations with lower hammer energies used at the beginning of the piling sequence before increasing energies to higher levels. A **Draft Piling Marine Mammal Protocol** (Document Reference 7.14) has been submitted with this application.	Scoping - updated at PEIR	DCO requirements or dML conditions	The use of soft start procedures for piling deter marine life, therefore reducing the noise exposure to fish and shellfish receptors.
C-53	An Outline Marine Pollution Contingency Plan (MPCP) has been submitted with this Application as Appendix A of the **Outline Project Environmental Management Plan** (Application Document Reference 7.11). This Outline MPCP provides details of procedures to protect personnel working and to safeguard the marine environment and mitigation measures in the event of an	Scoping updated for ES	DCO requirements or dML conditions	This measure will minimise the risk of accidental pollution associated with the Proposed

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
	accidental pollution event arising from offshore operations relating to Rampion 2. The Final MPCP will include relevant key emergency contact details.			Development on sensitive receptors.
C-65	The proposed offshore cable corridor and cable landfall (below mean high water springs [MHWS]) will avoid all statutory marine designated areas.	Scoping	DCO requirements or dML conditions	The implementation of this measure will ensure direct impacts to protected sites and designated features are avoided.
C-95	The assessment has taken into consideration the mitigation and control of invasive species measures, this has been incorporated into the **Outline Project Environmental Management Plan** (PEMP) (Document Reference 7.11).	Scoping updated for ES	DCO requirements or dML conditions	This measure will reduce where possible the risk of introducing invasive species into the region.
C-96	Subsea array and export cables will be installed via either ploughing, jetting, trenching, or post-lay burial techniques, to a target burial depth of 1m. Consideration will be given to the method that minimises the environmental impacts as far as practicable.	Scoping	DCO requirements or dML conditions.	This measure will reduce the risk of EMF impacts on sensitive receptors and requirements for cable protection, therefore minimising any long-term

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
				habitat loss, which will minimise impacts on substrates of key importance to demersal spawning fish receptors.
C-102	A UXO Clearance Marine Mammal Mitigation Protocol (MMMP) will be developed in consultation with Natural England to appropriately manage the risk to marine mammals during UXO clearance. A **Draft UXO Clearance MMMP** (Document Reference 7.15) has been submitted with this Application.	Scoping updated for ES	DCO requirements or dML conditions	This measure will also be of benefit to sensitive fish and shellfish receptors within the Proposed Development fish and shellfish Study Area.
C-111	A Decommissioning Plan will be prepared for the project in line with the latest relevant available guidance.	PEIR	DCO requirements or dML conditions	This measure will be developed to cover the decommissioning phase and will minimise impact on fish and shellfish receptors, where appropriate.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
C-265	Double big bubble curtains will be deployed as the minimum single offshore pilling noise mitigation technology will be utilised to deliver underwater noise attenuation for all foundation installations throughout the construction of the Proposed Development where percussive hammers are used in order to reduce predicted impacts to: • sensitive receptors at relevant Marine Conservation Zone (MCZ) sites and reduce the risk of significant residual effects on the designated features of these sites; • spawning herring; and • marine mammals.	ES updated for Examination	DCO requirements or dML conditions	The implementation of this commitment will reduce predicted impacts from underwater noise on sensitive receptors, features of MCZs principally nesting black seabream and breeding seahorse.
C-269	Cable routeing design will be developed to ensure micrositing where possible to identify the shortest feasible path avoiding subtidal chalk and reef features, peat and clay exposures and areas considered to potentially support black seabream nesting.	ES	DCO requirements or dML conditions	The implementation of this measure will ensure direct impacts to subtidal chalk features and consequently potential black seabream nesting areas.
C-270	As part of the routeing design, a working separation distance (buffer) will be maintained wherever possible from sensitive features, notably black seabream nesting areas, as informed by the outputs of the physical processes assessment, to limit the potential for impacts to arise (direct or indirect)).	ES	DCO requirements or dML conditions	The implementation of this measure will mitigate impacts to all seabed habitats, but particularly

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ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
				chalk and reef areas as well as potential (unknown) black seabream nesting locations, where avoidance is not possible
C-271	The offshore export cable routeing design will target areas of the seabed that enable maximising the potential for cables to be buried, thus providing for seabed habitat recovery in sediment areas and reducing the need for secondary protection and consequently minimising any potential for longer-term residual effects.	ES	DCO requirements or dML conditions	The implementation of this measure will mitigate impacts to all seabed habitats, aiding recovery.
C-272	Adoption of specialist offshore export cable laying and installation techniques will minimise the direct and indirect (secondary) seabed disturbance footprint to reduce impacts, which will provide mitigation of impacts to all seabed habitats, but particularly chalk and reef areas, peat and clay exposures, as well as potential (unknown) black seabream nesting locations, where avoidance is not possible. The Applicant will seek to utilise the most appropriate technology available at the time of construction and operation, if required, to reduce the direct footprint impact from cutting machinery.	ES	DCO requirements or dML conditions	The implementation of this measure will mitigate impacts to all seabed habitats, but particularly chalk and reef areas as well as potential (unknown) black seabream nesting locations, where avoidance is not possible.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
C- 273	A seasonal restriction will be put in place to ensure offshore export cable corridor installation activities (including construction and installation, preparatory works during cable installation, UXO clearance, preventive or scheduled maintenance, inspections and decommissioning) are undertaken outside the black seabream breeding period (1st March- 31st July inclusive) to avoid any effects from installation works on black seabream nesting within or outside of the Kingmere MCZ. This does not apply to emergency work required to maintain the operation, safety and integrity of the infrastructure.	ES updated for Examination	DCO requirements or dML conditions	The implementation of this measure is to avoid any effects from installation works on black seabream nesting.
C-274	Commitment to commence piling at locations furthest from the Kingmere MCZ during the black seabream breeding period (March-July), to reduce effects from installation works on breeding black seabream within or outside of the Kingmere MCZ.	ES	DCO requirements or dML conditions	The implementation of this commitment will reduce predicted impacts from underwater noise on sensitive receptors, features of MCZs principally nesting black seabream and breeding seahorse.

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ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
C-275	The use of low order detonations using the 'deflagration method' will be the prioritised method of disposal for Offshore UXOs, and will be implemented, where practicable.	ES updated for Examination	DCO requirements or dML conditions	This measure will also be of benefit to sensitive fish and shellfish receptors within the Proposed Development fish and shellfish Study Area.
C-279	As part of the construction method statement, RED will produce a foundation installation methodology, including a dredging protocol, drilling methods and disposal of drill arisings and material extracted.	ES	DCO requirements or dML conditions	This measure will be of direct benefit to seabed habitats by minimising and managing total impact.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
C-280	Commitment that no piling will occur in the piling exclusion zones during the seabream breeding period (March-July) which will be defined by the modelling in the Final Sensitive Features Mitigation Plan.	ES	DCO requirements or dML conditions	The implementation of this commitment will reduce predicted impacts from underwater noise on sensitive receptors, features of MCZs principally nesting black seabream and breeding seahorse.
C-281	Commitment to no piling within the western part of the Rampion 2 offshore array closest to the Kingmere MCZ during the majority of the black seabream breeding period (March-June); and sequenced piling in the western part of the Offshore Array Area during July in accordance with the zoning plan to be set out in the Final Sensitive Features Mitigation Plan, to reduce the risk of significant effects from installation works on breeding black seabream within or outside of the Kingmere MCZ.	ES	DCO requirements or dML conditions	The implementation of this commitment will reduce predicted impacts from underwater noise on sensitive receptors, features of MCZs principally nesting black seabream and breeding seahorse.
C-283	Gravel bags laid on the seabed to protect the cable barge during construction of Rampion 2, will be removed prior to the completion of construction, where practicable.	Examination	DCO requirements or dML conditions	This measure will minimise the total impact to seabed

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
				habitats which will minimise impacts on substrates of key importance to demersal spawning fish receptors.
C-288	The Applicant is committed to minimising the release of plastics into the marine environment, and commits to using suitable alternatives, where this is practicable.	Examination	DCO requirements or dML conditions	This measure will minimise the total impact to seabed habitats which will minimise impacts on substrates of key importance to demersal spawning fish receptors.
C-289	The Applicant will use secondary protection material, where practicable, that has the greatest potential for removal on decommissioning of the Proposed Development.	Examination	DCO requirements or dML conditions	The implementation of this measure will mitigate impacts to all seabed habitats from long term habitat loss which will minimise impacts on substrates of key importance to

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
				demersal spawning fish receptors.
C-297	The location of gravel bags will be microsited to avoid sensitive features, where practicable.	Examination	DCO requirements or dML conditions	This measure will minimise the total impact to seabed habitats, which will minimise impacts on substrates of key importance to demersal spawning fish receptors.
C-298	Where appropriate, the results of post-consent monitoring, data and reports will be made publicly available and provided to the relevant data repositories.	Examination	DCO requirements or dML conditions	Post consent monitoring will be undertaken to validate, within reason, the assumptions made within Chapter 8: Fish and shellfish ecology, Volume 2 (Document Reference: 6.2.8).

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ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to fish and shellfish ecology assessment
C-300	Cable protection will be used that minimises the environmental impacts as far as practicable. At the point of selecting a cable protection supplier, consideration will be given to using the method of cable protection which is likely to be removable at decommissioning.	Examination	DCO requirements or dML conditions	This measure will minimise the total impact to seabed habitats, which will minimise impacts on substrates of key importance to demersal spawning fish receptors.

8.8 Methodology for ES assessment

Introduction

8.8.1 The project-wide generic approach to assessment is set out in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference 6.2.5)). The assessment methodology for fish and shellfish ecology for the ES is consistent with that provided in the Scoping Report (RED, 2020) and no changes have been made since the scoping phase. Further method statements in relation to fish and shellfish ecology and underwater noise assessment, were also submitted to stakeholders and agreed through the EIA EPP. These were incorporated into the PEIR provided alongside Statutory Consultation and have been included in the ES.

8.8.2 The assessment of potential impacts upon fish and shellfish receptors is based on the maximum design scenario as identified from the design envelope (see **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference 6.2.4)). The key assumptions are the layout of the wind farm, the number and size of offshore structures, the type and size of foundations used, as well as the timing and duration of the proposed offshore works (see **Table 8-12**).

8.8.3 The assessment method used in the fish and shellfish ecology impact assessment is in line with the Chartered Institute for Ecological and Environmental Management (CIEEM) guidance (CIEEM, 2018). For each of the identified receptors, impacts have been considered throughout the construction, operation and maintenance and decommissioning phases of the Proposed Development.

8.8.4 Cumulative effects have been assessed by taking into consideration all other relevant developments, proposed or existing, that are in the vicinity of proposed DCO Order Limits, and which have the potential to affect the same receptors. Where other developments are expected to be completed prior to the construction of the Proposed Development, and the effects of these developments are fully determined, the effects arising from the developments have been considered as part of the baseline and may also be considered as part of the construction and operational cumulative assessment. Developments forming part of the dynamic baseline, and those included in the cumulative assessment have been identified in **Section 8.12**.

Guidance

8.8.5 Guidance on the EIA process has been sought from the following resources:

- Guidelines for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018);
- Guidance note for Environmental Impact Assessment in respect of FEPA 1985 and CPA 1949 requirements (Cefas *et al*., 2004);
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Judd, 2012);

- Guidance on Environmental Considerations for Offshore Wind Farm Development (OSPAR, 2008); and
- Renewable UK (2013) Cumulative impact assessment guidelines, guiding principles for cumulative impacts assessments in offshore wind farm.

8.8.6 In addition, the EIA follows the legislative framework as defined by the Wildlife and Countryside Act 1981 (as amended); the Marine and Coastal Access Act 2009 (as amended); The Conservation of Offshore Marine Habitats and Species Regulations 2017; and the Conservation of Habitats and Species Regulations 2010 (as amended).

Impact assessment criteria

8.8.7 The approach to determining the significance of the effect is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts. The terms used to define sensitivity and magnitude are informed by the EIA Regulations 2017, and the Ministry of Housing, Communities and Local Government's (MHCLG) EIA Planning Practice Guidance (DCLG, 2017) has been applied in undertaking the EIA, as part of the ES. Further details are provided in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference 6.2.5).

8.8.8 The sensitivities of fish and shellfish receptors are defined by both their potential vulnerability to an impact from the proposed development, their recoverability, and the value or importance of the receptor. Throughout the assessment, receptor sensitivities have been informed by thorough review of the available peer-reviewed scientific literature, and assessments available on the Marine Life Information Network (MarLIN) database. It is acknowledged that the MarLIN assessments have limitations. These limitations have been taken into account and other information and data accessed where relevant.

8.8.9 The definitions of terms relating to sensitivity and magnitude are outlined below in **Table 8-14** and **Table 8-15**.

Table 8-14 Definition of terms relating to receptor sensitivity or value

Sensitivity	Definition used in this chapter
High	Receptor is highly vulnerable to impacts that may arise from the project and recoverability is long term or not possible. Receptor is of national to international value / importance.
Medium	Receptor is generally vulnerable to impacts that may arise from the project and has low to medium recoverability. Receptor is of regional to national value / importance.
Low	Receptor is somewhat vulnerable to impacts that may arise from the project and has moderate levels of recoverability. Receptor is of local to regional value / importance.

Sensitivity	Definition used in this chapter
Negligible	Receptor is not vulnerable to impacts regardless of value/ importance. Locally important receptors with low vulnerability and medium to high recoverability.

8.8.10 The magnitude of potential impacts is defined by a series of factors including the spatial extent of any interaction, the likelihood, duration, frequency and reversibility of a potential impact. The definitions of the levels of magnitude used in the assessment as shown in **Table 8-15**.

Table 8-15 Definition of terms relating to magnitude of impact

Magnitude of impact	Definition used in this chapter
Major	Impact is of long-term duration and / or is of extended physical extent and is expected to result in one or more of the following: 1) loss of resource and/or quality and integrity of resource; and 2) severe damage to key characteristics, features or elements. (Adverse)
	Impact is expected to result in one or more of the following: 1) large scale or major improvement or resource quality; 2) extensive restoration or enhancement; and 3) major improvement of attribute quality. (Beneficial)
Moderate	Impact is of medium-term duration and / or is of moderate physical extent and is expected to result in one or more of the following: 1) loss of resource, but not adversely affecting integrity of resource; and 2) partial loss of / damage to key characteristics, features or elements. (Adverse)
	Impact is expected to result in one or more of the following: 1) benefit to, or addition of, key characteristics, features or elements; and 2) improvement of attribute quality. (Beneficial)
Minor	Impact is of short-term duration and / or is of limited physical extent and is expected to result in one or more of the following: 1) some measurable change in attributes, quality or vulnerability; and

Magnitude of impact	Definition used in this chapter
	2) minor loss or, or alteration to, one (maybe more) key characteristic, features or elements. (Adverse)
	Impact is expected to result in one or more of the following: 1) minor benefit to, or addition of, one (maybe more) key characteristic, features or elements; and 2) some beneficial impact on attribute or a reduced risk of negative impact occurring. (Beneficial)
Negligible	Impact is of short-term duration and / or is of negligible physical extent and is expected to result in the following: 1) very minor loss or detrimental alteration to one or more characteristics, features or elements. (Adverse)
	Impact is expected to result in the following: 1) very minor benefit to, or positive addition of one or more characteristics, features or elements. (Beneficial)

8.8.11 The significance of effect upon fish and shellfish ecology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in **Table 8-16**, with the final assessment for each effect based upon expert judgement. For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be **Not Significant** in terms of the EIA Regulations, 2017.

Table 8-16 Matrix used for the assessment of the significance of residual effect

Sensitivity	Magnitude of Change: Major	Moderate	Minor	Negligible
High	Major (Significant)	Major (Significant)	Moderate (Potentially significant)	Minor (Not significant)
Medium	Major (Significant)	Moderate (Potentially significant)	Minor (Not significant)	Minor (Not significant)
Low	Moderate (Potentially significant)	Minor (Not significant)	Minor (Not significant)	Negligible (Not significant)
Negligible	Minor (Not significant)	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)

8.9 Assessment of effects: Construction phase

Introduction

8.9.1 The impacts of the construction of the Proposed Development have been assessed on fish and shellfish receptors in the Study Area. The effects arising from the construction of the Proposed Development are listed in **Table 8-12** along with the maximum design scenario assumptions against which each construction phase impact has been assessed.

8.9.2 A description of the significance of effects upon fish and shellfish receptors caused by each identified impact is given below.

Mortality, injury, behavioural changes and auditory masking arising from noise and vibration

8.9.3 The assessment below focuses on underwater noise from pile-driving (monopiles and pin piles) for the installation of foundations for offshore structures (i.e., WTGs and offshore substations), cable installation, vessel disturbance and UXO clearance. To inform the assessment of potential impacts associated with underwater noise as a result of the installation of foundations, predictive underwater noise modelling has been undertaken for the relevant piling maximum design scenario, full details of which are presented in **Appendix 11.2: Marine mammal quantitative underwater noise impact assessment, Volume 4** of the ES (Document Reference 6.4.11.2).

8.9.4 The predictive subsea noise modelling for foundation installation has been undertaken at four locations (locations illustrated in **Figure 8.16, Volume 3** of the ES (Document Reference 6.3.8)), with consideration of the key parameters associated with two maximum design scenarios, a spatial maximum design scenario (the scenario with the greatest potential spatial extent of impact) and a temporal maximum design scenario (the scenario with the longest potential duration), as set out below. There is the potential for foundations to be installed both sequentially (multiple piles installed at separate locations within a period of 24 hours) and simultaneously (multiple piles at different locations within the array area). Each scenario is assessed through reference to the predictive modelling, and the relevant metric and associated threshold criteria for the key fish and shellfish receptors. The scenarios assessed are also tabulated within **Table 8-17**.

8.9.5 UXO removal will be sought in a separate future Marine Licence application, when there is greater certainty on the quantum of UXO requiring clearance, prior to construction, using high resolution geophysical survey data.

Definition of Maximum Design Scenarios for underwater noise

8.9.6 The following provides further information on the definition of the maximum design scenario for underwater noise. As detailed in **Table 8-12**, several activities have the potential to introduce an effect-receptor pathway for underwater noise. These can be broadly characterised as underwater noise associated with general seabed clearance, installation and vessel operations, underwater noise associated with foundation installation, and underwater noise associated with UXO specific seabed clearance.

8.9.7 General construction noise, arising from general vessel movements, dredging and seabed preparation works will generate low levels of continuous sounds (i.e., from the vessels themselves and/or the sounds from dredging tools). As detailed within **Chapter 13: Shipping and navigation, Volume 2** of the ES (Document Reference 6.2.13), the proposed DCO Order Limits are subject to high levels of shipping activity currently, and it is expected that the vessel activity would be no greater than the baseline during construction activities (due to construction exclusion zones reducing current shipping activity and the number of construction vessels expected to be much lower than that which currently transit the area).). The underwater noise impacts from vessel noise is generally spatially limited to the immediate area around the vessel rather than having impacts over a wide area (**Appendix 8.3: Underwater noise study for sea bream disturbance, Volume 4** of the ES (Document Reference 6.4.8.3)).

8.9.8 The piling maximum design scenarios are defined according to a maximum design scenario, i.e. the maximum design parameters that may be utilised during the construction of the Proposed Development, and a most-likely scenario, i.e. the most realistic design parameter that may be utilised during the construction of the Proposed Development.

8.9.9 In this context it is important to note that the maximum hammer energies assumed in the maximum design scenario are likely to be highly conservative and that in fact for many piling events, a lesser hammer energy will be required to complete the pile installation. **Table 8-17** provides the maximum design scenario for each scenario.

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Table 8-17 Maximum Design Scenario Piling Scenarios

Parameter	Single piling scenarios[6]		Sequential piling scenarios		Simultaneous piling scenario			
Piling scenario	Piling of a single pile, (monopiles, or pin piles)		Sequential installation of two monopiles, or multileg foundation (four pin piles), at a single location, within a 24-hour period		Simultaneous installation of single piles (one monopile, or one multileg foundation (four pin piles)) at both the East and West piling locations in the array area, within a 24-hour period		Sequential installation of multiple piles (two monopiles, or one multileg foundations (4 pin piles)) simultaneously at both the East and West piling locations in the array area, within a 24-hour period	
Foundation type	Monopiles	Multileg foundations (pin piles)	Monopiles	Multileg foundations (pin piles)	Monopiles	Multileg foundations (pin piles)	Monopiles	Multileg foundations (pin piles)
Pile Diameter	13.5m	4.5m	13.5m	4.5m	13.5m	4.5m	13.5m	4.5m
Hammer energy (maximum)	4,400 kJ	2,500 kJ	4,400 kJ	2,500 kJ	4,400 kJ	2,500 kJ	4,400 kJ	2,500 kJ
Hammer energy (most likely maximum)	4,000 kJ	2,000 kJ	4,000 kJ	2,000 kJ	4,000 kJ	2,000 kJ	4,000 kJ	2,000 kJ
Maximum number of piles	90	360	90	360	90	360	90	360

[6] Note that the modelling of a single pin pile has been undertaken purely for direct comparison with the piling of a single monopile.

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Parameter	Single piling scenarios[6]		Sequential piling scenarios		Simultaneous piling scenario			
Maximum piling duration	93 piling days (1 monopile per day)	99 days (4 pin piles per day)	45 days (2 monopiles per day)	99 days (4 pin piles per day)	45 days (2 monopiles per day)	99 days (4 pin piles per day)	23.25 days (4 monopiles per day)	49.5 days (8 pin piles per day)

8.9.10 The spatial maximum design scenario equates to the greatest area of effect from subsea noise at any one-time during piling. This is considered to result from the sequential installation of the piles of a multileg foundation (four pin piles) simultaneously at both the East and West piling locations in the array area for stationary receptors. For fleeing receptors, the maximum design scenario results from the sequential installation of monopile foundations simultaneously (two monopiles) at both the East and West piling locations in the array area (**Appendix 11.3: Underwater noise assessment technical report, Volume 4** of the ES (Document Reference 6.4.11.3)). The temporal maximum design scenario represents the longest duration of effects from subsea noise, this is also considered to result from the sequential installation of multileg foundations.

8.9.11 The sequential piling maximum design scenario represents greatest area of effect from subsea noise from the piling of multiple piles (monopile or multileg foundations) at separate locations within a 24-hour period. The simultaneous piling maximum design scenario equates to the greatest in combination area of effect from subsea noise from the piling of single and multiple piles (monopile or multileg foundations) at two different locations (East and West piling locations) within the array area.

8.9.12 With regards the seabed clearance works associated with UXO, as part of the site preparation activities for Rampion 2, UXO clearance will potentially be required. Whilst not always required, destructive UXO clearance through detonation of the UXO introduces a further underwater noise effect-receptor pathway that may result in an effect on noise sensitive receptors. The UXO clearance is anticipated to be completed within the Rampion 2 array area and the export cable corridor, as part of the pre-construction site preparatory works. Several UXO devices with a range of charge weights (or quantity of contained explosive) have been identified within the boundaries of the Rampion 2 site.

8.9.13 Detonation of UXO will represent a short term (seconds) increase in underwater noise (sound pressure levels and particle motion) and while noise levels will be elevated such that this may result in injury or behavioural effects on fish and shellfish species, these effects will be considerably reduced compared to those associated with piling operations. Clearance of UXO, if any are located prior to the construction of the Proposed Development, will be necessary to reduce the risk to personnel and equipment during the construction process. Until detailed pre-construction surveys are undertaken across the Proposed Development array area and offshore export cable corridor, the number of potential UXO which will need to be cleared is unknown. However, as the clearance of UXO is an activity which is likely to occur, for completeness it has been considered within this assessment. It should be noted, that in the event that UXO clearance is required, low-order detonation will be used where possible, however, to ensure a precautionary assessment, the assessment is based on worst-case assumptions (i.e., that high order detonation will be used on all UXOs).

8.9.14 The following sections consider the potential sensitive receptors, and provide information regarding the metrics and thresholds for assessment, followed by the assessment of the following effect-receptor pathways:

- Underwater noise associated with foundation installation;

- Spatial maximum design scenario, monopile foundations (maximum and most likely scenarios);
- Temporal maximum design scenario, multileg foundations (maximum and most likely scenarios);
- Sequential piling scenarios for monopile and multileg foundations (maximum and most likely scenarios); and
- Simultaneous piling scenario for monopile and multileg foundations (single and multiple pile scenarios).

- Underwater noise associated with UXO clearance.

Receptor sensitivity and criteria for assessment

8.9.15 Underwater noise can potentially have a negative impact on fish and shellfish species ranging from behavioural effects to physical injury/mortality. In general, biological damage as a result of sound energy is either related to a large pressure change (barotrauma) or to the total quantity of sound energy received by a receptor. Barotrauma injury can result from exposure to a high intensity sound even if the sound is of short duration (i.e., UXO clearance or a single strike of a piling hammer). However, when considering injury due to the energy of an exposure, the time of the exposure becomes important. Fish and shellfish are also considered to be sensitive to the particle motion element of underwater noise; an impact considered more important than sound pressure for many species, particularly invertebrates. However, research into this impact on fish populations is scarce, representing a source of uncertainty in the assessment process. For the purposes of the assessment, **Appendix 11.3: Underwater Noise Assessment Technical Report, Volume 4** of the ES (Document Reference 6.4.11.3) presents the results of modelling for a range of noise levels, representing the maximum design scenario and the most likely scenarios (based on variable hammer energies as defined in **Table 8-17**) for the installation of both monopiles and pin piles. The modelling results for cumulative sound exposure level (SEL_{cum}) provide outputs for both fleeing receptors (with the receptors fleeing from the source at a consistent rate of 1.5 ms-1), and stationary receptors to account for spawning activity for more static demersal spawners such as herring and sandeel, receptors of low mobility such as sea horse, and receptors engaged in nesting and spawning behaviours such as black seabream.

8.9.16 A fleeing rate of $1.5ms^{-1}$ is considered conservative, in relation to data from Hirata (1999). However, throughout the assessment a 'static receptor model' is also considered for the purposes of undertaking a precautionary assessment. A stationary model is considered as certain animals may be motivated to remain in the affected area, despite the noise exposure (e.g., due to prey availability, mating opportunities or protecting a nest) (Faulkner *et al*., 2018). Although, it is acknowledged that not all fleeing animals will travel in a straight line away from the source of noise, a fleeing model is also considered as travelling away responses tend to be more common than travelling towards response, and they comprise of around 50 to 90% of the total escapes (Domenici *et al*., 2011). Moreover, Faulker *et al*. (2018) also highlighted that assuming animals remain stationary for extended periods of time, including close to source, is unrealistic.

Injury Criteria

8.9.17 Peer-reviewed guidelines published by the Acoustical Society of America (ASA) provide directions and recommendations for setting criteria (including injury and behavioural criteria) for fish. For the purposes of this assessment, the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al*., 2014) were considered to be most relevant for impacts of underwater noise on fish species. The Popper *et al*. (2014) guidelines broadly group fish into the following categories based on their anatomy and the available information on hearing of other fish species with comparable anatomies.

- Group 1: Fishes lacking swim bladders that are sensitive only to sound particle motion and show sensitivity to a narrow band of frequencies (includes flatfishes and elasmobranchs).
- Group 2: Fishes with a swim bladder where the organ does not appear to play a role in hearing. These fish are sensitive only to particle motion and show sensitivity to a narrow band of frequencies (includes salmonids).
- Group 3: Fishes with swim bladders that are close, but not intimately connected to the ear. 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 about 500Hz (includes gadoids).
- Group 4: Fishes that have special structures mechanically linking the swim bladder to the ear. 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 (includes clupeids such as herring, sprat and shads).

8.9.18 The fish receptors within the Rampion 2 Study Area have been grouped into the Popper *et al*. (2014) categories based on their hearing system, as outlined in **Table 8-18**. In the case of shellfish, there are no specific impact criteria; therefore, an assessment has been based on a review of peer-reviewed literature on the current understanding of the potential effects of underwater noise on shellfish species.

Table 8-18 Hearing categories of fish receptors *(Popper et al., 2014)*

Category	Fish receptor relevant to the proposed DCO Order Limits
Group 1	Dover sole, lemon sole, dab, plaice, sandeel, mackerel, sea lamprey and elasmobranch (thornback ray, undulate ray, tope and lesser spotted dogfish)
Group 2	Atlantic salmon, sea trout and European eel*
Group 3	Black seabream, cod, European seabass and whiting
Group 4	Herring, sprat and shad species and seahorse

* Denotes uncertainty or lack of current knowledge with regards to potential role of swim bladder in hearing for eels. Sand and Karlsen (1986) suggest the swim bladder is not thought to provide auditory gain in the infrasound frequency range (<20Hz).

8.9.19 The Popper *et al.* (2014) guidance provides specific criteria (as both unweighted SPL_{peak} and unweighted SEL_{cum} values) for a variety of noise sources: in this case, the impact piling (pile driving) criteria have been considered. The criteria used for modelling are summarised in **Table 8-19**.

Table 8-19 Criteria for onset of injury in fish due to piling activity (Popper *et al*., 2014)

Type of animal	Mortality and potential mortal injury	Impairment	
		Recoverable injury	TTS
Fish: no swim bladder (Group 1)	>219 dB SEL_{cum} >213 dB SPL_{peak}	>216 dB SEL_{cum} >213 dB SPL_{peak}	>>186 dB SEL_{cum}
Fish: swim bladder is not involved in hearing (Group 2)	210 dB SEL_{cum} >207 dB SPL_{peak}	203 dB SEL_{cum} >207 dB SPL_{peak}	>186 dB SEL_{cum}
Fish: swim bladder involved in hearing (Group 3 and 4)	207 dB SEL_{cum} >207 dB SPL_{peak}	203 dB SEL_{cum} >207 dB SPL_{peak}	186 dB SEL_{cum}
Eggs and larvae	>210 dB SEL_{cum} >207 dB SPL_{peak}	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low
For eggs and larvae, relative risk (high, moderate, low) is given for animals at three distances from the source in relative terms as near field (N: 10s of metres), intermediate field (I: 100s of metres), and far field (F: 1000s of metres) (Popper *et al.,* 2014). (>> (much greater than)).			

8.9.20 The following sections present the assessment of potential impacts on noise sensitive fish receptors, initially presenting consideration of mortality and mortal injury, then presenting recoverable injury, temporary threshold shift and finally potential behavioural impacts. Each section initially presents the predicted magnitude of impact for each receptor, before then considering the sensitivity of the receptor, and finally presenting the predicted significance of effect with regards the EIA Regulations, 2017.

8.9.21 The results of the noise modelling for mortality and potential mortal injury, recoverable injury and TTS from the installation of monopile or multileg

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foundations in different receptor groups are presented in **Table 8-20** and **Table 8-21** for the worst case location within the array area (south modelling location[7]).

[7] Due to the bathymetry of the site, the impact ranges are the greatest from the South modelled location. As a precautionary approach these have therefore been presented below. The full suite of modelling outputs from all locations are presented in **Volume 4, Appendix 11.3 Underwater noise assessment technical report**.

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Table 8-20 Worst-case noise/most-likely impact ranges for fleeing and stationary fish at the South modelled location from monopile and pin pile installation within the array (single piling scenarios).

Receptor	Criteria	Noise level (dB re 1 µPa SPL/ dB re 1 µPa^2 s SEL	Impact ranges from the South modelled location			
			Monopile		Pin-pile	
			Fleeing (worst-case/most likely)	Stationary (worst-case/most likely)	Fleeing (worst-case/most likely)	Stationary (worst-case/most likely)
	Mortality and potentially mortal injury					
Group 1	SPL_{peak}	>213	120 m, 120 m	120 m, 120 m	100 m, 90 m	100 m, 90 m
	SEL_{cum}	>219	< 100 m, < 100 m	950 m, 700 m	< 100 m, < 100 m	750 m, 500 m
Group 2	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	210	< 100 m, < 100 m	3.5 km, 2.5 km	< 100 m, < 100 m	2.8 km, 1.9 km
Group 3 and 4	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	207	< 100 m, < 100 m	5.2 km, 3.8 km	< 100 m, < 100 m	4.3 km, 2.9 km
Eggs and larvae	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	>210	< 100 m, < 100 m	3.5 km, 2.5 km	< 100 m, < 100 m	2.8 km, 1.9 km
	Recoverable injury					
Group 1	SPL_{peak}	>213	120 m, 120 m	120 m, 120 m	100 m, 90 m	100 m, 90 m
	SEL_{cum}	>216	< 100 m, < 100 m	1.5 m, 1.1 km	< 100 m, < 100 m	1.2 km, 800 m
Group 2	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	203	400 m, 250 m	8.4 km, 6.3 km	< 100 m, < 100 m	7 km, 5 km
Group 3 and 4	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	203	400 m, 250 m	8.4 km, 6.3 km	< 100 m, < 100 m	7 km, 5 km
	TTS					
Group 1	SEL_{cum}	186	24 km, 22 km	35 km, 30 km	21 km, 19 km	32 km, 27 km
Group 2	SEL_{cum}	186	24 km, 22 km	35 km, 30 km	21 km, 19 km	32 km, 27 km
Group 3 and 4	SEL_{cum}	186	24 km, 22 km	35 km, 30 km	21 km, 19 km	32 km, 27 km
fleeing fish = 1.5ms^{-1}						

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Table 8-21 Worst-case noise/most-likely impact ranges for fleeing and stationary fish at the South modelled location from monopile and pin pile sequential installation within the array.

Receptor	Criteria	Noise level (dB re 1 µPa SPL/ dB re 1 µPa2 s SEL)	Impact ranges from the South modelled location for sequential installation			
			Monopile (2 sequentially installed piles)		Pin-pile (4 sequentially installed piles)	
			Fleeing (worst-case/most likely)	Stationary (worst-case/most likely)	Fleeing (worst-case/most likely)	Stationary (worst-case/most likely)
Mortality and potentially mortal injury						
Group 1	SPL_{peak}	>213	120 m, 120 m	120 m, 120 m	100 m, 90 m	100 m, 90 m
	SEL_{cum}	>219	< 100 m, < 100 m,	1.5 km, 1.1 km	< 100 m, < 100 m	1.9 km, 1.3 km
Group 2	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	210	< 100 m, < 100 m,	5.2 km, 3.8 km	< 100 m, < 100 m	6.2 km, 4.4 km
Group 3 and 4	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	207	< 100 m, < 100 m,	7.4 km, 5.6 km	< 100 m, < 100 m	8.9 km, 6.4 km
Eggs and larvae	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	>210	< 100 m, < 100 m,	5.2 km, 3.8 km	< 100 m, < 100 m	6.2 km, 4.4 km
Recoverable injury						
Group 1	SPL_{peak}	>213	120 m, 120 m	120 m, 120 m	100 m, 90 m	100 m, 90 m
	SEL_{cum}	>216	< 100 m, < 100 m,	2.3 km, 1.7 km	< 100 m, < 100 m	2.8 km, 1.9 km
Group 2	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	203	450 m, 300 m	12 km, 9 km	< 100 m, < 100 m	14 km, 10 km
Group 3 and 4	SPL_{peak}	>207	310 m, 300 m	310 m, 300 m	260 m, 230 m	260 m, 230 m
	SEL_{cum}	203	450 m, 300 m	12 km, 9 km	< 100 m, < 100 m	14 km, 10 km
TTS						
Group 1	SEL_{cum}	186	25 km, 24 km	41 km, 36 km	22 km, 20 km	44 km, 38 km
Group 2	SEL_{cum}	186	25 km, 24 km	41 km, 36 km	22 km, 20 km	44 km, 38 km
Group 3 and 4	SEL_{cum}	186	25 km, 24 km	41 km, 36 km	22 km, 20 km	44 km, 38 km
fleeing fish = 1.5ms-1						

Spatial distribution of sensitive features within the offshore export cable corridor and array area

8.9.22 Black seabream nests have been recorded within the Proposed Development cable corridor area through targeted repeat aggregate industry surveys, as well as the specific geophysical and benthic surveys undertaken in 2020 and 2021. Recognising that the wider area in the vicinity of the Kingmere MCZ is known to support black seabream spawning (nesting), there is a focus for the mitigation on the MCZ itself as it is within this site that specific protection is afforded the species during the spawning season. Notwithstanding, a reduction in noise propagation extents as a result of the embedded environmental measures proposed will ensure an attendant reduction in the risk of impact to all nesting areas (both known/mapped and potential/unknown locations) for the species in the wider area.

8.9.23 Records of seahorses are limited across the southwestern region, however again there are specific locations where seahorse is a listed feature, as described in above (**Section 8.6**), where individuals will be aggregated whilst breeding through the summer period. As outlined for black seabream, there are also wider areas within which seahorse will represent noise-sensitive receptors, specifically during the overwintering period for these species when it is understood they migrate to deeper waters further offshore. Low numbers of spiny/long-snouted and short-snouted seahorses have been observed in the area of the Proposed Development in common with the wider region.

8.9.24 With regard to herring, the proposed DCO Order Limits has a spatially limited interaction with a very small portion of the IHLS larval heatmap area (lowest abundance areas (0 or 0.1-750 larvae/m^2) and no direct overlap with recorded spawning grounds. The embedded environmental measures and approach presented will provide mitigation for the risk of disturbance to herring spawning activity through the reduction in noise propagation extents effected by the measures, however on the basis of the evident separation distance from the locations of piling, there is a low risk of any adverse effects arising even without mitigation as set out within this chapter.

Mortality and potential mortal injury

8.9.25 The following paragraphs provide the assessment of potential impacts on each receptor for the spatial maximum design scenario (maximum followed by most likely), temporal maximum design scenario (maximum followed by most likely) and sequential and simultaneous piling scenarios for underwater noise associated with foundation installation.

8.9.26 Initial consideration is given to the sensitivity of each receptor to underwater noise, before characterising the scale and magnitude of effect before providing the overall conclusion.

Sandeel

8.9.27 Sandeel (Group 1 receptor, mortality onset at >219 dB SEL_{cum}) are considered stationary receptors, due to their burrowing nature, substrate dependence, and demersal spawning behaviours, and therefore may have limited capacity to flee the area compared to other Group 1 receptors.

Magnitude of impact

8.9.28 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to sandeel spawning grounds (West location), and therefore have the greatest potential for impacts on spawning sandeel.

8.9.29 With regards to the single piling of monopiles, noise modelling suggests that the potential for mortality and potential mortal injury of spawning sandeel from noise impacts of monopile installation may occur up to 750m from the array area (4,00kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 110m from the array area (SPL_{peak}). Noise modelling for the most likely/realistic maximum impacts from monopile installation showed the potential for mortality and potential mortal injury may occur up to a maximum range of 550m from the array, a reduced impact than that proposed from the maximum design scenario. Instantaneous injury may occur up to 100m from the array area (SPL_{peak}).

8.9.30 The potential for mortality and potential mortal injury of spawning sandeel from multileg foundation installation may occur up to 600m from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 90m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for mortality and potential mortal injury may occur up to a maximum range of 450m from the array, a reduced impact than that resulting from the maximum design scenario. Instantaneous injury may occur up to 80m from the array area (SPL_{peak}).

8.9.31 The potential for mortality and potential mortal injury of spawning sandeel from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 1.2 km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.16, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for mortality and potential mortal injury may occur up to 850m from the array.

8.9.32 The potential for mortality and potential mortal injury of spawning sandeel from the sequential installation of four multileg foundations at a single location (multileg foundations) has the potential to occur up to 1.4km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.17, Volume 3** of the ES (Document Reference 6.3.8)), whilst piling impacts under the 'most-likely' scenario could occur up to 950m from the array area.

8.9.33 The potential for mortality and potential mortal injury of spawning sandeel from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 4.2km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 9.9km^2. The potential for mortality and potential mortal injury of spawning sandeel from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 2.7km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 15km^2.

8.9.34 Low intensity sandeel spawning and nursery habitats are located in the Rampion 2 fish and shellfish Study Area (see **Figure 8.3** (Document Reference 6.3.8), and **Figure 8.9, Volume 3** of the ES (Document Reference 6.3.8)). The degree of overlap between spawning and nursery grounds of the species and the area with potential for potential injury will be very small relative to the total area that the species could use for spawning in the English Channel and the southern North Sea (Jensen *et al*., 2011). Therefore, taking this into account, the spatial extent of the impact in the context of the wider environment is considered small, with the overall short duration of piling and its intermittent nature, the magnitude of impact that construction activities relating to the Proposed Development will have on sandeel is therefore considered to be **minor**.

Sensitivity or value of receptor

8.9.35 Sandeel lack a swim bladder and are therefore considered less sensitive to underwater noise. Sandeel are considered stationary receptors, due to their burrowing nature, substrate dependence, and demersal spawning behaviours, and therefore may have limited capacity to flee the area compared to other Group 1 receptors. Group 1 receptors are thought to be affected by vibration through the seabed, particularly when buried in the seabed during hibernation. Taking this into account, sandeel are deemed to be of low vulnerability, medium recoverability and are of regional importance. The sensitivity of the receptor to noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.36 Sandeel spawning habitat occurs over a large area across the English Channel and into the southern North Sea, including within the Rampion 2 fish and shellfish Study Area. Due to their demersal nature, sandeel are considered a stationary receptor to underwater noise in this assessment, and therefore will be exposed to underwater noise from piling activity during the construction phase of the Proposed Development. However, due to their reduced sensitivity, and small degree of disturbance to spawning grounds in the context of the wider habitat availability in the English Channel and within the southern North Sea, the species are assessed as having medium sensitivity to underwater noise during construction, and the magnitude of impact is deemed to be minor, therefore the effect on sandeel is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Herring

8.9.37 Herring (Group 4, mortality onset at 207 dB SEL_{cum}) have a swim bladder that is involved in hearing, and therefore are known to be sensitive to underwater noise. Herring are a mobile species and are expected to vacate the area in which the impact could occur with the onset of 'soft start' piling, however herring are considered sensitive due to their hearing ability and their demersal spawning nature. Due to a key herring spawning ground located to the south of the array area (**Figure 8.8, Volume 3** of the ES (Document Reference 6.3.8)) and the spawning site fidelity displayed by herring, and the consequential likelihood of herring not fleeing from piling noise when engaged in spawning activity, herring are considered stationary receptors for the sake of this assessment.

Magnitude of impact

8.9.38 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to herring spawning grounds (South location), and therefore have the greatest potential for impacts on spawning herring.

8.9.39 With regards the single piling of monopiles, noise modelling suggests that the potential for mortality and potential mortal injury from monopile installation on herring during peak spawning season (Downs stock; November to January) may occur up to 5.2km from the array area. Instantaneous injury may occur up to 310m from the array area (SPL_{peak}). On the basis of the static receptor modelling there is no overlap between from the array noise contours (207 dB SEL_{cum}) and herring spawning grounds.

8.9.40 Noise modelling for the most likely impacts from monopile installation showed the potential for mortality and potential mortal injury in this scenario may occur up to a maximum range of 3.8km from the array on spawning herring, a reduced impact than that arising from the maximum design scenario hammer energies. On the basis of the static receptor modelling there is no overlap between from the array noise contours (207 dB SEL_{cum}) and herring spawning grounds. When considered in the context of a fleeing receptors the impact ranges reduce to <100m for both the monopile foundation worst-case and most likely scenarios.

8.9.41 The potential for mortality and potential mortal injury of spawning herring from single multileg foundation installation may occur up to 4.3km from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 260m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for mortality and potential mortal injury may occur up to 2.9km from the array, a reduced impact than that proposed from the maximum design scenario. When considered in the context of a fleeing receptors the impact ranges reduce to <100m for both the multileg foundation worst-case and most likely scenarios.

8.9.42 The potential for mortality and potential mortal injury of spawning herring from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 7.4km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.19, Volume 3**). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for mortality and potential mortal injury may occur up to 5.6km from the array.

8.9.43 The potential for mortality and potential mortal injury of spawning herring from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 8.9km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.18, Volume 3** of the ES (Document Reference 6.3.8)), whilst piling impacts under the 'most-likely' scenario could occur up to 6.4km from the array area. On the basis of the static receptor modelling there is no overlap between from the array noise contours (207dB SEL_{cum}) and herring spawning grounds, or areas of high larval abundances.

8.9.44 The potential for mortality and potential mortal injury of spawning herring from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 100km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 200km^2. The potential for mortality and potential mortal injury of spawning herring from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 70km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 270km^2 (**Figure 8.21, Volume 3** of the ES (Document Reference 6.3.8).

8.9.45 Taking into consideration the limited spatial extent of impact, and the lack of overlap of the array noise contours from piling activities with herring spawning grounds, the magnitude of impact on herring is therefore deemed to be **negligible**.

Sensitivity or value of receptor

8.9.46 Herring have a swim bladder that is involved in hearing, and therefore are known to be sensitive to underwater noise. Key herring spawning and nursery habitats are located outside of the fish and shellfish Study Area. Herring are demersal spawners and are therefore considered stationary receptors in the assessment during the spawning season, increasing their theoretical exposure to underwater noise from the construction phase of the development. Taking this into account, herring are considered to be of high vulnerability, with medium recoverability and of regional importance, therefore the sensitivity of herring to noise impacts is considered to be **high**.

Significance of residual effect

8.9.47 Key herring spawning and nursery habitats are located outside of the fish and shellfish Study Area. Herring are demersal spawners and were therefore considered stationary receptors in the assessment, increasing their exposure to underwater noise from the construction phase of the Proposed Development. The magnitude of impact is considered to be **negligible** for injury. Due to their sensitivity to underwater noise, and likelihood of disturbance to spawning herring, the species were assessed as having **high** sensitivity to underwater noise during construction, and therefore the effect on herring is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Black seabream

8.9.48 Black seabream (Group 3, mortality onset at 207 dB SEL_{cum}) have swim bladders that are close, but not intimately connected to the ear, and are therefore known to be sensitive to underwater noise. Black seabream are a mobile species and are expected to vacate the area in which the impact could occur with the onset of ‘soft start’ piling, however black seabream are considered sensitive due to their hearing ability and their demersal spawning nature. Due to an important spawning/nesting area located directly north of the Proposed Development array area and the spawning site fidelity displayed by black seabream, and the consequential likelihood of black seabream not fleeing from piling noise when engaged in spawning/nesting activity (if black seabream are nesting they will likely remain stationary in order to protect the nest), black seabream are considered stationary receptors for the sake of this assessment. Due to the focused area of nesting activity, Kingmere MCZ was designated to protect this important breeding and spawning site and enforced seasonal restrictions during the black seabream nesting period implemented.

8.9.49 Male black seabream will largely remain with their nests until the eggs have hatched to protect them from smothering from sediment and predation. It should be noted that predation of eggs is be expected to be most prevalent while male black seabream are away from the nest, therefore any disturbance from potential piling operations could result in unprotected nests.

Magnitude of impact

8.9.50 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to black seabream nesting areas (north-west location), and therefore have the greatest potential for impacts on nesting black seabream.

8.9.51 With regards the single piling of monopiles, noise modelling suggests that the worst-case potential for mortality and potential mortal injury from monopile installation (4,400kJ hammer energy) on black seabream during peak spawning season may occur up to 2.7km from the array area (**Figure 8.19, Volume 3** of the ES (Document Reference 6.3.8)). Instantaneous injury may occur up to 210m from the array area (SPL_{peak}).

8.9.52 Noise modelling for the most likely impacts from monopile installation showed the potential for mortality and potential mortal injury in this scenario may occur up to 2.1km from the array, a reduced impact than that arising from the maximum design scenario hammer energies. When considered in the context of a fleeing receptors the impact ranges reduce to <100m for both the monopile foundation worst-case and most likely scenarios.

8.9.53 The potential for mortality and potential mortal injury of spawning black seabream from single multileg pile installation may occur up to 2.2km from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 170m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for mortality and potential mortal injury may occur up to 1.6km from the array, a reduced impact than that proposed from the maximum design scenario. When considered in the context of a fleeing receptors the impact ranges reduce to <100m for both the multileg foundation worst-case and most likely scenarios.

8.9.54 The potential for mortality and potential mortal injury of spawning/nesting black seabream from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 3.7km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.19, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for mortality and potential mortal injury may occur up to 2.9km from the array.

8.9.55 The potential for mortality and potential mortal injury of spawning/nesting black seabream from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 4.2km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.18, Volume 3** of the ES (Document Reference 6.3.8)), whilst piling impacts under the 'most-likely' scenario could occur up to 3.1km from the array area.

8.9.56 The potential for mortality and potential mortal injury of nesting black seabream from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 100km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 200km^2. The potential for mortality and potential mortal injury of nesting black seabream from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 70km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 270km^2 (**Figure 8.21** of the ES (Document Reference 6.3.8).

8.9.57 The modelled outputs for the installation of monopile and multileg foundations for both the worst case and most likely scenarios, have no interaction with areas of highest density nesting within the Kingmere MCZ, in addition there is no interaction with areas of black seabream nesting within the export cable corridor. Taking into consideration the locations of black seabream spawning and nesting grounds regionally, relative to the piling locations of the Proposed Development (**Figure 8.18, Figure 8.19, Volume 3** of the ES (Document Reference 6.3.8)), and the limited temporal impacts of piling, the magnitude of impact on black seabream from piling activities is considered **minor**.

Sensitivity or value of receptor

8.9.58 Black seabream have a swim bladder that is involved in hearing, and therefore are known to be sensitive to underwater noise. Important spawning/nesting areas are located present within the Rampion 2 fish and shellfish Study Area, specifically within the proposed offshore export cable corridor, which is located adjacent to the Kingmere MCZ, of which black seabream are a designated feature. Black seabream are demersal spawners and are therefore considered stationary receptors in the assessment during the spawning season, increasing their theoretical exposure to underwater noise from the construction phase of the development. Taking this into account, black seabream are considered to be of medium vulnerability, with medium recoverability and are of national importance, therefore the sensitivity of black seabream to noise impacts is considered to be **medium**.

Significance of residual effect

8.9.59 Black seabream were assessed as having medium sensitivity to underwater noise during construction due to their swim bladder being involved in hearing, and the likelihood of disturbance to spawning and nesting black seabream. Regarding physical injury to the receptor, there is limited interaction with areas of primary importance for breeding black seabream (areas within the Kingmere MCZ), and therefore the magnitude is considered minor, and the associated effect therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

European seabass

8.9.60 European seabass (Group 3, mortality onset at 207 dB SEL_{cum}) have swim bladders that are close, but not intimately connected to the ear, and are therefore known to be sensitive to underwater noise. They are a mobile species and are expected to vacate the area in which the impact could occur with the onset of 'soft start' piling.

Magnitude of impact

8.9.61 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to the coast (north-west location) due to the preference of European seabass to inhabit shallow coastal and estuarine habitats. Therefore, piling at this location has the greatest potential for impacts on seabass.

8.9.62 Noise modelling (assuming fleeing receptors) has demonstrated that mortality or mortal injury of seabass due to the proposed piling activities for single monopiles could arise within <100m from the array area (4,400kJ hammer energy, based on SEL_{cum}). Noise modelling for the most likely impacts also arise from the same distance. Instantaneous injury may occur up to 260m from the array area (SPL_{peak}).

8.9.63 The potential for mortality or mortal injury of seabass from single multileg foundation installation may occur <100m from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 220m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for mortality or mortal injury may occur <100m from the array.

8.9.64 The potential for mortality or mortal injury of seabass from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to range <100m from the array area (4,400kJ hammer energy, based on SEL_{cum}). Noise modelling for the most likely impacts also arise from the same distance.

8.9.65 The potential for mortality and potential mortal injury of seabass from the sequential installation of 4 pin piles at a single location (multileg foundations) has the potential to occur <100m from the array area (4,400kJ hammer energy, SEL_{cum}), Noise modelling for the most likely impacts also arise from the same distance.

8.9.66 Regarding the potential for mortality and potential mortal injury of seabass from the simultaneous installation of foundations, the individual ranges of impact from fleeing receptors were too small, and therefore the distant site does not produce an influencing additional exposure, and consequently there was no in-combination effect from piling at both the East and West modelling locations.

8.9.67 Taking into consideration the limited impact ranges from piling within the array on fleeing receptors, and the preference of European seabass to inhabit shallow coastal and estuarine habitats (there is no overlap from the impact range contours with the coast), along with the limited temporal impacts. The magnitude of the impact that construction activities relating to the Proposed Development will have on European seabass is considered **negligible**.

Sensitivity or value of receptor

8.9.68 European seabass have a swim bladder that is involved in hearing, and therefore are known to be sensitive to underwater noise. European seabass are pelagic spawners (Small, 2021), and do not display substrate dependency during spawning behaviours, they are therefore expected to flee the area with the onset of ‘soft start’ piling. Taking this into account, European seabass are considered to be of low vulnerability, medium recoverability, and regional importance, and are therefore considered to be of **medium** sensitivity to noise impacts.

Significance of residual effect

8.9.69 Due to the sensitivity of European seabass to noise, the receptor was assessed as having medium sensitivity to underwater noise during construction. For physical injury there is limited interaction with the areas of primary importance for breeding European seabass due to their pelagic spawning nature, and therefore the magnitude is considered negligible, and the associated effect therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

Seahorse

8.9.70 Both short-snouted and spiny/long-snouted seahorse species have been recorded in the English Channel. The external seahorse morphology is different from other bony fish, but the internal organs, including the gas bladder, are morphologically similar, so the effect of sound is likely to be similar to other fish (Palma *et al*., 2019). Seahorse hearing is considered similar to that of herring (Group 4) and are therefore likely to be sensitive to underwater noise.

8.9.71 Seahorses can be found in a variety of habitats, including sand and soft sediment, seagrass meadows, rock and algae and artificial habitats (such as marinas) (Woodall *et al*., 2018). Research suggests that seahorses are present in shallower waters during summer months for breeding and migrate to deeper water during winter months (usually around October to April) to avoid storms (The Seahorse Trust, 2013).

8.9.72 Seahorses are known to frequent the south coast of England and with four short-snouted seahorses recorded during surveys at Rampion 1 offshore wind farm (E.ON, 2012a) and a further three short-snorted seahorses recorded during the Rampion 1 post construction survey (OEL, 2020a). Several short-snorted seahorse observations have been recorded in the region, the most recent of which was a single observation at Brighton Marina in July 2020 (NBN Atlas, 2021a), with a single spiny seahorse observation recorded near Brighton in 2019 (NBN Atlas, 2021b).

8.9.73 Short-snouted seahorse are designated features at four MCZs in the area, The Bembridge MCZ, the Selsey Bill and the Hounds MCZ, Beachy Head East MCZ and Beachy Head West MCZ. Further detail on each of the MCZs are presented in **Table 8-11** above. In addition to being features at these sites, both species of seahorse and their habitat are protected under The Wildlife and Countryside Act (1981).

8.9.74 Seahorses have low swimming speeds, with very inefficient fins for conventional swimming (Ashley-Ross, 2002) and are therefore may have limited capacity to flee the area compared to other Group 4 receptors. However, seahorses are not expected in significant numbers in the area of the proposed DCO Order Limits, as there are no records or data that suggest that the area is of particular importance for seahorse. This is also the casein the overwintering period, when the species may move to deeper water areas, though clearly there is potential for seahorse to be present in the area during the winter months in common with other deeper water areas along the south coast.

Magnitude of impact

8.9.75 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to MCZs designated for seahorse (East and West locations), and therefore have the greatest potential for impacts on breeding seahorse. As the east modelling location represents the greatest impact ranges, these have been presented as the worst case.

8.9.76 Noise modelling (assuming static receptors) has demonstrated that the potential for mortality effects on seahorse due the proposed piling proposed piling activities for single monopiles could arise within 4.9km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Instantaneous injury may occur up to 310m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from single monopile installation showed the potential for mortality and potential mortal injury in this scenario may occur up to a maximum range of 3.6km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.77 The potential for mortality and potential mortal injury of seahorse from single multileg foundation installation may occur up to 4km from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 250m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for mortality and potential mortal injury may occur up to 2.8km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.78 The potential for mortality and potential mortal injury of seahorse from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 7.1km from the array area (4,400kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for mortality and potential mortal injury may occur up to 5.3km from the array.

8.9.79 The potential for mortality and potential mortal injury of seahorse from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 8.4km from the array area (4,400kJ hammer energy, SEL_{cum}), whilst piling impacts under the 'most-likely' scenario could occur up to 6.1km from the array area.

8.9.80 The potential for mortality and potential mortal injury of seahorse from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 100km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 200km^2. The potential for mortality and potential mortal injury of seahorse from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 70km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 270km^2.

8.9.81 There are several MCZs in the vicinity of the proposed DCO Order Limits, designated for breeding seahorse in the summer. Taking into consideration the impact ranges of mortality and mortal injury from each scenario, there is no overlap from the impact range contours with the designated sites, and therefore there is no potential for mortality and mortal injury of breeding seahorse.

8.9.82 The impact from underwater noise is considered to be most applicable to seahorses in the winter months when seahorses are known to migrate to deeper water (Garrick-Maidment, 2013), as seahorses are considered more likely to be in shallower inshore waters outside of the proposed DCO Order Limits (and therefore not exposed to lethal/physical injury levels) for breeding in summer. Moreover, low numbers of spiny and short-snouted seahorse have been observed in the region and are known to be present in shallow inshore areas around Newhaven, (NBN Atlas, 2021a; 2021b) particularly in seagrass areas. Whilst there is the potential for seahorse to be present, the Proposed Development does not lie within an area of specific importance for the species. Nevertheless, there is potential for seahorse to occur in deeper waters within the region generally, relating to overwintering migration, which could feasibly result in the seahorse species being present in the general area of the Proposed Development.

8.9.83 Whilst interaction with individual seahorses cannot be ruled out, the overall risk of interaction is considered to be low, and spatially discrete. This is due to the low population numbers at even the preferred habitat locations inshore and consequently the very low density following the species' broad migration to wide areas of 'deeper water', it is considered that the risk of one or more of these individuals being located within 6.7km of a foundation location at the time of active piling is very small.

8.9.84 Therefore, taking into consideration the limited temporal and spatial impact from the piling locations of the Proposed Development and the numbers of seahorse identified in the region, the magnitude of the impact that construction activities relating to the Proposed Development will have on spiny/long-snouted and short-snouted seahorse is considered **negligible**.

Sensitivity or value of receptor

8.9.85 Seahorse possess a swim bladder that is involved in hearing, and therefore are known to be sensitive to underwater noise. Seahorse have low mobility, and are therefore considered unlikely to flee with the onset of piling, therefore seahorses are considered stationary receptors within the assessment. The proposed DCO Order Limits is a potential overwintering area for both seahorse species, although population numbers within the fish and shellfish Study Area are low, with the overall risk of interaction considered to be low and spatially discrete. Taking this into consideration, seahorse are of high vulnerability, low recoverability, and of national importance, therefore the sensitivity of seahorse to noise impacts is considered to be **high**.

Significance of residual effect

8.9.86 The magnitude of impact is considered to be **negligible** for mortality and potential mortal injury. Due to the sensitivity of seahorse to underwater noise, and their low mobility, the species were assessed as having high sensitivity to underwater noise during construction, and therefore the effect is predicted to be **of minor adverse significance**, which is **Not Significant** in EIA terms.

Cuttlefish

8.9.87 Cuttlefish (Group 1 receptor, mortality onset at >219 dB SEL_{cum}) are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates, e.g. plants and sessile animals, and artificial structures, e.g. fishing pots, ropes and branches (Blanc and Daguzan, 1998; Bloor *et al*., 2013, cited in Ganias *et al*, 2021). Due to their demersal spawning nature, cuttlefish are considered stationary receptors for the sake of the assessment.

8.9.88 Cuttlefish migrate inshore to spawning grounds preferred habitat for eggs and juveniles (Bloor *et al*., 2013), in March and April with spawning occurring from March to July. In the English Channel, offshore migration occurs in winter and is influenced primarily by a reduction in water temperature as well as the reduction in daylight hours (Guerra, 2006). After spawning occurs adults return back into deeper, offshore areas around October in the UK (Dunn, 1999, Royer *et al*., 2006).

Magnitude of impact

8.9.89 The general consensus of studies describing noise impacts from offshore windfarms on cuttlefish is that there are very few physiological effects, unless the organisms are very close to the noise source (Mavraki *et al*., 2020; Solé *et al.,* 2022). Cuttlefish are distributed widely throughout the English Channel and into the southern North Sea, and their spawning grounds are located inshore. Therefore, taking the wider environment into context, the lack of overlap of noise contours with inshore areas and therefore lack of impact with spawning cuttlefish, and the overall short duration of piling and its intermittent nature, the magnitude of effect on cuttlefish are assessed as being **negligible** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.90 Cuttlefish lack a swim bladder and are therefore considered less sensitive to underwater noise. Cuttlefish are considered stationary receptors due to their demersal spawning behaviours, and therefore may have limited capacity to flee the area compared to other Group 1 receptors. Cuttlefish are be considered sensitive only in the direct proximity of the sound source (Solé *et al.,* 2022). Taking this into account, cuttlefish are deemed to be of low vulnerability, medium recoverability and are of regional importance. The sensitivity of the receptor to noise impacts is therefore considered to be **medium** during their spawning period (March to July).

Significance of residual effect

8.9.91 Due to the **medium** sensitivity of spawning cuttlefish to noise (stationary Group 1 receptors) and the **negligible** magnitude of impact, the significance of effect is of **minor adverse significance**, which is **Not Significant** in EIA terms.

Other fish receptors

8.9.92 All other fish receptors within the proposed DCO Order Limits are pelagic spawners and are considered mobile and will be expected to vacate the area in which the impact could occur with the onset of 'soft start' piling.

Magnitude of impact

8.9.93 All other fish receptors and their respective spawning grounds are distributed widely throughout the English Channel and into the southern North Sea, and therefore taking the wider environment into context, the magnitude of effect on all other fish receptors are assessed as being **minor** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.94 Cod, whiting (Group 3) and sprat (Group 4) all have swim bladders that are involved in hearing, and therefore are known to be sensitive to underwater noise. These receptors are pelagic spawners, and do not display substrate dependency during spawning behaviours, they are therefore expected to flee the area with the onset of 'soft start' piling. Taking this into account, these receptors are considered to be of medium vulnerability, medium recoverability, and are of regional importance, therefore cod, whiting and sprat are considered to be of **medium** sensitivity to noise impacts.

Significance of residual effect

8.9.95 Due to the sensitivity of these receptors to noise, the receptors were assessed as having medium sensitivity to underwater noise during construction. There is limited interaction with the areas of primary importance these receptors due to their pelagic spawning nature, and therefore the magnitude is considered minor, and the associated effect therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

Eggs and Larvae

8.9.96 Eggs and larvae (>210 dB SEL_{cum}) are considered potentially vulnerable to noise impacts due to reduced mobility and small size (Popper *et al*., 2014), therefore they are considered a stationary receptor within this assessment.

Magnitude of impact

8.9.97 Thresholds of effects for eggs and larvae have been defined separately within the Popper *et al*. (2014) guidance, with damage expected to occur at 210dB SEL_{cum} or >207 dB SPL_{peak}.

8.9.98 With regards the piling of a single monopile the modelling results indicate that the maximum potential range for mortality and potentially mortal injury of eggs and larvae is up to 3.5km from the array area (SEL_{cum} (static)). The results for the most likely spatial maximum design scenario indicate the potential range for mortality and potential mortal injury of eggs and larvae is up to 2.5km from the array (SEL_{cum} (static)).

8.9.99 The maximum predicted range for mortality and potentially mortal injury effects from the piling of a single multileg foundation is up to 2.8km from the array (based on SEL cum (static)). Instantaneous injury may occur up to 260m from the array area (SPL_{peak}). The results for the most likely temporal maximum design scenario indicate the potential range for mortality and potential mortal injury of eggs and larvae is up to 1.9km from the array a significantly reduced impact than that proposed in from the maximum design scenario (SEL_{cum} (static)).

8.9.100 The potential for mortality and potential mortal injury of eggs and larvae from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 5.2 km from the array area (4,400kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for mortality and potential mortal injury may occur up to 3.8km from the array.

8.9.101 The potential for mortality and potential mortal injury of eggs and larvae from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 6.2km from the array area (4,400kJ hammer energy, SEL_{cum}), whilst piling impacts under the 'most-likely' scenario could occur up to 4.4km from the array area.

8.9.102 The potential for mortality and potential mortal injury of eggs and larvae from the simultaneous installation of a single monopile at the East and West modelling locations in the array area equates to a maximum area of up to 49km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 100km^2. The potential for mortality and potential mortal injury of eggs and larvae from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 33km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 140km^2.

8.9.103 Taking into consideration the broad distribution of horse mackerel, lemon sole, plaice, sandeel, sole, cod, whiting and sprat whiting, cod and sandeel spawning grounds within UK, and the lack of overlap of noise contours over areas of high herring larval density, the magnitude of effect on eggs and larvae for all receptors from piling within the array area is assessed as being **negligible**.

Sensitivity or value of receptor

8.9.104 Horse mackerel, lemon sole, plaice, sandeel, sole, cod, whiting and sprat all have spawning grounds that overlap the fish and shellfish Study Area (**Figure 8.2** to **8.4, Volume 3** of the ES (Document Reference 6.3.8)). A key herring spawning ground (Coull *et al*., 1998) is also located to the south of the array area, although has no direct overlap with Rampion 2, being located at a distance of approximately 47km, however larvae drift on the currents and can therefore be moved closer to the Proposed Development (**Figure 8.8** (Document Reference 6.3.8))**, Volume 3** of the ES and as evidenced in **Appendix 8.1: Herring annual heatmaps, Volume 4** (Document Reference 6.4.8.1). Eggs and larvae are considered organisms of concern by Popper *et al*. (2014), due to their vulnerability, reduced mobility and small size. As a result of this, the sensitivity of eggs and larvae to noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.105 Due to the sensitivity of eggs and larvae to underwater noise, the receptor was assessed as having medium sensitivity to underwater noise during construction. Taking into account the broad distribution of the spawning grounds within UK waters, it is considered unlikely that there will be any population level effects, and therefore the overall effect on eggs and larvae is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Shellfish

8.9.106 On the basis that shellfish do not possess swim bladders or other gas filled organs, it is considered that shellfish are primarily sensitive to particle motion rather than sound pressure (e.g., Popper and Hawkins 2018). As there are currently no criteria for assessing particle motion, it is not possible to undertake a threshold-based assessment of the potential for injury to shellfish in the same way as can be done for fish. As such, a qualitative assessment of the potential for mortality or mortal injury has been made based on peer-reviewed literature.

Magnitude of impact

8.9.107 Shellfish species and their respective spawning grounds are distributed widely throughout the English Channel and into the southern North Sea, and therefore taking the wider environment into context, the magnitude of effect on shellfish receptors are assessed as being **minor** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.108 Pile driving is recognised as a source particle motion, generating high levels of particle motion in the nearfield (Hazelwood and Macey 2016) which could potentially result in injury or mortality to sensitive shellfish receptors. Impacts from particle motion are also likely to occur local to the source, with studies having demonstrated the rapid attenuation of particle motion with distance (Mueller-Blenkle *et al*. 2010). Studies on lobsters have shown no mortality effect on the species (>220 dB) (Payne *et al*. 2007). Similarly, studies of molluscs (e.g., mussels *Mytilus edulis* and periwinkles *Littorina* spp.) exposed to a single airgun at a distance of 0.5 m have shown no effects after exposure (Kosheleva 1992). Reactions to noise and vibrations are not likely to interfere with the ecological function of shellfish, with some mobile mollusc species likely to return to the area after the impact activity has stopped. Taking this into consideration, shellfish receptors within the Study Area are deemed to be of local to international importance, medium vulnerability, and high recoverability. The sensitivity of shellfish to mortality and potential mortal injury from underwater noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.109 There are to date no specific criteria published on the sensitivity of shellfish to underwater noise. Whilst some species have spawning and nursery grounds within the fish and shellfish Study Area, they typically occur over a large area and into the southern North Sea, any disturbance to spawning is considered small in the context of the wider habitat availability. Shellfish species are considered sessile, and therefore will be expected to remain in the area in which the impact could occur with the onset of 'soft start' / ramp up piling. Taking all of this into account, all shellfish species are assessed as having medium sensitivity to underwater noise during construction, and a minor magnitude of impact, the effects on these species are therefore predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Recoverable injury

Introduction

8.9.110 Recoverable injury is a survivable injury with full recovery occurring after exposure, although decreased fitness during this recovery period may result in increased susceptibility to predation or disease (Popper *et al*.., 2014). The impact ranges for recoverable injury and mortality / potential mortal injury are more or less the same due to the thresholds used, the potential for mortality or mortal injury is likely to only occur in extreme proximity to the pile, although the risk of this occurring will be reduced by use of soft start techniques at the start of the piling sequence. This means that fish in close proximity to piling operations will move outside of the impact range, before noise levels reach a level likely to cause irreversible injury.

Sandeel

8.9.111 Sandeel lack a swim bladder and are therefore considered less sensitive to underwater noise. Low intensity sandeel spawning and nursery habitats are located in the Rampion 2 fish and shellfish Study Area (see **Figure 8.3, Figure 8.6 and Figure 8.9, Volume 3** of the ES (Document Reference 6.3.8). Sandeel are a Group 1 receptor (recoverable injury onset at 216 dB SEL_{cum}) and are considered stationary receptors within this assessment due to their burrowing nature, substrate dependence, and demersal spawning behaviours, and therefore may have limited capacity to flee the area compared to other Group 1 receptors.

Magnitude of impact

8.9.112 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to sandeel spawning grounds (west location), and therefore have the greatest potential for impacts on spawning sandeel.

8.9.113 Regarding piling of a single monopile, noise modelling (assuming static receptors) has demonstrated that recoverable injury of sandeel due the proposed piling activities for single monopiles could arise within 1.2km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Instantaneous injury may occur up to 110m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from monopile installation showed the potential for recoverable injury in this scenario may occur up to a maximum range of 850m from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.114 Regarding the piling of a single multileg foundation, the potential for recoverable injury of sandeel from multileg foundation installation may occur up to 900m from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 220m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for recoverable injury may occur up to 650m from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.115 The potential for recoverable injury of spawning sandeel from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 1.7km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.16, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for recoverable injury may occur up to 1.3km from the array.

8.9.116 The potential for recoverable injury of spawning sandeel from the sequential installation of four pin piles at a single location (multileg foundations) has the potential to occur up to 2km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.17, Volume 3** of the ES (Document Reference 6.3.8)), whilst piling impacts under the 'most-likely' scenario could occur up to 1.4km from the array area.

8.9.117 The potential for recoverable injury of spawning sandeel from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 9.9km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 22km^2. The potential for recoverable injury of spawning sandeel from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 6.3km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 33km^2.

8.9.118 Sandeel spawning habitat occurs over a large area across the English Channel and into the southern North Sea, including within the proposed DCO Order Limits, therefore the spatial extent of the impact in the context of the wider environment is considered small. Considering the small spatial impact, the overall short duration of piling and its intermittent nature, together with the fact that any effect will be temporary, the magnitude of impact that construction activities relating to the Proposed Development will have on sandeel is therefore considered to be **minor**.

Sensitivity or value of receptor

8.9.119 Sandeel spawning and nursery habitats are present within the fish and shellfish Study Area and extend over a wide area (see **Figure 8.3** (Document Reference 6.3.8) and **Figure 8.9** (Document Reference 6.3.8)**, Volume 3** of the ES). The sensitivity of sandeel to underwater noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.120 Sandeel lack a swim bladder and are therefore considered less sensitive to underwater noise. Sandeel spawning habitat occurs over a large area across the English Channel and into the southern North Sea, including within the proposed DCO Order Limits. Due to their demersal nature, sandeel are considered a stationary receptor to underwater noise in this assessment, and therefore will be exposed to underwater noise from piling activity during the construction phase of the Proposed Development. However, due to their reduced sensitivity, and small degree of disturbance to spawning grounds in the context of the wider habitat availability in the English Channel and within the southern North Sea, the species are assessed as having medium sensitivity to underwater noise during construction, and the magnitude of impact is deemed to be minor, therefore the effect on sandeel is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Herring

8.9.121 Herring (Group 4 receptor, recoverable injury onset at 203 dB SEL_{cum}) have a swim bladder that is involved in hearing, and therefore are known to be sensitive to underwater noise. Due to the presence of a key herring spawning ground outside the array and Study Area, to the south (**Figure 8.8, Volume 3** of the ES (Document Reference 6.3.8)) and the demersal spawning nature of herring, the receptor is considered stationary for the assessment.

Magnitude of impact

8.9.122 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to herring spawning grounds (south location), and therefore have the greatest potential for impacts on spawning herring.

8.9.123 Regarding the piling of a single monopile, noise modelling (assuming static receptors) has demonstrated that recoverable injury of herring due the proposed piling activities could arise within a maximum range 8.4km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Instantaneous injury may occur up to 310m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from monopile installation showed the potential for recoverable injury in this scenario may occur up to a maximum range of 6.3km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.124 Regarding the piling of a single multileg foundation, the potential for recoverable injury of herring from multileg foundation installation may occur up to 7km from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 260m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for recoverable injury may occur up to 5km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.125 The potential for recoverable injury of spawning herring from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 12km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.19, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for recoverable injury may occur up to 9km from the array.

8.9.126 The potential for recoverable injury of spawning herring from the sequential installation of four pin piles at a single location (multileg foundations) has the potential to occur up to 14km from the array area (4,400kJ hammer energy, SEL_{cum}), whilst piling impacts under the 'most-likely' scenario could occur up to 10km from the array area (**Figure 8.18, Volume 3** of the ES (Document Reference 6.3.8)).

8.9.127 The potential for recoverable injury of spawning herring from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 240km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 430km^2. The potential for recoverable injury of spawning sandeel from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 180km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 560km^2 (**Figure 8.21, Volume 3** of the ES (Document Reference 6.3.8)).

8.9.128 Taking into consideration the limited spatial extent of impact, and the lack of overlap of the array noise contours from piling activities with herring spawning grounds, the magnitude of impact on herring is therefore deemed to be **negligible**.

Sensitivity or value of receptor

8.9.129 Herring have a swim bladder that is involved in hearing herring and are known to inhabit the English Channel. Herring have a key spawning ground located approximately 47km north of the Study Area. The sensitivity of herring to underwater noise impacts is therefore considered to be **high**.

Significance of residual effect

8.9.130 Herring have a swim bladder that is involved in hearing and therefore are known to be sensitive to underwater noise. The magnitude of impact is considered to be **negligible** for recoverable injury. Due to their sensitivity to underwater noise, and potential for disturbance to spawning herring, the species were assessed as having high sensitivity to underwater noise during construction, and therefore the effect on herring is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Black seabream

8.9.131 Black seabream (Group 3 receptor, recoverable injury onset at 203 dB SEL_{cum}) have a swim bladder close to, but not intimately connected to the ear, and therefore are known to be sensitive to underwater noise. Due to the presence of a key spawning/nesting area located directly north of the Proposed Development array area and the spawning site fidelity displayed by black seabream, black seabream are considered stationary receptors for this assessment.

Magnitude of impact

8.9.132 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to black seabream nesting areas (north-west location), and therefore have the greatest potential for impacts on nesting black seabream.

8.9.133 Regarding the piling of a single monopile, noise modelling (assuming static receptors) has demonstrated that recoverable injury of black seabream due the proposed piling activities could arise within 4.1km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Instantaneous injury may occur up to 210m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from monopile installation showed the potential for recoverable injury in this scenario may occur up to 3.2km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.134 Regarding the piling of a single multileg foundation, the potential for recoverable injury of black seabream from multileg foundation installation may occur up to 3.4km from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 170m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for recoverable injury may occur up to 2.5km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.135 The potential for recoverable injury of black seabream from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 5.6km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.19, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for recoverable injury may occur up to 4.4km from the array.

8.9.136 The potential for recoverable injury of black seabream from the sequential installation of four pin piles at a single location (multileg foundations) has the potential to occur up to 6.4km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.18, Volume 3** of the ES (Document Reference 6.3.8)), whilst piling impacts under the 'most-likely' scenario could occur up to 4.8km from the array area.

8.9.137 The potential for recoverable injury of black seabream from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 240km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 430km^2. The potential for recoverable injury of black seabream from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 180km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 560km^2 (**Figure 8.21, Volume 3** of the ES (Document Reference 6.3.8)).

8.9.138 Black seabream spawning and nesting grounds are located outside the noise contours of piling within the Rampion 2 array area. Taking into consideration the locations of black seabream spawning and nesting grounds relative to the piling locations of the Proposed Development (**Figure 8-19, Volume 3** of the ES (Document Reference 6.3.8)), and the limited temporal impacts, the magnitude of the impact that construction activities relating to the Proposed Development will have on black seabream is considered **minor**.

Sensitivity or value of receptor

8.9.139 Black seabream have a swim bladder that is involved in hearing. Black seabream have a key spawning/nesting area located directly north of the Proposed Development array area, and display site fidelity. The sensitivity of black seabream to underwater noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.140 Regarding the potential for recoverable injury of black seabream, there is limited interaction with the areas of primary importance, and therefore the magnitude is considered **negligible**. Black seabream were assessed as having medium sensitivity to underwater noise, therefore the effect on black seabream is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

European seabass

8.9.141 European seabass (Group 3 receptor, recoverable injury onset at 203dB SEL_{cum}) are a mobile species and are likely to flee the immediate area in which piling will occur. Seabass are considered sensitive to sound pressure components of underwater noise (Group 3), due to having a swim bladder close to, but not intimately connected to the ear.

Magnitude of impact

8.9.142 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to the coast (north-west location) due to the preference of European seabass to inhabit shallow coastal and estuarine habitats. Therefore, piling at this location has the greatest potential for impacts on seabass.

8.9.143 Noise modelling (assuming fleeing receptors) has demonstrated that recoverable injury of seabass due to the piling of a single monopile could arise within <100m from the array area (4,400kJ hammer energy, based on SEL_{cum}). Instantaneous injury may occur up to 210m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from monopile installation showed the potential for recoverable injury in this scenario may occur within <100m from the array (assuming fleeing receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.144 The potential for recoverable injury of seabass from single multileg foundation installation may occur <100m from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 170m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for recoverable injury may occur <100m from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.145 The potential for recoverable injury of seabass from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur within <100m from the array area (4,400kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for recoverable injury may occur up <100m from the array. The potential for recoverable injury of seabass from the sequential installation of 4 pin piles at a single location (multileg foundations) has the potential to occur <100m from the array area (4,400kJ hammer energy, SEL_{cum}), whilst piling impacts under the 'most-likely' scenario could occur <100m from the array area.

8.9.146 Regarding the potential for mortality and potential mortal injury of seabass from the simultaneous installation of foundations, the individual ranges of impact from fleeing receptors were too small, and therefore the distant site does not produce an influencing additional exposure, and consequently there was no in-combination effect from piling at both the East and West modelling locations.

8.9.147 Considering the spatial impact from the piling locations of the Proposed Development and the preference of European seabass to inhabit shallow coastal and estuarine habitats (there is no overlap of the impact ranges with either of these habitats), along with the limited temporal impacts. The magnitude of the impact that construction activities relating to the Proposed Development will have on European seabass is considered **negligible**.

Sensitivity or value of receptor

8.9.148 European seabass have a swim bladder that is involved in hearing. European seabass produce pelagic eggs (Small, 2021), and do not show site fidelity during spawning. The sensitivity of black seabream to underwater noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.149 Regarding the potential for recoverable injury of European seabass, there is limited interaction with the areas of primary importance for breeding European seabass, and therefore the magnitude is considered **negligible**. European seabass were assessed as having medium sensitivity to underwater noise, therefore the effect on European seabass is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Seahorse

8.9.150 Seahorse (Group 4 receptor, recoverable injury onset at 203 dB SEL_{cum}) are of low mobility and are therefore considered unlikely to flee with the onset of piling, therefore seahorses are considered stationary receptors within the assessment.

Magnitude of impact

8.9.151 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to MCZs designated for seahorse (east and west locations), and therefore have the greatest potential for impacts on breeding seahorse. As the east modelling location represents the greatest impact ranges, these have been presented as the worst case.

8.9.152 Regarding the impact ranges from piling, the ranges presented in the following text are from the nearest modelling location to MCZs designated for seahorse (east and west location), and therefore have the greatest potential for impacts on nesting black seabream. As the east modelling location represented the greatest impact ranges, these have been presented.

8.9.153 Regarding the piling of a single monopile, noise modelling (assuming static receptors) has demonstrated that recoverable injury of seahorse due the proposed piling activities could arise within a maximum range 8km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Instantaneous injury may occur up to 310m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from monopile installation showed the potential for recoverable injury in this scenario may occur up to a maximum range of 6km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

The potential for recoverable injury of seahorse from single multileg foundation installation may occur up to 6.7km from the array area (2,500kJ hammer energy, SEL_{cum}). Instantaneous injury may occur up to 250m from the array area (SPL_{peak}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for recoverable injury may occur up to 4.7km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.154 The potential for recoverable injury of seahorse from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 11km from the array area (4,400kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for recoverable injury may occur up to 8.6km from the array.

8.9.155 The potential for mortality and potential mortal injury of seahorse from the sequential installation of four pin piles at a single location (multileg foundations) has the potential to occur up to 13km from the array area (4,400kJ hammer energy, SEL_{cum}), whilst piling impacts under the 'most-likely' scenario could occur up to 9.6km from the array area.

8.9.156 The potential for recoverable injury of seahorse from the simultaneous installation of a single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 240km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 430km^2. The potential for recoverable injury of seahorse from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 180km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 560km^2.

8.9.157 There are several MCZs in the vicinity of the proposed DCO Order Limits, designated for breeding seahorse in the summer. Taking into consideration the impact ranges of recoverable injury from each scenario, there is no overlap from the impact range contours with the designated sites (**Figure 8.22 and Figure 8.23, Volume 3** of the ES (Document Reference 6.3.8)), and therefore there is no potential for recoverable injury of breeding seahorse. It is important to note, however that the distances cited within this assessment are the maximum extents of the individual contours, and therefore reflect the maximum noise propagation towards deeper waters (i.e., offshore). The noise contour extents in a nearshore direction, within shallower waters (i.e., towards the MCZs designated for breeding seahorse) are much less, due to the effects of water depths on the transmission of sound / pressure.

8.9.158 Surveys across the region have shown there is potential for seahorse to occur in deeper waters within the region generally, relating to overwintering migration, which could feasibly result in the seahorse species being present in the general area of the Proposed Development. However, interaction with individual seahorses cannot be ruled out, with the overall risk of interaction considered to be low, and spatially discrete, therefore the magnitude of the impact that construction activities relating to the Proposed Development will have on seahorse is considered to be **negligible**.

Sensitivity or value of receptor

8.9.159 As noted in **Paragraph 8.9.62** the proposed DCO Order Limits is a potential overwintering area for both seahorse species. The sensitivity of seahorse to noise impacts is therefore considered to be **high**.

Significance of residual effect

8.9.160 Seahorse are considered stationary receptors in the assessment. The magnitude of impact is considered to be **negligible** for recoverable injury. Due to their sensitivity to underwater noise, and likelihood of disturbance, the species were assessed as having high sensitivity to underwater noise during construction, and therefore the effect is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Cuttlefish

8.9.161 Cuttlefish (Group 1 receptor, mortality onset at >219 dB SELcum) are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates (Blanc and Daguzan, 1998; Bloor et al., 2013, cited in Ganias et al, 2021). Due to their demersal spawning nature, cuttlefish are considered stationary receptors for the sake of the assessment.

Magnitude of impact

8.9.162 The general consensus of studies describing noise impacts from offshore windfarms on cuttlefish is that there are very few physiological effects, unless the organisms are very close to the noise source (Mavraki *et al*., 2020; Solé *et al.,* 2022). Cuttlefish are distributed widely throughout the English Channel and into the southern North Sea, and their spawning grounds are located inshore. Therefore, taking the wider environment into context, the lack of overlap of noise contours with inshore areas and therefore lack of impact with spawning cuttlefish, and the overall short duration of piling and its intermittent nature, the magnitude of effect on cuttlefish is assessed as being **negligible** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.163 As noted in **Paragraph 8.9.90**, cuttlefish are considered to be of **medium** sensitivity to underwater noise on account of their demersal spawning behaviours and lack of swim bladder (therefore are considered less sensitive to noise in comparison to other receptors.

Significance of residual effect

8.9.164 Due to the **medium** sensitivity of spawning cuttlefish to noise (stationary Group 1 receptors) and the **negligible** magnitude of impact, the significance of effect is of **minor adverse significance**, which is **Not Significant** in EIA terms.

Other fish receptors

8.9.165 All other fish receptors within the proposed DCO Order Limits are pelagic spawners and are considered mobile and will be expected to vacate the area in which the impact could occur with the onset of ‘soft start’ piling.

Magnitude of impact

8.9.166 All other fish receptors and their respective spawning grounds are distributed widely throughout the English Channel and into the southern North Sea, and therefore taking the wider environment into context, the magnitude of effect on all other fish receptors are assessed as being **minor** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.167 Cod, whiting (Group 3) and sprat (Group 4) all have swim bladders that are involved in hearing, and therefore are known to be sensitive to underwater noise. These receptors are pelagic spawners, and do not display substrate dependency during spawning behaviours, they are therefore expected to flee the area with the onset of 'soft start' piling. Taking this into account, these receptors are considered to be of **medium** sensitivity to noise impacts.

Significance of residual effect

8.9.168 All other receptors are considered mobile, and therefore will be expected to vacate the area in which the impact could occur with the onset of 'soft start'/ramp up piling. Taking all of this into account, all other fish receptors are assessed as having medium sensitivity to underwater noise during construction, and a minor magnitude of impact, the effects on these species are therefore predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Eggs and Larvae

8.9.169 Eggs and larvae close to the substrate are considered vulnerable to particle motion generated by pile driving (Popper *et al*., 2014). As no criteria exist regarding impacts imposed by particle motion, a qualitative assessment based on sound pressure is recommended by Popper *et al*. (2014) for receptors that lack a swim bladder. Horse mackerel, lemon sole, plaice, sandeel, sole, cod, whiting and sprat all have spawning grounds that overlap the Rampion 2 fish and shellfish Study Area, furthermore a key herring spawning ground lies to the south of the Study Area, and therefore risks to eggs and larvae are considered in this assessment.

Magnitude of impact

8.9.170 In accordance with the Popper *et al*. (2014) qualitative assessment criteria, the extent of noise disturbance potentially causing recoverable injury in eggs and larvae would result in a moderate degree of disturbance at a near field (10s of meters) distance from the source, and a low degree of disturbance is anticipated to occur at intermediate (100s of meters) distance and far (1,000s meters) distances from the piling operations. Taking this into consideration, the magnitude of impact is therefore considered to be **minor**.

Sensitivity or value of receptor

8.9.171 Eggs and larvae are considered organisms of concern by Popper *et al*. (2014), due to their vulnerability, reduced mobility and small size. As a result of this, the sensitivity of eggs and larvae to noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.172 Due to the sensitivity of eggs and larvae to underwater noise, the receptor was assessed as having medium sensitivity to underwater noise during construction.

Taking into account the broad distribution of the spawning grounds within UK waters, it is considered unlikely that there will be any population level effects, and therefore the overall effect on eggs and larvae is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Shellfish

8.9.173 There are no criteria for shellfish sensitivity to noise, and therefore a qualitative assessment has been undertaken using peer-reviewed literature. On the basis that shellfish do not possess swim bladders or other gas filled organs, it is considered that shellfish are primarily sensitive to particle motion rather than sound pressure (e.g., Popper and Hawkins 2018).

Magnitude of impact

8.9.174 It is understood that particle motion attenuates rapidly, and therefore impacts on shellfish from particle motion are likely to occur local to the source. Taking this into account, and the broad distribution of these species along the UK coasts, and across the English Channel, the magnitude of effect on shellfish receptors is considered to be **minor**.

Sensitivity or value of receptor

8.9.175 Pile driving is recognised as a source particle motion, generating high levels of particle motion in the nearfield (Hazelwood and Macey 2016), and as a result shellfish are considered to be of **medium** sensitivity to underwater noise impacts.

Significance of residual effect

8.9.176 Whilst some species have spawning and nursery grounds within the fish and shellfish Study Area, they typically occur over a large area and into the southern North Sea, any disturbance to spawning is considered small in the context of the wider habitat availability. Shellfish species are considered sessile, and therefore will be expected to remain in the area in which the impact could occur with the onset of ‘soft start’/ramp up piling. Taking all of this into account, all shellfish species are assessed as having **medium** sensitivity to underwater noise during construction, and a **minor** magnitude of impact, the effects on these species are therefore predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Temporary Threshold Shift (TTS)

Introduction

8.9.177 TTS is a temporary reduction in hearing sensitivity caused by exposure to intense sound. TTS has been demonstrated in some fishes, resulting from temporary changes in sensory hair cells of the inner ear and/or damage to auditory nerves. However, sensory hair cells are constantly added to fishes and are replaced when damaged and therefore the extent of TTS is of variable duration and magnitude. Normal hearing ability returns following termination of the noise causing TTS, though this period is variable. When experiencing TTS, fish may have decreased fitness due to a reduced ability to communicate, detect predators or prey, and/or assess their environment.

Sandeel

8.9.178 Sandeel lack a swim bladder and are therefore considered less sensitive to underwater noise. Low intensity sandeel spawning and nursery habitats are located in the Rampion 2 fish and shellfish Study Area (**Figure 8.3** (Document Reference 6.3.8), and **Figure 8.9, Volume 3** of the ES (Document Reference 6.3.8)). Sandeel are a Group 1 receptor (TTS onset at 186 dB SEL_{cum}) and are considered stationary receptors within this assessment due to their burrowing nature, substrate dependence, and demersal spawning behaviours, and therefore may have limited capacity to flee the area compared to other Group 1 receptors.

Magnitude of impact

8.9.179 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to sandeel spawning grounds (west location), and therefore have the greatest potential for impacts on spawning sandeel.

8.9.180 Noise modelling (assuming static receptors) has demonstrated that the potential for TTS on sandeel due the piling of a single monopile could arise up to 26km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Noise modelling for the most likely impacts from monopile installation showed the potential for TTS in this scenario may occur up to 22km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.181 The potential for TTS of sandeel from single multileg foundation installation may occur up to 23km from the array area (2,500 kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for TTS may occur up to 19km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.182 The potential for TTS of sandeel from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 30km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.16, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for TTS may occur up to 27km from the array.

8.9.183 The potential for TTS of sandeel from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 33km from the array area (4,400 kJ hammer energy, SEL_{cum}) (**Figure 8.17, Volume 3** of the ES (Document Reference 6.3.8))**,** whilst piling impacts under the ‘most-likely’ scenario could occur up to 28km from the array area.

8.9.184 The potential for TTS injury of spawning sandeel from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 2,800km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 3,500km^2. The potential for TTS of spawning sandeel from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 2,500km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 3,900km^2.

8.9.185 Low intensity sandeel spawning and nursery habitats are located in the Rampion 2 fish and shellfish Study Area (see **Figure 8.3** (Document Reference 6.3.8) and **Figure 8.9, Volume 3** of the ES (Document Reference 6.3.8)). It should be noted however that the degree of overlap between spawning and nursery grounds of these species and the area with potential for TTS onset will be very small relative to the total area that the species could use for spawning in the English Channel and the southern North Sea (Jensen *et al*., 2011).Therefore taking this into account, the spatial extent of the impact in the context of the wider environment is considered small, with the overall short duration of piling and its intermittent nature, together with the fact that any effect associated with TTS will be temporary, the magnitude of impact that construction activities relating to the Proposed Development will have on sandeel is therefore considered to be **minor**.

Sensitivity or value of receptor

8.9.186 Sandeel spawning and nursery habitats are present within the fish and shellfish Study Area and extend over a wide area. The sensitivity of sandeel to TTS is therefore considered to be **medium**.

Significance of residual effect

8.9.187 Sandeel lack a swim bladder and are therefore considered less sensitive to TTS. Sandeel spawning habitat occurs over a large area across the English Channel and into the southern North Sea, including within proposed DCO Order Limits. Due to their demersal nature, sandeel are considered a stationary receptor to underwater noise in this assessment, and therefore will be exposed to TTS from piling activity during the construction phase of the Proposed Development. However, due to their reduced sensitivity, and small degree of disturbance to spawning grounds in the context of the wider habitat availability in the English Channel and within the southern North Sea, the species are assessed as having **medium** sensitivity to TTS during construction, and the magnitude of impact is deemed to be **minor**, therefore the effect on sandeel is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Herring

8.9.188 Herring (Group 4 receptor, TTS onset at 186 dB SEL_{cum}) have a swim bladder that is involved in hearing, and therefore are known to be sensitive to TTS. Due to the presence of a key herring spawning ground to the south of the Rampion 2 array area (**Figure 8.8** (Document Reference 6.3.8) and **Figure 8.10, Volume 3** of the ES (Document Reference 6.3.8)) and the demersal spawning nature of herring, the receptor is considered stationary for the assessment.

Magnitude of impact

8.9.189 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to herring spawning grounds (south location), and therefore have the greatest potential for impacts on spawning herring.

8.9.190 Noise modelling (assuming static receptors) has demonstrated that the potential for TTS on herring due the piling of a single monopile could arise up to 35km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Noise modelling for the most likely impacts from monopile installation showed the potential for TTS in this scenario may occur up to 30km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.191 The potential for TTS of herring from single multileg foundation installation may occur up to 32km from the array area (2,500kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for TTS may occur up to 27km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.192 The potential for TTS of herring from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 41km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.19, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for TTS may occur up to 36km from the array.

8.9.193 The potential for TTS of herring from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 44km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.18, Volume 3** of the ES (Document Reference 6.3.8)), whilst piling impacts under the 'most-likely' scenario could occur up to 38km from the array area.

8.9.194 The potential for TTS injury of spawning herring from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 2800km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 3500km^2. The potential for TTS of spawning herring from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 2,500km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 3,900km^2 (**Figure 8.21, Volume 3** of the ES (Document Reference 6.3.8).

8.9.195 As shown in **Figure 8.19** (Document Reference 6.3.8) **Figure 8.20** (Document Reference 6.3.8) and (**Figure 8.21** (Document Reference 6.3.8)**, Volume 3** of the ES there is no overlap of the 186db dB SEL_{cum} contour with herring spawning grounds a defined by Coull *et al*. (1998) and Ellis *et al*. (2012). Therefore, the magnitude of impact to spawning herring is considered to be **negligible**.

Sensitivity or value of receptor

8.9.196 Herring have a swim bladder that is involved in hearing and are known to inhabit the English Channel. Herring have a key spawning ground located approximately 47km south of the Study Area. The sensitivity of herring to underwater noise impacts is therefore considered to be **high**.

Significance of residual effect

8.9.197 Herring have a swim bladder that is involved in hearing and therefore are known to be sensitive to underwater noise. Key herring spawning and nursery grounds are located outside of the fish and shellfish Study Area. Herring are demersal spawners and are therefore considered stationary receptors in the assessment, increasing their exposure to TTS from the construction phase of the Proposed Development. However, there is no overlap between the spawning grounds and the maximum extents of the TTS contour from the underwater noise modelling. The magnitude of impact is considered to be **negligible** for TTS. Due to their sensitivity to underwater noise, and likelihood of disturbance to spawning herring, the species are assessed as having high sensitivity to underwater noise during construction, and therefore the effect on herring is predicted to be of **Minor adverse significance**, which is **Not Significant** in EIA terms.

Black seabream

8.9.198 Black seabream (Group 3 receptor, TTS onset at 186 dB SEL_{cum}) have a swim bladder close to, but not intimately connected to the ear, and therefore are known to be sensitive to underwater noise. Due to the presence of a key spawning/nesting area located specifically within the proposed offshore export cable corridor, which is located adjacent to the Kingmere MCZ, and the spawning site fidelity displayed by black seabream, black seabream are considered stationary receptors for this assessment.

Magnitude of impact

8.9.199 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to black seabream nesting areas (north-west location), and therefore have the greatest potential for impacts on nesting black seabream.

8.9.200 Noise modelling (assuming static receptors) has demonstrated that the potential for TTS on black seabream due to the piling of a single monopile could arise up to 21 km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Noise modelling for the most likely impacts from monopile installation showed the potential for TTS in this scenario may occur up to 17km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.201 The potential for TTS of black seabream from single multileg foundation installation may occur up to 18km from the array area (2,500kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for TTS may occur up to 14km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.202 The potential for TTS of black seabream from the sequential installation of 2 monopile foundations at separate locations within a period of 24 hours, may occur up to 26km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.19, Volume 3** of the ES (Document Reference 6.3.8)). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for TTS may occur up to 22km from the array.

8.9.203 The potential for TTS of black seabream from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 28km from the array area (4,400kJ hammer energy, SEL_{cum}) (**Figure 8.18,** (Document Reference 6.3.8) **Volume 3** of the ES), whilst piling impacts under the 'most-likely' scenario could occur up to 23km from the array area.

8.9.204 The potential for TTS injury of spawning black seabream from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 2,800km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 3,500km^2. The potential for TTS of spawning black seabream from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 2,500km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 3,900km^2 (**Figure 8.21, Volume 3** of the ES (Document Reference 6.3.8).

8.9.205 There is an interaction with TTS noise contours with areas of primary importance for breeding seabream (from March to July), however the implementation of embedded mitigation (C-265, C-274, C-280, C-281 **Table 8-13)** during the breeding season of black seabream (March to July) (when black seabream are within the impact range, and considered stationary receptors), including installation equipment choice and secondary noise mitigation options, will ensure a noise reduction is achievable to reduce the impact ranges of TTS to outside of areas of primary importance for breeding black seabream (Figure 3-6; RED, 2022b). These measures will ensure a magnitude of impact of **negligible** for TTS effects.

Sensitivity or value of receptor

8.9.206 Black seabream (Group 3) spawning and nursery are present within the fish and shellfish Study Area, specifically within the proposed offshore export cable corridor, which is located adjacent to the Kingmere MCZ. The sensitivity of black seabream to underwater noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.207 Black seabream have a swim bladder close to, but not intimately connected to the ear. Key spawning and nesting grounds for black seabream are located within the fish and shellfish Study Area, specifically within the proposed offshore export cable corridor, which is located adjacent to the Kingmere MCZ. Black seabream are demersal spawners and are therefore considered stationary receptors in the assessment, increasing their exposure to underwater noise from the potential piling operations during the construction phase of the Proposed Development. Due to their sensitivity to underwater noise, and likelihood of disturbance to spawning and nesting black seabream during the breeding season, the species were assessed as having medium sensitivity to underwater noise from construction activities. On this basis, considering the **negligible** magnitude of impact, and the **medium** sensitivity of black seabream, the residual effect significance will be **minor**, **Not Significant** in EIA terms.

European Seabass

8.9.208 European seabass (TTS onset at 186 SEL_{cum}) are mobile species and are likely to flee the immediate area in which piling will occur. Seabass are considered sensitive to sound pressure components of underwater noise (Group 3), due to having a swim bladder close to, but not intimately connected to the ear.

Magnitude of impact

8.9.209 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to the coast (north-west location) due to the preference of European seabass to inhabit shallow coastal and estuarine habitats. Therefore, piling at this location has the greatest potential for impacts on seabass.

8.9.210 Noise modelling (assuming fleeing receptors) has demonstrated that TTS of seabass due to the piling of a single monopile could arise within a maximum range 10km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Noise modelling for the most likely impacts from monopile installation showed the potential for TTS in this scenario may occur up to a maximum range of 9.4km from the array, a reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.211 The potential for TTS of seabass from multileg foundation installation may occur 7.9km from the array area (2,500kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for TTS may occur 6.5km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.212 The potential for TTS of seabass from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 11km from the array area (4,400 kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for TTS may occur up to 10km from the array.

8.9.213 The potential for TTS of seabass from the sequential installation of four pin piles at a single location (multileg foundations) has the potential to occur 8.1km from the array area (4,400kJ hammer energy, SEL_{cum}), whilst piling impacts under the 'most-likely' scenario could occur 7km from the array area.

8.9.214 The potential for TTS of seabass from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 1,500km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 1,600km^2. The potential for TTS of seabass from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to

1300km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 1300km^2.

8.9.215 Considering the spatial impact from the piling locations of the Proposed Development and the preference of European seabass to inhabit shallow coastal and estuarine habitats (there is no interaction of noise impact contours with the coast), along with the limited temporal impacts. The magnitude of the impact that construction activities relating to the Proposed Development will have on European seabass is considered **negligible**.

Sensitivity or value of receptor

8.9.216 European seabass (Group 3) are considered sensitive to underwater noise associated with piling. The sensitivity of European seabass to noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.217 Due to their sensitivity to underwater noise, European seabass were assessed as having medium sensitivity to underwater noise during construction. There is no interaction with the areas of primary importance for European seabass, and therefore the magnitude is considered **negligible**, and the associated effect therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

Seahorse

8.9.218 Seahorse (Group 4 receptor) are of low mobility and are therefore considered unlikely to flee with the onset of piling, therefore seahorses are considered stationary receptors within the assessment.

Magnitude of impact

8.9.219 Regarding the impact ranges from piling, the ranges presented in the following paragraphs are from the nearest modelling location to MCZs designated for seahorse (east and west locations), and therefore have the greatest potential for impacts on breeding seahorse. As the east modelling location represents the greatest impact ranges, these have been presented as the worst case.

8.9.220 Noise modelling (assuming static receptors) has demonstrated that the potential for TTS on seahorse due the proposed piling of single monopiles could arise up to 34km from the array area (4,400kJ hammer energy, based on SEL_{cum}). Noise modelling for the most likely impacts from monopile installation showed the potential for TTS in this scenario may occur up to 29km from the array (assuming static receptors), a significantly reduced impact than that proposed from the maximum design scenario hammer energies.

8.9.221 The potential for TTS of seahorse from single multileg foundation installation may occur up to 31km from the array area (2,500kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from multileg foundation installation showed the potential for TTS may occur up to 25km from the array, a reduced impact than that proposed from the maximum design scenario.

8.9.222 The potential for TTS of seahorse from the sequential installation of two monopile foundations at separate locations within a period of 24 hours, may occur up to 40km from the array area (4,400kJ hammer energy, SEL_{cum}). Noise modelling for the most likely impacts from the sequential installation of monopiles showed the potential for TTS may occur up to 35km from the array.

8.9.223 The potential for TTS of seahorse from the sequential installation of four pin piles (multileg foundations) has the potential to occur up to 43km from the array area (4,400kJ hammer energy, SEL_{cum}), whilst piling impacts under the 'most-likely' scenario could occur up to 37km from the array area.

8.9.224 The potential for TTS injury of seahorse from the simultaneous installation of single monopiles at the East and West modelling locations in the array area equates to a maximum area of up to 2,800km^2. The installation of two monopiles simultaneously at both the East and West modelling locations equates to a maximum area of up to 3,500km^2. The potential for TTS of seahorse from the simultaneous installation of a single multileg foundation at both the East and West modelling locations in the array area equates to a maximum area of up to 2,500km^2. The installation of four pin piles (multileg foundations) simultaneously at both the East and West modelling locations equates to a maximum area of up to 3,900km^2.

8.9.225 There are several MCZs in the vicinity of the proposed DCO Order Limits, designated for breeding seahorse in the summer. Taking into consideration the impact ranges of TTS from each scenario, there is no overlap from the impact range contours with the designated sites (**Figure 8.22 and Figure 8.23, Volume 3** of the ES (Document Reference 6.3.8)) (with the exception of the Beachy Head West MCZ), and therefore there is no potential for TTS of breeding seahorse. It is important to note, however that the distances cited within this assessment are the maximum extents of the individual contours, and therefore reflect the maximum noise propagation towards deeper waters (i.e. offshore). The noise contour extents in a nearshore direction, within shallower waters (i.e. towards the MCZs designated for breeding seahorse) are much less, due to the effects of water depths on the transmission of sound/pressure.

8.9.226 Regarding the potential for TTS on breeding seahorse within the Beachy Head West MCZ, there is an interaction of the impact ranges from piling in the array area, with the Beachy Head West MCZ. However embedded mitigation to reduce impacts from underwater noise on sensitive receptors will be implemented (C-265, **Table 8-13**). The mitigation is to deploy double big bubble curtains (DBBC) as the minimum single offshore piling noise mitigation technology to deliver underwater noise attenuation for all foundation installations throughout the construction of the Proposed Development where percussive hammers are used. This will reduce the impact ranges of TTS to areas outside of the MCZ.

8.9.227 Surveys across the region have shown there is potential for seahorse to occur in deeper waters within the region generally, relating to overwintering migration, which could feasibly result in the seahorse species being present in the general area of the Proposed Development. Although interaction with individual seahorses cannot be ruled out, the overall risk of interaction considered to be low given the low numbers of individuals dispersed across a wide sea area, and spatially discrete, therefore the magnitude of the impact that construction activities relating to the Proposed Development will have on seahorse is considered to be **negligible.**

Sensitivity or value of receptor

8.9.228 The proposed DCO Order Limits is a potential overwintering area for both seahorse species. The sensitivity of seahorse to noise impacts is therefore considered to be **high**.

Significance of residual effect

8.9.229 With mitigation in place, the magnitude of impact is **negligible**. Considering the high sensitivity of seahorse, the residual effect significance is **minor**, **Not Significant** in EIA terms for both breeding and over-wintering seahorse.

Cuttlefish

8.9.230 Cuttlefish (Group 1 receptor, mortality onset at >219 dB SEL_{cum}) are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates (Blanc and Daguzan, 1998; Bloor *et al*., 2013, cited in Ganias *et al*., 2021). Due to their demersal spawning nature, cuttlefish are considered stationary receptors for the sake of the assessment.

Magnitude of impact

8.9.231 The general consensus of studies describing noise impacts from offshore windfarms on cuttlefish is that there are very few physiological effects, unless the organisms are very close to the noise source (Mavraki *et al*., 2020; Solé *et al.,* 2022). Cuttlefish are distributed widely throughout the English Channel and into the southern North Sea, and their spawning grounds are located inshore. Therefore, taking the wider environment into context, the lack of overlap of noise contours with inshore areas and therefore lack of impact with spawning cuttlefish, and the overall short duration of piling and its intermittent nature, the magnitude of effect on cuttlefish is assessed as being **negligible** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.232 As noted in **Paragraph 8.9.90**, cuttlefish are considered to be of **medium** sensitivity to underwater noise on account of their demersal spawning behaviours and lack of swim bladder (therefore are considered less sensitive to noise in comparison to other receptors).

Significance of residual effect

8.9.233 Due to the **medium** sensitivity of spawning cuttlefish to noise (stationary Group 1 receptors) and the **negligible** magnitude of impact, the significance of effect is of **minor adverse significance**, which is **Not Significant** in EIA terms.

Other fish receptors

8.9.234 All other fish receptors within the proposed DCO Order Limits are pelagic spawners and are considered mobile and will be expected to vacate the area in which the impact could occur with the onset of 'soft start' piling.

Magnitude of impact

8.9.235 All other fish receptors and their respective spawning grounds are distributed widely throughout the English Channel and into the southern North Sea, and therefore taking the wider environment into context, the magnitude of effect on all other fish receptors are assessed as being **minor** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.236 Cod, whiting (Group 3) and sprat (Group 4) all have swim bladders that are involved in hearing, and therefore are known to be sensitive to underwater noise. These receptors are pelagic spawners, and do not display substrate dependency during spawning behaviours, they are therefore expected to flee the area with the onset of 'soft start' piling. Taking this into account, these receptors are considered to be of **medium** sensitivity to noise impacts.

Significance of residual effect

8.9.237 Due to the sensitivity of these receptors to noise, the receptors were assessed as having medium sensitivity to underwater noise during construction. There is limited interaction with the areas of primary importance these receptors due to their pelagic spawning nature, and therefore the magnitude is considered minor, and the associated effect therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

Eggs and larvae

8.9.238 Eggs and larvae close to the substrate are considered vulnerable to particle motion generated by pile driving (Popper *et al*., 2014). As no criteria exist regarding impacts imposed by particle motion, a qualitative assessment based on sound pressure is recommended by Popper *et al*. (2014) for receptors that lack a swim bladder. Horse mackerel, lemon sole, plaice, sandeel, sole, cod, whiting and sprat all have spawning grounds that overlap the fish and shellfish Study Area. Risks to eggs and larvae are therefore considered in this assessment.

8.9.239 A key herring spawning ground is also located to the south of Rampion 2 (Coull *et al.*, 1998), although there is no direct overlap of the fish and shellfish Study Area with the spawning ground, therefore herring eggs are outside of any zone of influence. However, larvae have the potential to drift (as evidenced in **Appendix 8.1: Herring annual heatmaps, Volume 4** (Document Reference 6.4.8.1), and therefore there is the potential for TTS to occur on herring larvae.

Magnitude of impact

8.9.240 In accordance with the Popper *et al*. (2014) qualitative assessment criteria, the extent of noise disturbance potentially causing recoverable injury in eggs and larvae would result in a moderate degree of disturbance at a near field (10s of meters) distance from the source, and a low degree of disturbance is anticipated to occur at intermediate (100s of meters) distance and far (1000s meters) distances from the piling operations. Taking this into consideration, the magnitude of impact is therefore considered to be **minor**.

Sensitivity or value of receptor

8.9.241 Eggs and larvae are considered organisms of concern by Popper *et al*. (2014), due to their vulnerability, reduced mobility and small size. As a result of this, the sensitivity of eggs and larvae to noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.242 Due to the sensitivity of eggs and larvae to underwater noise, the receptor was assessed as having medium sensitivity to underwater noise during construction. Taking into account the broad distribution of horse mackerel, lemon sole, plaice, sandeel, sole, cod, whiting and sprat spawning grounds within UK waters, it is considered unlikely that there will be any population level effects on these receptors. Considering the distance of areas of high-density herring larvae from the Rampion 2 array area (30 km), the degree of disturbance to herring larvae will be low in accordance with the Popper *et al*. (2014) qualitative assessment criteria. Therefore, the overall effect on eggs and larvae of all receptors is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Shellfish

8.9.243 There are no criteria for shellfish sensitivity to noise, and therefore a qualitative assessment has been undertaken using peer reviewed literature. On the basis that shellfish do not possess swim bladders or other gas filled organs, it is considered that shellfish are primarily sensitive to particle motion rather than sound pressure (e.g. Popper and Hawkins 2018). As the understanding of marine invertebrate sensitivity to particle motion is in its infancy (Lewandowski *et al*. 2016), there is limited information available on the potential for hearing damage on shellfish from particle motion. However, a study by Zhang *et al*. (2015) did suggest that severe particle motion could irreparably damage the statocysts of cephalopods at short range, causing hearing impairment. This was considered likely to occur as a result of pile driving, although thought to only occur at short range.

Magnitude of impact

8.9.244 It is understood that particle motion attenuates rapidly, and therefore impacts on shellfish from particle motion are likely to occur local to the source. Taking this into account, and the broad distribution of these species along the UK coasts, and across the English Channel, the magnitude of effect on shellfish receptors is considered to be **minor**.

Sensitivity or value of receptor

8.9.245 Pile driving is recognised as a source particle motion, generating high levels of particle motion in the nearfield (Hazelwood and Macey 2016), and as a result shellfish are considered to be of **medium** sensitivity to underwater noise impacts.

Significance of residual effect

8.9.246 Whilst some species have spawning and nursery grounds within the fish and shellfish Study Area, they typically occur over a large area and into the southern North Sea, any disturbance to spawning is considered small in the context of the wider habitat availability. Shellfish species are considered sessile, and therefore will be expected to remain in the area in which the impact could occur with the onset of 'soft start'/ramp up piling. Taking all of this into account, all shellfish species are assessed as having medium sensitivity to underwater noise during construction, and a minor magnitude of impact, the effects on these species are therefore predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Behavioural impacts

Introduction

8.9.247 Different fish and shellfish have varying sensitivities to pilling noise, depending on how these species perceive sound in the environment. Behavioural effects in response to construction related underwater noise include a variety of responses including startle response (C-turn), strong avoidance behaviour, changes in swimming or schooling behaviour, or changes of position in the water column (e.g. Hawkins *et al*., 2014b).

8.9.248 Depending on the strength of the response and the duration of the impact, there is the potential for some of these responses to lead to significant effects at an individual level (e.g. reduced fitness, increased susceptibility to predation) or at a population level (e.g. avoidance or delayed migration to key spawning grounds), although these may also result in short-term, intermittent changes in behaviour that have no wider effect, particularly once acclimatisation to the noise source is taken into account.

8.9.249 Regarding Group 1 fish and shellfish, these receptors lack a swim bladder, and so are largely considered to be less sensitive to sound pressure, with these species instead detecting sound in the environment through particle motion. The sensitivity of the receptors to acoustic particle velocity component of the sound field has been noted by a number of researchers (Hawkins, 2006; Nedwell *et al*., 2007; Popper and Hastings, 2009) and the potential for piling activity to generate the type of sound fields that may contain substantial acoustic particle velocity components has also been noted in the literature (Hawkins, 2009). As such, sensitivity to particle motion in the Group 1 fish receptors and shellfish is more likely to be important for behavioural responses rather than injury (Hawkins, 2009; Hawkins *et al*., 2014b; Mueller-Blenkle *et al*., 2010).

8.9.250 It has also been reported that slow, rolling interface waves that move out from a source like a pile driver can produce particle motion amplitudes travelling considerable distances (Hawkins and Popper, 2016), with implications for demersal and sediment dwelling fish (such as sandeel) and shellfish in close proximity to piling operations. Specifically, demersal dwelling receptors such as sandeel (Group 1 receptors) may be particularly affected by vibration through the seabed during winter hibernation when sandeel remain buried in sandy sediments.

8.9.251 However, as indicated by the risk criteria outlined for Group 1 in **Table 8-17**, particle motion generated from piling is expected to attenuate more rapidly than the acoustic pressure component in the water, with a low risk of behavioural effects in the far-field (i.e., kilometres from the source).

8.9.252 Mueller-Blenkle *et al*. (2010) measured behavioural responses of Dover sole to sounds representative of those produced during marine piling, with considerable variation across subjects (i.e., depending on the age, sex, condition etc. of the fish, as well as the possible influence of confinement in cages on the overall stress levels in the fish). This study concluded that it was not possible to find an obvious relationship between the level of exposure and the extent of the behavioural response, although an observable behavioural response was reported at 144 to 156dB re 1 μPa SPL_{peak} for Dover sole. However, this threshold should not be interpreted as the level at which an avoidance reaction will be elicited, as the study was not able to show this, especially considering the varied responses observed across subjects.

8.9.253 Research into the impact of underwater noise on shellfish receptors is scarce, and no attempt has been made to set exposure criteria (Hawkins *et al*., 2014a). Studies on marine invertebrates have shown sensitivity of shellfish receptors to substrate borne vibration (Roberts *et al*., 2016). Aquatic decapod crustaceans are equipped with a number of receptor types potentially capable of responding to the particle motion component of underwater noise (e.g., the vibration of the water molecules which results in the pressure wave) and ground-borne vibration (Popper *et al*., 2001). It is generally their hairs that provide the sensitivity, although these animals also have other sensor systems which could be capable of detecting vibration.

8.9.254 Group 2, 3 and 4 fish receptors possess a swim bladder and therefore are more sensitive to the sound pressure components of underwater noise (see paragraph 8.9.13), therefore the risks of behavioural effects are considered greater for these species. A number of studies have examined the behavioural effects of the sound pressure component of impulsive noise (including piling operations and seismic airgun surveys) on fish species, including Group 3 gadoids. Mueller-Blenkle *et al.* (2010) measured behavioural responses of cod to sounds representative of those produced during marine piling and observed behavioural responses at 140 to 161 dB re 1 μPa SPL_{peak} for cod. However, variable responses were observed across subjects and consequently this threshold should not be interpreted as the level at which an avoidance reaction will be elicited, as the study was not able to show this. A study by Pearson *et al*. (1992) on the effects of seismic airgun noise on caged rockfish (*Sebastes* species) observed a startle or C-turn response at peak pressure levels beginning around 200dB re 1 μPa, although this was less common with the larger fish. Studies by Curtin University in Australia for the oil and gas industry by McCauley *et al*. (2000) exposed various fish species in large cages, in open water to seismic airgun noise and assessed behaviour, physiological and pathological changes. The study made the following observations:

- a general fish behavioural response to move to the bottom of the cage during periods of high-level exposure (greater than root mean square (RMS) levels of around 156 to161 dB re 1 μPa; approximately equivalent to SPL_{peak} levels of around 168 to 173 dB re 1 μPa);
- a greater startle response by small fish to the above levels;
- a return to normal behavioural patterns some 14 to 30 minutes after airgun operations ceased;
- no significant physiological stress increases attributed to air gun exposure; and
- some preliminary evidence of damage to the hair cells when exposed to the highest levels, although it was determined that such damage will only likely occur at short range from the source.

8.9.255 The authors did, however, note that any potential seismic effects on fish may not necessarily translate to population scale effect or disruption to fisheries and McCauley *et al*. (2000) show that caged fish experiments can lead to variable results.

8.9.256 Picciulin *et al*., (2022) undertook a study based on free-living brown meagre (*Sciaena umbra*) fish and observed no influence on breeding site selection of brown meagre (*Sciaena umbra)* fish when exposed to vessel noise. Similar observations were made by Bruintjes *et al*., (2014), who observed no influence on the early-life survival and growth of the cichlid fish (*Neolsmprologus pulcher*) when exposed to moderate noise increases (motorboat noise). Although it should be noted that this study was conducted on captive fish.

8.9.257 Hawkins *et al*. (2014) undertook a study on schools of sprat (*Sprattus sprattus*) and mackerel (*Scomber scombrus*), observing behavioural responses to pile driving. A range of responses were observed at sound pressure levels of 163.2 SPL_{peak}-to-peak and estimated single strike SEL of 135dB re 1 μPa2 s for sprat and 163.3dB re 1μPa peak-to-peak and estimated single strike SEL 142.0dB re 1μPa2 s for mackerel. Although responses were found to vary (to the same stimulus type and intensity), differing between the two species, schooling fish and individuals, and during night and day.

8.9.258 Acoustic trauma has been observed in selected cephalopod species, as evidenced by André *et al*. (2011) who observed acoustic trauma in European squid, following exposure to low frequency sound. This was also observed by Samson *et al*. (2016) with a range of behavioural responses to underwater noise in cephalopods recorded, including inking, colour changes and startle responses. However, Fewtrell and McCauley (2012) suggest that such alterations are only temporary from experimental studies.

8.9.259 Seahorse hearing is considered similar to that of herring (Group 4) and are therefore likely to be sensitive to underwater noise. A study on wild spiny/long-snouted seahorse, found 87% of seahorse reacted to a noise stimulus (expressed by increased opercular movements per minute (OMPM)) during the induced sequence of transient (up to 127.6dB) and constant (137.1dB) sound exposure (Palma *et al*., 2019). In addition, Palma *et al*. (2019) also found <38% of those seahorses abandoned their holdfast and moved away, a behaviour the authors are interpreting as an attempt to avoid the negative sound stimuli. A study by

Anderson *et al*. (2011) examined the behavioural response of the lined seahorse (*H. erectus*) when exposed to 123dB to 137dB $_{rms}$ re 1μPa in a tank for a month. Seahorse exposed to loud noises showed a behavioural response such as irritation and distress, and a physiological response, including lower weight, worse body condition, higher plasma cortisol and other blood measures indicative of stress, and more parasites in their kidneys. In addition to the primary and secondary stress indices in the blood and plasma, seahorses exhibited tertiary indices (e.g., growth, behaviour, and mortality) (Anderson *et al*., 2011). However, the study found that some of the variability in these measures (such as time spent mobile) subsided after the first week, presumably due to habituation. It is important to note that Radford *et al*. (2016) recorded shipping sound levels of 124dB $_{rms}$ re 1μPa, seismic survey noise levels at 131dB $_{rms}$, and pile driving at 141dB $_{rms}$; in this context and based on the Anderson *et al*. (2011) paper, seahorses can be expected to habituate to the noise levels that may be experienced during piling operations.

8.9.260 The European seabass has increasingly been used in the study of anthropogenic noise effects on fish. The hearing sensitivity of seabass is most acute at low frequencies (100–1000 Hz); coincident with many anthropogenic noises in water (Götz *et al*., 2009). Spiga *et al*. (2017) investigated the effects of recordings of piling and drilling noise on the anti-predator behaviour of captive juvenile European seabass in response to a visual stimulus (a predatory mimic). None of the behavioural measures related to exploration, swimming activity or anxiety were affected by playback noise onset (Spiga *et al*., 2017).

8.9.261 Exploration behaviour is an important feature in fish as it leads to finding food, mates and escapes routes. Therefore, it has been suggested that although piling noise triggers reflex behaviours, the responses would appear not to be detrimental to the fish (Spiga *et al*., 2017). It is, therefore, reasonable to assume that this species be able to detect both particle motion and pressure changes of the sound (Radford *et al*., 2012). If seabass are close to the seabed, they may well be affected by seabed vibration (Hazelwood, 2012; Hazelwood and Macey, 2016a, 2016b). Research by Radford *et al*. (2016) using seabass was designed to examine the changes in ventilation rate (opercular beat rate (OBR)) caused by noise to captive fish, which would indicate a stress response. When pile driving noise was played at 147dB SEL_{ss}, 30dB above the ambient noise played prior to the stimulus (117dB SPLRMS), a clear increase in OBR was detected. Collett *et al*. (2012) measured an ambient noise level at sea at Rampion 1 of 113 to 120dB SPLRMS prior to WTG foundation installation, which was similar to the ambient noise in the Radford *et al*. (2016) experiment.

8.9.262 Additional research by Kastelein *et al*. (2017), also on seabass, identified that initial responses in adult fish (sudden short-lived changes in swimming speed) occurred in response to impulsive pile driving at 141dB SEL_{ss}, but concluded that no sustained responses (changes in school cohesion, swimming depth, and speed) occurred at levels up to 166dB SELss. Kastelein *et al*. (2017) concluded that the analysis showed that there is no evidence, even at the highest sound level, for any consistent sustained response to sound exposure by the study animals. In this context the conclusion drawn was that if seabass are exposed to pile driving sounds at the levels used in the present study, there are unlikely to be any adverse effects on their ecology, because the initial responses after the onset of the piling sound observed were short-lived. A study undertaken by Neo *et al*.,

(2018) on captive seabass, observed more significant behavioural responses of European bass to piling during the night than during the day, and also noted habituation over repeated sound exposure.

8.9.263 While these studies are informative to some degree, these, and other similar studies, do not provide an evidence base that is sufficiently robust to propose quantitative criteria for behavioural effects (Hawkins and Popper, 2016; Popper *et al*., 2014). Nonetheless, the quantitative criteria identified in the literature have been summarised below, for ease of the reader:

Table 8-22 Summary of behavioural noise response thresholds identified in literature

Literature	Receptor	Behavioural response threshold identified
Mueller-Blenkle *et al*. (2010)	Dover sole	144 to 156 dB re 1 μPa SPL_{peak}
Mueller-Blenkle *et al*. (2010)	Cod	140 to 161 dB re 1 μPa SPL_{peak}
Pearson *et al*. (1992)	Rock fish	200 dB re 1 μPa (mean-peak level)
McCauley *et al*. (2000)	N/A	156 to 161 dB re 1 μPa rms, 168 to 173 dB re 1 μPa SPL_{peak}
Hawkins *et al*. (2014)	Sprat	163.2 dB re 1 μPa SPL_{peak}, 135 dB re 1 μPa SELss
Hawkins *et al*. (2014)	Mackerel	163.3 dB re 1 μPa SPL_{peak}, 142.0 dB re 1 μPa SELss
Anderson *et al*. (2011)	Seahorse	123 dB to 137 dB re 1 μPa rms
Radford *et al*. (2016)	Seabass	147 dB re 1 μPa SELss
Kastelein *et al*. (2017)	Seabass	141 dB re 1 μPa SELss

8.9.264 As evidenced by the studies above, fish and shellfish behavioural responses to underwater noise are highly dependent on factors such as the type of fish/shellfish, sex, age and condition, as well as other stressors to which the fish/shellfish have been exposed. For example, it is expected that smaller fish might show behavioural responses at lower levels of noise. In addition to this, the response of the fish will depend on the reasons and drivers for the fish being in the area. Foraging or spawning, may increase the desire for the fish to remain in the area despite the elevated noise level (Peña *et al*., 2013). This is supported by Neo *et al.* (2014) who concluded that a single criterion value for behaviour does not take into consideration the substantial species differences in behaviour, nor does it take into consideration response changes with animal age, season, or motivational state. This is evidenced by Skaret *et al.* (2005) who observed no avoidance behaviours in herring, in response to vessel noise when engaged in spawning behaviours.

8.9.265 Due to the range of behavioural responses elicited from fish and shellfish receptors, and the influence from environmental variables and ecological stressors, Popper *et al*. (2014) recommend the application of a qualitative assessment. The qualitative behavioural criteria derived from Popper *et al*. (2014) for fish are provided in **Table 8-23** below. These categorise the risks of effects in relative terms as 'high, moderate or low' at three distances from the source: near (10s of metres), intermediate (100s of metres), and far (1,000s of metres), respectively. This qualitative approach as recommended by Popper *et al*. (2014) has been applied to the assessment of behavioural impacts of fish and shellfish in **Paragraph 8.9.268** *et seq.*

Table *8-23* Criteria for onset of behavioural effects in fish due to piling activity (Popper et al., 2014)

Type of animal	Impairment	
	Auditory masking	**Behaviour**
Fish: no swim bladder (Group 1)	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (Group 2)	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (Group 3 and 4)	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Eggs and larvae	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Risk of effect category (high, moderate low) is given at three distances from the source in relative terms: near field (N: 10s of metres), intermediate field (I: 100s of metres), and far field (F: 1,000s of metres); (Popper *et al*., 2014).		

8.9.266 The thresholds identified in the literature detailed above and summarised in **Table 8-22**, are largely based on captive animals (as reviewed by Popper and Hawkins, 2019). Whilst studies on captive animals are suitable for gaining physiological information such as hearing sensitivity, they may not be suitable for understanding how a wild animal will respond behaviourally to a stimulus (Oldfield, 2011). Notably, a need for further research on behavioural responses to external stimuli was highlighted by Popper *et al*., (2014) with an emphasis on the requirement for studies on wild fish receptors. Therefore, considering this, and the variability of behavioural responses observed within the studies detailed above, the use of the identified thresholds to inform the assessment of behavioural impacts on fish and shellfish is not supported by RED. However, following stakeholder engagement, consideration of the noise impact threshold as identified by Hawkins, (2014) for sprat, has been requested when describing the potential for behavioural effects in herring, as it focuses on species from the *Clupeidae* family. This threshold has therefore been presented in **Figure 8.20, Volume 3** of the ES (Document Reference 6.3.8) to inform the assessment of behavioural effects on herring from the Proposed Development. It should be noted however, that Hawkins *et al.* (2014) explicitly state within the publication that the data presented should not be used to define sound exposure criteria, specifically as it is not representative of the receiving environment, due to the study being undertaken within a quiet loch, which is not considered comparable to open sea conditions.

8.9.267 Furthermore, whilst following stakeholder discussions there remained disagreements on a definitive disturbance threshold specifically for black seabream, a threshold of 141dB re 1μPa SELss as defined by Kastelein *et al*. (2017) has been used to inform the assessment of behavioural effects on black seabream. As European seabass are of the same order as black seabream, perciform, they have therefore suggested as a proxy anatomically, physiologically and geographically for black seabream. It should be acknowledged however, that as reported by Kastelein *et al*. (2017), there was no evidence of any consistent sustained response to sound exposure by the study animals, and it was concluded that it would be unlikely for any adverse effects on seabass ecology, due to the short-lived nature of the responses.

Sandeel

8.9.268 Sandeel (Group 1) lack a swim bladder and therefore have low sensitivity to impacts from noise, therefore behavioural effects on this species are expected to be reduced. Sandeel spawning and nursery habitats are present within the fish and shellfish Study Area, these tend to extend over a wide area, and the relative proportion of these habitats affected by piling operations at any one time will therefore be small in the context of the wider habitat available.

Magnitude of impact

8.9.269 Considering the Popper *et al*. (2014) criteria, any risk of behavioural effects or auditory masking in sandeel from piling are expected to be moderate to high in the near field, low to moderate in the intermediate field, and low in the far field.

8.9.270 Low intensity sandeel spawning and nursery habitats are located in the fish and shellfish Study Area (see **Figure 8-3** (Document Reference 6.3.8 and **Figure 8-9** (Document Reference 6.3.8)**, Volume 3** of the ES). It should be noted however that the degree of overlap between spawning and nursery grounds of these species and the area with potential for behavioural impacts is very small relative to the total area that the species could use for spawning in the English Channel and the southern North Sea (Jensen *et al*., 2011). Therefore, taking this into account, the spatial extent of the impact in the context of the wider environment is considered small, with the overall short duration of piling and its intermittent nature, together with the fact that any effect associated with behavioural impacts will be temporary, the magnitude of impact that construction activities relating to the Proposed Development will have on sandeel is therefore considered to be **minor**.

Sensitivity or value of receptor

8.9.271 Sandeel (Group 1 receptor) lack a swim bladder, are assessed as having medium sensitivity to impacts from sound pressure in **paragraph 8.9.35** due to their reduced mobility, and therefore inability to flee from noise impacts. As a result of their reduced sensitivity to sounds pressure, the behavioural effects on this species are expected to be **medium**.

Significance of residual effect

8.9.272 Sandeel lack a swim bladder and are therefore considered less sensitive to underwater noise. Sandeel spawning habitat occurs over a large area across the English Channel and into the southern North Sea, including within proposed DCO Order Limits. Due to their demersal nature, sandeel are considered a stationary receptor to underwater noise in this assessment, and therefore will be exposed to underwater noise from piling activity during the construction phase of the Proposed Development. However, due to their reduced sensitivity, and small degree of disturbance to spawning grounds in the context of the wider habitat availability in the English Channel and within the southern North Sea, the species are assessed as having **medium** sensitivity to underwater noise during construction, and the magnitude of impact is deemed to be **minor**, therefore the effect on sandeel is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Herring

8.9.273 Group 4 fish are more sensitive to the sound pressure components of underwater noise and therefore the risks of behavioural effects in the intermediate and far-fields are greater for these species. Herring have a swim bladder which is involved with hearing, and therefore behavioural effects or auditory masking are expected to be greater, although, this may not result in a strong avoidance reaction.

Magnitude of impact

8.9.274 Considering the Popper *et al*. (2014) criteria, any risk of behavioural effects or auditory masking in herring from piling are expected to be high in the near to intermediate field and moderate in the far field.

8.9.275 As stated above, following stakeholder engagement, the noise impact threshold as identified by Hawkins *et al*. (2014) for sprat, has been deemed applicable when describing the potential for behavioural effects in herring, as it focuses on species from the *Clupeidae* family. This threshold is shown **Figure 8.20, Volume 3** of the ES (Document Reference 6.3.8) to inform the assessment, and estimate the potential impact ranges of behavioural effects on herring. As shown in **Figure 8.20, Volume 3** of the ES (Document Reference 6.3.8), the impact range of behavioural effects on herring has no overlap with the herring spawning grounds as defined by Coull *et al.* (1998) and Ellis *et al*. (2010). It is important in this context however to note that the use of the 135 dB SEL threshold in an open water receiving environment characterised by shipping is highly precautionary and very unlikely to elicit a comparable response to that observed by Hawkins *et al*. (2014.). Nonetheless, taking into consideration both the Popper *et al* (2014) qualitative criteria, and the precautionary Hawkins *et al*. (2014) threshold, the magnitude of impact on spawning herring is considered to be **negligible**.

Sensitivity or value of receptor

8.9.276 Herring have a swim bladder that is involved in hearing herring and are known to inhabit the English Channel. Herring have a key spawning ground located approximately 47km south of the Study Area. The sensitivity of herring to underwater noise impacts is therefore considered to be **high**.

Significance of residual effect

8.9.277 Herring have a swim bladder that is involved in hearing and therefore are known to be sensitive to underwater noise. Key herring spawning and nursery grounds are located outside of the fish and shellfish Study Area, and outside of the impact ranges for behavioural effects. Herring are demersal spawners and are therefore considered stationary receptors in the assessment, increasing their exposure to underwater noise from the construction phase of the Proposed Development. Taking into consideration the sensitivity of herring to underwater noise, and the lack of overlap of the behavioural impact contour with herring spawning grounds, the significance of effect on herring is predicted to be of **minor significance**, which is **Not Significant** in EIA terms.

Black seabream

8.9.278 Black seabream (Group 3 receptor) have a swim bladder close to, but not intimately connected to the ear, and therefore are known to be sensitive to underwater noise. Due to the presence of a key spawning/nesting area located specifically within the proposed offshore export cable corridor, which is located adjacent to the Kingmere MCZ, and the spawning site fidelity displayed by black seabream, black seabream are considered stationary receptors for this assessment.

Magnitude of impact

8.9.279 Considering the Popper *et al*. (2014) criteria, any risk of behavioural effects or auditory masking in spawning/nesting black seabream from piling are expected to be high in the near to intermediate field and moderate in the far field.

8.9.280 As stated above, a noise impact threshold of 141dB re 1µPa SEL_{SS} as defined by Kastelein *et al*. (2017) has been used to describe the potential for behavioural effects in black seabream. The impact range of behavioural effects on black seabream overlaps areas of black seabream nesting within the offshore export cable corridor and the Kingmere MCZ, therefore there is the potential for disturbance on nesting black seabream. It is important in this context however to note that the use of the 141dB re 1µPa SELss threshold is considered highly precautionary, considering the range of behavioural responses reported in literature. Specifically, as reported by Kastelein *et al*. (2017), there was no evidence of any consistent sustained response to sound exposure by the study animals, and it was concluded that it would be unlikely for any adverse effects on the receptors, due to the short-lived nature of the responses. Nonetheless, the implementation of embedded environmental mitigation (C-265, C-274, C-280, C-281, **Table 8-13**) during the nesting season will reduce the magnitude of the impact. The implementation of this mitigation will ensure that the predicted noise levels at the black seabream nesting areas within the Kingmere MCZ do not exceed the 141dB level that could (on a precautionary basis) elicit a response from black seabream (**In principle sensitive features site integrity plan** (Document Reference 7.17)). Therefore, with the implementation of this mitigation, a demonstrable reduction in magnitude will be provided and a material disturbance to the receptor will not occur. Therefore, the magnitude of impact will be **negligible**.

Sensitivity or value of receptor

8.9.281 Black seabream (Group 3) spawning and nursery are present within the fish and shellfish Study Area, specifically within the proposed offshore export cable corridor, which is located adjacent to the Kingmere MCZ. The sensitivity of black seabream to underwater noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.282 Black seabream have a swim bladder close to, but not intimately connected to the ear. Key spawning and nesting grounds for black seabream are located north of the array area within the fish and shellfish Study Area. Black seabream are demersal spawners and are therefore considered stationary receptors in the assessment, increasing their exposure to underwater noise from the potential piling operations during the construction phase of the Proposed Development. Due to their sensitivity to underwater noise, and likelihood of disturbance to spawning and nesting black seabream, the species are assessed as having medium sensitivity to underwater noise during construction. Considering the **negligible** magnitude of impact, and the **medium** sensitivity of black seabream, the residual effect significance will reduce to **minor**, which is **Not Significant** in EIA terms.

European Seabass

8.9.283 European seabass are mobile species and are likely to flee the immediate area in which piling will occur. Seabass are considered sensitive to sound pressure components of underwater noise (Group 3), due to having a swim bladder close to, but not intimately connected to the ear.

Magnitude of impact

8.9.284 Considering the Popper *et al*. (2014) criteria, any risk of behavioural effects or auditory masking in seabass from piling are expected to be high in the near to intermediate field and moderate in the far field. Taking into consideration the preference of European seabass to inhabit shallow coastal and estuarine habitats, along with the limited temporal impacts of piling. The magnitude of the impact that construction activities relating to the Proposed Development will have on European seabass is considered **negligible**.

Sensitivity or value of receptor

8.9.285 European seabass (Group 3) are considered sensitive to underwater noise associated with piling. The sensitivity of European seabass to noise impacts is therefore considered to be **medium**.

Significance of residual effect

8.9.286 Due to their sensitivity to underwater noise, European seabass were assessed as having medium sensitivity to underwater noise during construction. There is limited interaction with the areas of primary importance for breeding European seabass, and therefore the magnitude is considered **negligible**, and the associated effect therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

Seahorse

8.9.287 Seahorse (Group 4 receptor) are of low mobility and are therefore considered unlikely to flee with the onset of piling, therefore seahorses are considered stationary receptors within the assessment.

Magnitude of impact

8.9.288 Considering the Popper *et al*. (2014) criteria, any risk of behavioural effects or auditory masking in seahorse from piling are expected to be high in the near to intermediate field and moderate in the far field. Taking into consideration the location of the MCZs in relation to the array area (see **Table 8-11**, nearest MCZ is located 12 km from the array area), moderate effects are anticipated on breeding seahorse. However embedded mitigation to reduce impacts from underwater noise on sensitive receptors will be implemented (C-265, **Table 8-13**). The mitigation is to deploy DBBC as the minimum single offshore piling noise mitigation technology to deliver underwater noise attenuation for all foundation installations throughout the construction of the Proposed Development where percussive hammers are used. This mitigation measure will reduce the predicted noise levels on breeding seahorses within their relevant designations. Therefore, with the implementation of embedded mitigation, the magnitude of the impact that construction activities relating to the Proposed Development will have on breeding seahorse is considered **negligible**.

8.9.289 Considering the low risk of interaction and the spatially discrete presence of individual overwintering seahorse, the magnitude of the impact from construction activities relating to the Proposed Development on overwintering seahorse is considered to be **negligible**.

Sensitivity or value of receptor

8.9.290 The proposed DCO Order Limits is a potential overwintering area for both seahorse species, and seahorse are a feature of several MCZs within the region. The sensitivity of seahorse to noise impacts is therefore considered to be **high**.

Significance of residual effect

8.9.291 With mitigation in place, the magnitude of impact is **negligible**. Considering the high sensitivity of seahorse, the residual effect significance is **minor**, **Not Significant** in EIA terms for both breeding and over-wintering seahorse.

Cuttlefish

8.9.292 Cuttlefish (Group 1 receptor, mortality onset at >219 dB SELcum) are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates (Blanc and Daguzan, 1998; Bloor et al., 2013, cited in Ganias et al, 2021). Due to their demersal spawning nature, cuttlefish are considered stationary receptors for the sake of the assessment.

Magnitude of impact

8.9.293 The general consensus of studies describing noise impacts from offshore windfarms on cuttlefish is that there are very few behavioural effects, unless the organisms are very close to the noise source (Mavraki et al, 2020; Solé *et al.,* 2022). Cuttlefish are distributed widely throughout the English Channel and into the southern North Sea, and their spawning grounds are located inshore. Therefore, taking the wider environment into context, the distance of the Rampion 2 array area from the inshore spawning grounds, and the lack behavioural responses observed in the receptor and the overall short duration of piling and its intermittent nature, the magnitude of effect on cuttlefish is assessed as being **negligible** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.294 As noted in **Paragraph 8.9.90**, cuttlefish are considered to be of **medium** sensitivity to underwater noise on account of their demersal spawning behaviours and lack of swim bladder (therefore are considered less sensitive to noise in comparison to other receptors.

Significance of residual effect

8.9.295 Due to the **medium** sensitivity of spawning cuttlefish to noise (stationary Group 1 receptors) and the **negligible** magnitude of impact, the significance of effect is of **minor adverse significance**, which is **Not Significant** in EIA terms.

Other fish receptors

8.9.296 All other fish receptors within the proposed DCO Order Limits are pelagic spawners and are considered mobile and will be expected to vacate the area in which the impact could occur with the onset of 'soft start' piling.

Magnitude of impact

8.9.297 All other fish receptors and their respective spawning grounds are distributed widely throughout the English Channel and into the southern North Sea, and therefore taking the wider environment into context, the magnitude of effect on all other fish receptors are assessed as being **minor** from impacts associated with piling within the array area.

Sensitivity or value of receptor

8.9.298 Cod, whiting (Group 3) and sprat (Group 4) all have swim bladders that are involved in hearing, and therefore are known to be sensitive to underwater noise. These receptors are pelagic spawners, and do not display substrate dependency during spawning behaviours, they are therefore expected to flee the area with the onset of 'soft start' piling. Taking this into account, these receptors are considered to be of **medium** sensitivity to noise impacts.

Significance of residual effect

8.9.299 Due to the sensitivity of these receptors to noise, the receptors were assessed as having medium sensitivity to underwater noise during construction. There is limited interaction with the areas of primary importance these receptors due to their pelagic spawning nature, and therefore the magnitude is considered minor, and the associated effect therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

Eggs and larvae

8.9.300 Given the considered stationary nature of eggs and larvae the potential for behavioural impacts is considered limited. As such, it is considered that the assessment of behavioural impacts to eggs and larvae is sufficiently captured within consideration of TTS for this group.

Shellfish

8.9.301 There are no criteria for shellfish sensitivity to noise, and therefore a qualitative assessment has been undertaken using peer reviewed literature. Shellfish are considered a potential sensitive receptor to particle motion from piling, due to typically having low motility, and therefore are considered unlikely to be able to vacate the area at the onset of 'soft-start piling'.

Magnitude of impact

8.9.302 It is understood that particle motion attenuates rapidly, and therefore impacts on shellfish from particle motion are likely to occur local to the source. Taking this into account, and the broad distribution of these species along the UK coasts, and across the English Channel, the magnitude of effect on shellfish receptors is considered to be **minor**.

Sensitivity or value of receptor

8.9.303 Roberts (2015) suggested that vibroacoustic stimuli may elicit and affect anti-predator responses, such as startle response in crabs and valve closure in mussels. Such responses would effectively be distractions from routine activities such as feeding. Behavioural changes in mussels have also been observed in response to simulated pile-driving, with increased filtration rates observed in blue mussels (Spiga *et al*. 2016). In addition to this, Samson *et al*. (2016) recorded a range of behavioural responses to underwater noise in cephalopods, including inking, colour changes and startle responses. Taking the above into consideration, shellfish were considered to be of **medium** sensitivity to underwater noise impacts.

Significance of residual effect

8.9.304 Whilst some species have spawning and nursery grounds within the fish and shellfish Study Area, they typically occur over a large area and into the southern North Sea, any disturbance to spawning is considered small in the context of the wider habitat availability. Shellfish species are considered sessile, and therefore will be expected to remain in the area in which the impact could occur with the onset of 'soft start'/ramp up piling. Taking all of this into account, all shellfish species are assessed as having medium sensitivity to underwater noise during construction, and a minor magnitude of impact, the effects on these species are therefore predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

UXO clearance and noise vibrations

Introduction

8.9.305 RED is not applying for permission to undertake UXO clearance works as part of this Application, however, it is acknowledged that UXO clearance is likely to comprise part of the Proposed Development, albeit under a separate Marine Licence application, and as such, it is appropriate to consider the potential impacts of this additional source of underwater noise on fish and shellfish species.

8.9.306 UXO clearance activities are one of the loudest anthropogenic noise sources that occur underwater. UXO clearance is expected to result in mortality, mortal injury, recoverable injury, TTS and disturbance to fish and shellfish species, depending on the proximity of the individuals to the UXO location and the size of the UXO. Injury and disturbance effects will impact a progressively larger area, with TTS and disturbance effects potentially reaching 10's of kilometres from the UXO location. Existing information suggests that there may be temporary or partial loss of hearing at high sound levels, especially in fish where the swim bladder enhances sound pressure detection. In the case of behavioural impacts, it is considered that startle responses are likely to occur if the received signal is of sufficient magnitude. Such responses last less than a second and do not necessarily result in significant changes in subsequent behaviour (Popper *et al*., 2014).

8.9.307 It is possible that UXO operations will be planned to take place year-round during the UXO clearance campaign pre-construction and therefore has the potential to interact with the spawning period for different fish and shellfish species. However, each UXO clearance is a discrete event and while this may result in some temporary disturbance to spawning fish, it is less likely to result in the displacement of fish from specific spawning grounds, compared to more continuous noise sources such as piling operations.

8.9.308 Due to the early stage for the Proposed Development and the consequent lack of detailed site-specific magnetometer data and the need for UXO clearance activities to be undertaken sufficiently close to construction to ensure the safety certification remains valid, it is not currently possible to define the number (if any) of UXO which may require clearance prior to the start of construction. Therefore, the assessment below presents potential impact ranges from a variety of charge sizes which will be expected within the proposed DCO Order Limits. Previously in the area, two UXOs were found during the construction of Rampion 1, in the offshore cable route area and were disposed of in 2016 (Rampion Offshore Wind, 2016).

8.9.309 The UXO clearance operations will follow the avoid, reduce, mitigate process, with first intention being to avoid the need to detonate the UXO by micrositing infrastructure. In many instances, this will not be possible and therefore, for clearance operations, two primary types of clearance will be considered:

- high order – this comprises using a donor charge of explosive (typically between 5 – 20kg) to trigger a detonation of the explosive within the UXO; and
- low order – this comprises a number of methods which use a small amount (up to 2kg) of explosive to destroy the explosive material without detonating it, such as burning out the explosive (deflagration) or disrupting the explosive using high pressure water jets (named “*low yield*”).

8.9.310 The worst-case scenario will be all high order clearance, with impact ranges from low order techniques being smaller than those presented herein. The clearance techniques used at the time will employ industry best practice, with due consideration given to developing technology/techniques which are currently being introduced to the market (i.e., low order techniques) and a full assessment of the potential impacts from UXO clearance works will be presented in a separate Marine Licence application at the time will be drafted accordingly. **Table 8-24** below details the expected mortality and potential mortal injury impact ranges for high order clearance from the potential variety of UXO sizes which may be encountered. While individual UXO detonations have the potential to result in greater impact ranges than piling activity, the discrete nature of a UXO detonation (a very short-term single noise event) is considered to result in a lesser overall effect on populations of fish and shellfish species.

8.9.311 The risks of mortality and potential mortal injury effects from UXO clearance will be managed through the development of a UXO specific MMMP which will mitigate impacts from UXO (which will be identified through targeted survey post-consent/pre-construction, including consideration of alternative clearance techniques (e.g. low order instead of high) and displacement methods (acoustic deterrent devices (ADDs)) to remove animals from the risk area. A further potential environmental measure for UXO clearance is the use of bubble curtains for high order detonations which will reduce the impact ranges from those predicted herein (**Table 8-24**). However, these are not currently a commitment and therefore the assessment is not based on the use of these. It is likely that by the time RED applies for a separate UXO Marine Licence, industry knowledge around the contribution of bubble curtains to reducing underwater noise will be further advanced and this knowledge will be incorporated within the assessments and mitigation design (e.g., ongoing Department for Energy Security and Net Zero

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workstream of underwater noise impacts from UXO). Any required measures will therefore be applied to and secured in the Marine Licence application for UXO clearance to be made at that time.

8.9.312 In order to inform this assessment, estimated ranges of impact associated with UXO detonations for different charge weights have been calculated to provide an indication of the ranges at which mortality/potential injury may occur on fish species (see **Appendix 11.: Marine mammal quantitative underwater noise impact assessment, Volume 4** of the ES (Document Reference 6.4.11.2)). As outlined in Popper *et al*. (2014) fish species are considered to be at risk of mortality or potential mortal injury at 229dB re 1µPa SPL_{peak}. The ranges at which this noise level could occur are provided in **Table 8-24**.

Table 8-24 Summary of the impact ranges for UXO detonation using the unweighted SPL_{peak} explosion noise criteria from Popper *et al*. (2014) for species of fish

Popper *et al*. (2014) Unweighted SPL_{peak}		25kg	55kg	120kg	240kg	525kg
Mortality and potential mortal injury	234 dB	170m	230m	290m	370m	490m
	229 dB	290m	380m	490m	620m	810m

8.9.313 The risk of recoverable injury, TTS and behavioural impacts are presented qualitatively in line with Popper *et al*. (2014) approach in **Table 8-25**. It should be noted that the risks outlined in **Table 8-25** provided gives specific impact criteria for explosions. As noted above MMMP for UXO clearance will be developed in the pre-construction period (in consultation with the relevant stakeholders and the MMO), detailing the required embedded environmental measures to minimise the potential risk of physical and auditory injury (PTS) as a result of underwater noise during UXO clearance. This will also reduce the risk to fish and shellfish species.

Table 8-25 Summary of the qualitative effects on species of fish from explosions (Popper *et al*., 2014)

Type of animal	Impairment			
	Recoverable injury	TTS	Auditory masking	Behaviour
Fish: no swim bladder (Group 1)	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (Group 2)	(N) High (I) High (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low

Type of animal	Impairment			
	Recoverable injury	**TTS**	**Auditory masking**	**Behaviour**
Fish: swim bladder involved in hearing (Group 3 and 4)	(N) High (I) High (F) Low	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Eggs and larvae	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Risk of effect category (high, moderate low) is given at three distances from the source in relative terms: near field (N: 10s of metres), intermediate field (I: 100s of metres), and far field (F: 1000s of metres); (Popper *et al*., 2014).				

8.9.314 The impact of UXO disturbance will be of local spatial extent, short term duration and both intermittent and infrequent. The works will be subject to a separate Marine Licence and a specific MMMP.

Magnitude of impact

8.9.315 As detailed above, where the detonation of UXO within the proposed DCO Order Limits is required, it may result in injury and disturbance to fish species in the vicinity of the UXO detonation. Physical injury/trauma will occur in close proximity to the UXO detonation, with TTS and behavioural effects occurring at greater distance. As detailed in **Table 8-13**, the Applicant has proposed several embedded environmental measures, inclusive of the implementation of a UXO Clearance MMMP (C-102), the use of low order detonations where practicable (C-275), and the implementation of a seasonal restriction on UXO clearance in the export cable corridor during the black seabream breeding period (C-273).

8.9.316 The effects from underwater noise (mortality and potential mortal injury) from UXO on fish and shellfish, given the short and intermittent nature of this activity (limited to instances when detonation of UXO is required), the proposed embedded mitigation measures (**Table 8-13**), and the fact that for the most part any effects will be limited to the vicinity of the area where the detonation takes place, the magnitude of the effect is considered to be **minor**.

Sensitivity or value of receptor

8.9.317 There is potential for UXO detonations with the Rampion 2 array area and offshore export cable corridor during site preparation. The clearance of UXO will result in elevated noise levels with consequent effects on fish and shellfish behaviour, potentially over the same extent expected for piling operations (i.e., at a range of kilometres). However, these detonations will represent very short duration occurrences (i.e., seconds) and therefore will have a considerably shorter overall duration than piling operations.

8.9.318 There are no specific data currently published in respect of shellfish species, however studies on lobsters have shown no effect on mortality, appendage loss or the ability of animals to regain normal posture after exposure to very high sound levels (>220dB) (Payne *et al*., 2007). Similarly, studies of marine bivalves (e.g., mussels) exposed to a single airgun at a distance of 0.5m have shown no effects after exposure (Kosheleva 1992).

8.9.319 Whilst it is well established that explosions can result in potential mortality or injury to fish species at close range, there are no data on the effects of explosions on fish hearing (e.g., TTS) or behaviour currently available. Existing information suggests that there may be temporary or partial loss of hearing at high sound levels, especially in fish where the swim bladder enhances sound pressure detection. In the case of behavioural impacts, it is considered that startle responses are likely to occur if the received signal is of sufficient magnitude. As noted in **Paragraph 8.9.306** such responses last less than a second and do not necessarily result in significant changes in subsequent behaviour (Popper *et al*., 2014).

8.9.320 Taking account of the severity of the impact particularly at close range but acknowledging that impacts will occur at individual rather than at population levels, fish species are considered receptors of **medium** sensitivity.

Significance of residual effect

8.9.321 Overall, the maximum sensitivity of fish and shellfish to underwater noise from UXO is consider **medium**, with a maximum magnitude of effect predicted to be **minor**. Therefore, the significance of effect of underwater noise from UXO clearance is predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

8.9.322 The assessment is high-level and does not consider the various sensitivities and hearing capabilities of fish, or the timing of UXO events in relation to spawning and nesting seasons. However, as consent for UXO clearance requires a separate Marine Licence Application, the potential impacts of UXO detonation on fish and shellfish will be assessed in more detail at the time of application.

Underwater noise from seabed preparation, rock dumping and cable installation

8.9.323 While impact piling will be the worst-case noise source during the construction phase, there will also be several other construction activities that will produce underwater noise which may occur either alongside piling or separately. These include dredging, drilling, cable laying, rock placement and trenching. However, sound levels associated with cable installation have received considerably less attention and very little monitoring data is available.

8.9.324 Modelling presented in **Appendix 11.3: Underwater noise assessment technical report, Volume 4** of the ES (Document Reference 6.4.11.3), using continuous unweighted SEL_{RMS} thresholds for recoverable injury and TTS from Popper *et al*. (2014), resulted in estimated recoverable injury and TTS thresholds of <50m for fish species for non-piling construction noise sources such as cable laying, trenching, and medium to large sized vessels. As such, to be at risk of auditory injury, an animal would have to stay within the immediate vicinity of the noise source for 12 hours (TTS) and 48 hours (recoverable injury).

8.9.325 A report on the potential effects of cabling techniques used in the offshore wind farm industry reviewed various cable types and installation methods including burial ploughs, machines, remote operated vehicles (ROVs) and sleds and the burial methods themselves including jetting, rock ripping, and dredging (BERR, 2008). The BERR (2008) report noted that there are no significant impacts from cable burial noise on fish species. In addition, no harmful events have been reported from the well-established subsea telecommunications industry.

8.9.326 Nedwell *et al*. (2003) have reported that cable trenching in sandy gravel at North Hoyle offshore wind farm produced noise at a source level of 178dB re 1µPa at 1m with noise levels associated with a mixture of broadband noise, tonal components, and transients associated with rock breakage. However, based on some uncertainty, due to the high levels of variability in the noise produced significant avoidance reactions amongst fish will not be expected to occur. The findings from Nedwell *et al*. (2012) noted that the impact ranges to other noise sources show that the predicted impact ranges for the cable laying operations are much smaller than those predicted for other typical activities not occurring, such as impact piling or seismic operations.

8.9.327 External protection will need to be installed over the cable in areas where it cannot be trenched, such as areas of hard ground where trenching cannot be achieved. External cable protection involves constructing rock berms over the cable (rock placement) or installing other materials such as concrete mattresses or grout bags. Rock placement is considered to be the nosiest external protection method, since the rocks fall down a fall pipe from the rock placement vessel, which may result in underwater noise. Other external protection measures such as mattresses and grout bags will be placed using an ROV or crane, and as such are unlikely to result in any significant underwater noise, so will not be considered further. Nedwell and Edwards (2004), found that the noise of rock placement was not detectable over the vessel noise, since there was no determinable difference between measurements taken when rock placement was ongoing, and when the vessel was holding station without placing rock. Therefore, the noise from rock placement is accounted for under the assessment of vessel noise and will not be considered further.

Magnitude of impact

8.9.328 Noise impacts from other construction activities will be localised, short-term, intermittent, and reversible and as such the magnitude of the impact is considered to be **negligible**, indicating that the potential is for very short-term and recoverable effects, with no potential for survival and reproductive rates to be impacted to the extent that the population trajectory will be altered.

Sensitivity or value of receptor

8.9.329 With the exception of seahorse and herring, all of the fish and shellfish receptors are assessed to have a **medium** sensitivity to disturbance caused from noise. Seahorse and herring have **high** sensitivity to underwater noise disturbance.

Significance of residual effect

8.9.330 Overall, the majority of receptors exhibit a **medium** sensitivity to underwater noise from other construction activities, with a maximum magnitude of effect predicted to be **negligible**. Therefore, the significance of effect of underwater noise from other construction activities is predicted to be of **minor adverse significance** (**Not Significant** in EIA terms). Two species, herring and seahorse, have a **high** sensitivity, however magnitude of impact remains at **negligible** and is therefore of **minor adverse significance**, which is **Not Significant** in EIA terms.

Direct disturbance resulting from the installation of the export cable

Introduction

8.9.331 Cable installation methods include ploughing, trenching or jetting (see **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference 6.2.4)). Cable burial is the preferred option, however where this is not possible, cable protection may be required. Cable burial will be informed by the cable burial risk assessment and detailed within the Cable Specification and Installation Plan (see C-45, **Table 8-13**).

Magnitude of impact

8.9.332 Disturbance will occur during the installation of the offshore export cable corridor as well as sediment disturbance during seabed preparation works prior to cable burial operations (including potential sandwave clearance). All fish and shellfish receptors have the potential to be affected by this impact through loss of spawning, nursery or feeding habitats, though demersal fish and shellfish species and demersal spawning species have the greatest potential to be affected.

8.9.333 As detailed in **Table 8-10**, direct disturbance from the installation of the offshore export cable corridor will equate to a maximum area of disturbance of approximately 8.97km^2 of seabed habitat within the proposed DCO Order Limits. This equates to 15.3% of the offshore export cable corridor area of search (58.63km^2). The disturbance will be temporary during the four months of offshore export cable installation activity and habitats will be expected to recover to pre-installation condition where cables have been successfully buried below the seabed surface and habitats can naturally revert to baseline condition over time once the works have completed. RED have committed to cable burial where seabed conditions allow (see C-41, C-45, **Table 8-13**) in order that direct impacts to important fish and shellfish habitats can be avoided as far as practicable, and that any longer duration of impact is limited once the seabed recovers. Where this is not possible, cable protection may be required at the seabed surface. The installation of cable protection and cable crossings is regarded as permanent habitat loss/modification and the effects arising from the use of such is considered under the operation and maintenance phase (**Section 8.10**).

8.9.334 As described in **Chapter 9: Benthic and intertidal ecology, Volume 2** of the ES (Document Reference 6.2.9), predictive habitat model areas of patchy hard substrate or rock outcrop can occur across the middle of the offshore export cable corridor, with soft chalk or clay outcrops expected to occur in discreet locations also across the middle of the offshore export cable corridor. It is therefore noted that it may not be possible to avoid such seabed features.

Sandeel

8.9.335 As shown in **Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8), the offshore export corridor overlaps with low intensity sandeel spawning grounds as identified by Ellis *et al*. (2010). Sandeel spawning grounds are distributed throughout the English Channel and within the southern North Sea. Therefore, considering the spatially discrete, intermitted and reversible nature of the impact, the magnitude of impact on sandeel is considered to be **minor**.

Herring

8.9.336 The offshore export cable corridor does not overlap with the recorded herring spawning ground as detailed in **Figure 8.2** (Document Reference 6.3.8) and **Figure 8.8** (Document Reference 6.3.8)**, Volume 3** of the ES, with the spawning ground located some approximately 47km to the south of the proposed DCO Order Limits (including the 16km buffer) at its closest point (the array area). Therefore, there is no scope for direct temporary habitat disturbance on herring spawning grounds as a result of installation of the proposed offshore export cables. It can be seen from **Figure 8.8, Volume 3** of the ES (Document Reference 6.3.8) although herring larvae have been recorded within the Study Area, this was at relatively low abundances within the proposed DCO Order Limits (IHLS 2007 to 2020: 0.1 to 2,500 per m^2) and the area is clearly not of importance to the Downs stock herring population. Moreover, with the exception of a spike in herring larval intensity in the area between 2009 and 2010, and between 2016 and 2017 (see **Appendix 8.1: herring annual heatmaps, Volume 4** of the ES (Document Reference 6.4.8.1)), the remaining years between 2007 and 2020 should relatively low herring larval intensity in the east English Channel. As the preferred herring spawning ground is located 47 km from the Rampion 2 offshore export cable corridor, a **negligible** magnitude of impacts has been assigned.

Black seabream

8.9.337 The offshore export cable corridor is located within proximity to the Kingmere MCZ which contains important chalk habitat for black seabream nests which have been identified within the proposed offshore export cable corridor area of search. The majority of the recently active nest sites have been located within the Kingmere MCZ and within the Rampion 2 offshore export cable corridor (**Figure 8.14a and Figure 8.14b** (Document Reference 6.3.8)**, Volume 3** of the ES)**.** Seabed disturbances resulting from construction activities such as cable trenching within the black seabream nesting area may damage nests and could potentially prevent future use of the seabed for nest building if a physical change in its character in discrete locations was to occur. Whilst the cable will not be installed within the Kingmere MCZ the cable installation may, in discrete locations, have a long-term negative effect on areas of high intensity black seabream nesting if the physical nature of the seabed habitat is altered.

8.9.338 However, the implementation of a number of embedded environmental measures will provide a demonstrable reduction in magnitude of impact (**Table 8-13**). The export cable will be microsited to avoid, where possible, sensitive features such as black seabream nests (C-269, **Table 8-13**). In addition, different trenching methods will be utilised to minimise the footprint (C-272, **Table 8-13**). A seasonal restriction of cable installation works within the export cable corridor (C-273, **Table 8-13**) is also proposed during the key breeding season (March to July) for black seabream. There will therefore be no physical disturbance and temporary and/or permanent loss of black seabream nesting habitat during the breeding season. The magnitude of impact on nesting black seabream is therefore considered to be **negligible**.

Seahorse

8.9.339 There are several MCZs designated for breeding seahorse within the vicinity of the proposed DCO Order Limits, although due to the spatially discrete extent of impact from direct disturbance, there will be no impacts within the MCZs and therefore no impacts on breeding seahorse. Seahorses overwinter in deeper waters, where there are a multitude of available habitats for seahorses to inhabit during the winter months. In addition, there are no records or data that suggest that the proposed DCO Order Limits itself is an area of particular importance for seahorse, even in the overwintering period, being comparable to other deeper water areas off the southern English coastline. Therefore, it is considered that there will be no risk of material impact from direct disturbance on overwintering seahorse. The magnitude of impact on seahorse is therefore considered to be **negligible**.

Cuttlefish

8.9.340 Cuttlefish inhabit a range of habitats, which are widely distributed across the English Channel and southern North Sea. Taking into consideration the spatially discrete, intermittent and reversible nature of the impact, and the broad distribution of suitable habitats for cuttlefish, the magnitude of impact on cuttlefish is considered to be **minor.**

Shellfish

8.9.341 Shellfish inhabit arrange of habitats that are widely available in the English Channel and wider southern North Sea. While the route preparation and installation activities may lead to mortality of or injury to some individuals, it is expected that shellfish will recolonise the area quickly and no population level effect will therefore be expected. During cable installation, the area will likely be subject to some restrictions on fishing activity, this will allow larger shellfish, with an attendant capacity to produce a greater number of eggs, to contribute to the spawning stock without fishing pressures (Roach *et al*., 2018). Due to the spatially discrete and temporary nature of the works, the magnitude of impact on shellfish receptors is considered to be **minor**.

Elasmobranchs

8.9.342 Nursery areas for thornback ray, tope and undulate ray overlap the proposed DCO Order Limits. It should be noted however, that despite this overlap, the nursery areas are widely distributed around the UK.

8.9.343 The extent of the potential impact in relation to export cable installation is relatively small in comparison with the available nursery areas. In addition, the works are short in duration and where the offshore export cable is buried the habitat will recover quickly post construction. Therefore, the magnitude of impact on elasmobranchs is considered to be **minor**.

Sensitivity or value of receptor

8.9.344 Thornback ray, undulate ray, tope, herring, sandeel, cuttlefish and black seabream are all demersal spawners. Sandeel, herring and black seabream are substrate specific spawners and therefore are potentially more susceptible to any impacts relating to physical disturbance and temporary habitat loss.

Sandeel

8.9.345 As shown in **Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8), the offshore export corridor overlaps with low intensity sandeel spawning grounds as identified by Ellis *et al*. (2010). Sandeel have limited mobility, due to their demersal spawning nature and substrate dependency. Sandeel are considered to be medium vulnerability, medium recoverability, and are of regional importance, and are therefore considered to be of **medium** sensitivity.

Herring

8.9.346 Herring have limited mobility, due to their demersal spawning nature and substrate dependency. Herring are therefore considered to be of high vulnerability, low recoverability, and are of regional importance. Herring are therefore of **high** sensitivity to direct disturbance.

Black seabream

8.9.347 Black seabream favour a particular type of substrate to build their nests and lay eggs (generally hard and coarse substrate (gravel; chalk reefs)). Taking into account their specific substrate dependency during spawning, black seabream are considered to be of high vulnerability and low recoverability. Black seabream are of national importance and are considered to be of **high** sensitivity.

Seahorse

8.9.348 Seahorses typically inhabit shallow waters, amongst seagrass and algae, although short-snouted seahorse can also be found in rocky areas to a depth of 77m (Sabatini and Ballerstedt, 2007). Seahorses overwinter in deeper waters, where there are a multitude of available habitats for seahorses to inhabit during the winter months. Taking into account their dependency of certain habitats and their national importance, seahorse are therefore considered to be of **medium** sensitivity.

Cuttlefish

8.9.349 Cuttlefish are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates, e.g., plants and sessile animals, and artificial structures, e.g. fishing pots, ropes and branches (Blanc and Daguzan, 1998; Bloor *et al*., 2013, cited in Ganias *et al.*, 2021). Cuttlefish migrate inshore to spawning grounds preferred habitat for eggs and juveniles (Bloor et al., 2013), in March and April with spawning occurring from March to July. In the English Channel, offshore migration occurs in winter and is influenced primarily by a reduction in water temperature as well as the reduction in daylight hours (Guerra, 2006). After spawning occurs adults return back into deeper, offshore areas around October in the UK (Dunn, 1999, Royer *et al*., 2006). Whilst cuttlefish are demersal spawners, they do not exhibit strict substrate dependency, and lay their eggs on a variety of substrates in the nearshore. Taking this into consideration, cuttlefish are of regional importance and are considered to be of **low** sensitivity.

Shellfish

8.9.350 In terms of physical impacts on crabs and lobsters, it is considered that berried females are at a higher risk, given their propensity to bury themselves in sediment or hide in rock crevices during this sensitive period. However, these receptors have adopted a reproductive strategy of high egg production to compensate for losses during egg extrusion and the extended incubation period (McQuaid *et al*., 2009). Taking this into consideration, and considering the regional commercial importance of these receptors, brown crab and European lobster are considered to be of **low** sensitivity.

8.9.351 The king scallop is an important commercial shellfish which is represented in the ICES rectangle along the offshore export cable corridor. Commercial fisheries landings data highlights the importance of the centre of the English Channel for this species. Scallops prefer areas of clean firm sand, fine or sandy gravel and also muddy sand, therefore will be impacted by construction activities for installation in a range of sediment habitat types. The MarESA sensitivity assessment by MarLIN (Marshall and Wilson, 2008) identifies that scallop have low sensitivity and high recoverability to smothering, abrasion and physical disturbance. The sensitivity of king scallop to direct disturbance is therefore considered to be **low**.

8.9.352 Although there is potential impact from disturbance on whelk, this species is capable of moving away from an impact at 11cm/minute (Magúnsdóttir, 2010) and therefore, able to return and recolonise the disturbed area post construction. In relation to a consultation response provided by whelk commercial fishermen to the on the Kent and Essex IFCA fisheries byelaw, recovery of whelk beds is anticipated within 12 months following disturbance (Kent and Essex IFCA, 2017). Therefore, it is considered that the sensitivity of whelks is **low**.

8.9.353 Blue mussels are sessile, attached organisms and in significant quantities are known to as a type of biogenic reefs. Blue mussels are unable to repair significant damage to individuals and the only mechanism for recovery from significant impacts is larval recruitment to the bed or where previously a bed existed (Mainwaring *et al*. 2014). Blue mussels are considered to have a medium to high sensitivity to disturbance (Tillin *et al*., 2016; Tyler-Walters, 2016), with a medium resilience (recovery within two to 10 years) (Mainwaring *et al*., 2014). However, Mainwaring *et al*. (2014) concluded that beds occurring high on the shore and on less exposed sites took longer to recover after a disturbance event than beds found low on the shore or at more exposed sites. In addition, research by Holt *et al*. (1998) note blue mussel populations are considered to have a strong ability to recover from environmental disturbance. Therefore, it is considered that the sensitivity of blue mussels is **medium**.

8.9.354 Native oysters are identified as being sensitive to disturbance (Perry *et al*., 2017). Therefore, it is considered that the sensitivity of European native oyster to temporary direct disturbance is **medium**.

Elasmobranchs

8.9.355 Data relating to spawning grounds of tope, thornback ray and undulate ray is lacking from the scientific literature and are undefined by Ellis *et al*. (2010) and Coull *et al*. (1998), due to insufficient data on the occurrence of egg cases or egg-bearing females to delineate spawning grounds for these species (Ellis *et al*., 2012). Nursery areas are however defined, and undulate ray, thornback ray and tope show overlapping low intensity nursery areas with the proposed DCO Order Limits (Ellis *et al*., 2012). Mulberry Marine Experience noted the presence of thornback ray and undulate ray between Selsey and the Western edge of the proposed DCO Order Limits, and along the inshore route of the offshore export cable corridor.

8.9.356 The undulate ray is commonly encountered in the English Channel with Ellis *et al*. (2012) suggesting that due to the lack of data on spawning grounds that they may broadly overlap nursery grounds (see **Figure 8.7, Volume 3** of the ES (Document Reference 6.3.8)). The Rampion 2 offshore export cable corridor is located within a low intensity nursery area.

8.9.357 It is considered that as thornback ray, undulate ray and tope are highly mobile, and other nursery / spawning areas are available across the region, the population sizes will not be affected. Taking into consideration, the regional to national importance of these receptors, the sensitivity of these receptors is t considered to be **low**.

Significance of residual effect

8.9.358 Direct disturbance occurring outside the Rampion 2 offshore export cable corridor (e.g., anchor placement) will be highly limited in extent, and as the species found to either side of the offshore export cable corridor are comparable to those within, it is considered that the assessments presented above include provision for this impact.

8.9.359 As stated above, the magnitude for physical disturbance and temporary loss of habitat within the offshore export cable corridor is considered as **negligible** or **minor** for all receptors. The sensitivity of all receptors (with the exception of black seabream) is **low** to **medium**, and therefore the greatest significance of effect is **minor adverse**, which is **Not Significant** in EIA terms.

8.9.360 Black seabream are of **high** sensitivity to physical disturbance and temporary loss of habitat within the offshore export cable corridor. However, due to the implementation of embedded mitigation, the magnitude of impact is **negligible**, and therefore the greatest significance of effect is **minor adverse**, which is **Not Significant** in EIA terms.

Direct disturbance resulting from construction within the array

Magnitude of impact

8.9.361 Disturbance will occur during construction operations within the array area and is likely to include sediment compaction and disturbance during foundation installation (i.e., jack-up operations and anchor placements), sediment disturbance during seabed preparation prior to suction bucket multileg foundations installation and inter-array cable burial operations (including potential sandwave and boulder clearance). All fish and shellfish receptors have the potential to be affected by this impact through loss of spawning, nursery or feeding habitats, though demersal fish and shellfish species and demersal spawning species have the greatest potential to be affected. The Proposed Development commitments (as shown in **Table 8-13**) include the use of, where feasible, cable burial to avoid direct impacts to the fish and shellfish (see C-41, C-45, C-96, **Table 8-13**).

8.9.362 A maximum of approximately 23.7km^2 of seabed within the Rampion 2 array area is predicted to be directly impacted within the array area during construction of the Proposed Development, with the potential for direct disturbance to mobile demersal species and pelagic fish and shellfish within this area. This equates to 14.9% of the array area (159.58km^2). Considering the availability of similar suitable habitat both in the array area and in the wider context of the English Channel and into the southern North Sea, the impact is predicted to be of local spatial extent, of short-term duration, intermittent and reversible. It is predicted that the impact will affect fish and shellfish receptors directly.

8.9.363 In general, mobile fish species are expected to be able to avoid temporary disturbance (EMU Limited, 2004). The most vulnerable species are likely to be shellfish which are much less mobile than fish. The fish species in the fish and shellfish Study Area which are likely to be most sensitive to temporary habitat loss are those species that spawn on or near the seabed sediment (black seabream, herring, sandeel, elasmobranchs and seahorse).

Sandeel

8.9.364 As shown in **Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8) the array area overlaps with low intensity sandeel spawning grounds as identified by Ellis *et al*. (2010). Sandeel spawning grounds are distributed throughout the English Channel and within the southern North Sea. Therefore, considering the spatially discrete, intermitted and reversible nature of the impact, the magnitude of impact on sandeel is considered to be **minor**.

Herring

8.9.365 The array area does not overlap with the recorded herring spawning ground as detailed in **Figure 8.2** (Document Reference 6.3.8) and **Figure 8.8** (Document Reference 6.3.8)**, Volume 3** of the ES, with the spawning ground located some approximately 47km to the south of the proposed DCO Order Limits (including the 16km buffer) at its closest point (the array area). Therefore, there is no scope for direct temporary habitat disturbance on herring spawning grounds as a result of installation of the proposed offshore export cables. It can be seen from **Figure 8.8,**

Volume 3 of the ES (Document Reference 6.3.8) although herring larvae have been recorded within the Study Area, this was at relatively low abundances within the proposed DCO Order Limits (IHLS 2007 to 2020: 0.1 to 2,500 per m^2) and the area is clearly not of importance to the Downs stock herring population. Moreover, with the exception of a spike in herring larval intensity in the area between 2009 and 2010, and between 2016 and 2017 (see **Appendix 8.1: Herring annual heatmaps, Volume 4** of the ES (Document Reference 6.4.8.1),), the remaining years between 2007 and 2020 should relatively low herring larval intensity in the east English Channel. As the preferred herring spawning ground is located 47 km Rampion 2, a **negligible** magnitude of impact has been assigned.

Black seabream

8.9.366 The Rampion 2 array area is located within proximity to the Kingmere MCZ. Construction activities within the Rampion 2 array area will be outwith the Kingmere MCZ and therefore there will be no direct impacts to designated black seabream within the MCZ, the magnitude of effect is therefore **negligible**.

Seahorse

8.9.367 There are several MCZs designated for breeding seahorse within the vicinity of the proposed DCO Order Limits, although due to the spatially discrete extent of impact from direct disturbance, there will be no impacts within the MCZs and therefore no impacts on breeding seahorse. Seahorses overwinter in deeper waters, where there are a multitude of available habitats for seahorses to inhabit during the winter months. In addition, there are no records or data that suggest that the proposed DCO Order Limits itself is an area of particular importance for seahorse, even in the overwintering period. Therefore, it is considered that there will be no risk of material impact from direct disturbance on overwintering seahorse. The magnitude of impact on seahorse is therefore considered to be **negligible**.

Cuttlefish

8.9.368 Cuttlefish inhabit a range of habitats, which are widely distributed across the English Channel and southern North Sea. Taking into consideration the spatially discrete, intermittent and reversible nature of the impact, and the broad distribution of suitable habitats for cuttlefish, the magnitude of impact on cuttlefish is considered to be **minor**.

Shellfish

8.9.369 Shellfish inhabit arrange of habitats that are widely available in the English Channel and wider southern North Sea. While the route preparation and installation activities may lead to mortality of or injury to some individuals, it is expected that shellfish will recolonise the area quickly and no population level effect will therefore be expected. During cable installation, the area will likely be subject to some restrictions on fishing activity, this will allow larger shellfish, with an attendant capacity to produce a greater number of eggs, to contribute to the spawning stock without fishing pressures (Roach *et al*., 2018). Due to the spatially discrete and temporary nature of the works, the magnitude of impact on shellfish receptors is considered to be **minor**.

Elasmobranchs

8.9.370 Nursery areas for thornback ray, tope and undulate ray overlap the proposed DCO Order Limits. It should be noted however, that despite this overlap, the nursery areas are widely distributed around the UK.

8.9.371 The extent of the potential impact in relation to export cable installation is relatively small in comparison with the available nursery areas. In addition, the works are short in duration and where the offshore export cable is buried the habitat will recover quickly post construction. Therefore, the magnitude of impact on elasmobranchs is considered to be **minor**.

Sensitivity or value of receptor

8.9.372 Substrate specific spawners, such as sandeel, herring and black seabream are potentially more susceptible to impacts relating to direct disturbance. Sandeel and black seabream are known to have spawning habitats within, or in close proximity to the Rampion 2 array area, although these are predicted to be of low intensity.

Sandeel

8.9.373 As shown in **Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8), the array area overlaps with low intensity sandeel spawning grounds as identified by Ellis *et al*. (2010). Sandeel have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and their regional importance, sandeel are considered to be of **medium** sensitivity.

Herring

8.9.374 Herring have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and their regional importance, herring are therefore considered to be of **high** sensitivity.

Black seabream

8.9.375 Black seabream favour a particular type of substrate to build their nests and lay eggs (generally hard and coarse substrate (gravel; chalk reefs)). Taking into account, their specific substrate dependency during spawning, and their national importance, black seabream are considered to be of **high** sensitivity.

Seahorse

8.9.376 Seahorses typically inhabit shallow waters, amongst seagrass and algae, although short-snouted seahorse can also be found in rocky areas to a depth of 77m (Sabatini and Ballerstedt, 2007). Seahorses overwinter in deeper waters, where there are a multitude of available habitats for seahorses to inhabit during the winter months. Taking into account their dependency of certain habitats, and their national importance, seahorse are considered to be of **medium** sensitivity.

Cuttlefish

8.9.377 Cuttlefish are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates, e.g., plants and sessile animals, and artificial structures, e.g. fishing pots, ropes and branches (Blanc and Daguzan, 1998; Bloor *et al*., 2013, cited in Ganias *et al*, 2021). Cuttlefish migrate inshore to spawning grounds preferred habitat for eggs and juveniles (Bloor *et al*., 2013), in March and April with spawning occurring from March to July. In the English Channel, offshore migration occurs in winter and is influenced primarily by a reduction in water temperature as well as the reduction in daylight hours (Guerra, 2006). After spawning occurs adults return back into deeper, offshore areas around October in the UK (Dunn, 1999, Royer *et al*., 2006). Whilst cuttlefish are demersal spawners, they do not exhibit strict substrate dependency, and lay their eggs on a variety of substrates in the nearshore. Taking this into consideration, and considering their regional importance, cuttlefish are considered to be of **low** sensitivity.

Shellfish

8.9.378 In terms of physical impacts on crabs and lobsters, it is considered that berried females are at a higher risk, given their propensity to bury themselves in sediment or hide in rock crevices during this sensitive period. However, these receptors have adopted a reproductive strategy of high egg production to compensate for losses during egg extrusion and the extended incubation period (McQuaid *et al*., 2009). It is considered that the sensitivity of brown crabs and European lobster is **low**.

8.9.379 The king scallop is an important commercial shellfish which is represented in the ICES rectangle along the offshore export cable corridor. Commercial fisheries landings data highlights the importance of the centre of the English Channel for this species. Scallops prefer areas of clean firm sand, fine or sandy gravel and also muddy sand, therefore will be impacted by construction activities for installation in a range of sediment habitat types. The MarESA sensitivity assessment by MarLIN (Marshall and Wilson, 2008) identifies that scallop have low sensitivity and high recoverability to smothering, abrasion and physical disturbance. The sensitivity of king scallop to direct disturbance is therefore considered to be **low**.

8.9.380 Although there is potential impact from disturbance on whelk, this species is capable of moving away from an impact at 11cm/minute (Magúnsdóttir, 2010) and therefore, able to return and recolonise the disturbed area post construction. In relation to a consultation response provided by whelk commercial fishermen to the on the Kent and Essex IFCA fisheries byelaw, recovery of whelk beds is anticipated within 12 months following disturbance (Kent and Essex IFCA, 2017). Therefore, it is considered that the sensitivity of whelks is **low**.

8.9.381 Blue mussels are sessile, attached organisms and in significant quantities are known to as a type of biogenic reefs. Blue mussels are unable to repair significant damage to individuals and the only mechanism for recovery from significant impacts is larval recruitment to the bed or where previously a bed existed (Mainwaring *et al*. 2014). Blue mussels are considered to have a medium to high sensitivity to disturbance (Tillin *et al*., 2016; Tyler-Walters, 2016), with a medium resilience (recovery within two to 10 years) (Mainwaring *et al*., 2014). However, Mainwaring *et al*. (2014) concluded that beds occurring high on the shore and on less exposed sites took longer to recover after a disturbance event than beds found low on the shore or at more exposed sites. In addition, research by Holt *et al*. (1998) note blue mussel populations are considered to have a strong ability to recover from environmental disturbance. Therefore, it is considered that the sensitivity of blue mussels is **medium**.

8.9.382 Native oysters are identified as having a high sensitivity to disturbance (Perry *et al*., 2017). Therefore, it is considered that the sensitivity of European native oyster to temporary direct disturbance is **medium**.

Elasmobranch

8.9.383 Data relating to spawning grounds of tope, thornback ray and undulate ray is lacking from the scientific literature and are undefined by Ellis *et al*. (2010) and Coull *et al*. (1998), due to insufficient data on the occurrence of egg cases or egg-bearing females to delineate spawning grounds for these species (Ellis *et al*., 2012). Nursery areas are however defined, and undulate ray, thornback ray and tope show overlapping low intensity nursery areas with the proposed DCO Order Limits (Ellis *et al*., 2012). Mulberry Marine Experience noted the presence of thornback ray and undulate ray between Selsey and the Western edge of the proposed DCO Order Limits, and along the inshore route of the export cable corridor.

8.9.384 The undulate ray is commonly encountered in the English Channel with Ellis *et al*. (2012) suggesting that due to the lack of data on spawning grounds that they may broadly overlap nursery grounds (see **Figure 8.7, Volume 3** of the ES (Document Reference 6.3.8)). The Rampion 2 offshore export cable corridor is located within a low intensity nursery area.

8.9.385 It is considered that as thornback ray, undulate ray and tope are highly mobile, and other nursery / spawning areas are available across the region, the population sizes will not be affected. Taking this into consideration, and considering the regional to national importance of these receptors, the sensitivity of these receptors is **low**.

Significance of residual effect

8.9.386 As set out above, the magnitude for direct disturbance from construction within the array is considered as **negligible** or **minor** for all receptors. The sensitivity of most demersal and pelagic fish and shellfish species within the total installation footprint (apart from herring and black seabream) is **low** to **medium**, which equates to a **negligible** or **minor adverse significance**. For the high sensitivity receptors herring and black seabream, the significance of effect is also **minor** as the impact magnitude is **negligible** in both cases. The greatest effect significance arising is therefore **minor adverse**, which is **Not Significant** in EIA terms.

Temporary localised increases in SSC and smothering

Introduction

8.9.387 Temporary localised increases in SSC and associated sediment deposition are expected from foundation and cable installation works and seabed preparation works (including sandwave and boulder clearance). This assessment should be read in conjunction with **Chapter 6: Coastal Processes, Volume 2** of the ES (Document Reference 6.2.6) and **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference 6.4.6.3), which provides a full description of the offshore physical environment assessment.

Magnitude of impact

8.9.388 Background surface SSCs values within the Study Area typically range between 10 to 20mg/l during winter months and generally less than 4mg/l during the summer period. Surface turbidity is relatively low across the offshore array area, with monthly averaged concentrations typically less than 5mg/l across the whole year (Cefas, 2016).

8.9.389 **Table 8-26** presents the maximum assessment assumptions associated with increases in SSC and deposition. The maximum design scenario for SSC and deposition during the construction phase of the Proposed Development will result in the total release of approximately 2,614,005m^3 of sediment and drill fluid in the proposed DCO Order Limits.

8.9.390 **Table 8-26** details the maximum sediment plume distance and the peak increases in SSC and deposition that could occur because of construction activities and relates to individual plumes/activities.

8.9.391 Plumes, as a result of boulder clearance will be similar in nature to that described for 'offshore trenching of cables' in **Table 8-26**. The SSC, dimensions and duration of the plumes resulting from boulder clearance will be at most similar to, or relatively smaller than described for trenching activities.

8.9.392 Jack-up vessels might cause very localised and temporary plumes as their feet are lowered into and raised from the seabed. The volume of sediment disturbed will be relatively small compared to the other activities considered (proportional to the size and number of feet on the vessel). The SSC, dimensions and duration of the resulting plumes will be at most similar to, or relatively smaller than described for other activities.

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Table 8-26 Temporary increases in SSC and sediment deposition as a result of construction activities at Rampion 2

Construction impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
Sandwave clearance Seabed preparation for foundations (overspill during active dredging using a trailing suction hopper dredger)	Offshore export cable corridor and array area	16km (springs) and 8km (neaps)	• Within small distances (<50m) of the dredger, SSC associated with overspill at the water surface during active dredging can be in the order of thousands to low tens of thousands of mg/l, reducing rapidly with time and distance (through settlement and dispersion) to the order of hundreds or tens of mg/l. • All SSC effects associated with overspill of sands during active dredging are expected to be spatially limited to within 150 to 500m of the dredger, settling to the seabed within 5 to 15 minutes following the surface release (depending on the local water depth and current speed). Effects associated with gravels are expected to be more limited (up to tens of metres and 0 to 1.5 minutes). • At 2km downstream during or shortly after active dredging, the concentration of any fine sediments persisting in suspension is expected to be less than approximately 100mg/l; at 5km downstream, this may have reduced to approximately 10mg/l. Concentrations of suspended fines will continue to reduce gradually over time through dispersion, to less than measurable levels (<10mg/l) within two to three days. • For the Maximum Design Scenario of 90 smaller WTG multileg foundations and three OSP multileg foundations, resulting from overspill, An average deposit thickness of

Construction impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
			0.50m has been calculated to occur over a maximum area of 16,950m^2 whilst an average deposit thickness of 0.05m has been calculated for an area of 169,503m^2. These relate to 0.01% and 0.09% of the total Rampion 2 Offshore Array area, respectively. • Fines are expected to become widely dispersed and so will not resettle with measurable thickness locally.
Sandwave clearance Seabed preparation for foundations (spoil disposal from a trailing suction hopper dredger)	Offshore export cable corridor and array area	16km (springs) and 8km (neaps)	• Approximately 90% of the total spoil volume in the hopper will descend directly to the seabed as a high-density discrete unit in the 'active phase' of the plume. This does not directly cause any meaningful change of SSC. The remaining 10% of material will form a more diffuse suspension in the 'passive phase' of the plume. • Within a few tens of metres, at the time of spoil release, very high passive phase plume concentrations are expected, up to hundreds of thousands to millions of mg/l initially, reducing to thousands of mg/l as the plume diffuses to a size of 100m or larger. • All SSC effects associated with sands and gravels in the passive phase of the plume are expected to be spatially limited to within 65 to 650m of the dredger, and temporally limited to 5 to 15 minutes following release (depending on the local water depth and current speed). Effects

Construction impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
			associated with gravels are expected to be more limited (up to tens of metres and 0 to 1.5 minutes). • The concentration of any fine sediments persisting in suspension will vary in proportion to the dimensions of the plume as it is dispersed over time. A plume with a small footprint (100m) may have a maximum concentration in the order of thousands of mg/l, but when dispersed to a larger footprint (1000m) may have a maximum concentration in the order of low tens of mg/l. Concentrations of suspended fines will continue to reduce gradually over time through dispersion and deposition, to less than measurable levels (<10mg/l) within two to three days. • The final distribution of sediment on the seabed from the active phase cannot be predicted in advance, but the total volume, and therefore the area of effect for a given average thickness, is limited. If the average local thickness of deposition is 5cm, the maximum area of effect per spoil disposal event is approximately 198,000m^2, equivalent to a 500m diameter circle; if the average local thickness of deposition is 30cm, the maximum area of effect per spoil disposal event is approximately 33,000m^2, equivalent to a 200m diameter circle. In all cases, a relatively thicker deposit will have a smaller footprint and a relatively larger footprint will require a smaller average thickness. • Sands and gravels in the passive phase will also be advected by any tidal currents present as they settle to the

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Construction impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
			seabed, and so may or may not overlap the main active phase deposit. The additional deposit may contribute or may add up to approximately 10% to the area of effect for the given average thicknesses above, or 10% additional thickness for the same area, or a proportional combination of the two. • Fines in the passive phase are expected to become widely dispersed and so will not resettle with measurable thickness locally.
Offshore trenching for cables	Offshore export cable corridor and array area	16km (springs) and 8km (neaps)	• Within 5m of active trenching, very high plume concentrations are expected. SSC could be hundreds of thousands to millions of mg/l. • Within 100 to 200m downstream from active trenching (depending on the initial height of ejection and the local current speed) in a relatively narrow plume (up to tens of metres wide), mainly resuspended sands and gravels will cause high SSC in the order of thousands to tens of thousands of mg/l. However, the majority of such coarser sediments are expected to resettle to the seabed (reducing or ending any associated plume effects) within approximately 2 to 5 minutes of resuspension. • At 2km downstream during or shortly after active trenching, the concentration of any fine sediments persisting in suspension is expected to be less than approximately 100mg/l; at 5km downstream, this may have reduced to

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Construction impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
			approximately 50mg/l. Concentrations of suspended fines will continue to reduce gradually over time through dispersion, to less than measurable levels (<10mg/l) within two to three days. • The maximum expected average local thickness of deposition in the case of predominantly gravelly sediments is 30 to 60cm, over an area up to 5 to 10m downstream, along the length of the trench. • The maximum expected average local thickness of deposition in the case of predominantly sandy sediments is 3 to 6cm, over an area up to 100 to 200m downstream, along the length of the trench. • Fines are expected to become widely dispersed and so will not resettle with measurable thickness locally.
HDD exit pit preparations	Offshore export cable corridor	16km (springs) and 8km (neaps)	• Within 5m of active pit preparation (using dredging or trenching type techniques), very high plume concentrations are expected. SSC could be hundreds of thousands to millions of mg/l, but decreasing rapidly with distance, and with time following cessation of active works. • Within 100 to 200m downstream from active pit preparation (depending on the method and rate of excavation and the local current speed) in a relatively narrow plume (up to tens of metres wide), mainly resuspended sands and gravels will cause high SSC in the order of hundreds to thousands or

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Construction impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
			tens of thousands of mg/l. However, the majority of such coarser sediments are expected to resettle to the seabed (reducing or ending any associated plume effects) within approximately 2 to 5 minutes of resuspension. • At 2km downstream during or shortly after active trenching, the concentration of any fine sediments persisting in suspension is expected to be less than approximately 100mg/l; at 5km downstream, this may have reduced to approximately 50mg/l. Concentrations of suspended fines will continue to reduce gradually over time through dispersion, to less than measurable levels (<10mg/l) within two to three days. • The material excavated from the subtidal pits will be temporarily stored, either side cast nearby or moved into a nearby spoil disposal area (e.g., the array area). The thickness and extent of the deposit will be variable depending on the method and nature of the deposition, but will be relatively small, in proportion to the total volume of the pits being excavated. The material in storage may be subject to redistribution by naturally occurring sediment transport during the storage period. • Any fully resuspended fines are expected to become widely dispersed and so will not resettle with measurable thickness locally.

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Construction impact	Location	Maximum sediment plume distance	Details of increase in SSC and deposition
Drilling at foundations	Array area	16km (springs) and 8km (neaps)	• Within small distances (<50m) of the drilling, SSC associated with overspill at the water surface during active drilling can be in the order of thousands to low tens of thousands of mg/l, reducing rapidly with time and distance (through settlement and dispersion) to the order of hundreds or tens of mg/l. • All SSC effects associated with overspill of sands during active dredging are expected to be spatially limited to within 400 to 700m of the dredger, and temporally limited to the period of active dredging plus 10 to 25 minutes afterwards (depending on the local water depth and current speed). Effects associated with gravels are expected to be more limited (up to 100m and 1 to 5 minutes). • At 2km downstream during or shortly after active dredging, the concentration of any fine sediments persisting in suspension is expected to be less than approximately 1000mg/l; at 5km downstream, this may have reduced to approximately 300mg/l. Concentrations of suspended fines will continue to reduce gradually over time through dispersion, to less than measurable levels (<10mg/l) within two to three days. • Deposition thicknesses are comparable to and no more than described for spoil disposal from a trailing suction hopper dredger.

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8.9.393 To summarise the information presented above in **Table 8-26**, sediment plumes caused by seabed preparation and installation activities are expected to occur over a maximum distance of 16km (spring) from the source. Sediment plumes are expected to quickly dissipate after cessation of the activities, due to settling and wider dispersion with the concentrations reducing quickly over time to background levels. Sediment deposition will consist primarily of coarser sediments deposited close to the source, with a small proportion of silt deposition (reducing exponentially from source). **Figure 6.3.4** within **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference 6.4.6.3) provides a useful schematic summarising the spatial extent of the impact zones associated with SSC and deposition in relation to Rampion 2. The figure details that the results of modelling can be summarised broadly in terms of four main zones of effect, based on the distance from the activity causing sediment disturbance:

- 0 to 50m – zone of highest SSC increase and greatest likely thickness of deposition. All gravel sized sediment likely deposited in this zone, also a large proportion of sands that are not resuspended high into the water column, and also most or all dredge spoil in the active phase. Plume dimensions and SSC, and deposit extent and thickness, are primarily controlled by the volume of sediment released and the manner in which the deposit settles;
- 50 to 500m – zone of measurable SSC increase and measurable but lesser thickness of deposition. Mainly sands that are released or resuspended higher in the water column and resettling to the seabed whilst being advected by ambient tidal currents. Plume dimensions and SSC, and deposit extent and thickness, are primarily controlled by the volume of sediment released, the height of resuspension or release above the seabed, and the ambient current speed and direction at the time; and
- 500m to the tidal excursion buffer distance – zone of lesser but measurable SSC increase and no measurable thickness of deposition. Mainly fines that are maintained in suspension for more than one tidal cycle and are advected by ambient tidal currents. Plume dimensions and SSC are primarily controlled by the volume of sediment released, the patterns of current speed and direction at the place and time of release and where the plume moves to over the following 24 hours.

8.9.394 Further information on sediment plume distances and modelling are provided in **Chapter 6: Coastal Processes, Volume 2** of the ES (Document Reference 6.2.6) and **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference 6.4.6.3).

8.9.395 The magnitude of the maximum potential increase in SSC resulting from construction activities is within the natural range of SSC, within the region and the impact will be short-term, intermittent and of localised extent and reversible.

Sandeel

8.9.396 Due to the presence of sandeel habitats across the English Channel and the southern North Sea, the magnitude of impact from increased SSC resulting from construction within the array area is also considered to be **minor**.

Herring

8.9.397 Due to the distance between the proposed DCO Order Limits and the herring spawning ground (47km) there is no scope for impacts die to increased SSC or subsequent deposition within herring spawning ground areas. The magnitude of impact from an increase in SSC from construction within the array area on herring is assessed as **negligible**.

Black seabream

8.9.398 Damage or smothering of active black seabream nests from export cable installation will represent a temporary and short-term intermittent impact, however during the breeding season this could lead to potentially significant effects during the breeding season based on the high sensitivity of bream to changes in habitat from increase in SSC and associated sediment deposition associated with the Proposed Development at this crucial life-cycle stage. The implementation of embedded mitigation in the form of a seasonal restriction on cable installation activities in the export cable corridor during the black seabream nesting period (March to July) will ensure the avoidance of impacts from increased SSC and deposition on nesting black seabream during the breeding season (C-273, **Table 8-13**), therefore magnitude of impact is **negligible**.

Seahorse

8.9.399 Short-snouted and spiny/long-snouted seahorses are known to be present in the area, however records to date are low in number (E.ON, 2012a; NBN Atlas, 2021a; 2021b; OEL, 2020a; Sussex BRC, 2021). Seahorses are unlikely to be affected by an increase in suspended sediment and smothering from construction activities as they are mobile and are able to slowly swim away from the affected area. Moreover, habitat preference is generally within shallow water, amongst seagrass and algae (The Seahorse Trust, 2013), although short-snouted seahorse can also be found in rocky areas to a depth of 77m (Sabatini and Ballerstedt, 2007). Therefore, the intolerance to smothering is low, with high recoverability for both seahorse species (Neish, 2007; Sabatini and Ballerstedt, 2007). Temporary smothering from increased SSC is likely to result in indirect effects to seahorses as a result of potential localised habitat disturbance. The magnitude of impact from an increase in SSC from construction within the proposed DCO Order Limits on seahorse species is assessed as **minor**.

Shellfish

8.9.400 Shellfish species are likely to be at a low risk from increased levels of SSC and sediment deposition, with most species being somewhat mobile and relatively insensitive to deposition (e.g., MarLIN sensitivity assessments). Moreover, due to the distance between the proposed DCO Order Limits and the Beachy Head West MCZ (for which native oyster and blue mussel are a feature), which is located 13km from the array area and over 30km from the export cable corridor, the magnitude of impact from an increase in SSC from construction within the array area and offshore export cable corridor is assessed as **negligible**. In addition, any interaction with shellfish species within the proposed DCO Order Limits will inherently be of short-term duration.

Elasmobranch

8.9.401 Thornback and undulate ray eggs are likely to be tolerant of a degree of suspended sediment and smothering as a result of natural sediment movement within inshore waters (Guillou *et al*., 2017). As smothering is predicted only to occur in a small area (predominantly within the Rampion 2 offshore export cable corridor), it is considered that the magnitude of impact from suspended sediment and smothering is **negligible** on thornback or undulate ray eggs.

Migratory species

8.9.402 All of the Annex II fish species in the Habitats Directive (92/43/EEC) undergo migrations between freshwater and the sea at some stages in their life cycles and therefore significant increases in SSC could present a barrier to migratory pathways (Posford Duvivier Environment and Hill, 2001). However, estuarine fish generally show tolerance to variations in suspended sediment loadings and turbidity as a result of natural adaptation to living in a dynamic and environmentally variable habitat (ABPmer, 2005). Furthermore, due to the proximity of a number of rivers to the Rampion 2 fish and shellfish Study Area, it is possible that juvenile European eels will be present at the time of construction, however, both juvenile and adult European eel are highly tolerant to elevated level of SSC (Avant, 2007). SSC can only be a barrier to migration if the conditions extend across the entire width of the water body comprising the migration route at any given point (ABPmer, 2011), as fish can move around the adverse condition area, avoiding impacts.

8.9.403 Overall, the magnitude of this effect is judged to be **negligible** due to the small proportion of the overall water column that will be subjected to increased suspended sediments and the fact that any such plume effects will not be expected to impact the overall size or structure of Annex II fish populations. The Rampion 2 array area and offshore export cable corridor do not encompass an estuary mouth and as such does not form an unbroken barrier to migration. All diadromous species spend time within the river and estuary environments where SSC levels are considerably higher than those present within the open sea, and as such, they are likely to have an increased tolerance to suspended sediments (ABPmer, 2005). While some small scale and temporary avoidance may occur, this is not at a scale where migration will be hindered significantly.

Other fish receptors

8.9.404 Other species which spawn in the Study Area, such as cod, plaice and lemon sole, are broadcast spawners with buoyant eggs that are dispersed within the water column over a wide area, so their eggs will not be susceptible to potential sediment smothering. The magnitude of impact from an increase in SSC from construction within the Rampion 2 array area on these fish species is assessed as **negligible**.

Sensitivity or value of receptor

8.9.405 Construction activities may increase levels of suspended sediments and reduce light levels within the water column. Reduction in light levels within the water column can create a number of adverse effects particularly upon species reliant on their visual acuity to detect and locate prey (BERR, 2008).

8.9.406 Juvenile and adult fish are mobile and will be able to avoid the localised areas disturbed by increased SSCs and smothering. If displaced, these fish are able to move to adjacent, undisturbed areas within their normal habitat range.

8.9.407 Adult fish will normally be able to detect significantly elevated levels of suspended sediment and avoid the affected area (ABP Research, 1999; EMU Limited, 2004). Juvenile fish, including those likely to occur in nursery habitats in the vicinity of the Rampion 2 fish and shellfish Study Area, are generally considered to be more sensitive to suspended sediment plumes than adults (Wilber and Clarke, 2001). This may arise as a consequence of their reduced mobility compared to adults and increased biological susceptibility (for instance smaller gill surface areas (ABP Research, 1999)). The Rampion 2 fish and shellfish Study Area has been identified as supporting both foraging and nursery grounds for a number of commercially and ecologically important species. These species are expected to be resilient to any increase in SSC as winter storm events in their natural environment cause temporary increases in suspended sediment concentration of a similar magnitude to that which will be produced by the construction operations. However, the SCC levels within the immediate vicinity of construction works will be localised in extent and short-term in duration, within elevations of SSC above background levels being expected to reduce with fine sediments potentially becoming diluted to low concentrations after approximately 72 hours.

8.9.408 The species likely to be affected by sediment deposition are those which either feed or spawn on or near the seabed. The majority of species that have known spawning grounds in close proximity to the Proposed Development are herring, sandeel and black seabream. Eggs and larvae stages of fish and shellfish do not however have the same capacity to avoid increased SSCs as juvenile or adult fish as they are either passively drifting in the water column or present on/attached to benthic substrates. The sensitivity of eggs and larvae is therefore considered to be higher than for later life stages and is the main focus of this assessment. The redeposition of sediments may affect fish eggs and larvae through smothering. Of the fish species, by being demersal spawners and the adhesive properties of the membranes, black seabream, herring and sandeel eggs have the greatest potential to be affected by increased SSCs and sediment re-deposition.

8.9.409 Studies on the effect of temporary SSC and smothering on foraging marine fish and shellfish are limited. However, fish that are unable to utilise the full extent of their home range due to elevated SSC, experience fitness consequences through a reduction in foraging and territorial defence (Lewis, 1997; Lönnstedt and McCormick, 2011).

8.9.410 Herring, plaice, sole and cod larvae sight prey at a distance of only a few millimetres (Bone and Moore, 2008). There is evidence to suggest however that SSCs may enhance feeding rates by providing a visual contrast to prey items on the small perceptive scale used by the larvae. In addition, larvae may be subject to reduced predation from larger visual planktivores in turbid environments (Bone and Moore, 2008). Moreover, turbidity interferes with light penetration and will hinder vision, but it is unlikely to inhibit other sensory modalities (Eiane *et al*., 1999; Ohata *et al*., 2011). Thus, organisms that forage by tactile cues or chemoreception may be unaffected by turbidity and may gain a competitive advantage in turbid waters over competitors that forage using visual cues (Eiane *et al*., 1999).

Sandeel

8.9.411 Sandeel spawning grounds and preferred habitats (**Figure 8-3** (Document Reference 6.3.8) and **Figure 8-9** (Document Reference 6.3.8)**, Volume 3** of the ES) are located across the array area and offshore export cable corridor, however any impacts on this species are expected to be relatively small in the context of the spawning habitat available in the wider region. Furthermore, the secondary effects of increased concentrations of SSC in the water column and smothering (from deposition of particles), have been shown to be inconsequential to sandeel species (MarineSpace Ltd *et al*., 2013a). Sandeel eggs are likely to be tolerant to increases in SSC and deposition due to the nature of resuspension and deposition within their natural high energy environment. Sandeel deposit eggs on the seabed in the vicinity of their burrows between December and January. Grains of sand may become attached to the adhesive egg membranes. Tidal currents can cover sandeel eggs with sand to a depth of a few centimetres, however experiments have shown that the eggs are capable of developing normally and hatch as soon as currents uncover them again (Winslade, 1971). Buried eggs experiencing reduced current flow, and therefore lower oxygen tension, can have delayed hatching periods, which is considered a necessary adaptation to survival in a dynamic environment (Hassel *et al*., 2004; MacDonald *et al*., 2019). High intensity spawning sites for sandeel do not occur within the Rampion 2 fish and shellfish Study Area, and so effects on sandeel spawning are expected to be minimal. Based on the species reduced sensitivity to increased SSC and deposition, sandeel are deemed to be of low vulnerability, medium recoverability and of regional importance, and therefore the sensitivity of the receptor is **low**.

Herring

8.9.412 As shown in **Figure 8.8, Volume 3** of the ES (Document Reference 6.3.8) the main area of herring spawning is located to the south of the proposed DCO Order Limits, and therefore effects on spawning herring populations will be limited. Furthermore, it has been shown that herring eggs are tolerant of very high levels of SSC (Kiørboe *et al*., 1981; Messieh *et al*., 1981). It was concluded by Kiørboe *et al*. (1981) that herring eggs suffered no adverse effects from suspended sediment concentrations in excess of the maximum levels expected from mining, dredging and similar operations. Detrimental effects may be seen if smothering occurs (Griffin *et al*., 2009) and the deposited sediment is not removed by currents (Birklund and Wijsmam, 2005), however this is expected to occur quickly with the small amount of sediment deposition forecast. Adult herring are mobile and therefore may show avoidance behaviour to the impact. Spawning herring may not show these avoidance behaviours, however as any increases in SSC are expected to be short term and within the natural range of SSC, herring are expected to be largely unaffected by this impact. Based on the increase in sensitivity of herring eggs to the smothering effects of increased sediment deposition, herring is deemed to be of low vulnerability, high recoverability and of regional importance, and therefore the sensitivity of this receptor is considered to be **low**. This is due to the distance between known spawning grounds and the Rampion 2 fish and shellfish Study Area, no effects of increased SSC and sediment deposition are predicted to occur on herring spawning habitats.

Black seabream

8.9.413 Direct disturbance to the seabed will have the potential to temporarily increase suspended sediments within and around the area of activity. When these sediments drop out of suspension, they may form a smothering layer over favourable substrates in the immediate vicinity of the activity, but also at some distance from the source.

8.9.414 Based on current information there is the potential for suspended sediments to drift into nesting areas within the offshore export cable corridor. Black seabream, like most marine fish, will be able to tolerate a degree of suspended sediment. As previously mentioned, storm events can reportedly raise SSC in nearshore naturally turbid environments in the Channel by a factor of 10 to 20 (Guillou *et al*., 2017; RSK Environmental Limited, 2012). There is potential that SSC may exceed those experienced during natural storm events, with a return to background levels within a short period (up to three days). However, there was no evidence of black seabream nests being impacted from suspended sediment from nearby aggregate extraction work (EMU Limited, 2012a). Nonetheless, considering the locality of black seabream nesting areas to the proposed DCO Order Limits, and the sensitivity of eggs to sediment deposition, black seabream are deemed to be of high vulnerability, medium recoverability and of national importance, and therefore the sensitivity of this receptor is considered to be **high**.

Seahorse

8.9.415 Direct disturbance to the seabed will have the potential to temporarily increase suspended sediments within and around the area of activity. When these sediments drop out of suspension, they may form a smothering layer over favourable substrates in the immediate vicinity of the activity, but also at some distance from the source.

8.9.416 As detailed previously, seahorses have low swimming speeds, with very inefficient fins for conventional swimming (Ashley-Ross, 2002) and are therefore may have limited capacity to flee the area compared to other fish receptors. However, seahorses are not expected in significant numbers in the area of the proposed DCO Order Limits (see in **paragraph 8.6.66** to **paragraph 8.6.68**), as there are no records or data that suggest that the area is of particular importance for seahorse, even in the overwintering period when the species may move to deeper water areas. Seahorse are deemed to be of medium vulnerability, high recoverability and national importance in the English Channel and proposed DCO Order Limits. The sensitivity of the receptor is, therefore, considered to be **low**.

Shellfish

8.9.417 More sedentary species (such as shellfish) are likely to be more vulnerable to increases in SSCs, which may result in reduced growth or increased mortality, particularly when spatfall occurs (ABP Research, 2007). Brown crabs have a high tolerance to suspended sediment and are reported to be insensitive to increases in turbidity, although they are likely to avoid areas of increased SSC as they rely on visual acuity during predation (Neal and Wilson, 2008). However, berried crustaceans (for example brown crab and European lobster) are likely to be more vulnerable to increased SSC as the eggs carried by these species require more regular aeration and as they are considered to have limited mobility, remaining sedentary while egg bearing. Increased SSCs will only affect a small area at any one time and will be temporary in nature (two to three days and return to background levels in a short time frame). Furthermore, these species are mobile and can move outside of the affected area if necessary. Smothering may cause some temporary displacement of these mobile invertebrates if sedimentary conditions change markedly, however, due to their mobility and ability to burrow out of sediments, no mortality is predicted (Neal and Wilson, 2008). Shellfish receptors are of local to international importance.

8.9.418 Brown crab and European lobster are deemed to be of medium vulnerability, high recoverability and regional importance in the southern North Sea fish and shellfish Study Area. The sensitivity of the receptor is, therefore, considered to be **low**.

8.9.419 Whelk are known to spend much of their time buried in soft sediment (Himmelman, 1988). It was also shown that whelk species such as *Busycon carica* can be naturally buried to depths of 14.4cm in intertidal areas and can dig themselves out quickly (Walker *et al*., 2004). Given the whelks tolerance to smothering and elevated suspended sediment, the sensitivity of the receptor is, therefore, considered to be **negligible**.

8.9.420 Molluscan shellfish species, such as king scallop, blue mussel and European native oyster, do exhibit avoidance behaviour over very short distances, but are less mobile than crustacean species and likely to be directly impacted by trenching operations (BERR, 2008). Smothering can result in significant mortalities on shellfish beds as they are less mobile than fish species, with many having life stages that are sensitive to variations in sediment particle size within the water. Filter feeders such as, oyster, mussel and scallop are therefore among the most vulnerable to smothering effects (BERR, 2008). As scallops are capable of swimming away from threats and can dig their way out of deposits of under 5cm, some scallops are likely to be able to survive, however a burial depth of 5cm is conservatively considered to be fatal (Marshall and Wilson, 2008). Native oyster and blue mussels are sessile and are therefore unable to move to avoid an impact such as smothering or increases in suspended sediment. Conversely, Widdows *et al*. (2002) noted that mussels buried by 6cm of sandy sediment (caused by resuspension of sediment due to turbulent flow across the bed) were able to move to the surface within one day.

8.9.421 Outside the array area and offshore export cable corridor native oyster, mussels and scallops are unlikely to be affected, as the depth of sediment deposition is expected to reduce with distance from the construction activity (5km downstream, may have reduced to approximately 10mg/l) and will happen gradually over time. Moreover, the SSC values within the Proposed Development are 10 to 20mg/l during winter months with storm raising the SSC in these areas by a factor of 10 to 20 (Guillou *et al*., 2017). Therefore, native oysters and blue mussels must be tolerant of a degree of natural variation in suspended sediments. Scallops have high recoverability from smothering due to their high fecundity (Le Pennec *et al*.,

2003) and widely dispersed pelagic larvae (Beaumont and Gjedrem, 2007), which can originate from unaffected scallop beds in the vicinity and repopulate smothered areas. Furthermore, scallops exhibit specialised behaviours which mitigate potential negative effects of increases in SSC, such as increased clapping rate (Szostek *et al*., 2013), food selectivity and particle excretion (Shumway *et al* ., 1997). Native oysters have also adapted a filtering mechanism to separate inorganic particles from food in suspension (Perry *et al*., 2017). There is the potential for short-term impacts on reproductive and larval life stages, however the impact will not have any long-lasting effects with adult spawning behaviour and recruitment cycles returning to normal upon cessation of the impact. Given the high recoverability of scallops to SSC and smothering, it is therefore considered that the sensitivity of scallops are considered to be **low**. However, as native oyster and blue mussels are more susceptible to smothering the sensitivity is **medium** for both receptors.

Migratory species

8.9.422 Migratory species within the fish and shellfish Study Area are deemed to be of low vulnerability, high recoverability and of local to international importance. The sensitivity of the receptor is therefore considered to be **low**.

Other fish receptors

8.9.423 All other fish receptors within the fish and shellfish Study Area are deemed to be of low vulnerability, high recoverability and of local to international importance. The sensitivity of the receptor is therefore considered to be **low**.

Significance of residual effect

8.9.424 An increase in SSC and associated sediment deposition will represent a temporary and short-term intermittent impact, affecting a relatively small portion of the fish and shellfish habitats in the Study Area. Most receptors are predicted to have some tolerance to this impact.

Sandeel

8.9.425 The sensitivity of sandeel is considered to be **low** and the magnitude of the impact is deemed to be **minor**. The effect will, therefore, be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Herring

8.9.426 The sensitivity of herring is considered to be **low,** and the magnitude of the impact is deemed to be **negligible**. The effect will, therefore, be of **negligible adverse significance**, which is **Not Significant** in EIA terms.

Black seabream

8.9.427 Taking into account the **high** sensitivity of nesting black seabream, and the **negligible** magnitude of impact, the significance of effect will be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Seahorse

8.9.428 The sensitivity of seahorse is considered to be **low,** and the magnitude of the impact is deemed to be **minor**. The effect will, therefore, be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Shellfish

8.9.429 Although native oyster and blue mussels have **medium** sensitivity from smothering during the installation of the offshore export cable, the magnitude is considered **negligible**. Therefore, the impact will be **minor adverse significance**, which is **Not Significant** in EIA terms.

Migratory species

8.9.430 Due to the small scale of the impact, the **low** sensitivity and the absence of barrier effects, the effects on migratory fish species (for instance sea lamprey, allis shad, twaite shad and European eels) in the fish and shellfish Study Area are predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Other fish receptors

8.9.431 The sensitivity of all other fish receptors is considered to be **low,** and the magnitude of the impact is deemed to be **negligible**. The effect will, therefore, be of **negligible adverse significance**, which is **Not Significant** in EIA terms.

Direct and indirect seabed disturbances leading to the release of sediment contaminants

Introduction

8.9.432 As identified in **Table 8-12** and assessed in the section above, construction activities will re-suspend sediment. While in suspension, there is the potential for sediment bound contaminants, such as metals, hydrocarbons and organic pollutants, to be released into the water column and lead to an effect on fish and shellfish receptors, as a result of construction activities and associated sediment mobilisation.

8.9.433 Evidence from the nearby IFA-2 interconnector suggests that the area is not heavily contaminated. IFA-2 is situated at a minimum distance of 700m west of the Rampion 2 array area. Contaminated sediment surveys undertaken for IFA-2 detected arsenic at two sites, located approximately 10km west of the Proposed Development, and measurable amounts of Dibutyltin (DBT) and Tributyltin (TBT) at the mouth of Southampton Water (IFA-2, 2016).

8.9.434 The assessment of subtidal sediment contaminants undertaken across the Rampion 1 offshore wind farm baseline characterisation, which covers part of the proposed DCO Order Limits and wider fish and shellfish ecology Study Area, revealed that the levels of contaminants within the sediments were generally low, suggesting sediments will not present any concern for seabed disturbance. However, eleven of the sites sampled supported levels of contaminants in excess of Action Level 1 for Arsenic and Chromium, at four of the sites (EMU Limited, 2011).

8.9.435 The results of the sediment contaminant survey that has been undertaken across proposed DCO Order Limits (see **Appendix 9.3, Volume 4** of the ES (Document Reference 6.4.9.3)). A total of eight heavy and trace metals were analysed from sediments taken at each of the seven stations (see **Paragraph 8.6.39**). Concentrations of arsenic were recorded at levels that exceeded Cefas AL1 at five stations. All stations exceeded OSPAR BAC ERL levels for arsenic. In addition, six stations exceeded BAC levels for chromium, but did not exceed ERL levels (see **Table 11** of **Appendix 9.3: EUNIS sediment descriptions, Volume 4** of the ES (Document Reference 6.4.9.3)). Concentrations of arsenic above CSQG TEL were recorded at all seven stations and above PEL at one station (ST051) (see **Table 11 of Appendix 9.3: EUNIS sediment descriptions, Volume 4** of the ES (Document Reference 6.4.9.3)). As detailed in **Paragraph 8.6.41**, all PAHs were recorded below limits of detection across all seven sampling stations, with the exception of Phenanthrene (ST020) and Pyrene (ST030).

Magnitude of impact

8.9.436 The maximum design scenario for the potential release of sediments contaminants of the Proposed Development that is likely to be disturbed by construction activities, with the associated potential release of sediment-bound contaminants, is predicted to be a total release of approximately 2.6km^3 of seabed sediment in the array area and offshore export cable corridor, from seabed preparation which is localised in extent with the proposed DCO Order Limits. In addition, the nature of the subtidal sediments is predominantly coarse and mixed sediments, in the western section of the proposed DCO Order Limits and offshore export cable corridor, and sand and muddy sediments in the eastern section of the proposed DCO Order Limits. Following disturbance as a result of construction activities, the majority of re-suspended sediments are expected to be deposited in the immediate vicinity of the works. The release of contaminants from the small proportion of fine sediments is likely to be rapidly dispersed with the tide and/or currents and therefore increased bioavailability resulting in adverse eco-toxicological effects are not expected. Moreover, an Outline MPCP will outline embedded environmental measures in the event of an accidental pollution event arising from offshore operations relating to the Proposed Development (see C-53, **Table 8-13**).

8.9.437 The impacts to fish and shellfish receptors as a result of the release of sediment-bound contaminants are therefore considered to be of **negligible** magnitude.

Sensitivity or value of receptor

8.9.438 The sensitivity of fish and shellfish receptors will vary depending on a range of factors including species and life stage. Due to their increased mobility, adult fish are less likely to be affected by marine pollution. However, eggs and larvae are likely to be particularly sensitive, with potentially toxic effects of pollutants on fish eggs and larvae (von Westernhagen, 1988). Effects of resuspension of sediment bound contaminants (e.g., heavy metals and hydrocarbon pollution) on fish eggs and larvae are likely to include abnormal development, delayed hatching and reduced hatching success (Bunn *et al*., 2000). Any such events therefore will have varying levels of effect dependent on the species present and pollutants involved. For shellfish species, including king scallop, blue mussel and European native oyster[8], there is low or limited evidence on their sensitivity to contaminates and trace metals. However, the accumulation of trace metals in filter-feeding shellfish is species-specific and depends on animal size and reproductive state and season. Trace organic contaminants, including PAH, can bioaccumulate in bivalves from direct adsorption from water. However, as detailed above in **Paragraph 8.9.436**, the small proportion of fine sediments is likely to be rapidly dispersed with the tide and/or currents and therefore increased bioavailability resulting in adverse eco-toxicological effects are not expected.

8.9.439 The fish and shellfish receptors are deemed to be of medium vulnerability, high recoverability and local to international importance in the English Channel. The sensitivity of all receptors is therefore considered to be **medium**.

Significance of residual effect

8.9.440 The direct and indirect impact of seabed disturbances leading to the resuspension of contaminants as a result of sediment disturbance is predicted to occur on a small scale, with contaminants predicted to be rapidly dispersed by the tide. Overall, the magnitude of the impact is deemed to be **negligible**, and the sensitivity of the receptors is considered to be **medium**. The effect on fish and shellfish receptors will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

8.10 Assessment of effects: Operation and maintenance phase

Introduction

8.10.1 The potential impacts of the operation and maintenance phase of the Proposed Development have been assessed on fish and shellfish ecology in the Study Area. The effects arising from the operation of the Proposed Development are listed in **Table 8-12** along with the maximum assessment assumptions against which each construction phase impact has been assessed.

8.10.2 A description of the significance of effects upon fish and shellfish receptors caused by each identified impact is given below.

[8] King scallop (https://www.marlin.ac.uk/species/detail/1398), blue mussel (https://www.marlin.ac.uk/habitats/detail/36/mytilus_edulis_beds_on_sublittoral_sediment) and European native oyster (https://www.marlin.ac.uk/species/detail/1146).

Long-term loss of habitat and increased hard substrate and structural complexity due to the presence of turbine foundations, scour protection and cable protection

Long-term habitat loss

8.10.3 The presence of infrastructure such as foundations and cable protection at crossings have the potential to impact on fish and shellfish ecology by the removal of essential habitats for survival (e.g., spawning, nursery and feeding habitats). Species that are highly dependent on the presence of specific seabed substrates during sensitive periods of their life cycle such as sandeel and herring may have increased susceptibility to the potential impact of habitat loss. Impacts on these species are therefore assessed separately below.

8.10.4 The introduction of foundations and scour protection will result in a permanent loss of seabed habitat (the methodology of scour protection will be defined within an Outline Scour Protection Management Plan (see C-44, **Table 8-13**)). Fish and shellfish that are reliant on the presence of suitable sediment/habitat for their survival are considered to be more vulnerable to change depending on the availability of habitat within the wider geographical region. The Proposed Development fish and shellfish Study Area coincides with fish spawning and nursery habitats including sandeel, herring and black seabream.

Magnitude of impact

8.10.5 The long-term habitat loss due to the presence of foundations, scour protection and cable protection is expected to be up to a maximum of 1.39km^2, which represents 0.64% of the area within the proposed DCO Order Limits, and a much smaller proportion of the wider Study Area. Comparable habitats are present and widespread within the wider area.

8.10.6 The impact is predicted to be of local spatial extent (i.e., within the proposed DCO Order Limits), long-term duration, continuous and irreversible (within the lifetime of the project).

Sandeel

8.10.7 Due to the wide distribution of sandeel habitat across the English Channel and southern North Sea, the magnitude is considered **minor**.

Herring

8.10.8 Due to the separation distance between herring spawning grounds and the Proposed Development, with no direct overlap possible, the magnitude is considered **negligible**.

Black seabream

8.10.9 Considering the localised nature of black seabream spawning and nesting grounds to the Proposed Development, there is potential for an impact on nesting black seabream, as although the Proposed Development does not overlap the Kingmere

MCZ, it is recognised that some nesting habitat outside the MCZ may potentially be lost through the introduction of cable protection. However, the implementation of a number of embedded environmental measures will provide a demonstrable reduction in magnitude (**Table 8-13**). The export cable will be microsited during construction to avoid, where possible, sensitive features such as black seabream nests (C-269, C-270, **Table 8-13**). In addition, different trenching methods will be utilised to minimise the footprint (C-272, **Table 8-13**). There will therefore be no long-term loss of areas of importance to black seabream. Taking this into account, the magnitude of effect is **negligible**.

Seahorse

8.10.10 The magnitude of impact from long term habitat loss, is assessed as **minor**, as the Proposed Development does not overlap designated seahorse MCZs (see **Table 8-11**), but it is recognised that some seahorse habitat may potentially be lost through the associated operation and maintenance activities of the Proposed Development.

Shellfish

8.10.11 It is predicted that the impact will affect shellfish receptors directly, the magnitude is therefore considered to be **minor**.

Other fish receptors

8.10.12 It is predicted that the impact will affect fish receptors directly, the magnitude is therefore considered to be **minor**.

Sensitivity or value of receptor

8.10.13 Fish and shellfish species that are reliant upon the presence of suitable sediment/habitat for their survival are considered to be more vulnerable to change depending on the availability of habitat within the wider region. The fish species most vulnerable to habitat loss include Black seabream and sandeel (demersal spawners) as these have specific habitat requirements for spawning. Loss of habitat and alteration of the seabed will also affect shellfish populations such as brown crab and European lobster within the immediate area.

Sandeel

8.10.14 As shown **in Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8), the proposed DCO Order Limits overlap with low intensity sandeel spawning grounds as identified by Ellis *et al*. (2010). Sandeel have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and the regional importance of the receptor, sandeel are considered to be of **medium** sensitivity.

Herring

8.10.15 Herring have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and the regional importance of the receptor, herring are therefore considered to be of **high** sensitivity.

Black seabream

8.10.16 Black seabream favour a particular type of substrate to build their nests and lay eggs (generally hard and coarse substrate (gravel; chalk reefs)). Taking into account their specific substrate dependency during spawning, and national importance, black seabream are considered to be of **high** sensitivity.

Seahorse

8.10.17 Seahorses typically inhabit shallow waters, amongst seagrass and algae, although short-snouted seahorse can also be found in rocky areas to a depth of 77m (Sabatini and Ballerstedt, 2007). Seahorses overwinter in deeper waters, where there are a multitude of available habitats for seahorses to inhabit during the winter months. Taking into account their dependency of certain habitats, and their national importance, seahorse are therefore considered to be of **medium** sensitivity.

Cuttlefish

8.10.18 Cuttlefish are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates, e.g., plants and sessile animals, and artificial structures, e.g. fishing pots, ropes and branches (Blanc and Daguzan, 1998; Bloor *et al*., 2013, cited in Ganias *et al*, 2021). Cuttlefish migrate inshore to spawning grounds preferred habitat for eggs and juveniles (Bloor *et al*., 2013), in March and April with spawning occurring from March to July. In the English Channel, offshore migration occurs in winter and is influenced primarily by a reduction in water temperature as well as the reduction in daylight hours (Guerra, 2006). After spawning occurs adults return back into deeper, offshore areas around October in the UK (Dunn, 1999, Royer *et al*., 2006). Whilst cuttlefish are demersal spawners, they do not exhibit strict substrate dependency, and lay their eggs on a variety of substrates in the nearshore. Taking this into consideration, and the regional importance of the receptor, cuttlefish are considered to be of **low** sensitivity.

Shellfish

8.10.19 A 10-year research programme conducted in Germany provides a multiyear perspective and a synopsis of wind effects on a broad range of marine resources (Lüdeke, 2015). A second pre-construction and operation study (over a period of seven years) observed an increase in the number of species during the operation phase along with an increased biomass of shore crab (*Carcinus maenas*; Langhamer *et al*., 2016).

8.10.20 Research has documented observations of increased biodiversity and biomass of certain shellfish species, including brown crab (Hooper and Austen, 2014; Krone *et al*., 2017) and lobster (Roach *et al*., 2018) on hard substrate habitat created by

WTG foundations and the associated scour protection. Both the hard substrate of the pile foundations and the scour protection created new habitats and areas of shelters that were immediately colonised by marine species. The presence of juveniles from a range of age cohorts has been observed, leading to the suggestion that offshore windfarms act as nursery areas (Hooper and Austen, 2014). Attraction to this new habitat has been recorded for certain species such as brown crab and lobster (van Hal *et al*., 2017).

8.10.21 Most shellfish receptors in the Study Area are deemed to be of medium vulnerability and of local to international importance (recoverability is not applicable for this impact due to the impact occurring over the lifetime of the project). Given the widespread nature of preferred habitat in the wider area, and the ability of certain species to colonise offshore wind infrastructure (Smaal *et al*., 2015; Degraer *et al*., 2020), the sensitivity of these receptors is considered to be **low**.

Elasmobranch

8.10.22 The Rampion 2 array area and offshore export cable corridor will overlap with nursery areas for undulate ray (**Figure 8.7**, **Volume 3** of the ES (Document Reference 6.3.8). Due to the mobile nature of adults, there is expected to be no impact. However, undulate ray spawning grounds are thought to broadly overlap nursery areas (Ellis *et al*., 2012) and the sediments in the inshore area (sand) may be suitable for undulate ray spawning. Even so, alternative nursery areas (and therefore potential spawning grounds) are available along the entire south coast with scour and cable protection representing only a very small proportion of this. Taking this into consideration, and given the regional to national importance of the receptors, the sensitivity of elasmobranchs is **low**.

Other fish receptors

8.10.23 Overall, the 10-year programme (Lüdeke, 2015) results could not confirm negative effects on fish from the presence of WTGs. The second pre-construction and operation study observed an increase in the number of species during the operation phase along with greater total fish biomass and increased biomass of and cod (Bergstrom *et al*., 2013). Furthermore, when comparing the difference in fish densities between the foundation and through the water column, and the surrounding seawater, Andersson and Öhman (2010) found a positive effect around the foundations.

8.10.24 Research has also shown an increase in fish assemblages (Wilhelmsson *et al*., 2006) over both short (Lindeboom *et al*., 2011) and long term (Stenberg *et al*., 2015). Reubens *et al*. (2011) indicated that fish communities are influenced by the type of epifaunal food resource colonising WTG foundations, with species selecting prey that live specifically on these structures. While attraction to this new habitat has been recorded for certain species such as cod, observations also indicate avoidance by other species, such as flatfish species (common dab, Dover sole, and solenette) and whiting. However, these differences could not be distinguished between the physical structures and the impacts that season and weather conditions also have on fish presence (van Hal *et al*., 2017).

8.10.25 Most other fish receptors in the Study Area are deemed to be of low vulnerability and of local to international importance (recoverability is not applicable for this impact due to the impact occurring over the lifetime of the Proposed Development). Given the widespread nature of spawning and nursery habitat in the wider area, the sensitivity of these receptors is considered to be **low**.

Significance of residual effect

8.10.26 Long-term habitat loss will represent a long-term and continuous impact throughout the lifetime of the project. However, only a relatively small proportion of the fish and shellfish habitats within the proposed DCO Order Limits and wider Study Area are likely to be affected. Most receptors are predicted to have some tolerance to this impact.

Sandeel

8.10.27 It is predicted that the sensitivity of sandeel are considered to be **low** and the magnitude is deemed to be **minor**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Herring

8.10.28 It is predicted that the sensitivity of herring are considered to be **medium,** and the magnitude is deemed to be **negligible**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Black seabream

8.10.29 Considering the **high** sensitivity of breeding black seabream, and the **negligible** magnitude of impact, an impact of **minor adverse significance** is expected from long term habitat loss, which is **Not Significant** in EIA terms.

Seahorse

8.10.30 Seahorse are predicted to have a **medium** sensitivity, with a **minor** magnitude. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Shellfish

8.10.31 It is predicted that the sensitivity of shellfish receptors are considered to be **low,** and the magnitude is deemed to be **minor**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Other fish receptors

8.10.32 It is predicted that the sensitivity of elasmobranch and all other fish receptors are considered to be **low,** and the magnitude is deemed to be **minor**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Increased hard substrate and structural complexity

8.10.33 Any introduction of infrastructure such as foundations and scour protection will result in the introduction of hard substrate to the currently predominantly soft seabed habitat of the Rampion 2 Study Area (the methodology of scour protection will be defined within an Outline Scour Protection Management Plan (see C-44, **Table 8-13**)). This will result in an increase in the heterogeneity of the seabed habitat and a change of the composition of the benthic community. As a result, an increase in the biodiversity if the benthic community in the vicinity of the area where hard substrate is introduced is expected to occur (Wilhelmsson and Malm, 2008).

8.10.34 This increase in diversity and productivity of the seabed communities expected may have an impact on fish and shellfish receptors, resulting in either attraction or increased productivity (Hoffman *et al*., 2000). The potential for marine structures, whether man-made or natural, to attract and concentrate fish is well documented (Bohnsack, 1989; Bohnsack and Sutherland, 1985; Hoffman *et al*., 2000; Sayer *et al*., 2005; Wilhelmsson and Malm, 2008). However, whether these structures act only to attract and aggregate fish or increase biomass is currently unclear.

8.10.35 It should be noted that the increase of hard substrate as a result of the Proposed Development may provide habitat for seahorses, which are known to visit artificial habitats and structures, including marinas (Garrick-Maidment, 2011), gas platforms (Fabi *et al*., 2002) and jetty piles and piers (Foster and Vincent, 2004). Field experiments have shown that by increasing the structural complexity of artificial habitats, high abundances of seahorse were supported (Hellyer *et al*., 2011).

Invasive species

8.10.36 The colonisation of new habitats may potentially lead to the introduction of nonindigenous and invasive species. With respect to fish and shellfish populations, this may have indirect adverse effects on shellfish populations as a result of competition. There is little evidence of adverse effects resulting from colonisation of other offshore wind farms by non-indigenous species; the post-construction monitoring report for the Barrow offshore wind farm demonstrated no evidence of invasive or alien species on or around the monopiles (EMU Limited, 2008a), and a similar study of the Kentish Flats monopiles only identified slipper limpet (EMU Limited, 2008b), which was also recorded within the Thanet Extension Study Area (OEL, 2017). Although not prevalent in the area, two non-native invasive species were collected during the pre- and post-construction fish monitoring beam trawl surveys for Rampion 1 offshore wind farm, with both slipper limpet and leathery sea squirt collected in the 2015/16 pre-construction surveys and only slipper limpet collected in the post-construction surveys in 2019/20 (OEL, 2020a).

8.10.37 As detailed in **Table 8-13**, a PEMP will incorporate mitigation and control of invasive species (C-95).

Magnitude of impact

8.10.38 Up to 1.39km^2 of new hard substrate is likely to be created by the Proposed Development as a result of foundation installation, scour protection and cable protection. The impact is predicted to be of local spatial extent (within the proposed DCO Order Limits), long-term duration, continuous and irreversible (during the lifetime of the Proposed Development).

Sandeel

8.10.39 Due to the wide distribution of sandeel habitat across the English Channel and southern North Sea, the magnitude of impact on sandeel is considered **minor**.

Herring

8.10.40 The proposed DCO Order Limits do not overlap with the recorded herring spawning ground as detailed in **Figure 8.2** (Document Reference 6.3.8) and **Figure 8.8** (Document Reference 6.3.8)**, Volume 3** of the ES, with the spawning ground located some approximately 47km to the south of the proposed DCO Order Limits (including the 16km buffer) at its closest point (the array area). Therefore, there is no scope for direct temporary habitat disturbance on herring spawning grounds as a result of installation of the proposed offshore export cables. It can be seen from **Figure 8.8, Volume 3** of the ES (Document Reference 6.3.8) although herring larvae have been recorded within the Study Area, this was at relatively low abundances within the proposed DCO Order Limits (IHLS 2007 to 2020: 0.1 to 2,500 per m^2) and the area is clearly not of importance to the Downs stock herring population. Moreover, with the exception of a spike in herring larval intensity in the area between 2009 and 2010, and between 2016 and 2017 (see **Appendix 8.1: Herring annual heatmaps, Volume 4** of the ES (Document Reference 6.4.8.1)), the remaining years between 2007 and 2020 should relatively low herring larval intensity in the east English Channel. As the preferred herring spawning ground is located 47 km from the Rampion 2 offshore export cable corridor, a **negligible** magnitude of impacts has been assigned.

Black seabream

8.10.41 Considering the localised nature of black seabream spawning and nesting grounds to the Proposed Development, increased structure and structural complexity from with construction within the array is not expected to affect nesting areas, however there is the potential for an impact to arise from the introduction of cable protection along the export cable route. This is because although the Proposed Development does not overlap the Kingmere MCZ, it is recognised that some nesting habitat may potentially be lost through the introduction of cable protection in areas outside of the MCZ. The implementation of a number of embedded environmental measures will provide a demonstrable reduction in impact magnitude (C-269, C-270, C-271 **Table 8-13**) as the export cable will be microsited during construction to avoid, where possible, sensitive features such as black seabream nests. In addition, different trenching methods will be utilised to minimise the footprint. There will therefore be minimal, if any, increased hard substrate in areas of importance to black seabream. Taking this into account, the magnitude of impact is **negligible**.

Seahorse

8.10.42 The magnitude of impact from long term habitat loss, associated with construction within the array and the offshore export cable is assessed as **minor**, as the Proposed Development does not overlap designated seahorse MCZs (see **Table 8-11**), but it is recognised that some seahorse habitat may potentially be lost through the associated operation and maintenance activities of the Proposed Development.

Shellfish

8.10.43 It is predicted that the impact will affect shellfish receptors directly, the magnitude is therefore considered to be **minor**.

Other fish receptors

8.10.44 It is predicted that the impact will affect fish receptors directly, the magnitude is therefore considered to be **minor**.

Sensitivity or value of receptor

8.10.45 Hard substrate created by the introduction of WTG foundations and scour/cable protection are likely to be primarily colonised within hours or days after construction by demersal and semi-pelagic fish species (Andersson, 2011). Continued colonisation has been seen for a number of years after the initial construction, until a stratified re-colonised population is formed (Krone *et al*., 2013). Fish aggregate from the surrounding areas, attracted by feeding opportunities or the prospect of encountering other individuals which may increase the carrying capacity of the area (Andersson and Öhman, 2010; Bohnsack, 1989; Lindeboom *et al*., 2011). Research has shown in some cases that artificial structures have no apparent reef effect for certain fish species, suggesting that there is no noticeable increase or decrease for a given species. For example, abundances of adult individuals of several pelagic species, including horse mackerel, mackerel, herring, and sprat were unaffected by the presence of scour protection (van Hal *et al*., 2017). While these pelagic species seemed unaffected by scour protection, they may still utilise scour protection as spawning or rearing habitat.

8.10.46 The loss of soft-bottom substrate arising from offshore wind farm installations may decrease the abundance of soft-bottom fish species (Krone *et al*., 2017; Lindeboom *et al*., 2011; van Hal *et al*., 2017); however, due to the small amount of area covered by scour protection within an offshore wind farm (<1%), possible negative impacts are considered insignificant at the population level, on sand-dwelling species such as dab and sandeel as indicated by previous studies (Stenberg *et al*., 2015; van Hal *et al*., 2017). Even though scour protection may have negative effects on soft-bottom species at the local scale, the effects should be evaluated at larger spatial scales and related to fish population sizes and movements (Glarou *et al*., 2020).

8.10.47 The dominant natural substrate character of the construction area (e.g., soft sediment or hard rocky seabed) will determine the number of new species found on the introduced vertical hard surface and associated scour protection. When placed on an area of seabed which is already characterised by rocky substrates, few species will be added to the area, but the increase in total hard substrate could sustain higher abundance (Andersson and Öhman, 2010). Conversely, when placed on a soft seabed, most of the colonising fish will be normally associated with rocky (or other hard bottom) habitats, thus the overall diversity of the area may increase (Andersson *et al*., 2009). A new baseline species assemblage will be formed via re-colonisation and the original soft-bottom population will be displaced (Desprez, 2000). This was observed in studies by Stenberg *et al*. (2015) at the Horns Rev offshore wind farm, Lindeboom *et al*. (2011) at the Egmond aan Zee offshore wind farm, and Bergström *et al*. (2013) at the Lillgrund offshore wind farm, where an increase in fish species associated with reefs, such as sole, whiting, striped red mullet (*Mullus surmuletus*) goldsinny wrasse (*Ctenolabrus rupestris*), lumpsucker (*Cycloplerus lumpus*) and eelpout (*Zoarces viviparous*), and a decrease in the original sandy-bottom fish population, were reported at all three offshore wind farms. Lindeboom *et al*. (2011) and Stenberg *et al*. (2015) also found that fish species such as cod were attracted to the new hard substrate within the offshore wind farm due to the provision of shelter and a food source.

8.10.48 Stenberg *et al*. (2011) found the introduction of hard substrates such as WTG foundations resulted in minor changes in the fish community and species diversity and only affected the local soft-bottom assemblage of sandeel species temporarily, with no change to the sandeel population noted seven years later. Furthermore, a long running fish monitoring survey conducted at the Lillgrund offshore wind farm showed no overall increase in the total abundance of fish, although redistribution towards the foundations within the offshore wind farm area was noticed for some species (i.e. cod, European eel and eelpout) (Andersson, 2011). More species were recorded after construction than before, which is consistent with the hypothesis that localised increases in biodiversity may occur following the introduction of hard substrates in a soft sediment environment.

8.10.49 These studies correlate with the MMO (2014) study, where there were minor changes in fish communities due to the addition of hard substrate at sites including North Hoyle and Kentish Flats. Overall, results from earlier studies reported in the scientific literature did not provide robust data (e.g. some were visual observations with no quantitative data) that could be generalised to the effects of artificial structures on fish abundance in offshore wind farm areas (Wilhelmsson *et al*., 2010). More recent papers are, however, beginning to assess population changes and observations of re-colonisation in a more quantitative manner (Krone *et al*., 2013).

8.10.50 Post-construction fisheries surveys conducted in line with the FEPA licence requirements for the Barrow and North Hoyle offshore wind farms, found no evidence of fish abundance across these sites being affected, either positively or negatively, by the presence of the offshore wind farms (Cefas, 2010) therefore suggesting that any effects, if seen, are likely to be highly localised. The post-construction survey conduction for Rampion 1 offshore wind farm noted a significant change in abundance between the pre- and post-construction surveys, seasons and treatment areas. However, it was noted that these changes were either observed in reference stations, where no impact from Rampion 1 offshore wind farm was expected or were in line with expected natural variability.

Sandeel

8.10.51 As shown in **Figure 8.3, Volume 3**, the offshore export corridor overlaps with low intensity sandeel spawning grounds as identified by Ellis *et al*. (2010). Sandeel have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and the regional importance of the receptor, sandeel are considered to be of **medium** sensitivity.

Herring

8.10.52 Herring have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and the regional importance of the receptor, herring are considered to be of **high** sensitivity.

Black seabream

8.10.53 The proposed DCO Order Limits is in close proximity to the Kingmere MCZ, with the offshore export cable corridor crossing over areas which contain important chalk habitat for black seabream nests. These nests have been identified within the proposed offshore export cable corridor area of search (ABPmer, 2020a) (see **Figure 8.13**, **Figure 8.14a, and Figure 8.14b Volume 3** of the ES (Document Reference 6.3.8)). Black seabream are deemed to be vulnerable to permanent changes in substrate, with a low ability to recovery and are of regional importance. Due to the location of potential nesting habitat across the offshore export cable corridor, the specific habitat requirement of these species, and the national importance of the receptor, the sensitivity of black seabream is considered to be **high**.

Seahorse

8.10.54 Seahorses are not expected in significant numbers in the area of the proposed DCO Order Limits (see in **paragraph 8.6.66** to **paragraph 8.6.68**), as there are no records or data that suggest that the ES proposed DCO Order Limits itself is an area of particular importance for seahorse, even in the overwintering period when the species may move to deeper water areas. Seahorse are deemed to be of medium vulnerability, high recoverability and national importance. As a result, the sensitivity of the receptor is, therefore, considered to be **medium**.

Cuttlefish

8.10.55 Cuttlefish are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates, e.g. plants and sessile animals, and artificial structures, e.g. fishing pots, ropes and branches (Blanc and Daguzan, 1998; Bloor *et al*., 2013, cited in Ganias *et al*, 2021). Cuttlefish migrate inshore to spawning grounds preferred habitat for eggs and juveniles (Bloor *et al*., 2013), in March and April with spawning occurring from March to July. In the English Channel, offshore migration occurs in winter and is influenced primarily by a reduction in water temperature as well as the reduction in daylight hours (Guerra, 2006). After spawning occurs adults return back into deeper, offshore areas around October in the UK (Dunn, 1999, Royer *et al*., 2006). Whilst cuttlefish are demersal spawners, they do not exhibit strict substrate dependency, and lay their eggs on a variety of substrates in the nearshore. Taking this into consideration, and the regional importance of the receptor, cuttlefish are considered to be of **low** sensitivity.

Shellfish

8.10.56 Crustacean species such as the brown crab and European lobster are expected to exhibit the greatest potential for positive effects from foundations and scour protection material through the expansion of their natural habitats (Linley *et al*., 2007) and the creation of additional refuge areas. Where foundations and scour protection are placed within areas of sandy and coarse sediments, this will represent novel habitat and new potential sources of food in these areas and could potentially extend the habitat range of some shellfish species. Post-construction monitoring surveys at the Horns Rev offshore wind farm noted that the hard substrates were used as a hatchery or nursery grounds for several species and were particularly successful for brown crab. They concluded that larvae and juveniles rapidly invade the hard substrates from the breeding areas (BioConsult, 2006). Studies in the UK have identified increases of benthic species including crabs and lobsters from colonisation of sub-surface structures by subtidal sessile species on which they can feed (Linley *et al*., 2007). The new hard substrate increases shelter for shellfish and has been found to increase. Biodiversity and biomass of associated fauna in some areas (Roach *et al*., 2018). There is evidence that offshore windfarms provide suitable habitat for shellfish species including blue mussels and European native oysters, and hence may have a positive effect on populations (Hooper and Austen, 2014; Smaal *et al*., 2015; Degraer *et al*., 2020). Sensitivity of shellfish receptors is therefore categorised as **low**.

Elasmobranchs

8.10.57 Data relating to spawning grounds of tope, thornback ray and undulate ray is lacking from the scientific literature and are undefined by Ellis *et al*. (2010) and Coull *et al*. (1998), due to insufficient data on the occurrence of egg cases or egg-bearing females to delineate spawning grounds for these species (Ellis *et al*., 2012). Nursery areas are however defined, and undulate ray, thornback ray and tope show overlapping low intensity nursery areas with the proposed DCO Order Limits (Ellis *et al*., 2012). Mulberry Marine Experience noted the presence of thornback ray and undulate ray between Selsey and the Western edge of the proposed DCO Order Limits, and along the inshore route of the export cable corridor.

8.10.58 The undulate ray is commonly encountered in the English Channel with Ellis *et al*. (2012) suggesting that due to the lack of data on spawning grounds that they may broadly overlap nursery grounds (see **Figure 8.7, Volume 3** of the ES (Document Reference 6.3.8)). The Rampion 2 offshore export cable corridor is located within a low intensity nursery area.

8.10.59 It is considered that as thornback ray, undulate ray and tope are highly mobile, and other nursery/spawning areas are available across the region, the population sizes will not be affected. Taking the above into consideration, and given the regional to national importance of the receptors, the sensitivity is therefore **low**.

Other fish receptors

8.10.60 All other fish receptors in the Study Area are deemed to be of low vulnerability and local to international importance (recoverability is not relevant to this impact). The sensitivity is therefore considered to be **low**.

Significance of residual effect

8.10.61 There is some uncertainty associated with the likely effects of introduction of hard substrates into the marine environment on fish and shellfish receptors. Fish populations are unlikely to show noticeable benefits as a result of this impact, though there is evidence that shellfish populations (particularly brown crab and European lobster) will benefit from the introduction of hard substrates.

Sandeel

8.10.62 It is predicted that the sensitivity of sandeel are considered to be **medium** and the magnitude is deemed to be **minor**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Herring

8.10.63 It is predicted that the sensitivity of herring are considered to be **high,** and the magnitude is deemed to be **negligible**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Black seabream

8.10.64 Considering the **high** sensitivity of breeding black seabream, and the **negligible** magnitude of impact, an impact of **minor adverse significance** is expected, which is **Not Significant** in EIA terms.

Seahorse

8.10.65 Seahorse are predicted to have a **medium** sensitivity, with a **minor** magnitude. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Shellfish

8.10.66 It is predicted that the sensitivity of shellfish receptors are considered to be **low,** and the magnitude is deemed to be **minor**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Other fish receptors

8.10.67 It is predicted that the sensitivity of elasmobranch and all other fish receptors are considered to be **low,** and the magnitude is deemed to be **minor**. The effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Electromagnetic field (EMF) impacts arising from cables

Introduction

8.10.68 Electromagnetic fields (EMFs) are produced as a result of the electricity passing through the cables (inter-array and export cables). EMF will result from the operation of up to 250km of High Voltage Alternating Current (HVAC) inter-array (at a likely operating voltage of 33kV (kilo volts) or 66kV), 40km of HVAC interconnector cable (operating up to 275kV) and 170km of HVAC export cable (comprising of up to four cables operating at a capacity up to 275kV).

8.10.69 The transport of electricity through cables has the potential to emit a localised EMF which could potentially affect the sensory mechanisms of some species of fish and shellfish, particularly electro-sensitive species (including elasmobranchs) and migratory fish species (CMACS, 2003). Three different EMF types can be generated by offshore wind cables: electric fields (E fields); magnetic fields (B fields); and induced electric fields (iE fields). Industry standard offshore wind cables all contain shielding which prevents E fields from passing into the marine environment and as such, these are not considered any further.

8.10.70 Cable shielding does not however significantly alter or prevent the emission of B fields. It is the movement of the B fields within a medium (i.e., seawater) which then causes the iE fields. These iE fields can either be produced by the movement of the alternating B field (in the case of alternating current (AC) transmission) through the seawater or by the movement of seawater and / or an organism through a static B field (in the case of direct current (DC) transmission).

Magnitude of impact

8.10.71 Many fish and shellfish species are thought to be able to sense electric and magnetic fields, with some species having developed specialised organs to facilitate this. The most well-known example of these is the Ampullae of Lorenzini in elasmobranchs, with this group of animals using electroreceptors to find prey. iE fields may cause either attraction or repulsion, with varying strength fields having been demonstrated to cause both reactions (Gill & Taylor 2001; Yano, et al 2000; Kalmijn 1982; Kimber et al 2011). The threshold for the change between attraction and avoidance of E fields in elasmobranchs is considered to be between 400–1,000µV/m (reviewed in CMACS, 2012) and these levels will only likely be found at or within 1 – 2 metres of the seabed for a cable buried at 1m. For deeper burial, the iE field at the seabed will be correspondingly lower.

8.10.72 In a review by Tricas and Gill (2011), it was noted that the sensitivity of elasmobranchs to E fields was highest at frequencies of 1 – 10 Hz, with a broader response frequency range of 0.01 – 25 Hz where fields intensities of 10x or greater were required to elicit a reaction. This suggests that weak fields such as those generated by offshore wind AC cables are likely to be mostly undetectable.

8.10.73 Some fish species are known to have magneto-receptors, with this thought to primarily be for the purposes of navigation (Walker *et al*., 2007). However, most of the research to date on magneto-reception in fish has been undertaken in migratory species such as Salmonidae, Anguillidae and Scombridae, with information on other species being limited (reviewed in Tricas & Gill, 2011). There have been suggestions (Gill & Kimber, 2005) that the presence of magnetic fields generated by cables may interrupt navigation and consequently migration.

8.10.74 EMFs monitored around subsea electricity cables have been shown to attenuate exponentially vertically and horizontally away from the cables, with the magnetic field generated by the cables typically having reached zero within 10m of the cable (reviewed by Tricas & Gill, 2011). Burial of the cables and protection with cable protection where shallow buried or surface laid will not reduce the strength of the fields, however, it moves the cables further from the receptors, and as such the receptors will be subject to reduced field strengths.

8.10.75 For the Proposed Development, as part of the embedded environmental measures, offshore cables will be buried (see C-41, C-45, C-96, **Table 8-13**) at a target depth of 1.0 to 1.5m below the seabed surface for the majority of the route (see **Chapter 4: The Proposed Development , Volume 2** of the ES (Document Reference 6.2.4)).

8.10.76 The final burial depth will be defined post consent following the outcome of the CBRA (or similar) when a detailed study has been completed to assess the relevant factors for each part of the cable route. This will be detailed within the Cable Specification and Installation Plan (see C-45, **Table 8-13**).

8.10.77 The impact is therefore predicted to be highly localised, of long-term duration (over the lifetime of the project), continuous and irreversible (over the lifetime of the project). It is predicted that the impact will affect fish and shellfish receptors directly. Due to the localised spatial extent, the magnitude is considered to be **minor**.

Sensitivity or value of receptor

Elasmobranchs

8.10.78 Elasmobranchs (sharks, skates and rays), especially demersal species, are known to be the most electro-receptive of all fish. A study commissioned by the MMO (2014) found no evidence to suggest that EMF posed a significant risk to elasmobranchs at the site or population level. A recent study by Hutchison et al (2020) observed an increase in exploratory/foraging behaviour in Little skate (*Leucoraja erinacea*) in response to EMF. Taking this into consideration, and given the regional to national importance of the receptors, elasmobranchs are deemed to be of **low** sensitivity to impacts from EMF.

Fish

8.10.79 A broad scale study of fish aggregations and directional movement around cables at Nysted offshore wind farm in Denmark, showed no evidence of any change in directionality or distribution of species as a result of the cable installation (Hvidt *et al*., 2004). Taking this into consideration, all other fish VERs are deemed to be of **low** sensitivity to impacts from EMF.

Migratory species

8.10.80 Studies on European eel have shown some deviation from migratory routes in response to low (5µT) DC B fields, however, the effects were short-term and short scale and not thought to impact on overall migration (Westerberg, 2000; Ohman *et al*., 2007). Interestingly, no effects were seen in European eel from AC fields of 9.6µT (Orpwood *et al*., 2015), suggesting that there may be differences in effects between DC and AC cabling. A review of potential effects of EMF on migratory fish for Scottish Natural Heritage (Gill & Bartlett, 2010) identified that there was insufficient evidence to be able to confirm whether any impacts will arise from the field strengths generated by offshore wind farm cabling. Taking this into consideration, it is considered unlikely that EMF will impact any migratory behaviours, and therefore migratory species are deemed to be of **low** sensitivity to impacts from EMF.

Shellfish

8.10.81 Many marine invertebrates are thought to be magneto-sensitive, with this often being used for navigational purposes (migration etc.). However, evidence for potential impacts from anthropogenic B fields is limited and can be contradictory even within the same species. Studies on the green shore crab (*Carcinus maenas*) have been directly contradictory, with one study demonstrating reduced aggression in response to AC B fields matching those from an offshore wind farm (Everitt, 2008), however, another study showed no effects from static B fields (Bochert & Zettler, 2004). Brown shrimp (*Crangon crangon*) were recorded as being attracted to B fields of the magnitude expected from offshore wind cabling (ICES, 2003). One recent study (Hutchinson *et al*., 2020) has suggested potential changes to exploratory behaviour in American lobster (*Homarus americanus*) in response to DC B fields when in tanks placed near a subsea cable. Taking this into consideration, any effects on marine invertebrates are anticipated to only occur in the immediate vicinity of the cable. Therefore, marine invertebrates are deemed to be of **low** sensitivity to impacts from EMF.

Significance of residual effect

8.10.82 The cable burial depth for the Proposed Development (including interarray, interconnector and offshore export cable corridor) may not be attained due to seabed conditions and in these areas, cable protection will be used. Burial of a marine cable acts as a buffer between the potential source of EMF and the receptor. The ZOI from EMF around a cable remains the same regardless of the substrate that surrounds it. Accordingly, the use of cable protection acts in the same way as burial, by distancing the receptor from the source.

8.10.83 Potential EMF from the Proposed Development offshore cables will represent a long term and continuous impact throughout the lifetime of the project. However, effects will be highly localised, affecting a relatively small portion of fish and shellfish habitats in the Study Area. The Proposed Development commitments (as shown in **Table 8-13**) include the use of, where feasible, cable burial to avoid direct impacts to the fish and shellfish (see C-41, C-45, C-96, **Table 8-13**).

Elasmobranchs

8.10.84 Overall, the sensitivity of elasmobranchs is **low**, and the magnitude of the impact is deemed to be **minor**. The effect, therefore, will be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Fish

8.10.85 Overall, the sensitivity of fish is **low**, and the magnitude of the impact is deemed to be **minor**. The effect, therefore, will be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Migratory species

8.10.86 For migratory fish species, due to the small scale of the impact, the **low** sensitivity and the absence of barrier effects, effects on migratory fish species are predicted to be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Shellfish

8.10.87 Overall, the sensitivity of shellfish is **low**, and the magnitude of the impact is deemed to be **minor**. The effect, therefore, will be of **minor adverse significance**, which is **Not Significant** in EIA terms.

Direct disturbance resulting from maintenance within the array area and the offshore cable corridor

Introduction

8.10.88 Temporary habitat loss / disturbance is likely to occur during the operation and maintenance phase of the Proposed Development as a result of spud-can impacts from jack-up vessels and also cable re-burial works (where necessary). The impacts associated with these operations are likely to be similar (at least in nature) to those associated with the construction phase.

Magnitude of impact

8.10.89 Direct impacts to the seabed from maintenance within the array area and the offshore cable corridor will affect a maximum footprint of 4,334,900m^2. These impacts will be temporary and localised to the immediate area of the works. Maintenance operations will represent intermittent occurrences throughout the lifetime of the Proposed Development, with only a small proportion of the total area of temporary habitat loss / disturbance being affected at any one time.

Fish

8.10.90 Given that the habitats affected are common and widespread throughout the region, this impact represents a small footprint compared to their overall extent. Although it is predicted that the impact has the potential to affect fish and shellfish receptors directly, the impact is predicted to be of local special extent (i.e. within the proposed DCO Order Limits), short term duration, intermittent and reversible..

Therefore, the magnitude is assessed as **minor**, with the exception of herring for which the impact magnitude is **negligible** due to the substantial distance between the Proposed Development and herring spawning habitat (47km).

8.10.91 Although the Proposed Development does not overlap the Kingmere MCZ designated for nesting black seabream, it is recognised that some nesting habitat outside the MCZ may potentially be disturbed through maintenance activities along the export cable route. However, the implementation of embedded environmental measures during the construction phase will provide a demonstrable reduction in magnitude of impact (**Table 8-13**). The export cable will be microsited during construction to avoid, where possible, sensitive features such as black seabream nests (C-269, C-270, C-271, **Table 8-13**). In addition, areas potential subject to disturbance during maintenance works will be much smaller than those affected during the construction phase and limited temporally. On this basis, maintenance operations will be undertaken outwith areas of importance for breeding black seabream and consequently it is considered that these will be no direct impacts from maintenance operations on breeding populations. The magnitude of impact on nesting black seabream is therefore **negligible**.

Shellfish

8.10.92 Shellfish species such as brown crab, European lobster, king scallop, whelk, blue mussel and European native oyster are present within the fish and shellfish Study Area. The habitats affected are common and widespread throughout the region, as the area of seabed predicted to be directly disturbed is represented by a small footprint compared to their overall extent or effects during construction (see **paragraph 8.9.361** and **paragraph 8.9.362**). The impact is predicted to be of local special extent (i.e. within the proposed DCO Order Limits), short term duration, intermittent and reversible. It is predicted that the impact has the potential to affect shellfish receptors directly. Therefore, the magnitude is assessed as **minor**.

Sensitivity or value of receptor

8.10.93 The receptors affected by direct disturbance from maintenance operations will be largely restricted to those within the proposed DCO Order Limits, for instance, the proposed array area and, if cable reburial is required, at discrete sections within the Rampion 2 offshore export cable corridor. The species most likely to be affected are demersal fish species and shellfish species whose life strategies are strongly connected to the use of the seabed for shelter (i.e. through burrowing) or reproduction (e.g. the demersal spawners; black seabream and sandeel).

Sandeel

8.10.94 As shown in **Figure 8.3, Volume 3** of the ES (Document Reference 6.3.8) the offshore export corridor overlaps with low intensity sandeel spawning grounds as identified by Ellis *et al*. (2010). Sandeel have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and the regional importance of the receptor, sandeel are considered to be of **medium** sensitivity.

Herring

8.10.95 Herring have limited mobility, due to their demersal spawning nature and substrate dependency. Taking this into consideration, and the regional importance of the receptor, herring are considered to be of **high** sensitivity.

Black seabream

8.10.96 Black seabream favour a particular type of substrate to build their nests and lay eggs (generally hard and coarse substrate (gravel; chalk reefs)). Taking into account, their specific substrate dependency during spawning, and their national importance, black seabream are considered to be of **high** sensitivity.

Seahorse

8.10.97 Seahorses typically inhabit shallow waters, amongst seagrass and algae, although short-snouted seahorse can also be found in rocky areas to a depth of 77m (Sabatini and Ballerstedt, 2007). Seahorses overwinter in deeper waters, where there are a multitude of available habitats for seahorses to inhabit during the winter months. Taking into account their dependency of certain habitats, and their national importance, seahorse are considered to be of **medium** sensitivity.

Cuttlefish

8.10.98 Cuttlefish are demersal spawners, laying their eggs separately in cases on structures fixed to the seabed including natural substrates, e.g. plants and sessile animals, and artificial structures, e.g. fishing pots, ropes and branches (Blanc and Daguzan, 1998; Bloor *et al*., 2013, cited in Ganias *et al*, 2021). Cuttlefish migrate inshore to spawning grounds preferred habitat for eggs and juveniles (Bloor *et al*., 2013), in March and April with spawning occurring from March to July. In the English Channel, offshore migration occurs in winter and is influenced primarily by a reduction in water temperature as well as the reduction in daylight hours (Guerra, 2006). After spawning occurs adults return back into deeper, offshore areas around October in the UK (Dunn, 1999, Royer *et al*., 2006). Whilst cuttlefish are demersal spawners, they do not exhibit strict substrate dependency, and lay their eggs on a variety of substrates in the nearshore. Taking this into consideration, and the regional importance of the receptor, cuttlefish are considered to be of **low** sensitivity.

Shellfish

8.10.99 In terms of physical impacts on crabs and lobsters, it is considered that berried females are at a higher risk, given their propensity to bury themselves in sediment or hide in rock crevices during this sensitive period. However, these receptors have adopted a reproductive strategy of high egg production to compensate for losses during egg extrusion and the extended incubation period (McQuaid *et al*., 2009). It is considered that the sensitivity of brown crabs and European lobster is **low**.

8.10.100 The king scallop is an important commercial shellfish which is represented in the ICES rectangle along the offshore export cable corridor. Commercial fisheries landings data highlights the importance of the centre of the English Channel for this species. Scallops prefer areas of clean firm sand, fine or sandy gravel and also muddy sand, therefore will be impacted by construction activities for installation in a range of sediment habitat types. The MarESA sensitivity assessment by MarLIN (Marshall and Wilson, 2008) identifies that scallop have low sensitivity and high recoverability to smothering, abrasion and physical disturbance. The sensitivity of king scallop to direct disturbance is therefore considered to be **low**.

8.10.101 Although there is potential impact from disturbance on whelk, this species is capable of moving away from an impact at 11cm / minute (Magúnsdóttir, 2010) and therefore, able to return and recolonise the disturbed area post construction. In relation to a consultation response provided by whelk commercial fishermen to the on the Kent and Essex IFCA fisheries byelaw, recovery of whelk beds is anticipated within 12 months following disturbance (Kent and Essex IFCA, 2017). Therefore, it is considered that the sensitivity of whelks is **low**.

8.10.102 Blue mussels are sessile, attached organisms and in significant quantities are known to as a type of biogenic reefs. Blue mussels are unable to repair significant damage to individuals and the only mechanism for recovery from significant impacts is larval recruitment to the bed or where previously a bed existed (Mainwaring *et al*. 2014). Blue mussels are considered to have a medium to high sensitivity to disturbance (Tillin *et al*., 2016; Tyler-Walters, 2016), with a medium resilience (recovery within two to 10 years) (Mainwaring *et al*., 2014). However, Mainwaring *et al*. (2014) concluded that beds occurring high on the shore and on less exposed sites took longer to recover after a disturbance event than beds found low on the shore or at more exposed sites. In addition, research by Holt *et al*. (1998) note blue mussel populations are considered to have a strong ability to recover from environmental disturbance. Therefore, it is considered that the sensitivity of blue mussels is **medium**.

8.10.103 Native oysters are identified as being sensitive to disturbance (Perry *et al* ., 2017). Therefore, it is considered that the sensitivity of European native oyster to temporary direct disturbance is **medium**.

Elasmobranchs

8.10.104 Data relating to spawning grounds of tope, thornback ray and undulate ray is lacking from the scientific literature and are undefined by Ellis *et al*. (2010) and Coull *et al*. (1998), due to insufficient data on the occurrence of egg cases or egg-bearing females to delineate spawning grounds for these species (Ellis *et al*., 2012). Nursery areas are however defined, and undulate ray, thornback ray and tope show overlapping low intensity nursery areas with the proposed DCO Order Limits (Ellis *et al*., 2012). Mulberry Marine Experience noted the presence of thornback ray and undulate ray between Selsey and the Western edge of the proposed DCO Order Limits, and along the inshore route of the export cable corridor.

8.10.105 The undulate ray is commonly encountered in the English Channel with Ellis *et al*. (2012) suggesting that due to the lack of data on spawning grounds that they may broadly overlap nursery grounds (see **Figure 8.7, Volume** 3 of the ES (Document Reference: 6.3.8). The Rampion 2 offshore export cable corridor is located within a low intensity nursery area.

8.10.106 It is considered that as thornback ray, undulate ray and tope are highly mobile, and other nursery/spawning areas are available across the region, the population sizes will not be affected. Taking this into consideration, and given the regional to national importance of the receptors, the sensitivity tope, thornback ray and undulate ray is therefore **low**.

Significance of residual effect

8.10.107 Disturbance as a result of maintenance during the operational lifetime of the Proposed Development is predicted to affect a very small proportion of fish and shellfish habitats within the Rampion 2 Study Area, with limited effects on fish and shellfish receptors. Overall, it is predicted that the sensitivity of fish and shellfish is considered to be **low** to **medium** and the magnitude is deemed to be **minor**. The effect, therefore, will be of **minor adverse significance**, which is **Not Significant** in EIA terms, for the majority of receptors. Herring are considered to have a **high** sensitivity but impacts to herring habitat are assessed as being **negligible**, which gives a **minor adverse significance**, which is **Not Significant** in EIA terms.

8.10.108 Considering the **high** sensitivity of breeding black seabream, and the **negligible** magnitude of impact, an impact of **minor adverse significance** is expected which is **Not Significant** in EIA terms.

8.11 Assessment of effects: Decommissioning phase

Introduction

8.11.1 Impacts from decommissioning are expected to be similar to those listed for construction if Rampion 2 infrastructure is removed from the seabed at the end of the development's operational life phase. The nature and scale of impacts arising from decommissioning are expected to be of a similar or reduced magnitude to those generated during the construction; certain activities such as piling will not be required. The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment.

8.11.2 The sensitivity of receptors during the decommissioning is assumed to be the same as given for the construction phase (see **Section 8.9**). The magnitude of effect is considered to be no greater or potentially less than those considered for the receptors within the construction phase. Therefore, it is anticipated that any decommissioning impacts will be no greater, and likely less, than those assessed for the construction phase.

8.11.3 If it is deemed closer to the time of decommissioning that removal of certain parts of the development (e.g. export and inter-array cables) will have a greater environmental impact than leaving *in situ*, it may be preferable to leave those parts *in situ*. In this case, the impacts will be similar to those described for the operation and maintenance phase. If certain parts of the development were left *in situ*, effects dependent on the operation of the wind farm such as EMF effects will not occur.

8.11.4 To date, no large offshore wind farm has been decommissioned in UK waters. It is anticipated that any future programme of decommissioning will be developed in close consultation with the relevant statutory marine and nature conservation bodies. This will enable the guidance and best practice at the time to be applied to minimise any potential impacts (see C-111, **Table 8-13**).

Mortality, injury, behavioural changes and auditory masking arising from noise and vibration

8.11.5 Decommissioning of offshore infrastructure for the Proposed Development may result in temporarily elevated underwater noise levels which may have effects on fish and shellfish species, with subsequent effects on spawning and nursery habitats. These elevated noise levels may be due to increased vessel movements and removal of the WTG foundations with the resulting noise levels dependant on the method used for removal of the foundation. The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. As detailed in **Chapter 4: The Proposed Development, Volume 2** (Document Reference 6.2.4) the maximum levels of underwater noise during decommissioning will be from underwater cutting required to remove structures, with piled foundations cut approximately 1.0m below the seabed.

8.11.6 The nature and extent of disturbance during decommissioning of offshore infrastructure is assumed (for the purposes of this assessment) that the noise levels from this process are expected to be much less than pile driving and therefore impacts will be less than as assessed during the construction phase. Studies of underwater construction noise (decommissioning) reported source levels that are similar to those reported for medium-sized surface vessels and ferries (Malme *et al*., 1989; Richardson *et al*., 1995). The noise resulting from WTG decommissioning employing abrasive cutting is unlikely to result in any injury, avoidance or significant disturbance of local marine animals. Some temporary minor disturbance might be experienced in the immediate vicinity of the decommissioning activity, for example, from jack-up vessels or from cutting piled foundations. The impact is predicted to be of highly local spatial extent, short term duration, intermittent and reversible.

8.11.7 Further details will be included within the Decommissioning Plan (see C-111, **Table 8-13**) which will be developed to minimise environmental disturbance and will be updated throughout the lifetime of the Proposed Development to account for changing best practice.

8.11.8 The magnitude of the impact and the sensitivities of fish and shellfish to underwater noise impacts are as described for the construction phase (described in detail in **Section 8.9**).

Significance of residual effect

8.11.9 Based on the assessment undertaken for construction the sensitivity of the majority of receptors is **medium**, with the exception of black seabream and herring which are deemed to have **medium** to **high** sensitivity respectively. As defined in **paragraph 8.11.6**, the underwater noise from decommissioning is anticipated to significantly reduced to that predicted in the construction phase, and is expected to be of local spatial extent, short term duration, intermittent and reversible. The magnitude of impact is therefore anticipated to be **negligible**.

8.11.10 Therefore, the significance of effect from underwater noise occurring as a result of decommissioning activities has a maximum of **minor adverse significance**, which is **Not Significant** in EIA terms.

Direct disturbance resulting from the removal of the export cable

8.11.11 Although it is expected that most of the Proposed Development array and offshore export cables will be left *in situ*, for the purposes of the EIA it has been assumed that all cables will be removed during decommissioning, though any cable protection installed will be left *in situ*. Exposed cables are more likely to be removed to ensure they do not become hazards to other users of the seabed. At this point in time, it cannot be accurately determined whether and which cables will be exposed at the time of decommissioning.

8.11.12 It is likely that equipment similar to that which is used to install the cables could be used to reverse the burial process and expose them. Therefore, the area of seabed impacted during the removal of the cables could be the same as the area impacted during the installation of the cables. Divers and/or ROVs may be used to support the cable removal vessels.

8.11.13 The nature and extent of disturbance during decommissioning of export cables is assumed (for the purposes of this assessment) to be similar to that described for equivalent activities during the construction phase in **paragraph 8.9.331** to **paragraph 8.9.361**, unless otherwise stated. Therefore, the cables may be left buried in place or alternatively partially removed by pulling the cables back out of the ducts (see **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference 6.2.4)). However, this approach is precautionary, as there is no statutory requirement for decommissioned cables to be removed. In the event that decommissioned cables are removed the implementation of embedded mitigation in the form of a seasonal restriction on cable decommissioning activities in the export cable corridor during the black seabream nesting period (March to July) will ensure the avoidance of impacts from direct disturbance on nesting black seabream during the breeding season (C-273, **Table 8-13**). Decommissioning will be secured in accordance with a Decommissioning Plan. The Energy Act (2004) requires that a decommissioning plan must be submitted to and approved by the relevant secretary of State, a draft of which will be submitted prior to the construction of the Proposed Development. The decommissioning plan and programme will be updated during the Proposed Development's lifespan. To take account of changing best practice and new technologies, the approach and methodologies employed at decommissioning will be compliant with the legislation and policy requirements at the time of decommissioning. In accordance with requirement 11 provided in the DCO, a written decommissioning programme will be submitted to the Secretary of State pursuant to the Energy Act prior to works commencing.

8.11.14 Such details will be included within the Decommissioning Plan (see C-111, **Table 8-13**) which will be developed to minimise environmental disturbance and will be updated throughout the lifetime of the Proposed Development to account for changing best practice. It should be noted that the Decommissioning Plan will be subject to best practice at the time of decommissioning, and surveys conducted to assess the quality of the communities established and a decision on infrastructure removal made in conjunction with the statutory authorities and key stakeholders.

Significance of residual effect

8.11.15 Based on the assessment undertaken for construction (which represents the maximum design scenario), and the sensitivity of the majority of receptors is **low** to **medium**, with the exception of black seabream which have a **high** sensitivity. As defined in **Table 8-13**, the implementation of a seasonal restriction on cable decommissioning activities in the export cable corridor during the black seabream nesting period (March to July) will ensure the avoidance of impacts on nesting black seabream during the breeding season (C-273). Therefore, there will be no effect on breeding black seabream from decommissioning activities in the export cable corridor. The magnitude of impact from direct disturbance from decommissioning of the export cable is **negligible**.

8.11.16 The significance of effect from direct disturbance in the offshore export cable corridor occurring as a result of decommissioning activities has a maximum of **minor adverse significance** of effect, which is **Not Significant** in EIA terms.

Direct disturbance resulting from decommissioning within the array

8.11.17 WTGs and offshore substations will be removed by reversing the methods used to install them. Piled foundations will likely be cut approximately 1m below the seabed, with due consideration made of likely changes in seabed level and removed. This could be achieved by inserting a pile cutting device. Once the piles are cut, the foundations could be lifted and removed from the site. At this point in time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but endeavours will be made to ensure that the sections of the pile that remain in the seabed are fully buried.

8.11.18 As detailed in **Table 8-12**, it is assumed that during the decommissioning phase, all offshore infrastructures will be removed from the seabed (i.e. foundations and subsea cables) with the exception of scour protection and cable protection, which is assumed, based on current evidence, will be left *in situ*.

8.11.19 Further details will be included within the Decommissioning Plan (see C-111, **Table 8-13**) which will be developed to minimise environmental disturbance and will be updated throughout the lifetime of the Proposed Development to account for changing best practice.

Significance of residual effect

8.11.20 Based on the assessment undertaken for construction (which represents the maximum design scenario), the magnitude of the impact on the majority of receptors has been assessed as **negligible**, with the maximum sensitivity of the receptors being **low** to **medium**, with the exception of herring and black seabream which have a **high** sensitivity. The significance of effect from direct disturbance in the array area occurring as a result of decommissioning activities has a maximum of **minor adverse significance** of effect, which is **Not Significant** in EIA terms.

Temporary localised increases in SSC and smothering

8.11.21 Decommissioning has the potential to cause temporary increase in suspended sediment and sediment deposition within the proposed DCO Order Limits, similar to those described during the construction phase. However, as seabed preparation works will not be required, the magnitude of this impact will be significantly lower than during the construction phase.

8.11.22 Furthermore, as detailed in **Table 8-13**, the implementation of a seasonal restriction on cable decommissioning activities in the export cable corridor during the black seabream nesting period (March to July) will ensure the avoidance of impacts from increased SSC and smothering on nesting black seabream during the breeding season (C-273).

8.11.23 The details of the proposed decommissioning process will be included within the Decommissioning Programme which will be developed and updated throughout the lifetime of the Proposed Development to account for changing best practice.

Significance of residual effect

8.11.24 Based on the assessment undertaken for construction, the maximum sensitivity of the receptors being **low** to **medium**, with the exception of black seabream which are considered to be of **high** sensitivity. As stated above, the decommissioning of Rampion 2 will result in impacts of significantly lower magnitude due to the lack of seabed preparation works required. Furthermore, the implementation of a seasonal restriction on cable decommissioning activities during the black bream breeding season (C273) will further reduce impacts on breeding black seabream. Therefore, the magnitude of impact is considered to be **negligible**.

8.11.25 The significance of effect from increased SSC and deposition occurring as a result of decommissioning activities has a maximum of **minor adverse significance**, which is **Not Significant** in EIA terms.

Direct and indirect seabed disturbances leading to the release of sediment contaminants

8.11.26 The nature and extent of direct and indirect seabed disturbances leading to the release of sediment contaminants during decommissioning is assumed (for the purposes of this assessment) to be similar to that described for the equivalent activities during the construction phase in **paragraph 8.9.436** to **paragraph 8.9.437**, unless otherwise stated.

8.11.27 The details of the proposed decommissioning process will be included within the Decommissioning Programme which will be developed and updated throughout the lifetime of the Proposed Development to account for changing best practice.

Significance of residual effect

8.11.28 To summarise, re-suspended sediments as a result of decommissioning activities are expected to be deposited in the immediate vicinity of the works, with the potential release of sediment-bound contaminants likely to be rapidly dispersed with the tide and/or currents. The nature and scale of impacts arising from decommissioning are expected to be of similar, or reduced magnitude to those generated during the construction; therefore, the magnitude of the impact has been assessed as **negligible** for fish and shellfish receptors. The maximum sensitivity of the receptors was assessed as **medium**. Therefore, the significance of effect from the release of sediment contaminants has a maximum of **minor adverse significance** of effect, which is **Not Significant** in EIA terms.

8.12 Assessment of cumulative effects

Approach

8.12.1 A cumulative effects assessment (CEA) examines the combined impacts of Rampion 2 in combination with other developments on the same single receptor or resource and the contribution of Rampion 2 to those impacts. The overall method followed in identifying and assessing potential cumulative effects in relation to the offshore environment is set out in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference 6.2.5).

8.12.2 The offshore screening approach is based on the Planning Inspectorate's Advice Note Nine (Planning Inspectorate, 2018) and Advice Note Seventeen (Planning Inspectorate, 2019), with relevant components of the RenewableUK (RenewableUK, 2013) accepted guidance, which includes aspects specific to the marine elements of an offshore wind farm, addressing the need to consider mobile wide-ranging species (foraging species, migratory routes etc).

Cumulative effects assessment

8.12.3 For fish and shellfish ecology, a ZOI (as described in **Section 8.4: Scope of the assessment** and shown in **Figure 8.1**, **Volume 3** of the ES (Document Reference 6.3.8)*)* has been applied for the CEA to ensure direct and indirect cumulative effects can be appropriately identified and assessed. The ZOI has been determined as the largest distance over which an impact may occur, for the purpose of the fish and shellfish ecology assessment, this is defined over the distance which increased SSC and deposition may occur and therefore extends 16km around the proposed DCO Order Limits. For the impact of underwater noise, a larger area of search was used (100km), as noise is predicted to have a greater area of effect than the other effects identified. The fish and shellfish ecology ZOI is shown in **Figure 8.25, Volume 3** (Document Reference 6.3.8).

8.12.4 A short list of 'other developments' that may interact with the Rampion 2 ZOIs during their construction, operation or decommissioning is presented in **Appendix 5.4: Cumulative effects assessment shortlisted developments, Volume 4** of the ES (Document Reference 6.4.5.4) and on **Figure 5.4.1, Volume 3** of the ES (Document Reference 6.4.5.4). This list has been generated applying criteria set out in **Chapter 5: Approach to the EIA, Volume 2** of the ES

(Document Reference 6.2.5) and has been collated up to the finalisation of the ES through desk study, consultation and engagement.

8.12.5 Only those 'other developments' in the short list that fall within the fish and shellfish ecology ZOI of 16km (and 100km for potential cumulative underwater noise impacts) have the potential to result in cumulative effects with the Proposed Development on fish and shellfish ecology. All 'other developments' falling outside the fish and shellfish ecology ZOI are excluded from this assessment. The following types of 'other development' have the potential to result in cumulative effects on fish and shellfish ecology:

- sub-sea cables (telecommunication and power cables) and pipelines:
- aggregate production areas;
- disposal sites;
- tidal energy; and
- offshore wind farms.

8.12.6 On the basis of the above, the 'other developments' that are scoped into the fish and shellfish ecology CEA are outlined in **Table 8-27**. It should be noted that developments which are proposed or under construction, at the time of writing this chapter, are included in the table below due to lack of certainty around any ongoing effect.

8.12.7 The cumulative Project Design Envelope is described in **Table 8-28.**

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Table 8-27 Developments considered as part of the fish and shellfish ecology CEA

ID (Figure 5.4.1)	Development type	Application reference	Status	Confidence in assessment	Tier[9]	Distance to Rampion 2 (km)
W10	Offshore wind farm	Dieppe – Le Treport (France)	Under construction (2019 to 2023)	Medium – Third-party project details published in the public domain but not confirmed as being 'accurate'.	1	<50
W20	Offshore wind farm	Fécamp (France)	Under construction (2019 to 2023)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	<50
W48	Offshore wind farm	Rampion 1	Operational10	High – Third-party project details published in the public domain and confirmed as	1	0

[9] **Chapter 5: Approach to the EIA, Volume 2** (Document Reference 6.2) sets out the full definitions of the tiers. Tier 1: high level of certainty or information availability (including under construction or where a planning application has been approved or is awaiting decision). Tier 2: medium level of certainty or information (such as developments on the Planning Inspectorate Programme of Projects where a Scoping Report has been submitted). Tier 3: low level of certainty or information available (no planning applications submitted or identified for potential future development only).

[10] The Planning Inspectorate Advice Note 17 states 'Where other projects are expected to be completed before construction of the proposed NSIP and the effects of those projects are fully determined, effects arising from them should be considered as part of the baseline and may be considered as part of both the construction and operational assessment.' Rampion 1, IFCA-2 is therefore included in the CEA because the full effects of the project offshore are considered to not yet be fully realised.

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ID (Figure 5.4.1)	Development type	Application reference	Status	Confidence in assessment	Tier[9]	Distance to Rampion 2 (km)
				being 'accurate' by the developer.		
T1	Tidal energy	Perpetuus Tidal Energy Centre (PTEC)	Proposed (Offshore plans approved 2016, plan to be operational 2025 for 25 years)	Medium – Third-party project details published in the public domain but not confirmed as being 'accurate'	1	43.3
C1	Cable	AQUIND Interconnector	Dormant	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	0
C2	Cable	Interconnexion France-Angleterre 2 – IFA-2 HVDC	Active	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	0.9
TC1	Telecommunication	ATLANTIC CROSSING 1 Century Link	Active	Low, ES not available	1	14.6
TC6	Telecommunication	CIRCLE SOUTH ZAYO	Active (end date 05/03/2028)	Low, ES not available or does not contain marine	1	16

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ID (Figure 5.4.1)	Development type	Application reference	Status	Confidence in assessment	Tier[9]	Distance to Rampion 2 (km)
				archaeology impact assessment		
A351	Aggregates	395/1 Off Selsey Bill – Aggregates Industries UK Ltd / Kendall Bros (Portsmouth) Ltd / Tarmac Marine Ltd (MLA/2012/00374 /5)	Active (end date 07/07/2030)	High, marine archaeology and environmental statement impact assessments are undertaken.	1	15.8
A395/1	Aggregates	395/1 Off Selsey Bill – Aggregates Industries UK Ltd / Kendall Bros (Portsmouth) Ltd / Tarmac Marine Ltd (MLA/2012/00374 /5)	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being ‘accurate’ by the developer	1	15
A396/1	Aggregates	396/1 Inner Owers – Tarmac Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being ‘accurate’ by the developer.	1	0

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ID (Figure 5.4.1)	Development type	Application reference	Status	Confidence in assessment	Tier[9]	Distance to Rampion 2 (km)
A396/2	Aggregates	396/2 Inner Owers – Tarmac Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	2
A435/1	Aggregates	435/1 Inner Owers – Hanson Aggregates Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	0.7
A435/2	Aggregates	435/2 Inner Owers – Hanson Aggregates Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	1.5
A453	Aggregates	453 Owers Extension – CEMEX UK Marine Ltd.	Active (end date 31/03/2032)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	0.4
A488	Aggregates	488 Inner Owers North – Tarmac Marine Ltd.	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as	1	0.5

ID (Figure 5.4.1)	Development type	Application reference	Status	Confidence in assessment	Tier[9]	Distance to Rampion 2 (km)
				being 'accurate' by the developer.		
D1[11]	Burial at sea	Open disposal site - Newhaven	Open	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	17
D2	Disposal for the existing Rampion 1 project	Open disposal site - Rampion 1	Open	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	0
D4	Dredged material from Brighton Marina	Open disposal site - Brighton/ Rottingdean	Open	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	13.3
D6	Unknown waste type	Open disposal site – AQUIND Cable Site A	Open	High – Third-party project details published in the public domain and confirmed as	1	0

[11] Open disposal sites are those where activities are still ongoing, hence effects arising from them may still be ongoing. In line with the Planning Inspectorate Advice Note 17, all such sites are included in the CEA as the effects are considered to not yet be fully realised.

ID (Figure 5.4.1)	Development type	Application reference	Status	Confidence in assessment	Tier[9]	Distance to Rampion 2 (km)
				being 'accurate' by the developer		
C1	Cable	AQUIND Interconnector	Dormant	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	1	0

Table 8-28 Cumulative Project Design Envelope for fish and shellfish ecology

Project phase and activity / impact	Scenario	Justification
Construction		
Mortality, injury, behavioural changes and auditory masking arising from noise and vibration	Maximum design scenario as described for the construction of the Proposed Development assessed cumulatively with the following projects within the fish and shellfish ecology Study Area: Tier 1: 1) offshore wind farm under construction (Dieppe – Le Treport) 2) planned PTEC (construction phase) Tier 2 and Tier 3: 1) offshore wind farm under construction (Fécamp) Tier 3: No other developments to consider.	Maximum potential for interactive effects from underwater noise associated with construction and offshore wind farm piling activities is considered within a representative 100km buffer of the Proposed Development array area. This buffer was chosen as underwater noise effects are expected to occur over a wider area.
Cumulative temporary increase in SSC and smothering	Maximum design scenario as described for the construction of the Proposed Development assessed cumulatively with the following projects within the fish and shellfish ecology Study Area: Tier 1: 1) Construction phase of AQUIND interconnector cables.	Maximum cumulative increases in SSC and smothering is calculated within a representative buffer of the Proposed Development to represent the maximum distance sediments may travel in one tidal excursion buffer distance (16km).

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Project phase and activity / impact	Scenario	Justification
	2) Operation and maintenance of operational cables 3) Operation of aggregate licence areas (351, 395/1,396/1, 396/2, 435/1, 435/2, 453, 488) 4) Operation of active disposal sites Tier 2: No other developments to consider. Tier 3: No other developments to consider.	
Operation and Maintenance		
Long-term loss of habitat and increased hard substrate and structural complexity due to the presence of turbine foundations, scour protection and cable protection	Maximum design scenario as described for the construction of the Proposed Development assessed cumulatively with the following projects within the fish and shellfish ecology Study Area: Tier 1: 1) Construction phase of AQUIND interconnector cables. 2) operation and maintenance of operational cables Tier 2: No other developments to consider. Tier 3: No other developments to consider.	Maximum cumulative long-term habitat loss and increase in hard substrate and structural complexity is calculated within a representative buffer of the Proposed Development as habitats within this buffer are representative of those within the Proposed Development fish and shellfish Study Area.

8.12.8 A description of the significance of cumulative effects upon fish and shellfish ecology arising from each identified impact is given below. The cumulative effects assessment has been based on information available in the ESs for the other developments where these are available; it is noted that the maximum assessment assumptions quoted within these ESs are often refined during the determination period and in the post-consent phase such that the final schemes built out may have a reduced impact compared to what has been concluded in the ES.

8.12.9 The other developments considered in this CEA are illustrated in **Figure 8.25, Volume 3** of the ES (Document Reference 6.3.8).

Cumulative mortality, injury, behavioural changes and auditory masking arising from noise and vibration

8.12.10 There is potential for mortality, injury, behavioural changes and auditory masking arising from noise and vibration as a result of construction activities associated with the Proposed Development and other projects. For the purposes of this assessment, this additive impact has been assessed within 100km of proposed DCO Order Limits, which is considered the maximum extent of impacts from noise as highlighted in noise modelling undertaken as part of their ES assessment.

8.12.11 The only Tier 1 projects identified within the 100km buffer that may be under construction at the same time as the Proposed Development, is PTEC (see **Table 8-27**). PTEC is aimed at the deployment of up to full scale single units and, in particular, small arrays of tidal devices. As PTEC is a tidal energy demonstration facility, to date no known tidal WTG construction is detailed, however various tidal devices and array configurations have the potential to be deployed at PTEC over its 25-year life. As a result, the demonstration facility is also categorised as Tier 3 to take into consideration potential deployment of tidal testing infrastructure which may require drilling or piling activities. There is the potential for a temporal overlap in construction activities with the Tier 1 French offshore wind farm Dieppe – Le Treport which is proposed to undertake construction works from 2024 and will be fully commissioned in 2026. A temporal overlap in construction works between Rampion 2 and Dieppe – Le Treport offshore windfarm has the potential to occur in 2025 and 2026.

8.12.12 The Tier 2 project, the Fécamp offshore windfarm is currently under construction, with the installation of turbines having commenced. The offshore windfarm is anticipated to be operational before construction activities commence for Rampion 2, and therefore there will be no cumulative temporal overlap.

8.12.13 The greatest risk of cumulative impacts of underwater noise on fish and shellfish species has been identified as being that produced by impact piling during the construction phase at other offshore wind farm sites in the wider Study Area. Injury or mortality of fish from piling noise is not expected to occur cumulatively due to the small range within which potential injury effects will be expected (i.e. predicted to occur within tens of kilometres of piling activity within each of the offshore wind farm projects). Cumulative effects of underwater noise are therefore discussed in the context of behavioural effects, particularly on spawning or nursery habitats.

8.12.14 Due to the lack of temporal overlap with the Tier 2 Fécamp offshore windfarm (construction to be completed for Fécamp offshore windfarm prior to the commencement of construction for Rampion 2), there is not considered to be a cumulative impact of this project on fish and shellfish receptors. The PTEC tidal energy demonstration (Tier 1 and Tier 3) and Dieppe – Le Treport offshore windfarm related construction and associated underwater noise during foundations installation may result in a cumulative impact with the Proposed Development construction phase. Particularly as PTEC is a demonstration facility and underwater noise may result from the drilling of foundations, and removal of infrastructure at repowering phases or on final decommissioning. However, as it is a demonstration facility the number of tidal WTGs and type of WTGs will vary, e.g. the use of mooring chains and anchors, gravity-based foundations (PTEC, 2014). Furthermore, these impacts will be highly localised, temporary in nature and unlikely to greatly exceed background underwater noise levels (PTEC, 2014).

8.12.15 There is currently limited detail on Tier 1 French offshore wind farm Dieppe – Le Treport, therefore it is not possible to undertake detailed assessments of the significance of effect. However, given the intermittent nature of piling, it is unlikely that there will be a temporal overlap resulting in significant effects on fish and shellfish receptors. As evidenced by McCauley *et al* . (2000), it is expected that fish will resume to normal behaviour and distribution well within this time period, and as such, significant effects are not expected to occur in terms of cumulative duration of exposure. The cumulative impact of underwater noise on fish and shellfish receptors is predicted to be of regional spatial extent, short-term duration, intermittent and reversible. It is predicted that the impact will affect the receptor directly. The magnitude of the cumulative impact is therefore considered to be **minor**.

8.12.16 The sensitivities of fish and shellfish receptors to underwater noise are discussed in **Section 8.9**. Fish injury as a result of piling noise will only be expected within the immediate vicinity of piling operations, and the area within which effects on eggs and larvae is expected is similarly small.

8.12.17 Behavioural effects on fish species as a result of piling noise are predicted to be dependent on the nature of the receptors. The predicted behavioural response may be sufficient to result in temporary avoidance by some species, with some temporary redistribution of fish in the wider area between the affected areas. Between piling events, fish may resume normal behaviour and distribution. This is evidenced by McCauley *et al* (2000), which showed that fish returned to normal behavioural patterns within 14 to 30 minutes after the cessation of seismic airgun firing. However, there are some uncertainties over the response of fish to intermittent piling over a prolonged period of time and the extent that behavioural reactions will cause a negative effect in individuals (Mueller-Blenke *et al* , 2010).

8.12.18 Herring, seahorse and shellfish (for TTS) are considered to be of high vulnerability, with medium to low recoverability and of regional importance. The sensitivity of these receptors is therefore considered to be **high**.

8.12.19 All other fish and shellfish receptors are considered to be of low vulnerability, high recoverability and of local to international importance. The sensitivity of these receptors is therefore considered to be **medium**.

8.12.20 Overall, it is predicted that the sensitivity of fish and shellfish receptors is **medium** to **high,** and the magnitude is considered to be **negligible** due to the distance between the projects and the lack of temporal overlap. The cumulative effect will therefore by of **minor adverse significance** (**Not Significant** in EIA terms).

Cumulative temporary increases in SSC and smothering during construction

8.12.21 There is potential for cumulative increases in SSC and smothering as a result of construction activities associated with the Proposed Development and other developments (see **Table 8-28**). For the purposes of this assessment, this additive impact has been assessed within the fish and shellfish ecology ZOI, which extends 16km around the proposed DCO Order Limits, representing the maximum tidal excursion in the area, and therefore the furthest distance sediments can travel from the site. The projects identified in Tier 1 are the construction of the AQUIND interconnector cables, the operation of aggregate licence areas 351, 395/1,396/1, 396/2, 435/1, 435/2, 453, 488 and the operation of active disposal sites. There are no Tier 2 or Tier 3 projects.

8.12.22 The AQUIND interconnector cable is located with the proposed DCO Order Limits and it is assumed that construction will coincide with the construction of the Proposed Development. From kilometre point 21 to 109 the worst-case scenario for increased SSC is considered to be surface release of up to 1,754,000 m^3 of sediment (AQUIND Limited, 2019). Cumulatively with the Proposed Development construction this may result in the disturbance and deposition of up to 4,645,000 m^3 of sediment. However, only a small portion of the AQUIND interconnector cable intersects with the proposed DCO Order Limits (9.34km of cable) with a total of 24.72 km overlapping the Secondary ZOI, and therefore the maximum amount of sediment released cumulatively with the Proposed Development will be considerably less. Any cable maintenance repairs undertaken within the operational phase of the developments will be short term, intermittent and localised to the site and therefore cumulative impacts are expected to be minimal. Additionally, due to the naturally dynamic environment of the site, any sediment released from these operations during the construction and operational phases of the development will likely be dispersed in the faster flows. Therefore, taking this into consideration, there are not predicted to be any significant cumulative impacts from the construction or operation of the AQUIND interconnector cable.

8.12.23 A small number of operational disposal sites are located in proximity to Rampion 2 and within one tidal excursion distance of the site, and therefore there is the potential for a cumulative sediment plume effect. It is not known what volumes of sediment will be deposited at these disposal sites at any one time, and as the use of these sites is intermittent, it is not possible to determine if the use of these sites will overlap with sediment deposition from the construction phase of Rampion 2. If Rampion 2 construction activities are undertaken at the same time as spoil disposal is occurring at the disposal sites then a larger sediment plume may form, however, this will quickly disperse given the dynamic nature of the site.

8.12.24 Aggregate licence areas 351, 395/1,396/1, 396/2, 435/1, 435/2, 453, 488 will be operational during the construction of the Proposed Development, therefore the potential for cumulative temporary increases in SSC and sediment deposition from these active dredge operations. A small number of active aggregate dredging license areas (see **Table 8-27**) are sufficiently close to Rampion 2 (within one tidal excursion distance) that an overlapping plume effect is at all likely. The target material at these marine aggregate areas is sands and gravels and characteristically, the aggregate deposits in the MAREA region contain 1 to 3% mud (silt and clay) *in situ* and therefore the suspended sediment concentrations in the overflow from dredging vessels are relatively low compared to other regions of the UK (EMU Limited, 2012b). As part of the Rampion 1 offshore wind farm ES changes to seabed sediment thickness as a result of combined foundation installation and aggregate extraction works were modelled as part of the impact assessment (ABPmer, 2012). The modelling predicted that bed level changes of up to around 1mm could occur; however, it was expected that this sediment will be widely remobilised. The addition of 1mm of sediment is not anticipated to cause any significant impacts to fish or shellfish associated with the proposed DCO Order Limits. Furthermore, EMU Limited (2012a) reported that there was no evidence of black seabream nests being impacted by nearby aggregate extraction work. ABPmer (2012) also considered that there was only a minimal potential for of any interaction between suspended sediment from export cable installation and aggregate extraction. Similar observations are anticipated for the Proposed Development.

8.12.25 The aggregate dredging sites are located immediately to the north of the array area and immediately to the east of the offshore export cable corridor. The interaction between plumes created by aggregate dredging and activities in the array area are very unlikely, although, some overlap of plumes might occur in relation to export cable burial in the offshore end of the export cable corridor only, however, as assessed in **Chapter 6: Coastal processes, Volume 2** (Document Reference 6.2) the extent and duration of sediment plumes from cable burial are very limited. Overall, it is therefore considered that there will be limited scope for cumulative impacts to fish and shellfish from seabed disturbance.

8.12.26 Cumulative effects can also be considered in terms of duration of exposure from multiple projects which do not overlap but happen consecutively. However, as the effects from the majority of the projects will be short-lived, there are likely to be significant temporal gaps between the discrete construction and maintenance events, which will have localised effects. Moreover, as detailed in **Chapter 6: Coastal processes, Volume 2** of the ES (Document Reference 6.2.6) it can be confirmed that there is sufficient distance between the array area and the aggregate sites that any increase in bed level will be immeasurable in practice. As aggregate activities are not considered to cause a significant cumulative increase to SSC and deposition and as a result of the **low** to **medium** sensitivity fish and shellfish receptors in the fish and shellfish ecology Study Area (**paragraph 8.9.405** to **paragraph 8.9.423**), cumulative effects in terms of duration of exposure are not expected.

8.12.27 The cumulative impacts of increased SSC and sediment deposition is considered to be **minor**, indicating that the potential is for localised disturbance that does not threaten the long-term viability of the resource.

8.12.28 The sensitivity of fish and shellfish ecology receptors to increase SSC and smothering is detailed in **paragraph 8.9.405** to **paragraph 8.9.423** which conclude that most fish and shellfish receptors are not sensitive to increased SSC and deposition. The maximum sensitivity of receptors in the area is therefore assessed as **medium**, with a **minor** magnitude of impact. Taking into consideration the localised, short-term nature of the SSCs and deposition rates and the tolerance and recoverability of the majority of fish and shellfish receptors, it is concluded that the significance of the cumulative effect from temporary disturbance of the Proposed Development with Tier 1 projects/developments is deemed **minor adverse significance**, which is **Not Significant** in EIA terms.

Cumulative long-term loss of habitat and increased hard substrate and structural complexity due to the presence of turbine foundations, scour protection and cable protection

8.12.29 Cumulative long-term habitat loss is predicted to occur as a result of the presence of the Proposed Development infrastructure and cable installation projects identified in **Table 8-27**. Long-term habitat loss may result from the physical presence of foundations, scour protection and cable protection (see **paragraph 8.10.3** et seq.) which are assumed to be in place for the lifetime of the relevant offshore wind and cable project and potentially beyond the lifetime of these projects. Conversely, the introduction of hard substrate into areas of predominantly soft sediment has the potential to alter fish and shellfish community composition including potentially acting as fish aggregation devices (see **paragraph 8.10.33** to **paragraph 8.10.35**).

8.12.30 The CEA has been based on information available within ESs where available and it is noted that the maximum assessment assumptions quoted in ESs are often refined during the determination period of the application or post consent. The assessments presented within this assessment are therefore considered to be conservative, with the level of impact on fish and shellfish ecology expected to be reduced from those presented here. No Tier 2 or 3 projects have been identified.

8.12.31 AQUIND aim to bury the majority of the interconnector cable where applicable. However, if cable protection is used for the AQUIND interconnector, the significance of effect of habitat loss/change from the AQUIND interconnector has been assessed as being **Not Significant** (AQUIND Limited, 2019b). While the impact is permanent and irreversible (during the lifetime of the project), the area affected is highly localised and small compared to the wider region and is small relative to the habitat loss/change associated with proposed DCO order limits.

8.12.32 IFA-2 and consequently its associated maintenance activities is located within the fish and shellfish ecology secondary ZOI. However, the interconnectors will be buried below the seabed and therefore do not represent long term effects on physical processes.

8.12.33 No Tier 2 or 3 projects are identified. As previously discussed, some of these projects do not fully overlap with the Rampion 2 fish and shellfish ecology Study Area, therefore the total long-term habitat loss that should be considered as part of this assessment is likely to be significantly less. Comparable spawning and nursey grounds and habitats are widely distributed in the English Channel (see **Section 8.6**) so this loss is not predicted to impact the majority of fish and shellfish species. Moreover, many of these are cables and interconnectors are buried below the seabed and therefore do not represent long term habitat loss.

8.12.34 While the cumulative impact of from long-term habitat loss will be locally significant and comprise a long-term or permanent change in seabed habitat within the footprint of the structures and scour and cable protection, the footprint of the area affected is highly localised. It is expected that the impacts are reversible following removal of any of the hard substrate, where this might occur however is less certain. As the habitats are common and widespread throughout the wider region, the loss of these habitats is assessed as discernible and the magnitude is assessed as **minor**, indicating that the loss of habitat does not threaten the long-term viability of the fish and shellfish resource.

8.12.35 The sensitivity of fish and shellfish receptors is discussed in **paragraph 8.10.13** to **paragraph 8.10.25** and **paragraph 8.10.45** to **paragraph 8.10.37**. The sensitivity of most fish and shellfish receptors is deemed to be low, while the sensitivity of species with specific habitat requirements, such as black seabream and seahorse, is considered to be **medium**.

8.12.36 Cumulative long-term habitat loss will represent a long-term and continuous impact throughout the lifetime of the projects. However, only a relatively small proportion of the fish and shellfish habitats in the wider area are likely to be affected. Overall, it is predicted that the sensitivity of fish and shellfish receptors is considered to be **low** (and **medium** for black seabream and seahorse), and the magnitude is deemed to be **minor**. The cumulative effect will therefore be of **minor adverse significance**, which is **Not Significant** in EIA terms.

8.12.37 The coastal processes assessment (**Chapter 6: Coastal processes, Volume 2** of the ES (Document Reference 6.2.6)) has determined that the impacts on hydrodynamic and wave regimes from cumulative impacts will be **Not Significant** and will therefore not result in any significant changes to sediment transport and consequently will not have any significant adverse impacts on fish and shellfish ecology.

8.12.38 The CEA for fish and shellfish ecology is set out in **Table 8-29***.*

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Table 8-29 Cumulative effects assessment for fish and shellfish ecology

ID (Figure 5.4.1)	Development name	Application reference	Assessment discussion	Embedded environmental measures
W10	Dieppe – Le Treport	Dieppe – Le Treport (France)	No spatial overlap or direct impact expected. Indirect impact as a result of loss or accumulation of sediment (should it occur) is assumed to be minor or indistinguishable from natural variation.	Relevant embedded environmental measures, as outlined in **Table 8-13**, focus on minimising long-term habitat loss, where possible (C-44), cables will be buried where possible to ensure minimal use of cable protection (C-41, C-45 and C-96).
W20	Fécamp	Fécamp (France)		
W48	Rampion 1	Rampion 1		
T1	Perpetuus Tidal Energy Centre (PTEC)	Perpetuus Tidal Energy Centre (PTEC)		
C2	IFA-2	Interconnexion France-Angleterre 2 – IFA-2 HVDC		
C3	CrossChannel Fibre	CrossChannel Fibre		
C1	AQUIND (UK to France)	AQUIND Interconnector		
TC1	ATLANTIC CROSSING 1	ATLANTIC CROSSING 1 Century Link		
TC6	CIRCLE SOUTH ZAYO	CIRCLE SOUTH ZAYO		
A351	351 South East IOW Area	351 South East IOW Area – Tarmac Marine Ltd / Volker Dredging Ltd (MLA/2012/00374/5)		
A395/1	395/1 Off Selsey Bill	395/1 Off Selsey Bill – Aggregates Industries UK Ltd / Kendall Bros		

ID (Figure 5.4.1)	Development name	Application reference	Assessment discussion	Embedded environmental measures
		(Portsmouth) Ltd / Tarmac Marine Ltd (MLA/2012/00374/5)		
A396/1	396/1 Inner Owers	396/1 Inner Owers – Tarmac Marine Ltd		
A396/2	396/2 Inner Owers	396/2 Inner Owers – Tarmac Marine Ltd		
A435/1	435/1 Inner Owers	435/1 Inner Owers – Hanson Aggregates Marine Ltd		
A435/2	435/2 Inner Owers	435/2 Inner Owers – Hanson Aggregates Marine Ltd		
A453	453 Owers Extension	453 Owers Extension – CEMEX UK Marine Ltd.		
A488	488 Inner Owers North	488 Inner Owers North – Tarmac Marine Ltd.		
D1	Newhaven	Open disposal site - Newhaven		
D2	Rampion 1	Open disposal site - Rampion 1		
D4	Brighton/ Rottingdean	Open disposal site - Brighton/ Rottingdean		
D6	AQUIND Cable Site A	Open disposal site – AQUIND Cable Site A		

8.13 Transboundary effects

8.13.1 Transboundary effects arise when impacts from a development within one European Economic Area (EEA) states affects the environment of another EEA state(s). A screening of transboundary effects has been carried out and is presented in Appendix B of the Scoping Report (RED, 2020).

8.13.2 The potential transboundary impacts screened into the assessment for fish and shellfish ecology were:

- direct effects as a result of underwater noise exposure to fish during construction (piling operations); and
- indirect effects may occur in relation to spawning and nursery grounds arising from habitat disturbance / loss during all project phases.

8.13.3 Underwater noise levels expected to elicit behavioural responses in certain fish and shellfish are predicted to extend to several tens of kilometres beyond the Proposed Development and therefore have the potential to affect fish and shellfish habitats of France, an EEA state (approximately 44.5km from the proposed DCO Order Limits) during the construction phase. These impacts were predicted to be short term and intermittent, with recovery of fish and shellfish populations to affected areas following completion of all piling activities during construction. Overall, the sensitivity of fish and shellfish receptors to this impact were assessed as **medium** and the magnitude predicted to be **minor**. The effect was therefore considered to be a **minor adverse significance**, which is considered **Not Significant** in EIA terms. Although TTS for seahorse was considered to be a **high** sensitivity, the magnitude for both breeding and over-wintering seahorse was identified to be of **negligible** magnitude, resulting in a **minor adverse significance**, which is considered **Not Significant** in EIA terms. For TTS and behavioural impacts on black seabream, this species was considered to have a **medium** sensitivity and, following mitigation, a **negligible** impact magnitude, resulting in an effect of **minor adverse significance**, which is **not significant** in EIA terms. It is also notable that effects on black seabream will only be relevant for areas specific to the north-west of the array area, which is approximately 55km from an EEA state and therefore no direct effects to an EEA state from underwater noise is anticipated due to this distance.

8.13.4 Effects of habitat disturbance/loss are predicted to be limited in extent to within a number of kilometres of the Proposed Development and are therefore not predicted to extend into the waters of other EEA states (such as France). However, in the English Channel, eggs and larvae from spawning grounds found in English waters can be transported to nursery grounds in French waters (Katara *et al*., 2021). Nevertheless, the assessment on spawning grounds and the effects on the Downs herring spawning stock from habitat disturbance/loss were predicted to be **Not Significant** in EIA terms (see **Section 8.9**).

8.13.5 Moreover, embedded environmental measures set out in **Table 8-13** will be implemented to reduce the impact of underwater noise, including installation equipment choice and secondary noise mitigation options, to ensure a noise reduction is achieved to reduce the risk of significant effects and reduce impact ranges (RED, 2022b).

8.14 Inter-related effects

8.1.1 The inter-related effects assessment considers likely significant effects from multiple impacts and activities from the construction, operation and maintenance and decommissioning phases of Rampion 2 on the same receptor, or group of receptors.

8.14.1 Inter-related effects could potentially arise in one of two ways. The first type of inter-related effect is a Proposed Development lifetime effect, where multiple phases of the Proposed Development interact to create a potentially more significant effect on a receptor than in one phase alone. The phases for Rampion 2 are construction, operation and maintenance, and decommissioning. All Proposed Development lifetime effects are assessed in **Chapter 30: Inter-related effects, Volume 2** of the ES (Document Reference 6.2.30).

8.14.2 The second type of inter-related effect is receptor-led effects. Receptor-led effects are where effects from different environmental aspects combine spatially and temporally on a receptor. These effects may be short-term, temporary, transient or longer-term.

8.14.3 Receptor-led effects have been considered, where relevant, in this chapter for potential interactions between fish and shellfish ecology and the following environmental aspects:

- **Chapter 6: Coastal processes, Volume 2** of the ES (Document Reference 6.2.6); and
- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference 6.2.9).

8.14.4 Full results of the receptor-led effects assessment can be found in **Chapter 30: Inter-related effects, Volume 2** of the ES (Document Reference 6.2.30).

8.15 Summary of residual effects

8.15.1 **Table 8-30** presents a summary of the assessment of significant impacts, any relevant embedded environmental measures and residual effects on fish and shellfish ecology receptors.

Table 8-30 Summary of assessment of residual effects

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
Construction				
Mortality, injury, behavioural changes and auditory masking arising from noise and vibration	Black seabream: **Moderate** (TTS and behavioural only) Seahorse (breeding): **Moderate (**behavioural only) All other receptors: **Negligible** to **Minor**	Sandeel: **medium** Herring: **high** Black seabream: **medium** Sea bass: **medium** Seahorse: **high** Cuttlefish: **medium** Eggs and larvae: **medium** All other receptors: **medium** Shellfish: **medium**	C-52, C-265, C-274, C-280, C-281. See **Draft Piling Marine Mammal Protocol** (Document Reference 7.14)	All receptors: **Minor adverse**
Impacts arising from UXO Clearance	All fish and shellfish species: **Minor**	All fish and shellfish species: **medium**	C-102, C-273, C-275. See **Draft UXO Clearance MMMP** (Document Reference 7.15)	All receptors: **Minor adverse**

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Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
Impacts of underwater noise from seabed preparation, rock dumping and cable installation	All fish and shellfish species: **Negligible**	Herring: **high** Seahorse: **high** All other fish and shellfish species: **medium**	N/A	All receptors: **Minor adverse**
Direct disturbance resulting from the installation of the export cable	Black seabream: **Moderate** All other receptors: **Negligible- Minor**	Sandeel: **medium** Herring: **high** Black seabream: **high** Seahorse: **medium** Cuttlefish: **low** Shellfish: **low to medium** Elasmobranchs: **low**	C-44, C45, C-65, C-269, C-270, C-271, C-272, C-273	All receptors: **Minor adverse**
Direct disturbance resulting from construction within the array	All receptors: **Negligible- Minor**	Sandeel: **medium** Herring: **high** Black seabream: **high** Seahorse: **medium** Cuttlefish: **low** Shellfish: **low to medium** Elasmobranchs: **low**	C-41, C-44, C-45	All receptors: **Minor adverse**

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
Temporary localised increases in SSC and smothering	Black seabream: **Moderate** Sandeel and seahorse: **Minor** All other receptors: **Negligible**	Sandeel: **low** Herring: **low** Black seabream: **high** Seahorse: **low** Shellfish: **negligible** to **medium** Migratory species: **low** Other fish receptors: **low**	C-272, C-273,	All receptors: **Negligible to Minor adverse**
Direct and indirect seabed disturbances leading to the release of sediment contaminants	**Negligible**	**Medium**	C-53	All receptors: **Minor adverse**
Operation and maintenance				
Long-term loss of habitat and increased hard substrate and structural complexity due to the presence of turbine foundations, scour protection and cable protection	*Long-term habitat loss*			
	Black seabream: **Moderate** All other receptors: **Negligible** to **Minor**	Sandeel: **medium** Herring: **high** Black seabream: **high** Seahorse: **medium** Cuttlefish: **low** Shellfish: **low to medium**	C-44, C-95	All receptors: **Negligible to Minor adverse**

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
		Elasmobranchs: **low**		
	Increase hard substrate			
	Black seabream: **Moderate** All other receptors: **Negligible** to **Minor**	Sandeel: **medium** Herring: **high** Black seabream: **high** Seahorse: **medium** Cuttlefish: **low** Shellfish: **low** Elasmobranchs: **low**	C-41, C-44, C-45, C-95, C-96	All receptors: **Minor adverse**
EMF impacts arising from cables	**Minor**	**Low**	C-41, C-45, C-96	All receptors: **Minor adverse**
Direct disturbance resulting from maintenance within the array area and export cable	Black seabream: **Moderate** Herring: **Negligible** All other receptors: **Minor**	Sandeel: **medium** Herring: **high** Black seabream: **high** Seahorse: **medium** Cuttlefish: **low** Shellfish: **low to medium** Elasmobranchs: **low**	N/A	All receptors: **Minor adverse**
Decommissioning				

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Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
Mortality, injury, behavioural changes and auditory masking arising from noise and vibration	**Negligible**	Sandeel: **medium** Herring: **high** Black seabream: **medium** Sea bass: **medium** Seahorse: **high** Eggs and larvae: **medium** All other receptors: **medium** Shellfish: **medium**	C-111	All receptors: **Minor adverse**
Direct disturbance resulting from the removal of the export cable	**Negligible**	Sandeel: **medium** Herring: **high** Black seabream: **high** Seahorse: **medium** Cuttlefish: **low** Shellfish: **low to medium** Elasmobranchs: **low**	C-44, C-111, C-273, C-300	All receptors: **Minor adverse**
Direct disturbance resulting from decommissioning within the array	**Negligible**	Sandeel: **medium** Herring: **high** Black seabream: **high**	C-44, C-111, C-300	All receptors: **Minor adverse**

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
		Seahorse: **medium** Cuttlefish: **low** Shellfish: **low to medium** Elasmobranchs: **low**		
Temporary localised increases in SSC and smothering	**Negligible**	Sandeel: **low** Herring: **low** Black seabream: **high** Seahorse: **low** Shellfish: **negligible** to **medium** Elasmobranchs: **low**	C-111, C-273	All receptors: **Negligible** to **Minor adverse**
Direct and indirect seabed disturbances leading to the release of sediment contaminants	**Negligible**	**Medium**	C-53, C-111	All receptors: **Minor adverse**

8.16 Glossary of terms and abbreviations

Table 8-31 Glossary of terms and abbreviations – fish and shellfish ecology

Term (acronym)	Definition
AC	Alternating Current
AL1	Action Level 1
AL2	Action Level 2
Aspect	Used to refer to the individual environmental topics.
BAC	Background Assessment Concentration
BAP	Biodiversity Action Plan
Barrier effect	Barrier effect is experienced by bird species which intend forage beyond or migrate past the array but due to avoidance behaviour, have to navigate around the array. Barrier effect is often not discernible from displacement behaviour.
Baseline	The environment as it appears (or would appear) immediately prior to the implementation of the Proposed Development together with any known or foreseeable future changes that will take place before completion of the Proposed Development.
Baseline conditions	The environment as it appears (or would appear) immediately prior to the implementation of the Proposed Development together with any known or foreseeable future changes that will take place before completion of the Proposed Development.
Beam trawl	A trawl where the mouth or opening of the net is kept open by a beam, which is mounted at each end on guides which travel along the seabed.
Benthic ecology	Benthic ecology encompasses the study of the organisms living in and on the sea floor, the interactions between them and impacts on the surrounding environment.
B-field	Magnetic fields
BGS	British Geological Survey
Bottom trawl/Otter trawl	A large, usually cone shaped net, which is towed across the seabed.

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Term (acronym)	Definition
BRC	Biodiversity Record Centre
Centre for Environment Fisheries and Aquaculture Science (Cefas)	The Government's marine and freshwater science experts, advising the UK government and overseas partners.
Climate Change	A change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes, to external forcing or to persistent anthropogenic changes in the composition of the atmosphere, ocean or in land use.
cm	centimetre
Coastal processes	The processes that interact to control the physical characteristics of a natural environment, for example: winds, waves, currents, water levels, sediment transport, turbidity, coastline, beach and seabed morphology.
Compensation	Loss of value is remedied or offset by a corresponding compensatory action on the same site or elsewhere, determined through the process of Environmental Impact Assessment.
Construction effects	Used to describe both temporary effects that arise during the construction phases as well as permanent existence effects that arise from the physical existence of development (for example new buildings).
Crustacea	Arthropod of the large, mainly aquatic group Crustacea, such as a crab, lobster, shrimp, or barnacle.
CSQG	Canadian sediment quality guideline
Cumulative effects	Additional changes caused by a Proposed Development in conjunction with other similar developments or as a combined effect of a set of developments, taken together.
Cumulative Effects Assessment (CEA)	Assessment of impacts as a result of the incremental changes caused by other past, present and reasonably foreseeable human activities and natural processes together with the Proposed Development.
Cumulative impact	Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the Proposed Development.

Term (acronym)	Definition
DC	Direct Current
DCO Application	An application for consent under the Planning Act 2008 to undertake a Nationally Significant Infrastructure Project made to the Planning Inspectorate who will consider the application and make a recommendation to the Secretary of State, who will decide on whether development consent should be granted for the Proposed Development.
Decommissioning	The period during which a development and its associated processes are removed from active operation.
Demersal	Relating to the seabed and area close to it. Demersal spawning species are those which deposit eggs onto the seabed.
Department for Environment, Food and Rural Affairs (DEFRA)	The lead UK Government Department for overall environmental policy.
Development Consent Order (DCO)	This is the means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects, under the Planning Act 2008.
dML	Deemed Marine Licence
Drop Down Video (DDV)	A survey method in which imagery of habitat is collected, used predominantly to survey marine environment.
Ecological feature	Ecological feature is the term used to refer to biodiversity receptors. This term is taken directly from Ecological Impact Assessment guidance from the Chartered Institute of Ecology and Environmental Management.
E-field	Electric field
EIA Regulations, 2017	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. The EIA Regulations require that the effects of a project, where these are likely to have a significant effect on the environment, are taken into account in the decision-making process for the project.
Elasmobranchs	Cartilaginous fishes such as sharks, rays, and skates.
Electromagnetic field (EMF)	An electromagnetic field is an electric and magnetic force field that surrounds a moving electric charge.

Term (acronym)	Definition
Elements	Individual parts which make up the landscape, such as, for example, trees, hedges and buildings.
Embedded environmental measures	Equate to 'primary environmental measures' as defined by Institute of Environmental Management and Assessment (2016). They are measures to avoid or reduce environmental effects that are directly incorporated into the design of the Proposed Development.
Enhancement	A measure that is over and above what is required to mitigate the adverse effects of a project.
Environment Agency	A non-departmental public body, with responsibilities relating to the protection and enhancement of the environment in England.
Environmental Impact Assessment (EIA)	The process of evaluating the likely significant environmental effects of a proposed project or development over and above the existing circumstances (or 'baseline').
Embedded environmental measures	Equate to 'primary environmental measures' as defined by Institute of Environmental Management and Assessment (2016). They are measures to avoid or reduce environmental effects that are directly incorporated into the design of the Proposed Development.
Environmental Statement (ES)	The written output presenting the full findings of the Environmental Impact Assessment.
ERL	Effect Range Low
ETG	Expert Topic Group
EUNIS habitat classification	A pan-European system which facilitates the harmonised description and classification of all types of habitat, through the use of criteria for habitat identification.
European site	European sites are those that are designated through the Habitats Directive and Birds Directive (via national legislation as appropriate). Within England additional sites designated through international convention are given the same protection through policy – overall all of these are referred to as European sites. European sites in England are considered to be SPAs, SACs, candidate SACs and Sites of Community Importance (SCI). Potential SPAs (pSPA), possible SACs (pSACs), Ramsar sites

Term (acronym)	Definition
	(designated under international convention) and proposed Ramsar sites
Evidence Plan Process (EPP)	A voluntary consultation process with specialists' stakeholders to agree the approach, the information to support, the EIA and HRA for certain aspects.
Fish larvae	The developmental stage of fish which have hatched from the egg and receive nutrients from the yolk sac until the yolk is completely absorbed.
Future Baseline	Refers to the situation in future years without the Proposed Development.
Geographical Information System (GIS)	A system that captures, stores, analyses, manages and presents data linked to location. It links spatial information to a digital database.
Geophysical	Relating to the physical properties of the earth.
GES	Good Environmental Status
Habitats Directive	The Habitats Directive (more formally known as Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) is a directive adopted by the European Community in 1992 as a response to the Berne Convention. The European Community was reformed as the European Union the following year, but the directive is still recognised. The Habitats Directive required national governments to specify areas that are expected to be ensuring the conservation of flora and fauna species. This led to the setting up of a network of protected areas across the EU, along with 'Special Areas of Conservation', which together with the existing Special Protection Areas, became the so-called Natura 2000 network established to protect species and habitats.
Habitats Regulation Assessment (HRA)	The assessment of the impacts of implementing a plan or policy on a European Site, the purpose being to consider the impacts of a project against conservation objectives of the site and to ascertain whether it would adversely affect the integrity of the site.
Habitats Regulations	EC Council Directive 92/43/EEC, known as the Habitats Directive, was transposed in the UK by the Habitats Regulations 1994 (as amended). The Habitats Regulations apply to UK land and territorial waters and act to ensure biodiversity of natural habitats and of wild

Term (acronym)	Definition
	flora and fauna through a range of measures including designation of SACs.
Heatmaps	Map-based, pictorial representation of the relative usage of routes from collated 'tracks' gathered from Strava users.
Horizontal Directional Drill (HDD)	A trenchless crossing engineering technique using a drill steered underground without the requirement for open trenches. This technique is often employed when crossing environmentally sensitive areas, major water courses and highways. This method is able to carry out the underground installation of pipes and cables with minimal surface disruption.
Hz	Hertz
iE field	Induced electric field
IHLS	International Herring Larvae Survey
Impact	The changes resulting from an action.
Indirect effect	Effects that result indirectly from the Proposed Development as a consequence of the direct effects, often occurring away from the site, or as a result of a sequence of interrelationships or a complex pathway. They may be separated by distance or in time from the source of the effects. Often used to describe effects on landscape character that are not directly impacted by the Proposed Development such as effects on perceptual characteristics and qualities of the landscape.
Inshore	The sea up to two miles from the coast (landward of MHWS).
Inshore Fisheries and Conservation Authority (IFCA)	There are 10 Inshore Fisheries and Conservation Authorities (IFCAs) in England. The 10 IFCA Districts cover English coastal waters out to 6 nautical miles from Territorial Baselines. The IFCAs have shared powers and duties which are found in the Marine and Coastal Access Act, 2009.
Institute of Environmental Management and Assessment (IEMA)	International membership organisation for environment and sustainability professionals.
Intertidal	The area of the shoreline which is covered at high tide and uncovered at low tide.

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Term (acronym)	Definition
Iterative design	A process by which the design is repeated to make improvements, solve problems, respond to environmental measures and engage local communities and statutory stakeholders.
Joint Nature Conservation Committee (JNCC)	JNCC is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation.
km	Kilometre
Level of effect	Determined through the combination of sensitivity of the receptor and the proposed magnitude of change brought about by the development.
Likely Significant Effects (LSE)	It is a requirement of Environmental Impact Assessment Regulations to determine the likely significant effects of the Proposed Development on the environment which should relate to the level of an effect and the type of effect.
m	Metre
Magnitude (of change)	A term that combines judgements about the size and scale of the effect, the extent of the area over which it occurs, whether it is reversible or irreversible and whether it is short term or long term in duration'. Also known as the 'degree' or 'nature' of change.
MALSF	Marine Aggregate Levy Sustainability Fund
MAREA	Marine Aggregates Regional Environmental Assessment
MarESA	Marine Evidence Based Sensitivity Assessment
Marine aggregate	Marine dredged sand and/or gravel.
Marine Conservation Zone (MCZ)	A Marine Conservation Zone (MCZ) is a type of marine nature reserve in UK waters. They were established under the Marine and Coastal Access Act (2009) and are areas designated with the aim to protect nationally important, rare or threatened habitats and species.
Marine Mammal Mitigation Protocol (MMMP)	To include measures to minimise the risk of injury (PTS) in marine mammals.
Marine Management Organisation (MMO)	MMO is an executive non-departmental public body, sponsored by the Department for Environment, Food & Rural Affairs. MMO license, regulate and plan marine

Term (acronym)	Definition
	activities in the seas around England so that they're carried out in a sustainable way.
Marine Policy Statement (MPS)	Framework for preparing Marine Plans and taking decisions affecting the marine environment.
MBES	Multi-beam Echo Sounders
MEMR	Mitigation, Enhancement and Monitoring Register
MHCLG	Ministry of Housing, Communities and Local Government's
MHWS	Mean High Water Springs
mm	Millimetre
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MSFD	The Marine Strategy Framework Directive
MW	Megawatts
Nationally Significant Infrastructure Project (NSIP)	Nationally Significant Infrastructure Projects are major infrastructure developments in England and Wales which are consented by DCO. These include proposals for offshore wind farms with an installed capacity over 100MW.
Natural England	The government advisor for the natural environment in England.
nm	Nautical Mile
Noise sensitive receptors	Locations or receptors that may potentially be adversely affected by the addition of a new source of noise. These can include residential properties, people and sensitive species.
Non-statutory consultation	Non-statutory consultation refers to the voluntary consultation that RED undertake in addition to the statutory consultation requirements.
NPS	National Policy Statement
Nursery habitat	Habitats where high numbers of juveniles of a species occur, having a greater level of productivity per unit area than other juvenile habitats.

Term (acronym)	Definition
OBR	Opercular beat rate
OEL	Ocean Ecology Limited
Offshore	The sea further than two miles from the coast.
Offshore area	An area that encompasses all planned offshore infrastructure.
Offshore Wind Farm	An offshore wind farm is a group of wind turbines in the same location (offshore) in the sea which are used to produce electricity.
PEL	Probable Effect Level
Pelagic	Any part of the water column (for example the sea from surface to bottom sediments) that is not close to the seabed. Pelagic spawning species release their eggs into the upper layers of the sea.
PEMP	Project Environmental Management Plan
Permanent Threshold Shift (PTS)	A permanent reduction in an animal's sensitivity to sound.
Planning Act 2008	The legislative framework for the process of approving major new infrastructure projects.
Planning Inspectorate	The Planning Inspectorate deals with planning appeals, national infrastructure planning applications, examinations of local plans and other planning-related and specialist casework in England and Wales
Preliminary Environmental Information Report (PEIR)	The written output of the Preliminary Environmental Impact Assessment undertaken for the Proposed Development. It was developed to support Statutory Consultation and presented the preliminary findings of the assessment to allow an informed view to be developed of the Proposed Development, the assessment approach that was undertaken, and the preliminary conclusions on the likely significant effects of the Proposed Development and environmental measures proposed.
Proposed Development	The development that is subject to the application for development consent, as described in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.4).
PSA	Particle size analysis

Term (acronym)	Definition
Rampion 1	The existing Rampion Offshore Wind Farm located in the English Channel in the south of England.
Receptor	These are as defined in Regulation 5(2) of The Infrastructure Planning 'Environmental Impact Assessment' Regulations 2017 and include population and human health, biodiversity, land, soil, water, air, climate, material assets, cultural heritage and landscape that may be at risk from exposure to direct and indirect impacts as a result of the Proposed Development.
Recoverable injury	Recoverable injury is a survivable injury with full recovery occurring after exposure.
RED	Rampion Extension Development Limited
SAMARCH	Salmonid Management Round the Channel
SBES	Single-beam Echo Sounders
SBP	Sub-bottom Profiler
Scoping Opinion	A Scoping Opinion is adopted by the Secretary of State for a Proposed Development.
Scoping Report	A report that presents the findings of an initial stage in the Environmental Impact Assessment process.
Scour	A localised sediment erosion feature caused by local enhancement of flow speed and turbulence due to interaction with an obstacle.
Secretary of State (SoS)	The senior minister at the Department for Energy Security and Net Zero who makes the decision to grant development consent.
Sediment deposition	Settlement of sediment in suspension back to the seabed, causing a localised accumulation.
Sediment transport	The movement of sediment by natural processes, as individual grains or as a collective volume.
SEL	Sound Exposure Level
Semi-pelagic (or benthopelagic)	Partially living their life on the seabed (benthic) and partially living their life in the water column above (pelagic).
Sensitivity	A term applied to specific receptors, combining judgements of the susceptibility of the receptor to the

Term (acronym)	Definition
	specific type of change or development proposed and the value associated to that receptor.
Significance	A measure of the importance of the environmental effect, defined by criteria specific to the environmental aspect.
Significant effects	It is a requirement of the EIA Regulations 2017 to determine the likely significant effects of the development on the environment which should relate to the level of an effect and the type of effect. Where possible significant effects should be mitigated. The significance of an effect gives an indication as to the degree of importance (based on the magnitude of the effect and the sensitivity of the receptor) that should be attached to the impact described. Whether or not an effect should be considered significant is not absolute and requires the application of professional judgement. Significant – 'noteworthy, of considerable amount or effect or importance, not insignificant or negligible' (The Concise Oxford Dictionary). Those levels and types of landscape and visual effect likely to have a major or important / noteworthy or special effect of which a decision maker should take particular note.
SIR	Supplementary Information Report
Site of Special Scientific Interest (SSSI)	Sites designated at the national level under the Wildlife & Countryside Act 1981 (as amended). They are a series of sites that are designated to protect the best examples of significant natural habitats and populations of species.
SNCB	Statutory Nature Conservation Body
Source	A substance that is in, on or under the land and has the potential to cause harm or to cause pollution of controlled waters.
Spatial Scope	Spatial scope is the area over which changes to the environment are predicted to occur as a consequence of a Proposed Development.
Spawning	The release or deposition of eggs and sperm, usually into water, by aquatic animals.

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Term (acronym)	Definition
Special Area of Conservation (SAC)	International designation implemented under the Habitats Regulations for the protection of habitats and (non-bird) species. Sites designated to protect habitats and species on Annexes I and II of the Habitats Directive. Sufficient habitat to maintain favourable conservation status of the particular feature in each member state needs to be identified and designated.
Special Protection Area (SPA)	Sites designated under EU Directive (79/409/EEC) to protect habitats of migratory birds and certain threatened birds under the Birds Directive
SPL	Sound Pressure Level
SSS	Side Scan Sonar
Stakeholder	Person or organisation with a specific interest (commercial, professional or personal) in a particular issue.
Statutory consultation	Statutory consultation refers to consultation that is required under Section 42 and Section 47 of the Planning Act 2008 with the relevant consultation bodies and the public on the preliminary environmental information.
Study Area	Area where potential impacts from the Proposed Development could occur, as defined for each aspect.
Subtidal	The region of shallow waters which are below the level of low tide.
Susceptibility	The ability of a defined landscape or visual receptor to accommodate the specific Proposed Development without undue negative consequences.
Suspended sediment concentration (SSC)	The mass concentration (mass/volume) of sediment in suspension.
Sussex NBN	Sussex National Biodiversity Network
Sustainability	The principle that the environment should be protected in such a condition and to such a degree that ensures new development meets the needs of the present without compromising the ability of future generations to meet their own needs.
T	Tesla
TEL	Threshold Effect Level

Term (acronym)	Definition
Temporal Scope	The temporal scope covers the time period over which changes to the environment and the resultant effects are predicted to occur and are typically defined as either being temporary or permanent.
Temporary or permanent effects	Effects may be considered as temporary or permanent. In the case of wind energy development the application is for a 30 year period after which the assessment assumes that decommissioning will occur and that the site will be restored. For these reasons the development is referred to as long term and reversible.
Temporary Threshold Shift (TTS)	A temporary reduction in an animal's sensitivity to sound.
The Applicant	Rampion Extension Development Limited (RED).
Tidal excursion buffer	The greatest distance and direction that water carrying an impact might be carried during one mean spring tide, from a given location or area.
Transboundary effects	Assessment of changes to the environment caused by the combined effect of past, present and future human activities and natural processes on other European Economic Area Member States.
Type or Nature of effect	Whether an effect is direct or indirect, temporary or permanent, positive (beneficial), neutral or negative (adverse) or cumulative.
UK	United Kingdom
Unexploded Ordnance (UXO)	Unexploded ordnance are explosive weapons (bombs, shells, grenades, land mines, naval mines, etc.) that did not explode when they were employed and still pose a risk of detonation, potentially many decades after they were used or discarded.
Vm^{-1}	Volts per metre
WTG	Wind Turbine Generator
Zone of Influence (ZOI)	The area surrounding the Proposed Development which could result in likely significant effects.
μT	Micro tesla
μVm^{-1}	Micro volt per metre

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8.17 References

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Rampion 2
WIND FARM