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Environmental Statement – Volume 1 – Chapter 9 Fish and Shellfish

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The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 – Regulation 5(2)(a)

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9. FISH AND SHELLFISH

9.1. SCOPE OF THE ASSESSMENT

9.1.1. INTRODUCTION

9.1.1.1. This chapter provides the information regarding the potential environmental impacts on fish and shellfish as a result of the Proposed Development.

9.1.1.2. The fish and shellfish assessments consider the potential impacts of activities associated with the construction, operation (including maintenance, repair and replacement) and decommissioning of the Proposed Development.

9.1.1.3. Where effects arise as a result of both the combination of the impacts of the Proposed Development and the impacts of projects in the UK Marine Area and/or other Member States, these will also be identified and assessed in Section 8.7.

9.1.1.4. This chapter should be read in conjunction with Chapter 6 (Physical Processes) of the Environmental Statement ('ES') Volume 1 (document reference 6.1.6), which provides further information regarding potential effects assessed and Appendix 8.1 (Benthic Ecology Survey Report) of the ES Volume 3 (document reference 6.3.8.1) presents the findings of the benthic ecology survey.

9.1.1.5. A Habitats Regulations Assessment ('HRA') Report (document reference. 6.8.1) has also been submitted as part of the Application, in which likely significant effects ('LSE') on European sites and their qualifying features have been considered.

9.1.1.6. Appendix 8.5 presents the assessment of potential effects on Marine Conservation Zones ('MCZ's).

9.1.2. STUDY AREA

9.1.2.1. The Entire Marine Cable Corridor extends from Eastney on the South coast of the UK, to Pourville located on the Normandy coast of France.

9.1.2.2. Due to the mobile nature of many fish species, the study area encompasses the Entire Marine Cable Corridor and is defined by the International Council for the Exploration of the Sea ('ICES') rectangles through which the Entire Marine Cable Corridor passes (Figure 9.1 of the ES Volume 2 (document reference 6.2.9.1)). As fisheries landings data is collected per ICES rectangle, this is the smallest special unit available for the collection and collation of fisheries landings data which is used to form part of this baseline.

LANDFALL

9.1.2.3. The Marine Cables will make Landfall through the use of Horizontal Directional Drilling ('HDD') methods which will travel underneath the intertidal areas at Eastney between an exit/entry point in the marine environment beyond 1 km (between Kilometre Point ('KP') 1 and KP 1.6) and the Transition Joint Bays ('TJB') located in the car park behind Fraser Range (Figure 3.3 of the ES Volume 2 (document reference 6.2.3.3)). It is not determined yet whether the HDD direction will be onshore to marine, marine to onshore, or drilling from both ends. For the purposes of this assessment, the area of study at Landfall at Eastney is seaward of Mean High Water Springs ('MHWS') to the HDD marine exit/entry points.

9.1.2.4. HDD is also proposed to be undertaken at Langstone Harbour to enable the cables to cross underneath Langstone Harbour from Portsea Island to the mainland (see Sheet 2 of Figure 3.9 (shown in Section 7 of the map) of the ES Volume 2 (document reference 6.2.3.9)). It is anticipated that no HDD works will occur within the marine environment of Langstone Harbour as the drilling will be underneath the seabed of the harbour area. The entry/exit points of the drill will be located above the MHWS mark. It has been agreed with the Marine Management Organisation ('MMO') that this is considered to be an exempt activity that does not require a Marine Licence, subject to the conditions of Article 35 of Marine Licensing (Exempted Activities) Order 2011 (as amended). The Consultation Report provides further details on this and other consultations (document reference 5.1).

9.1.2.5. Chapter 3 (Description of the Proposed Development) of the ES Volume 1 (document reference 6.1.3) provides further information on the HDD methodology at Langstone Harbour. Onshore HDD works relating to the Proposed Development are not included in this assessment but are covered in the onshore chapters of the ES.

MARINE CABLE CORRIDOR

9.1.2.6. The Marine Cable Corridor encompasses the location of the Landfall and extends from MHWS at Eastney, out to the UK/France Exclusive Economic Zone ('EEZ') Boundary Line (see Figure 3.1 of the ES Volume 2 (document reference 6.2.3.1)

9.1.2.7. For the purposes of the ES, the assessment will be focussed on the Marine Cable Corridor and Landfall within the UK Marine Area (as this comprises the Proposed Development).

9.2. LEGISLATION, POLICY AND GUIDANCE

9.2.1.1. This assessment has taken into account the current legislation, policy and guidance relevant to fish and shellfish. These are listed below.

9.2.2. LEGISLATION

International

- European Commission ('EC') Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the 'Habitats Directive');
- Water Framework Directive ('WFD') (EC Directive 2000/60/EC);
- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention, 1979);

- Rio Convention on Biological Diversity (1992); and
- Convention on the Protection of the Marine Environment of the North-East Atlantic ('OSPAR') (1992).

National

- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017;
- The Conservation of Habitats and Species Regulations 2017 (known as the Habitats Regulations) which transpose the Habitats Directive into national law. This legislation covers waters within the 12 nautical mile ('nmi') limit (known as Territorial Waters);
- The Conservation of Offshore Marine Habitats and Species Regulations 2017 (known as the Offshore Regulations) which transpose the Habitats Directive into UK law for all offshore activities. This legislation covers UK waters beyond the 12 nmi limit;
- Marine and Coastal Access Act ('MCAA') (2009);
- UK Biodiversity Action Plan ('BAP') (2007);
- Natural Environment and Rural Communities ('NERC') Act 2006;
- Wildlife and Countryside Act 1981 ('WCA') (as amended);

9.2.3. PLANNING POLICY

National Policy

- EN-1 Overarching National Policy Statement ('NPS') for Energy (2011).

  Paragraph 5.3.3 states: '*Where the development is subject to Environmental Impact Assessment ('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 Infrastructure Planning Commission ('IPC') consider thoroughly the potential effects of a proposed project.*'

- UK Marine Policy Statement ('MPS') (2011).

  The UK MPS is the framework for preparing Marine Plans and taking decisions affecting the marine environment. This policy aims to contribute to the achievement of sustainable development and ensure that development aims to avoid harm to marine ecology and biodiversity through consideration of issues such as impacts of noise, ecological resources and water quality.

The South Marine Plan, which covers the spatial extent of the Proposed Development, was adopted in July 2018.

Regional Policy

9.2.3.1. South Inshore and South Offshore Marine Plan hereafter known as The South Marine Plan (MMO, 2018) including:

- Objective 10 includes policies to avoid, minimise or mitigate adverse impacts on Marine Protected Areas ('MPAs').
- Objective 11 includes policies to avoid, minimise or mitigate significant adverse impacts on highly mobile species as a consequence of the generation of underwater noise (impulsive or ambient).
- Objective 12 includes policies to avoid, minimise or mitigate significant adverse impacts on natural habitat and species including:
  - Policy S-DIST-1 requires proposals to avoid, minimise or mitigate significant cumulative adverse disturbance or displacement impacts on highly mobile species.
  - S-FISH-4 requires that 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.
  - S-FISH-4-HER requires that proposals consider herring spawning mitigation in the area highlighted in Figure 26 (within the technical annex to the Plan) during the period 01 November to the last day of February annually.

9.2.3.2. Further detail and consideration on how the proposals for the Proposed Development have had regard of these policies is presented within the Planning Statement (document reference 5.4) that accompanies the Application

Local Policy

9.2.3.3. The following BAPs are in place for Hampshire:

- The Coastal Habitat Action Plan (2003);
- The Water and Biodiversity Topic Action Plan (2003).

9.2.4. GUIDANCE

9.2.4.1. Relevant guidance includes:

- Chartered Institute of Ecology and Environmental Management ('CIEEM') (2019) - Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine;

- Centre for Environmental, Fisheries and Aquaculture Science ('Cefas') (2011) - Guidelines for data acquisition to support marine environmental assessment of offshore renewable energy projects;
- Planning Inspectorate ('PINS') (2019) - Advice Note Seventeen: Cumulative Effects Assessment;
- OSPAR (2009) - Assessment of the environmental impacts of cables;
- Institute of Environmental Management and Assessment ('IEMA') (2017) - Delivering Proportionate EIA: A Collaborative Strategy for Enhancing UK Environmental Impact Assessment Practice; and
- MMO (2013) - Marine conservation zones and marine licencing.

9.3. SCOPING OPINION AND CONSULTATION

9.3.1. SCOPING OPINION

9.3.1.1. As detailed within Chapter 5 (Consultation) of the ES Volume 1 (document reference 6.1.5), a Scoping Opinion was received by the Applicant from PINS on 7 December 2018. The Scoping Opinion comments from PINS and key consultees in relation to fish and shellfish and how they were addressed is set out in Table 1 in Appendix 9.1 (Fish and Shellfish Consultation Responses) of the ES Volume 3 (document reference 6.3.9.1). The key items that were addressed included;

- Definition of the study area;
- Identification of the conservation status and value of the fish and shellfish species and assessment of effects on these species;
- Inclusion of habitat loss as an effect during construction; and
- Consideration of the potential impacts on species listed the UK and Hampshire BAPs should be included.

9.3.2. CONSULTATION PRIOR TO PUBLICATION OF THE PRELIMINARY ENVIORNMENTAL INFORMATION REPORT ('PEIR')

9.3.2.1. Consultation was also undertaken prior to the publication of the PEIR. The items discussed and outcomes are summarised in Table 2 in Appendix 9.1 (Fish and Shellfish Consultation Responses). The key items that were addressed included:

- The Proposed Development was introduced and openly discussed with consultees (Sussex Inshore Fisheries Conservation Authority ('IFCA'), Southern IFCA, MMO, Environment Agency('EA') and Natural England ('NE'));
- A request was made to Southern IFCA for black seabream (*Spondyliosoma cantharus)* nesting sites and available reports to inform the baseline and assessment;

- A request for migratory fish data in the Isle of Wight area was requested from the EA; and
- NE were consulted on the HDD works in Langstone Harbour and confirmed that no surveys were required within Langstone Harbour.

9.3.3. PEIR CONSULTATION

9.3.3.1. Consultation on the PEIR was undertaken between February and April 2019. All of the comments received from the consultation are presented in Table 3 of Appendix 9.1 (Fish and Shellfish Consultation Responses) however the key items that were raised included:

- It was identified by the MMO that they consider there to be uncertainly surrounding the potential effects of electromagnetic fields ('EMF') on elasmobranchs from larger cables;
- Certain methodologies (MarineSpace *et al.*, 2013a) were recommended for assessing sandeel (Ammodytidae) habitat along the Marine Cable Corridor;
- Consideration should be given to the potential effects from the Proposed Development on black seabream nesting sites;
- International Herring Larvae Surveys ('IHLS') data should be used to assess impacts to herring (*Clupea harengus*) spawning areas;
- Consideration should be given to the entrainment of fish eggs, larvae, juvenile and adults from dredging operations;
- A cumulative assessment should be undertaken with consideration given to aggregate dredging sites;
- Any additional construction methodologies such as grounding of installation vessels and driving of ducts at the HDD exit/entry point need to be assessed;
- The inclusion of certain migratory fish species such as Atlantic salmon (*Salmo salar)*, sea trout (*Salmo trutta)* and European eel (*Anguilla anguilla*) for the assessment of noise and vibration; and
- Salmonids and cod (*Gadus morhua*) should be included in the assessment of EMF.

9.3.4. POST-PEIR CONSULTATION

9.3.4.1. Further consultation with key stakeholders on specific fish and shellfish related data and information has been undertaken following the start of the PEIR consultation in February 2019. This was to ensure all species and impacts are assessed. The key items that have been discussed are presented in the table below, with full details provided in the Consultation Report (document reference 5.1).

Table 9.1 – Post-PEIR consultation

Consultee	Date (Method of Consultation)	Discussion
NE	13 February 2019 Teleconference	Discussion on the approach to HRA and pre-screening of sites for Annex I habitat, marine bird, Annex II migratory fish and marine mammal features.
Southern IFCA Recreational Angling Committee	27 March 2019 Quarterly Meeting	Overview of the Proposed Development provided and information on how to respond to the PEIR. Information was gathered on black seabream. Overall the attendees were appreciative of being consulted and generally not too concerned about proposal, compared to other offshore works in the region (such as aggregate dredging) and the proposed MCZs (and their potential to restrict fishing). The main concerns related to an outcrop of rock called the Bullock Patch which is a breeding ground for black seabream, which they fish. The Marine Cable Corridor passes close to the edge of the outcrop. Some attendees suggested attendance of the Sussex IFCA quarterly meeting to introduce the project to the members. Contact has been made with the Sussex Recreational Sea Angling Partnership to attend one of their meetings.
Isle of Wight/Bembridge Angling Club	8 April 2019 Meeting held in Ryde	Overview of the Proposed Development provided and information on how to respond to the PEIR. Information was gathered on black seabream and other key species. Smooth-hounds and tope were identified as key species targeted by sports anglers, however dredging projects are considered to be a bigger issue to anglers than the Proposed Development. Black seabream was also identified as a main species that is angled for. Anglers requested that work is not undertaken in the Bullock Patch area during breeding season for black seabream. Potential issues as a result of the project were

Consultee	Date (Method of Consultation)	Discussion
		identified as suspended sediment on the reef, noise and vessel movement.
Selsey and Portsmouth Fishermen's Organisations	9 April 2019 Meetings held in Selsey and Portsmouth	Overview of the Proposed Development provided, and assessments undertaken. Information on how to respond to the PEIR.
NE, MMO and Joint Nature Conservation Committee ('JNCC')	7 May 2019 Teleconference	Discussions on the approach to dredge and disposal and the approach to plume dispersion modelling.
Sussex Recreational Sea Angling ('RSA') Partnership	18 June 2019 Email	Provided information on the Proposed Development and fish and shellfish assessment. Also provided information on how to access the PEIR.
NE	27 June 2019 Teleconference	Discussion on the Applicant's responses to the feedback received from NE on the PEIR including comments on fish and shellfish
EA	8 July 2019 Email	Agreement on the approach to dredge and disposal and the approach to plume dispersion modelling.
MMO	18 July 2019 Teleconference	Discussion on the Applicant's responses to the feedback received from MMO on the PEIR including comments on fish and shellfish.
MMO	24 July 2019 Email	Further recommendation to include MarineSpace *et al*. (2013b) methodology for identifying potential spawning habitat for herring.
JNCC	24 July 2019 Email	Consultation feedback received on the draft Deemed Marine Licence ('dML')
Southern IFCA	July 2019 Email communications	Information and spatial data (provided on 25 July 2019) on the location of oyster beds in the Solent.
NE	25 July 2019 Teleconference	Review and discussions on the draft dML.
EA	31 July 2019 Email	Review and feedback on the draft dML.
MMO	1 August 2019 Teleconference	Review and discussions on the draft dML.
JNCC	13 August 2019	Review and feedback on the draft dML.

Consultee	Date (Method of Consultation)	Discussion
	Email	
EA	20 August 2019 Email	Review and agreement on the Applicant's responses to EA feedback on the PEIR.
Southern IFCA	28 August 2019 Email	Provided Applicant's responses to Southern IFCA feedback on the PEIR.
PINS	23 August 2019 Letter/Email	Feedback on draft HRA.
MMO	19 September and 02 October 2019 Email	MMO are content with approach to cumulative assessment and requested one new coastal project to be added to long list.
NE	20 September 2019 Email	Feedback on draft HRA.
MMO	23 September 2019 Email	Feedback on approach to sandeel and herring assessment.
EA	26 September 2019 Email	Review and feedback on the WFD assessment and HRA report.
JNCC	28 September 2019 Email	Feedback on draft HRA. Further feedback provided on 11 October 2019 in response to query for clarification.
States of Alderney	01 October 2019 Email	Feedback on draft HRA.
NE	08 October 2019 Email	Review and feedback on MCZ assessment.
JNCC	09 October 2019 Email	Review and feedback on MCZ assessment.
NE	09 October 2019 Email	NE are content with the plume dispersion modelling approach taken for disposal activities and the resultant outputs with respect to predicted sedimentation and Suspended Sediment Concentration ('SSC') levels, spatial extent and duration.
MMO	11 October 2019 Email	MMO provided feedback that the rationale for the additional 10% non-burial protection contingency during operation looks satisfactory however further

Consultee	Date (Method of Consultation)	Discussion
		clarity to be provided post submission.
MMO/Cefas	22 October 2019	Review and feedback on the disposal site characterisation report.

9.3.4.2. Consultation on the standalone HRA Report (document reference 6.8.1) was undertaken with statutory and non-statutory consultees including NE, EA, JNCC and the State of Alderney. Feedback on the MCZ assessment is presented in Appendix 8.5 (Marine Conservation Zone Assessment) of the ES Volume 3 (document reference 6.3.8.5).

9.3.4.3. Comments received from these consultations on the HRA for fish and shellfish specifically are provided in HRA Report Appendix 4 (Habitats Regulations Assessment Consultation Responses, document reference 6.8.2.4).

9.3.4.4. The key items with relevance to this chapter of the ES included;

- PINS strongly advised the Applicant to seek agreement with relevant consultation bodies, including NE, on the approach to baseline data appropriate for use in the HRA.
- NE were content with the data sources used to inform the environmental baseline used for the HRA.
- NE agreed with the UK Special Areas of Conservation ('SACs') screened in for the HRA.
- NE agreed with the approach to HRA in combination assessment and were content with the list of projects identified for assessment.
- EA were content with the approach and conclusions made in the HRA.

9.3.5. ELEMENTS SCOPED OUT OF THE ASSESSMENT

9.3.5.1. No elements have been scoped out of the assessment.

9.3.6. IMPACTS SCOPED IN TO THE ASSESSMENT

9.3.6.1. The following impacts have been scoped into the assessment:

- Construction (and decommissioning):
  - Temporary habitat disturbance/temporary habitat loss;
  - Temporary increase in suspended sediments and smothering;
  - Entrainment/Removal of eggs and larvae; and
  - Noise and vibration.
- Operation (including repair and maintenance):

- Seabed disturbance (and associated increases in sediment concentrations and deposition):
- EMF; and
- Permanent habitat loss.

9.4. ASSESSMENT METHODOLOGY

9.4.1.1. The assessment methodology used for fish and shellfish has followed that recommended by CIEEM for ecological impact assessment of marine and coastal developments (CIEEM, 2019). CIEEM promotes the highest standards of practice for the benefit of nature and society. These guidelines set out the process for assessment through the following stages:

- Describing the baseline within the study area;
- Identifying the receptors;
- Determining the nature conservation importance of the receptors present within the study area that may be affected by the Proposed Development;
- Identifying and characterising the potential impacts, based on the nature of the construction, operation and maintenance including repair and replacement, and decommissioning activities associated with the Proposed Development;
- Determining the significance of the impacts, using expert judgement;
- Identifying the counter effect of any mitigation measures to be undertaken, that may be implemented in order to address significant adverse effects;
- Determining the residual impact significance after the effects of mitigation have been considered; and
- Assessing cumulative effects (with mitigation where applicable).

9.4.2. CHARACTERISING THE IMPACT

9.4.2.1. Each impact has been characterised in accordance with CIEEM (2019) guidelines. Wherever possible, the following criteria used to qualitatively describe each impact:

- Positive or Negative – direction of change in accordance with nature conservation objectives and policy;
- Extent – geographical area over which the impact will extend;
- Magnitude – size, amount, intensity, or volume of any change;
- Duration – time over which the impact will occur;
- Timing – coincidence with receptor activities;
- Frequency – how often the impact will occur; and
- Reversibility – recovery potential.

9.4.3. DETERMINING SIGNIFICANCE

9.4.3.1. The evaluation of whether an effect is ecologically significant will be undertaken in line with CIEEM (2019) guidance. In determining whether an effect is of ecological significance, the following was considered:

- Any removal or change of any process or key characteristic;
- Any effect on the nature, extent, structure, and function of the component habitats; and
- Any effect on the average population size or viability of component species.

9.4.3.2. Assessments were undertaken in the context of the wider conservation status of that receptor, and where uncertainty exists this has been acknowledged, and professional judgement applied.

9.4.3.3. In general, significance is assessed on a population level for receptor species, rather than impacts to individual animals, whereby a significant effect is only be concluded should the impact affect the viability of the population within the study area. For example, a significant effect is considered to be one which changes the structure and function of an ecosystem within the study area, or one which undermines the conservation objectives of a designated site, the conservation status of qualifying features or habitats; and/or affects the condition of the site or its interest/qualifying features.

9.4.3.4. It should be noted that as per CIEEM (2019) guidance, all receptors are not assessed for all impacts, rather, only those receptors that are potentially vulnerable to an impact, or where a significant effect may arise have been assessed.

9.4.3.5. Embedded mitigation and, where appropriate, additional mitigation measures have been identified and described where they will avoid, reduce and/or compensate for potentially significant effects. This includes avoidance through the design process. It is also good practice to propose mitigation measures to reduce negative effects that are not significant.

9.4.4. ASSUMPTIONS AND LIMITATIONS

9.4.4.1. Assessment has been undertaken based on the information provided within Chapter 3 (Description of the Proposed Development) of the ES Volume 1 (document reference 6.1.3) and using the worst-case design parameters presented in Appendix 3.2 (Marine Worst-Case Design Parameters) of the ES Volume 3 (document reference 6.3.3.2). How these parameters are relevant for worst case scenarios for fish and shellfish ecology is presented in Section 9.6.3.

9.4.4.2. Data was gathered from a wide variety of data sources and information on the limitation of these data sources is provided in Table 9.2. The study area for identification of receptors is defined in Section 9.1.2

9.4.4.3. The Zones of Influence ('ZOI's) are defined per impact as each potential impact differs in spatial extent. The spatial extent of each impact is defined in Section 9.6.

9.5. BASELINE ENVIRONMENT

9.5.1.1. The following sets out the baseline for the relevant fish and shellfish receptors for the Proposed Development. Although the Entire Marine Cable Corridor will pass through both English and French waters, this chapter concentrates on the Proposed Development within the UK Marine Area of the Channel, although information from outside of the UK Marine Area is also presented if it contributes to the assessment.

9.5.2. DATA SOURCES

9.5.2.1. The baseline has been compiled from desk-based sources due to the wealth of information already available for the Channel. The most up to date data was used at the time of writing this chapter. Although no site-specific surveys have been undertaken, a thorough literature review of publicly available data has been used to inform this baseline in addition to those data sources identified in the Scoping Opinion (Table 9.2).

Table 9.2 – Data sources

Organisation	Data Type	Details of data available and data limitations
MMO	Commercial fisheries landings data by ICES rectangle	2013 – 2017 UK landings data for UK ports for ICES rectangles 28F0, 29E9, 29F0, 30E8, 30E9 and 28F1 (MMO, 2019). 2012 – 2016 Foreign landings data for UK ports for ICES rectangles 29E9, 29F0 and 30E9. 2014 – 2016 Foreign landings data for UK ports for ICES rectangle 28F0. There are limitations to this data namely, not all species are represented; ICES rectangles cover an area of 900 nmi^2 so identifying exact areas within the rectangles where fish were caught is impossible; species of conservation importance such as shad cannot be internationally harmed or killed within coastal waters (12 nmi limit) therefore landings of these species in coastal rectangles (30E8 and 30E9) may not be representative of shad numbers. 2018 data was not available at the time of writing.
ICES	Commercial fisheries landings data by ICES Area	2011 – 2015 ICES landings data for all ports from member countries (Belgium, Denmark, France, Germany, Ireland, Lithuania, Netherlands, Poland, Spain and UK) that fished in ICES Area VII.7.d. (ICES, 2018a). The limitations of these data include; not all species are

Organisation	Data Type	Details of data available and data limitations
		represented; ICES areas cover a large area of the sea (Area VII.7.d. is 9717.98 nmi^2) so identifying where species were caught within the ICES area is impossible; landings data are recorded for each member state which may be subject to different landings regulations.
ICES	Survey data	Long term monitoring of commercial demersal and pelagic fish for stock assessments, changes in distribution and abundance. The limitation is that it is only for fish species.
Coull *et al.* (1998)	Report	Fisheries sensitivity maps in British waters (Coull *et al.*, 1998). The limitations of these data is the age (20 years old) and the limited species it covers. In addition, spawning distributions are under continual revision. The maps are not rigid, unchanging descriptions of presence and absence.
Ellis *et al.* (2012)	Report	Spawning and nursery grounds of selected fish species in UK waters (Ellis *et al.*, 2012). The limitation of these data is considered to be the limited number of species it covers, with data not available for all fish species and many coastal, continental shelf and shelf edge waters.
AQUIND benthic surveys	Project specific benthic surveys	Site specific benthic surveys were undertaken along the entire length of the Marine Cable Corridor. Consisting of 42 benthic grabs between the UK and France (July 2017 – March 2018), drop down video surveys and 10 contaminated sediment samples within the UK (see Appendix 8.1 (Benthic Ecology Survey Report) and Appendix 7.3 (Contaminated Sediment Survey Report) of the ES Volume 3 (document reference 6.3.7.3)). This survey data is for benthos and doesn't specifically include fish and shellfish.
Rampion Offshore Wind Farm ('OWF')	Project specific Fish surveys	Site specific fish survey for the EIA, were undertaken in 2011 – 2012 which included: demersal otter trawling scientific 2 m beam trawls; commercial beam trawls (RSK, 2012). In addition, assessment of the spawning

Organisation	Data Type	Details of data available and data limitations
		condition of black seabream by assessing commercially landed fish caught in the Rampion offshore array area in 2012 and 2013 (RSK, 2016); as well as a desk-based study on black seabream in the English Channel off the Sussex Coast (EMU, 2012). These surveys centred on Rampion OWF which is approximately 20 km to the east of the Proposed Development.
Navitus Bay Wind Farm	Project specific fish surveys	Site specific fish surveys were conducted, which included fixed large mesh trammel and finer mesh gill nets to target electro-sensitive elasmobranch and other demersal fish and shellfish species (Navitus Bay Development Ltd, 2014). These surveys centred on the Navitus Bay OWF which is approx. 30 km to the west of the Proposed Development.
IFA2 High-Voltage, Direct Current ('HDVC') Interconnector	Project specific benthic surveys	Grab and drop-down video ('DDV') surveys conducted to characterise the benthic communities along the cable route (IFA2, 2016). This survey is for benthos and doesn't specifically include fish and shellfish.
EA	Transitional and coastal waters ('TraC') Fish Monitoring Programme	2011 – 2016 Fish counts for all species for all areas and all years – takes into account migratory species that may occur near the Proposed Development at various times of the year (Environment Agency, 2018). The limitation of these data is that deeper water fish species are likely to be under represented.
Cefas	The Cefas Young Fish Survey	A 30-year demersal fisheries study (from 1981 to 1997) using fine mesh beam trawl gear covering the inshore ICES rectangles 30E8 and 30E9 (Rogers *et al.*, 1998). The limitations of these data is the age (21 years) with fish diversity and structure likely to have changed. In addition, some species may not be recorded (e.g. smelt) as survey methodology is not specific to individual species.

Organisation	Data Type	Details of data available and data limitations
Cefas	Solent Bass Pre-recruit Survey	Long term survey initiated in 1970's assessing the abundance of two – four-year-old bass species and density of other incidental catch in the inshore ICES rectangles 30E8 and 30E9 (Cefas, 2016). This data only covers the inshore areas with bass numbers outside these areas not represented.
Cefas	The Fish Atlas of the Celtic Sea, North Sea and Baltic Sea	This atlas presents the current data of all Western European species in the period 1977 to 2013 with particular focus on commercially interesting species (Heessen *et al.*, 2015). The limitations of this data source is that it focuses on commercially interesting species, with other species having less of a focus.
Cefas/ICES	International Herring Larvae Survey (IHLS)	The IHLS (1967-2017) provide quantitative estimates of herring larval abundance. Data is available from 1972. It covers ICES rectangles 28F0, 29E9, 29F0, 30E8, 30E9 and 28F1. It is shown not to be an area of high density (ICES, 2018b).
MMO	Report	East English Channel Herring Spawning Assessment (RPS, 2013) for the East Channel Association. This report focuses on the eastern Channel which is outside the Proposed Development, however there is focus on the herring spawning area through which the Proposed Development passes.
Southern IFCA	Fish and shellfish studies within this region	Solent Oyster Fishery stock survey report (Southern IFCA, 2018a), Native oyster stock assessment (Southern IFCA, 2017a), Solent bivalve stock assessment (Southern IFCA, 2017b), Black seabream status report (Southern IFCA, 2014), fish monitoring (Southern IFCA, 2017c), Solent Oyster Management Plan (Southern IFCA 2017d), Solent Manila Clam Management Plan (Southern IFCA, 2018b) and black seabream sidescan sonar surveys (Cooper, P. *pers. comms*., 2018). These are species specific studies undertaken throughout the Southern IFCA's area, however, only a

Organisation	Data Type	Details of data available and data limitations
		small number of survey sites are in the vicinity of the Marine Cable Corridor. Black seabream sidescan sonar surveys were in the coastal zone on the south east coast of the Isle of Wight.
Sussex IFCA	Fish and shellfish studies within this region	Side scan sonar surveys of seabream nests (2014) (Fugro EMU, 2015), Anglers activity - recording of recreational caught seabream within the Kingmere MCZ, annual small fish surveys (Sussex IFCA, 2017a), native oyster stock assessment in Chichester Harbour (Sussex IFCA, 2017b), native oyster fishery valuation assessment in Chichester Harbour (Williams *et al.*, 2018; Williams & Davis, 2018). The limitations of this data are the distances from the Proposed Development, with the nearest study being undertaken in Chichester Harbour.
Hanson Aggregates Marine Ltd ('HAML')	Black seabream nest area survey on in West Sussex	Multibeam and sidescan sonar and DDV surveys of six black seabream nest areas 12 km south of Littlehampton and Bognor Regis (EMU, 2011). The applicability of these surveys is limited due to their distance from the Marine Cable Corridor.
Natural Power	Particle Size Distribution (PSD) data	PSD data from benthic samples taken during the benthic surveys of the Marine Cable Corridor (Chapter 8 (Benthic and Intertidal Habitats) of the ES Volume 1 (document reference 6.1.8))
British Geographical Society (BGS) data	Geographical Information System ('GIS') data layer on the makeup of the seabed	Marine sediments 250k digital map showing the distribution of seabed sediment types in the UK area. Seabed sediments were mapped further offshore, where the most recent deposits commonly form a veneer or superficial layer of unconsolidated material on the seabed. Their distribution and composition is determined using a range of remotely sensed and physical ground-truthing data.

9.5.3. MARINE CABLE CORRIDOR

9.5.3.1. The South Marine Plan (MMO, 2013 and 2018) provides a good overview of species present in the UK Channel:

- The deeper waters in the mid Channel are dominated by thickback sole (*Microchirus variegatus*) and red gurnard (*Chelidonichthys cuculus*) and the inshore waters are dominated by flatfish such as plaice (*Pleuronectes platessa*), dab (*Limanda limanda*), sole (*Solea solea*) and solenette (*Buglossidium luteum*), with other inshore species including lesser weever (*Echiichthys vipera*) and common dragonet (*Callionymus lyra*);

- Species of conservation interest that occur in the South Marine Plan areas include seahorses which are occasionally caught off Sussex and Dorset;
- Estuarine fish communities are generally considered to be in poor status in the South Marine Plan areas;
- Seabass (*Dicentrarchus labrax*) have dominated catches since 1983 in the river catchments opening into the Solent (Test, Itchen, Hamble, Bealieu and Lymington); and
- Salmon (*Salmo salar*) numbers have shown declines in many rivers since 1988, with both Cefas and the EA classifying populations in the Test, Itchen, Hampshire-Avon as failing statutory conservation limits. However, recent increases have been evidenced in both the Test and Itchen.

9.5.3.2. Commercial fisheries data provides a greater insight into the range of species found within the Marine Cable Corridor. MMO landings data provides information on UK and foreign vessel landing into UK ports for individual ICES rectangles (see Figure 9.2 of the ES Volume 2 (document reference 6.2.9.2)). While there may be some data gaps (e.g. landing foreign vessels into foreign ports), this data does provide a good picture of the range of species captured in the study area. Full analysis of fish landings from all nationalities fishing in the study area is provided in Chapter 12 (Commercial Fisheries) of the ES Volume 1 (document reference 6.1.12).

9.5.3.3. The most recent five years' worth of fisheries data was examined in order to provide a list of species recorded in commercial fisheries landings (MMO, 2018; average tonnage 2013 – 2017). Of the six ICES rectangles which cover the whole of the Channel area, 30E9, 29E9, and 29F0 are within the UK Marine Area, and therefore cover the Marine Cable Corridor (Figure 9.1; Table 9.3) while 28F0 and 28F1 are entirely in French waters. Landings data for rectangle 28F1 is not available from the MMO as it is entirely in French fisheries limits and there are no UK landings in this rectangle.

9.5.3.4. For the ICES rectangles that cover the UK coastal waters (30E8 and 30E9) there were a total of 71 fish and 24 shellfish species over the five-year period examined (Table 9.3). In inshore rectangle 30E8, where the Landfall is located, 71 fish and 28 shellfish species were recorded over this five-year period. This rectangle had a relatively low catch of fish (by weight) with sole, bass, mullet (*Mugilidae sp.*) and plaice dominating landings, other species include smooth-hound (*Mustelus mustelus*), thornback ray (*Raja clavata*), pollock (*Pollachius pollachius*), lesser spotted dogfish (*Scyliorhinus canicular*), cod (*Gadus morhua*) and brill (*Scophthalmus rhombus*). In rectangle 30E9, horse mackerel (*Trachurus trachurus*) was the dominant species by weight followed by plaice, herring (*Clupea harengus*), sole, bass and black seabream (*Spondyliosoma cantharus*) (Plate 9.1). Other species in this rectangle include lesser spotted dogfish, smooth-hound cod and gurnard (*Triglidae sp.*).

Table 9.3 – All commercial fish and shellfish species landed in the ICES Rectangles covering the Marine Cable Corridor

ICES Rectangle	All Fish Species Caught
30E9	Albacore (*Thunnus alalunga*), bass, blonde ray (*Raja brachyura*), black seabream, blue ling (*Molva dipterygia*), bonito (*Scombridae sp.*), brill, brown shrimp (*Crangon crangon*), catfish (*Siluriformes sp.*), cockles (*Cerastoderma edule*), cod, common dragonet, common mora (*Mora moro*), common prawn (*Palaemon serratus*), conger eels, cuckoo ray (*Leucoraja naevus*), cuttlefish (*Sepiida sp.*) dab, dogfish (*Scyliorhinidae sp.*), edible crab (*Cancer pagerus),* eels, flounder, garfish (*Belone belone*), gilt-head seabream (*Sparus aurata),* greater weever (*Trachinus draco*), green crab (*Carcinus maenas*), gurnard and latchet. (*Trigiidae sp.*), grey gurnards (*Eutrigla gurnardus*), red gurnard, haddock (*Melanogrammus aeglefinus*), hake (*Merluccius merluccius*), halibut (*Hippoglossus hippoglossus*) herring, horse mackerel, John Dory (*Zeus faber*), King scallop (*Pecten maximus*), lesser spotted dogfish, ling (*Molva molva*), lobster (*Homarus gammarus*,) long-nosed skate (*Dipturus oxyrinchus*), lumpfish (*Cyclopteridae sp.*), manilla clam (*Venerupis philippinarum*), megrim (*Lepidorhombus whiffiagonis*), mixed clams, monkfish or anglers fish, mullet, mussels (*Mytilidae, sp.*), native oyster (*Ostrea edulis*), *Nephrops* (Norway Lobster), nursehound (*Scyliorhinus stellaris*), octopus, periwinkle (*Littorina littorea*), Pacific oysters (*Magallana gigas*), pilchards (*Sardina pilchardus*), plaice, pollock, Portuguese oysters (*Mangallana angulata*), pouting (*Trisopterus luscus*), queen scallops (*Aequipecten opercularis*), red mullet, rockling, saithe (*Pollachius virens*), sand sole (*Pegusa lascaris*), seabreams, sea urchin (*Echinoidea sp.*), shad (*Alosinae sp.),* sole*,* pink shrimps (*Pandalus* borealis), small-eyed ray (*Raja microocellata*), smooth-hound, spider crabs, spotted ray (*Raja montagui*), sprats (*Sprattus sprattus*), spurdog, starry ray (*Raja asterias*), starry smooth-hound (*Mustelus asterias*), squid (*Cephalopoda sp.*), thornback ray, thresher shark (*Alopiidae sp.*), tope (*Galeorhinus galeus*), topknot, triggerfish (*Balistidae sp.),* tub gurnards (*Chelidonichthys lucerna*), turbot (*Zeugopterus punctatus*), undulate ray (*Raja undulata*), squal sharks (*Squaliformes sp.*), velvet swim crab (*Necora puber*), wedge

ICES Rectangle	All Fish Species Caught
	sole (*Dicologlossa cuneata*), whelk (*Buccinum undatum*), witch (*Glyptocephalus cynoglossus*), wrasses (*Labridae*).
30E8	Bass, blonde ray, brill, brown shrimps, catfish, chub mackerel (*Scomber japonicus*), clams, cockles, cod, common prawns, conger eels (*Congridae sp.*), crawfish, cuckoo ray, cuttlefish, dabs, dogfish, edible crabs, eels (*Anguilla Anguilla*) flounder (*Platichthys flesus)* garfish, gilt-head seabream, green crab, gurnard and latchet, grey gurnards, red gurnards, haddock, hake, halibut, herring, horse mackerel, John Dory, king scallop, lemon sole, lesser spotted dogfish, ling, lobsters, lumpfish, manilla clam (*Venerupis philippinarum*), megrim, monks or anglers, mixed clams, mussels, mullet (*Mugilidae sp.*), native oysters, Norway Lobster (*Nephrops norvegicus*), octopus, Pacific oysters, periwinkles, pink shrimps, plaice, Portuguese oysters, pollock, pouting, razor clam (*Ensis magnus),* red mullet, rockling (*Lotidae sp.*), saithe, sand sole, sandy ray (*Leucoraja circularis*), scorpionfish (*Scorpaenidae sp.*), seabreams, shad, shagreen ray (*Leucoraja fullonica*), sole, pink shrimps, small-eyed ray, spider crabs, spotted ray, sprats, spurdog, squid, starry ray, starry smooth-hound, thornback ray, tope, topknot, triggerfish, turbot, undulate ray, velvet swim crab, wedge sole, whelks, whiting (*Merlangius merlangus*), witch, wrasses.
29F0	Axillary seabream (*Pagellus acarne*), black seabream, blonde ray, Brill, catfish, cod, common mora, conger eels, cuckoo ray, cuttlefish, dabs, dogfish, edible crabs, eels, flounder, greater weever, gurnard and latchet, grey gurnard, red gurnards, haddock, hake, herring, horse mackerel, John Dory, King scallop, lemon sole, lesser spotted dogfish, ling, lobsters, long-nosed skate, lumpfish, mackerel, megrim, mixed clams, monks or anglers, mullet, octopus, pilchard, pollock, pouting queen scallop, red seabream (*Pagellus bogaraveo*), redfishes (*Beryciformes sp.*), red mullet (*Mullus surmuletus*), saithe, sand sole, round sardinella (*Sardinella aurita*), shad, small-eyed ray, smooth-hound, sole, spotted ray, spurdog, starry smooth-hound, squid, sunfish, thornback ray, tope, tub gurnards, turbot, weever fishes, whelk, whiting, witch, wrasses.

9.5.3.5. The mid Channel rectangles of 29E9 and 29F0 both show a total of 60 fish and 11 shellfish species, with catches dominated by herring and horse mackerel, with other species including whiting, mackerel, red mullet, tub gurnard *(Chelidonichthys lucerna),* pouting, pilchards, mackerel, red gurnards, dabs, and black seabream. Rectangle 28F0, with a total of 34 fish and six shellfish, highlights comparatively low catches of fish with mackerel and tub gurnards dominating. Other species include horse mackerel, red mullet, red gurnards, whiting, pouting, pilchards, thornback ray and bass.

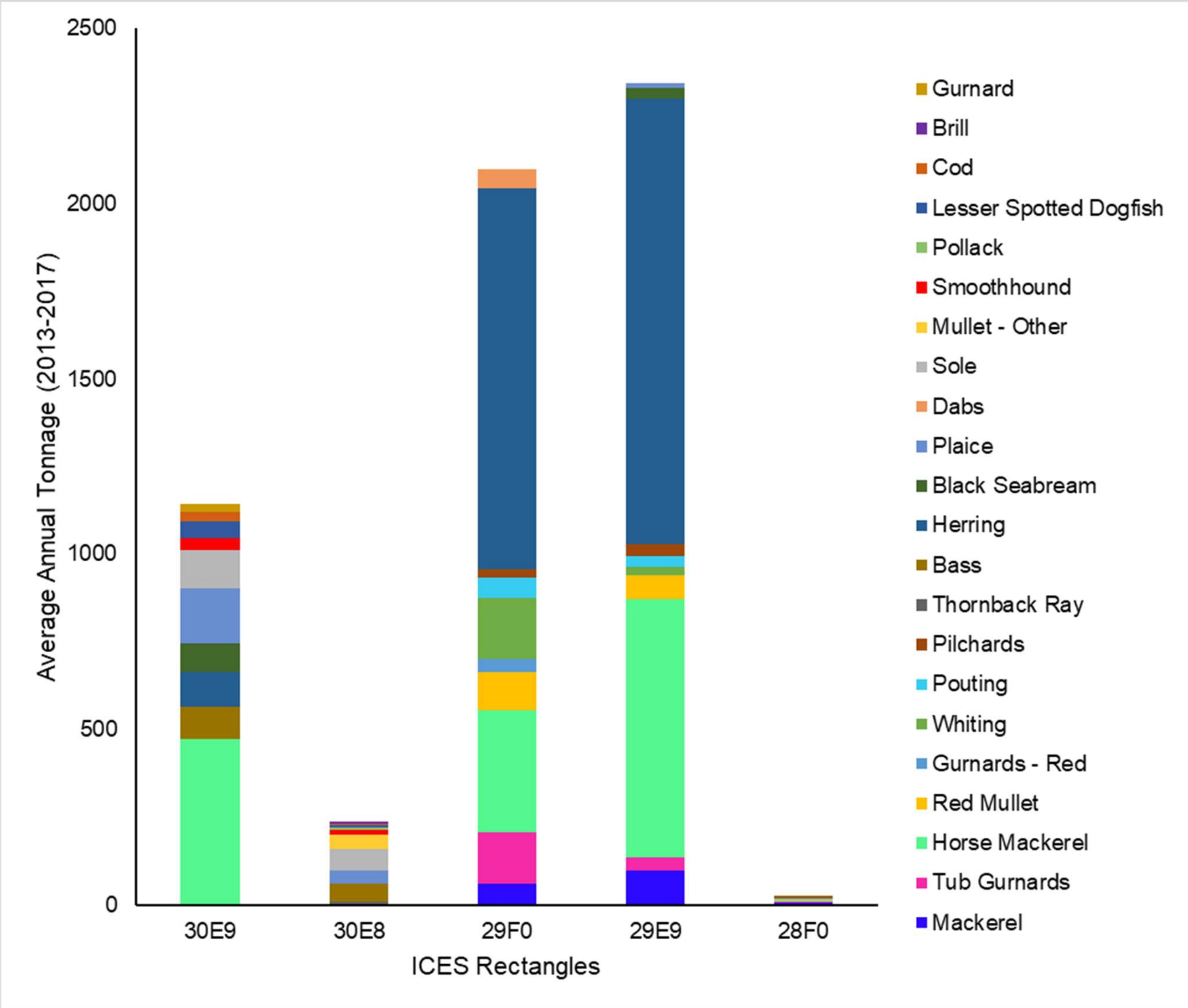

Plate 9.1 – Top 10 Fish species landed in each ICES Rectangles along the Entire Marine Cable Corridor (Annual Average Tonnage; MMO 2013-2017)

9.5.3.6. Shellfish landings in inshore rectangles (30E8 and 30E9) over this same period were dominated by whelks, then scallops (*Pectinidae sp.*), edible crabs, Manilla clam, cuttlefish (*Sepiida sp.*), (*Nephropoidea sp.*), cockles (*Cardiidae* sp.), native oyster (*Ostrea edulis*), squid (*Teuthid* sp.) clams (*Veneridae sp.*), mixed clams and periwinkles (*Littorinidae littorea*) (Plate 9.2). Further offshore in rectangles 29E9 and 29F0 catches are dominated by scallops and to a lesser degree squid, whelks, squid and octopus, cuttlefish, edible crab, lobster, mixed clams, octopus (*Octopda sp.*) and spider crabs (*Majoidea sp.*). Rectangle 28F0 highlights scallops as the dominant shellfish species by weight and also includes squid, edible crab, mixed squid and octopus, cuttlefish and lobster.

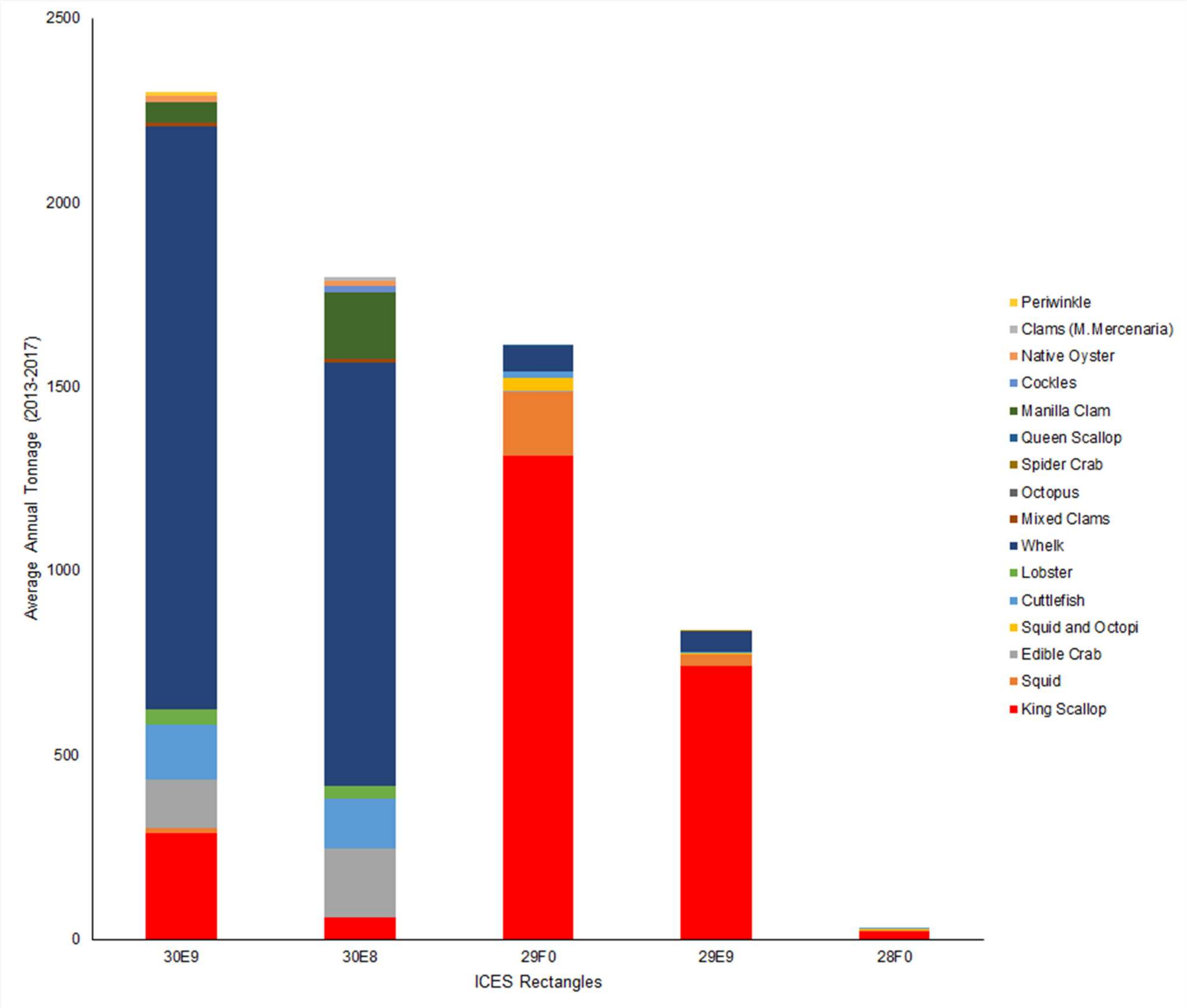

Plate 9.2 – Top 10 shellfish species landed in each ICES Rectangles along the Entire Marine Cable Corridor (Annual Average Tonnage; MMO 2013-2017)

9.5.3.7. The fish assemblage in ICES Division VII.7.d was found to be more diverse with 231 fish and 74 shellfish recorded over the five-year period (2011 – 2015), which is expected as it covers a larger area. In addition, this data covers landings by all member countries and uses different fish categories to the MMO data. Of the top 10 species landed, Atlantic herring was the dominant species followed by a range of mackerel species (horse mackerel, mackerel and jack mackerel (*Trachurus symmetricus*) (Plate 9.3).

9.5.3.8. Shellfish landings in ICES Division VII.7.d were dominated by king scallop, followed by whelks, then common cuttlefish, mussels, edible crab, blue mussels (*Mytilus edulis*) and squid (Plate 9.4). Other shellfish species included cuttlefish, bobtail squid (*Sepiolida sp.*) and Manilla clam.

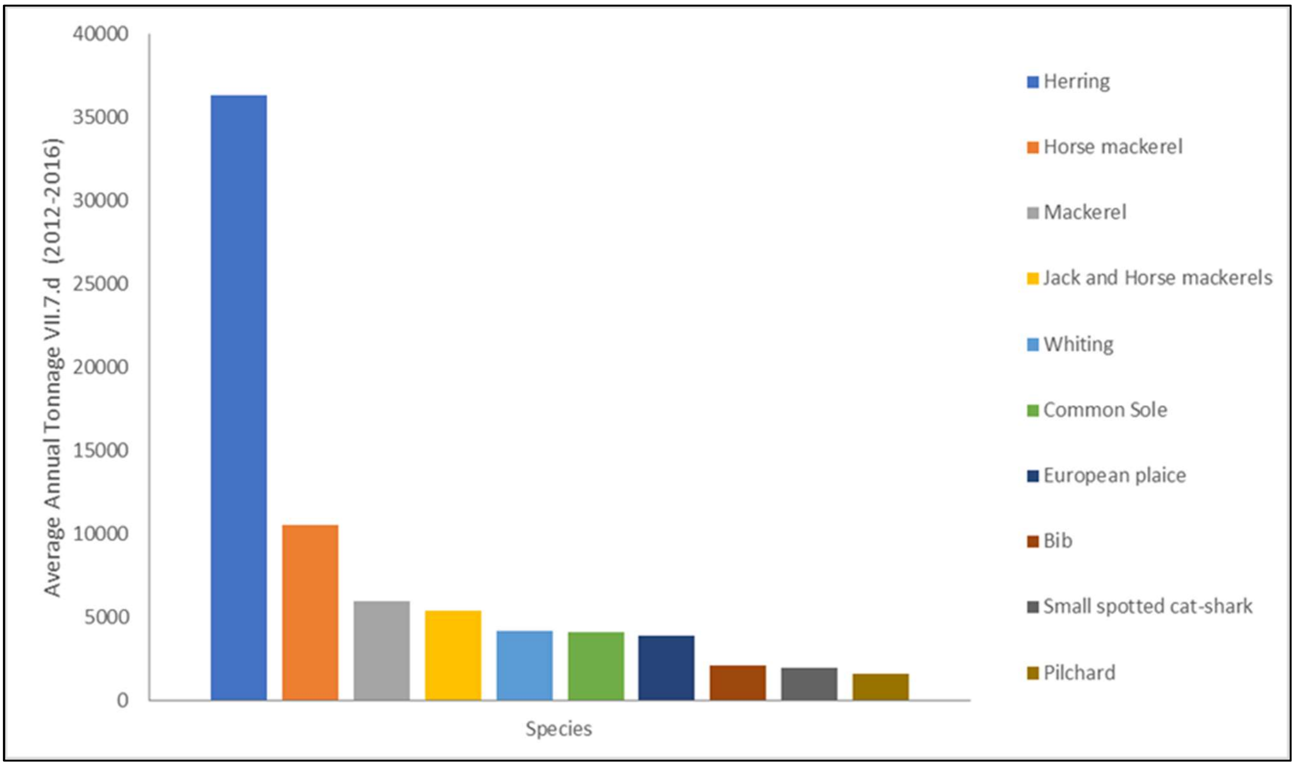

Plate 9.3 – Top 10 fish species (by Weight) landed by Member States (2011-2015) in Division VII.7.d (ICES)

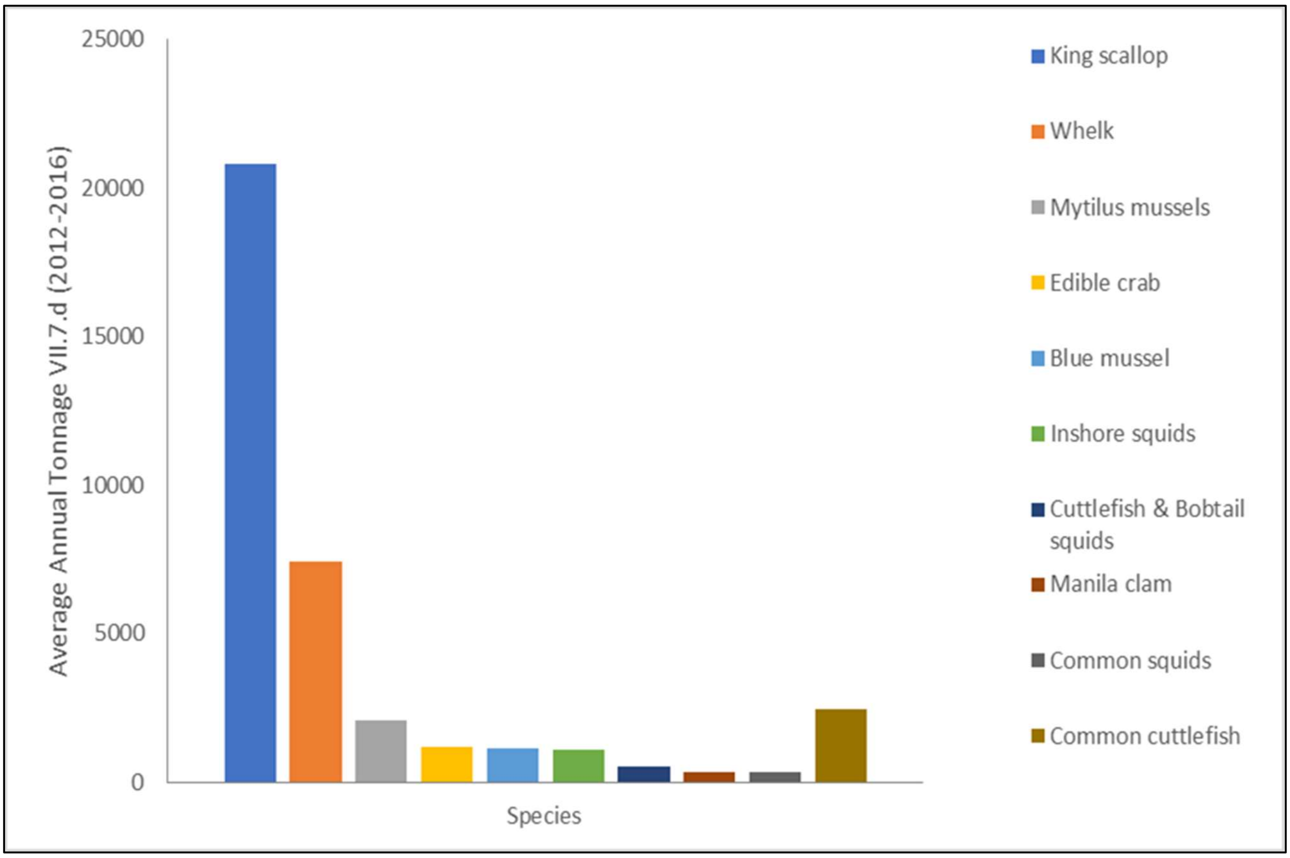

Plate 9.4 – Top 10 Shellfish species (by weight) landed by ICES Member States (2011-2015) in Division VII.7.d (ICES)

9.5.3.9. Additional information on species that are captured by under 15 m vessels in UK waters can be collected by examination of IFCA data. Figure 9.2 illustrates the jurisdiction areas for both the Sussex and Southern IFCAs. Commercial shellfish catch data from the Sussex IFCA (Sussex IFCA, 2017c) identifies that whelks are the dominant species caught in ICES rectangles 30E9 and 30F0, followed by lobster, edible crab, cuttlefish, spider crab, velvet swimming crab, prawns and native oyster (Williams *et al*., 2018 and Williams and Davies, 2018).

Spawning and Nursery Areas

9.5.3.10. A range of fish and shellfish species are known to spawn or have nursery grounds which overlap the study area (Figures 9.3 to 9.5 of the ES Volume 2 (document references 6.2.9.3 to 6.2.9.5)), of which those present within the Marine Cable Corridor are identified in Table 9.4.

9.5.3.11. According to Ellis *et al*. (2012) and Coull *et al*. (1998) this includes spawning grounds for horse mackerel, cod, plaice, sprat, sole and lemon sole, with herring spawning grounds located 5.8 km from the Marine Cable Corridor in the central Channel; and nursery grounds for horse mackerel, whiting, mackerel, plaice, sole, lemon sole, tope, undulate ray and thornback ray. Beyond the boundaries of the Marine Cable Corridor, nursery areas for herring and sprat are present (Ellis *et al*., 2012; Coull *et al*., 1998). Figures 9.3 to 9.5 illustrate the datasets shown in Table 9.4.

Table 9.4 – Spawning and nursery grounds present in Marine Cable Corridor (Coull *et al*., 1998; Ellis *et al*., 2012)

Species	**Spawning areas within the study area**		**Nursery areas within the study area**	
	Coull *et al.* (1998)	**Ellis *et al.* (2012)**	**Coull *et al.* (1998)**	**Ellis *et al.* (2012)**
Cod	Yes	Yes – Low intensity	No	No
Herring	5.8 km from Marine Cable Corridor	N/A	No	Approximately 160 km from Marine Cable Corridor
Mackerel	No	No	Yes	Yes – Low intensity
Horse mackerel	N/A	Yes	N/A	No
Whiting	No	No	No	Yes – Low intensity
Sprat	Yes	Unknown	No	Unknown
Sandeels	No	Yes – Low intensity	No	No
Sole	Yes	Yes – High intensity	No	Yes – Low intensity
Lemon sole	Yes	N/A	Yes	N/A
Plaice	Yes	Yes – High intensity	No	Yes – Low intensity
Tope shark	N/A	N/A	N/A	Yes – Low intensity
Thornback ray	Unknown N/A	N/A	N/A	Yes – Low intensity
Undulate ray	Unknown N/A	N/A	N/A	Yes – Low intensity

9.5.3.12. It is recognised that not all species are represented in Coull *et al*. (1998) and Ellis *et al*. (2011), such as black seabream and bass.

9.5.3.13. 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 (Southern IFCA, 2017a; Collins and Mallinson, 2012; EMU, 2003; EMU, 2009; EMU, 2011; Fugro EMU, 2015) (Figure 9.5). Black seabream specific studies identified black seabream nest areas off the coast of Littlehampton to Bogner Regis (EMU, 2011; EMU, 2003; EMU, 2009), to the east and west of the Rampion OWF and to the north of Kingmere MCZ (EMU, 2012). Black seabream nesting sites were also found on the south east coast of the Isle of Wight (Cooper, P. *pers. Comms*., 2018). According to local anglers, the Bullock Patch, a raised outcrop on the edge of the Solent, is also a known spawning area for this species. Information on the exact geographical extent of the Bullock Patch spawning area is difficult to ascertain, however according to the admiralty chart the north east edge falls within the south west edge of the Marine Cable Corridor (Figure 9.5).

9.5.3.14. Black seabream arrive on the south coast in early spring and construct nests on the seabed into which eggs are laid. Preferred spawning substrates are open gravel areas, gravel areas adjacent to chalk reefs, sandstone reefs and ships wreckage (Vause & Clark, 2011). 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 – 8 cm (Sussex IFCA, 2011).

9.5.3.15. Langstone, Portsmouth and Chichester Harbours (as well as Southampton Water and a small area off Fawley power station) are designated as bass nursery areas under the Bass Order 1999 (Langstone Harbour Board, 2018). The importance of these regions as bass nursery areas was confirmed during the Sussex IFCA small fish surveys and Cefas Solent bass pre-recruit survey when juvenile (one-year old fish) bass were recorded (Sussex IFCA 2017a; Cefas, 2016).

9.5.3.16. It is also noted that while Coull *et al*. (1998) and Ellis *et al*. (2011), provide a sound basis for identifying the location of potential presence of spawning areas, for certain species, additional data should also be considered when establishing a baseline of where spawning may take place. This is the case for herring, which is both commercially and ecologically important, and as substrate spawning fish are particularly vulnerable to impacts that may affect its spawning habitat.

9.5.3.17. Herring spawn on well oxygenated gravel and sandy gravel with little fine material (Ellis *et al*., 2012). Coull *et al*. (1998) cites spawning to occur from November to February, however Orr (2013), through an extensive literature review, suggests spawning actually occurs in December and January only.

9.5.3.18. Coull *et al*. (1998) identified two spawning areas in the eastern Channel; one in French waters (Baie de Seine) and the central Channel, and one due south of the Sussex coast (both of which are part of the Downs stock, which is found in the Channel and southern North Sea). While none of these areas overlap the Marine Cable corridor on the UK side, there is overlap with a section of the French AQUIND marine cable corridor, some 5.8 km away.

9.5.3.19. The South Marine Plan (2018) identifies potential herring spawning areas within the Channel based on densities of herring larvae present (Figure 9.6 of the ES Volume 2 (document reference 6.2.9.6)). Using this data, it can be clearly seen that the UK Marine Cable Corridor passes through areas of 'low' herring larvae density (within

12nmi limit), 'low to medium' (beyond 12 nmi), as well as, a small area of 'high' herring larvae density (near the EEZ).

9.5.3.20. The map in the South Marine Plan (2018) (Figure 26 in the Plan) is based on IHLS data. In order to update this information, data from this survey has been examined from 2007-2017 (Plates 9.5 and 9.6)

9.5.3.21. This clearly shows that the locations of peak herring larvae densities vary from year to year and while the year average does show peak densities in 29F0 particularly sub-rectangle 29F02. However, this should be treated with caution as this was heavily influenced by on one exceptionally high annual average (in 2012) for this ICES square when only one survey was undertaken for that year (for most years 5-6 surveys are undertaken hence high averages tend to be brought down).

9.5.3.22. None the less the 10-year data set does support the information provided in the South Marine Plan and clearly show that the Marine Cable Corridor passes through areas where high herring larvae densities occur in some years.

9.5.3.23. It should also be cautioned that IHLS data may overestimate the area of potential herring spawning habitat due to larval dispersal from the actual egg site/spawning bed (Marine Space *et al*. 2013b). To take this into account, MarineSpace *et al*. (2013b) developed a methodology which provides a framework for which data to use to inform habitat availability, combining PSD habitat data along with other data to demonstrate habitat suitability and demonstrating shifting patterns over years. Herring typically spawn on coarse gravel (0.5-5 cm) through to stone (8-15 cm) substrates, and this methodology categorises these sediments into four sediment preference groups for herring (Table 9.5).

Table 9.5 – Sediment preference groups for herring (MarineSpace *et al.*, 2013b)

Herring Spawning Preference	% Particle contribution (Muds = clays and silts <63 µm)	Folk sediment unit
Preferred	<5% muds, >50% gravel	Gravel and part sandy Gravel
Preferred	<5% muds, >25% gravel	Part sandy Gravel and part gravelly Sand
Suitable	<5% muds, >10% gravel	Part gravelly Sand
Unsuitable	>5% muds, <10% gravel	Everything excluding Gravel, part sandy Gravel and part gravelly Sand

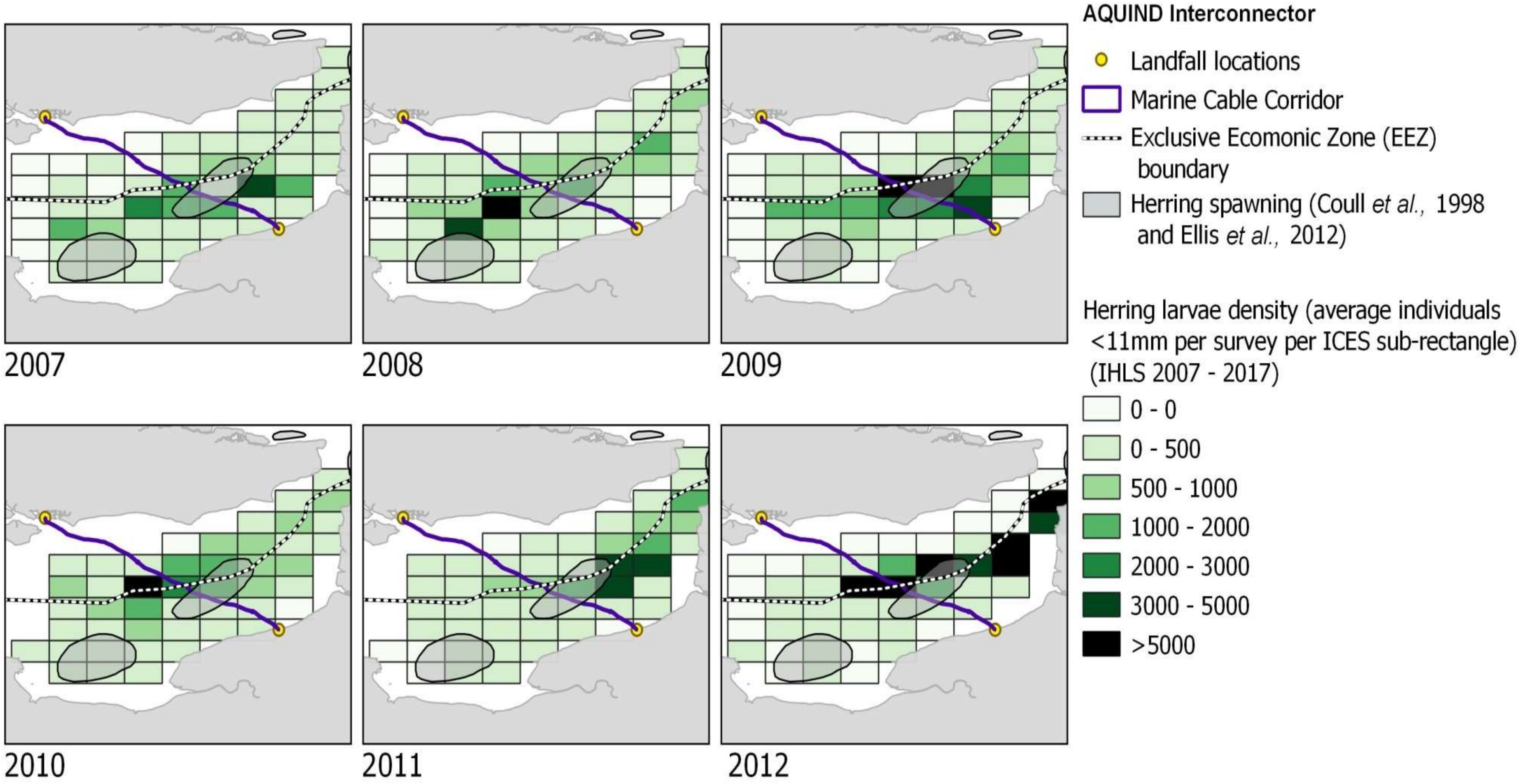

Plate 9.5 – IHLS Data by year (2007 to 2012)

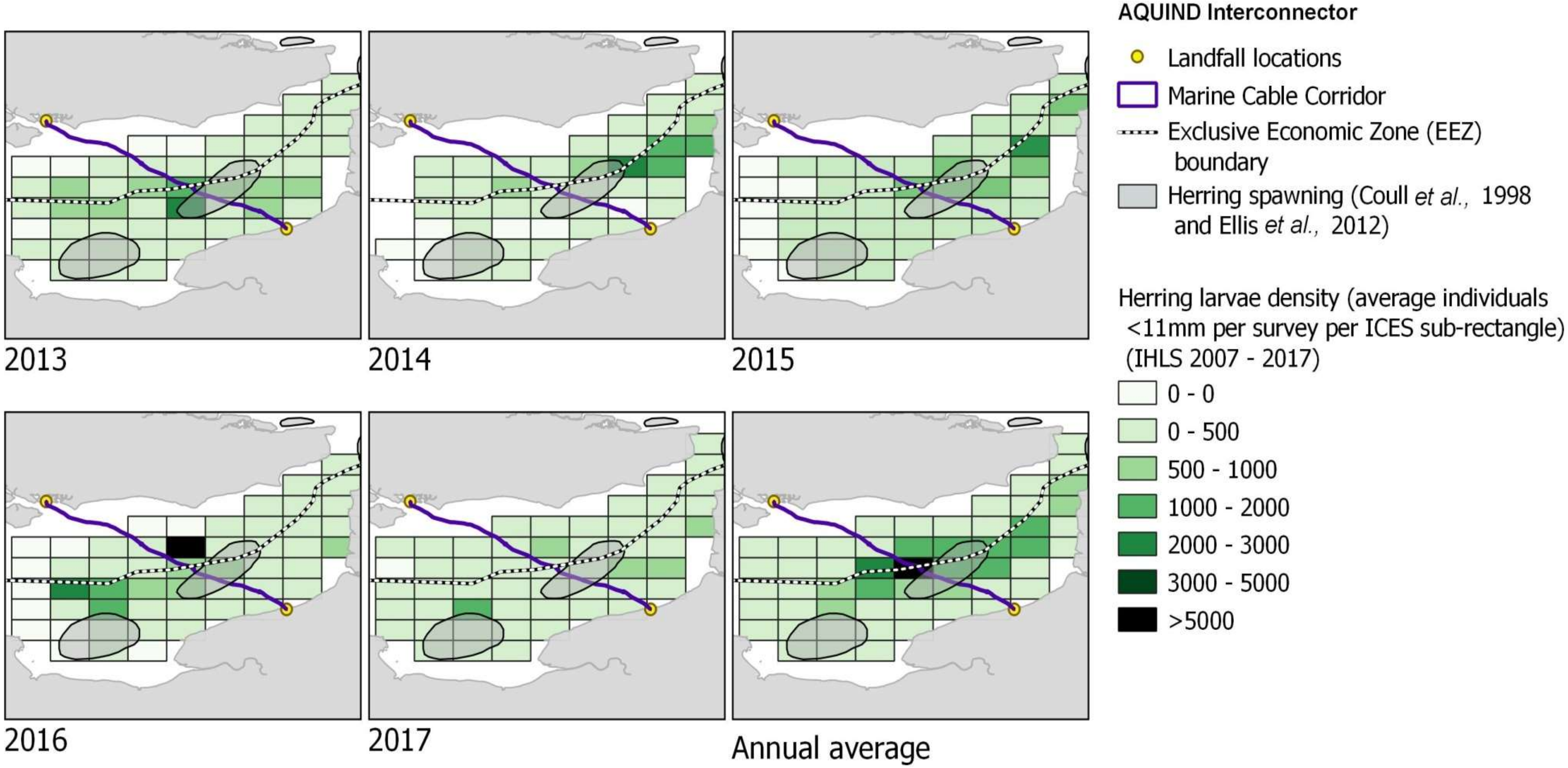

Plate 9.6 – IHLS Data by year (2013 to 2017) and 10-year annual average

9.5.3.24. The PSD data collected during the benthic surveys (Chapter 8 (Intertidal and Benthic Habitats)) for the Proposed Development were overlaid on BGS (2017) sediment characterisation data for the Channel (Figure 9.7). The sediments from both benthic grab samples and those identified by the BGS data were classified as 'preferred', 'marginal' or 'unsuitable' using Folk (1954) and MarineSpace *et al*. (2013b) (Table 9.5). As can be seen from Figure 9.7, the benthic PSD samples correspond well with the background BGS data and the majority of the sediment through which the Marine Cable Corridor passes are 'preferred', with some areas of marginal or unsuitable habitat identified, particularly in the inshore zone, where sediments are less gravelly and more sandy. It can also be seen from Figure 9.7 that large areas of the UK side of the Channel are also identified as preferred herring spawning substrate.

9.5.3.25. Taking into account the Coull *et al*. (1998), Ellis *et al.* (2012), IHLS data, and the interpreted PSD and BGS data (using the MarineSpace *et al*. 2013b methodology) it is clear that the Channel is of importance for herring spawning. However, the exact areas utilised by herring for spawning vary from year to year, depending on the suitability of the sediments and the size of the stock. This variation or preference for alternative spawning substrate is likely to be driven by factors such as oxygenation of sediments, temperature, current speeds and availability of seabed features (ripples and ridges) (National Grid, 2017).

9.5.3.26. In conclusion, while the Marine Cable Corridor does not pass through the spawning area identified for the Downs stock by Coull *et al*. (1998) and Ellis *et al.* (2012), the majority of sediments sampled along the route were identified as preferable for herring spawning and these areas coincides with areas of reasonably high herring larvae density. Hence for the purposes of this assessment it is assumed that the Marine Cable Corridor passes through herring spawning areas.

9.5.3.27. Neither Coull *et al*. (1998) and Ellis *et al.* (2012) identified herring nursery grounds within the Channel, however it is noted that juvenile herring have been caught in both Chichester Harbour and Medmerry during Sussex IFCA's small fish surveys indicating that these inshore bays may be potential nursery areas.

9.5.3.28. Sandeel, are another substrate spawner and of particular ecological importance as they are considered a keystone species playing a considerable role in the marine ecosystem as prey species for fish and other animals. Sandeels choose to spawn on clean sand from November to January/February in the Channel. Coull *et al.,* (1998) did not identify any sandeel spawning or nursery areas in the area that overlaps with the Marine Cable Corridor, however Ellis *et al.,* 2012 assigned the majority of the Channel and Southern North Sea as low intensity spawning grounds. Due to their ecological importance, other sources of data have also been considered to assess the presence of sandeel spawning grounds on the Marine Cable Corridor.

9.5.3.29. Sandeel are faithful to a discrete area of seabed sediment after recruitment (Jensen *et al.,* 2011), as they are dependent on a particular mix of sand/mud/gravel, hence areas of adult occupation act as a proxy for spawning (MarineSpace *et al*. 2013a).

9.5.3.30. Lesser sandeels (*Ammodytes marinus*), have been recorded in the coastal area of the Marine Cable Corridor during small fish surveys by Sussex and Southern IFCA's (Sussex IFCA, 2017a; Southern IFCA, 2017a). Southern IFCA also reported that a small-scale non-commercial fishery for sandeels for use as angling bait for charter vessels in Langstone harbour and overlapping with the Marine Cable Corridor just offshore from Eastney Beach (Patrick Cooper *pers. comm*; Figure 12.9 of the ES Volume 2 (document reference 6.2.12.9)), providing evidence of their presence in this area. It should be noted that beyond the evidence provided by Southern IFCA, no other information on this fishery can be found and there are no records of sandeel landings in the MMO landings data (2012-2017) for this ICES rectangle (or other ICES rectangle overlapping the Marine Cable Corridor). This is supported by a lack of VMS data for sandeel dredging in this area (Chapter 12 (Commercial Fisheries).

9.5.3.31. Sandeels are known to favour coarse sand dominated sediments and information on sediment make up can be used to predict where sandeels are likely to be found. In order to provide more specific information on where sandeels are likely to occur along the Marine Cable Corridor MarineSpace *et al.* 2013a methodology (Table 9.6) was used. PSD data of sediments taken from samples collected for the benthic surveys were assessed for their suitability for sandeels and plotted against BGS data (2017) on sediment characterisation data for the Channel, again classified by sandeel habitat preference (Figure 9.8 of the ES Volume 2 (document reference 6.2.9.8)). Spawning and nursery areas as predicted by Coull *et al.,* (1998) and Ellis *et al.,* (2012) were also considered in this assessment. It is worth noting that no commercial fishing data was plotted as there is no Vessel Monitoring System ('VMS') data for sandeel dredging recorded in this area.

Table 9.6 – Sediment preference groups for sandeel (MarineSpace *et al.,* 2013a)

Herring Spawning Preference	% Particle contribution (Muds = clays and silts <63 µm)	Folk sediment unit
Preferred	<1% muds, >85% Sand	Part Sand, Part slightly gravelly Sand and part gravelly Sand
Preferred	<4% muds, >70% Sand	Part Sand, Part slightly gravelly Sand and part gravelly Sand
Suitable	<10% muds, >50% Sand	Part gravelly Sand and part sandy Gravel
Unsuitable	>10% muds, <50% Sand	Everything excluding Gravel, part sandy Gravel

		and part gravelly Sand

9.5.3.32. The results of the sandeel habitat classification of the PSD largely match the sandeel preference classified BGS data for the majority of the Marine Cable Corridor, with the exception within the Solent where PSD data was found to be 'unsuitable' where BGS data was predicted to be 'preferred'. This can likely be attributed to the broad scale nature of the BGS data. The majority of stations along the Marine Cable Corridor were either classified as 'marginal' or 'unsuitable', with only one benthic sampling station identified as 'preferred' close to the Landfall at Eastney. This coincides with the reports of sandeels in this area and the non-commercial fishery for bait from Southern IFCA.

9.5.3.33. In conclusion, while Ellis *et al.,* (2012) identify only low intensity sandeel spawning grounds in the areas overlapping with the Marine Cable Corridor, the majority of the Marine Cable Corridor has been classified as marginal or unsuitable habitat for sandeels. Only one area of preferred habitat was identified close to the Landfall at Eastney where sandeels are known to occur (Southern IFCA *pers. comm*). Hence, as sandeels are faithful to specific habitats, there may be some spawning and nursery sites in proximity to the Landfall.

Species of Conservation Importance

9.5.3.34. There are a number of SACs, Sites of Special Scientific Interest ('SSSI'), and MCZs designated for fish and shellfish species within the vicinity of the Proposed Development, these include migratory fish as well as other species of fish and shellfish (Table 9.7; Figure 9.9 of the ES Volume 2 (document reference 6.2.9.9)).

9.5.3.35. Whilst some recommended MCZs ('rMCZ') are listed below which have subsequently been dropped from formal designation, they have been included for the sake of completeness and the features of those sites have been considered as part of the impact assessment where relevant.

Table 9.7 – SACs, MCZs, SSSIs and WFD highly sensitive habitats designated for fish and shellfish species in the vicinity of the Marine Cable Corridor

Name	Criteria*	Status	Approx. closest Distance to the Proposed Development (km)
Bembridge (MCZ)	Feature species: Short-snouted seahorse (*Hippocampus hippocampus*) and native oyster	Designated	3.8
Selsey Bill and the Hounds	Feature species: Short-snouted	Designated	4

Name	Criteria*	Status	Approx. closest Distance to the Proposed Development (km)
(MCZ)	seahorse		
Norris to Ryde (rMCZ)	Feature species: Native oysters	Dropped	6.9
Fareham Creek (rMCZ)	Feature species: Native oysters	Dropped	7.6
Kingmere (MCZ)	Feature species: Black seabream nesting site	Designated	10.8
Yarmouth to Cowes (MCZ)	Feature species: Native oysters	Designated	19.9
WFD high sensitivity habitat	Mussel beds	-	20
River Itchen (SAC and SSSI)	Designated for: Atlantic salmon; river lamprey; brown trout.	Designated	27.5
Beachy Head West (MCZ)	Feature species: Blue mussel beds; native oyster and short-snouted seahorse	Designated	34.5
The Needles (MCZ)	Feature species: Native oysters	Designated	35.4
Beachy Head East (MCZ)	Feature species: Short-snouted seahorse	Designated	44.5
River Avon (SAC and SSSI)	Designated for: Sea lamprey and Atlantic salmon	Designated	51.4
Southbourne Rough (MCZ)	Feature species: Black seabream nesting site	Designated	55
Poole Rocks (MCZ)	Feature species: Native oysters Black seabream nesting site Couch's goby (*Gobius couchi*)	Designated	59.1
Purbeck Coast (MCZ)	Feature species: Black seabream nesting site	Designated	63
Studland Bay (MCZ)	Feature species: long snouted seahorse	Designated	63.7
River Axe SAC	Designated for: Sea lamprey	Designated	168
Plymouth Sound and Estuaries SAC	Designated for: Allis shad	Designated	229

**Information available from JNCC website (jncc.defra.gov.uk), Government Website (gov.uk) and the Wildlife Trusts (wildlifetrusts.org).*

9.5.3.36. In addition to those species which are listed as interest features of SACs and MCZs, there are a number of other fish and shellfish of conservation importance which may occur in the vicinity of the Proposed Development. These include:

- WCA species: Basking sharks occasionally occur in the eastern Channel in the summer months, although this area is believed to be relatively unimportant in comparison to other UK waters (e.g. the Irish Sea) (Chapter 10 (Marine Mammals and Basking Sharks) of the ES Volume 1 (document reference 6.1.10)). Short-snouted seahorse are known to be present in shallow inshore areas around Newhaven, particularly in seagrass areas. The spiny seahorse (*Hippocampus guttulatus*) is also present on the south coast. Allis shad (*Alosa alosa*) and twaite shad (*Alosa fallax*) are also protected under this Act and are present in the Channel.
- UK BAP species: European eels, brown/sea trout, allis shad, twaite shad, river lamprey (*Lampetra fluviatilis*), smelt, tope, lesser sandeel, herring, cod, whiting, blue ling, ling, native oyster, undulate ray, mackerel and sole.
- Regional BAP species (Sussex): Allis shad, twaite shad, European eel, smelt, Atlantic salmon, brown/sea trout, long-snouted seahorse, short-snouted seahorse, native oyster, plaice, undulate ray, mackerel, Dover sole and scad (Sussex Biodiversity Partnership, 2007).
- Regional BAP species (Hampshire): Allis shad, twaite shad, tope, brook lamprey, sea lamprey, Atlantic salmon, European oyster (Hampshire Biodiversity Partnership, 2018).
- Species of Principle Importance in the UK NERC Act 2006: This includes: Allis shad, twaite shad, lesser sandeel, European eel, herring, cod, long-snouted seahorse, short-snouted seahorse, Atlantic halibut, sea monkfish, whiting, European hake, blue whiting, blue ling, ling, smelt, plaice, Greenland halibut, Atlantic salmon, brown/sea trout, mackerel, common sole, horse mackerel, river lamprey, sea lamprey, basking shark, common skate, tope shark, porbeagle shark, blue shark, undulate ray, spiny dogfish and native oyster.
- Council Regulation (EU) 2018/120: Seabass have been given protection under this regulation which prevents recreational anglers from retaining this species in 2018. In addition, the taking of seabass is prohibited between February and March (inclusive) by any fishery.
- OSPAR list of threatened and/or declining species and habitats in the North-East Atlantic: native oyster and native oyster beds, allis shad, European eel,

basking shark, spotted ray, cod, long-snouted seahorse, short-snouted seahorse, sea lamprey, thornback ray, and Atlantic salmon.

9.5.4. IDENTIFICATION OF RECEPTORS

9.5.4.1. The number of fish and shellfish species present within the study area is extensive and it is impractical to assess each individual species. To ensure the most important species are assessed a Valued Ecological Receptor ('VER') approach has been adopted as outlined in the CIEEM (2019) guidance.

9.5.4.2. A list of all fish recorded in the study area through the data sources reviewed was compiled. Each species was then assessed against a number of criteria (e.g. SAC feature species, spawning within the Marine Cable Corridor, stock stability, commercial importance) which was assigned a consistent arbitrary value. The species with the highest values were combined to produce the list of VERs shown in Table 9.8.

9.5.4.3. It is accepted that different species from the VERs list will be sensitive to different potential impacts arising from the construction, decommissioning and operation of the Proposed Development. Therefore, receptor groups have been identified within the assessment for each potential impact based on their sensitivity to that impact (e.g. elasmobranchs for EMF rather than assessing fixed groups of species).

9.5.4.4. In order to do this VERs have been grouped into receptor groups based on high level physiological traits and their sensitivity to specific impacts. These assemblages have been identified in Table 9.8 and are considered below in the context of the Proposed Development.

9.5.4.5. It should be noted that as per CIEEM (2019) guidance, all receptors are not assessed for all impacts, rather, only those receptors that are potentially vulnerable to an impact, or where a significant effect may arise have been assessed. Therefore, not all VERS per receptor group have been assessed for every impact.

Table 9.8 – Fish and Shellfish VERs

*International Union for Conservation of Nature ('ICUN') abbreviations: CE (Critically Endangered), V (Vulnerable), E (Endangered), NT (Near threatened), LC (Least Concern), NA (Not assessed).

Stock status taken from www.iucnredlist.org/

X – Indicates the criteria which applies to that species

		Designation		Designated site			Stock status		Spawning and/ or nursey location		
Receptor (Species)	**Species name**	**ICUN***	**UKBAP**	**SAC**	**SSSI**	**MCZ**	**Declining**	**Stable**	**Channel**	**Proposed Development**	**Species of Local Commercial Importance**
SHELLFISH											
Crabs	*Cancer pagurus*	NA							X	X	X
Lobsters	*Homarus gammarus*	NA							X	X	X
Native oysters	*Ostrea edulis*	NA	X			X			X	X	X
Whelks	*Buccinum undatum*	NA						X	X	X	X
King Scallop	*Pecten maximus*	NA							X	X	X

		Designation		Designated site			Stock status		Spawning and/ or nursey location		
Receptor (Species)	**Species name**	**ICUN***	**UKBAP**	**SAC**	**SSSI**	**MCZ**	**Declining**	**Stable**	**Channel**	**Proposed Development**	**Species of Local Commercial Importance**
MARINE FISH											
Herring	*Clupea harengus*	LC	X					X	X	X	X
Black seabream	*Spondyliosoma cantharus*	LC				X			X	X	X
Plaice	*Pleuronectes platessa*	LC	X						X	X	X
Sole	*Microchirus variegatus*	LC	X					X	X	X	X
Cod	*Gadus morhua*	V	X				X		X	X	X
Bass	*Dicentrarchus labrax*	LC							X	X	X
Whiting	*Merlangius merlangus*	LC							X	X	
Sandeels	Ammodytidae	LC	X						X		
Cuttlefish	*Sepiida*	LC				X			X		X
Short	*Hippocampus*	LC	X			X		X	X		

		Designation		Designated site			Stock status		Spawning and/ or nursey location		
Receptor (Species)	**Species name**	**ICUN***	**UKBAP**	**SAC**	**SSSI**	**MCZ**	**Declining**	**Stable**	**Channel**	**Proposed Development**	**Species of Local Commercial Importance**
snouted seahorse	*hippocampus*										
ELASMOBRANCHS											
Undulate ray	*Raja undulata*	E	X				X		X	X	X
Tope	*Galeorhinus galeus*	V	X				X		X	X	
Spurdog	Squalidae	V					X		X	X	
Thornback ray	*Raja clavata*	NT					X		X	X	
Dogfish	*Scyliorhinus canicula*	V					X				X
Spotted ray	*Raja montagui*	LC						X	X		
Smooth-hound	*Mustelus sp.*	V									X
MIGRATORY											
European eel	*Anguilla anguilla*	CE	X				X				

		Designation		Designated site			Stock status		Spawning and/ or nursey location		
Receptor (Species)	**Species name**	**ICUN***	**UKBAP**	**SAC**	**SSSI**	**MCZ**	**Declining**	**Stable**	**Channel**	**Proposed Development**	**Species of Local Commercial Importance**
Shad	Alosinae	LC	X	X							
Sea lamprey	*Petromyzon marinus*	LC	X	X	X			X			
River lamprey	*Lampetra fluviatilis*	LC	X		X			X			
Salmon	*Salmo salar*	LC	X	X	X			X			X
Brown trout	*Salmo trutta*	LC	X		X			X			
European smelt	*Osmerus eperlanus*	LC	X								

Shellfish

9.5.4.6. Shellfish are of particular commercial importance along the Entire Marine Cable Corridor with commercial landings outweighing landings of fish. Shellfish species are therefore important receptors when considering the potential impacts from the Proposed Development.

9.5.4.7. Catches of whelks account for the greatest UK landings across the Marine Cable Corridor with the two inshore rectangles of 30E9 and 30E8 accounting for the largest quantities by weight. Whelks were confirmed as present within the Marine Cable Corridor during benthic surveys, as reported in Chapter 8 (Intertidal and Benthic Habitats).

9.5.4.8. The scallop fishery (made up of predominately king scallops) is of significant importance in the Channel with landings mainly in the central Channel ICES rectangles of 29F0 and 29E9 which highlights the importance of this area for scallops. This species is usually found on clean firm sand or sandy gravel and may occasionally be found on muddy sand (Marshall and Wilson, 2008).

9.5.4.9. Commercial fish landings also show that the inshore areas are important for edible crabs, lobsters, cuttlefish and clams. Edible crabs favour boulders, mixed coarse sediments and muddy sand in offshore areas (Neal and Wilson, 2008). These types of sediments are common along the Marine Cable Corridor with the highest landings from rectangles 30E9 and 30E8. Lobsters prefer rocky substrates which are more abundant in rectangles 30E9 and 30E8 this is reflected in commercial landings with highest landing occurring in these rectangles. Clams are also landed in the nearshore rectangles which corresponds with the clam fishery in Langstone Harbour (Southern IFCA, 2017b).

9.5.4.10. Native oysters are also known to be present in the inshore areas of the UK coast, particularly in the Solent, Southampton Water, and harbours (Sussex IFCA, 2017b; Southern IFCA, 2017a; Williams *et al.*, 2018).

Marine Fish

9.5.4.11. Marine fish are those species which spend all of their lives within the marine environment (please note while elasmobranches are marine fish, these have been split out in a separate group below).

9.5.4.12. Fisheries landing data provides an indication of where these marine fish VER receptors may be found on the Marine Cable Corridor. In the UK coastal rectangles most common VER species in catch were plaice, herring, sole, bass and black seabream, as well as smaller catches of cod. While technically not a fish, cuttlefish, which are of commercial importance in the inshore areas of the Marine Cable Corridor (Chapter 12 (Commercial Fisheries)), have been included in this group due to their mobile nature. In the mid Channel catches are dominated by herring with other species including whiting and black seabream.

9.5.4.13. Black seabream is known to be present both to the east and west of the Proposed Development (Southern IFCA, 2017a; Collins & Mallinson, 2012; EMU, 2003; EMU, 2009; EMU, 2011; Fugro EMU, 2015). In addition, the Proposed Development overlaps nursery and spawning grounds for whiting, cod, plaice, sandeel, and sole. Bass are known to be present in the UK Territorial Waters, and Cefas have undertaken pre-recruit bass (1 – 3-year olds) surveys since 1983 off Eastney and South Hayling, which makes these surveys particularly relevant to the Proposed Development (Cefas, 2016).

9.5.4.14. Sandeels are considered a keystone species which play a considerable role in the marine ecosystem as prey species for fish and other animals. Lesser sandeels were identified as present in the coastal area during small fish surveys by Sussex and Southern IFCA's (Sussex IFCA, 2017a: Southern IFCA, 2017a;). In addition, low intensity spawning and nursery areas for sandeel are identified across the Channel (Ellis *et al*., 2012). Southern IFCA reported that a small-scale non-commercial fishery for sandeels for use as angling bait for charter vessels can be found just offshore of Langstone harbour (Figure 12.9), providing evidence of their presence in this area (Southern IFCA *pers. comm*).

9.5.4.15. Short-snouted seahorses are known to frequent the south coast of England however they do not appear in any commercial landings data. Four short-snouted seahorses were recorded during surveys at Rampion OWF (RSK, 2012) which confirms their presence in the wider area. In addition, both the Bembridge and Selsey Bill and the Hounds MCZs are within 5 km of the Proposed Development, both of which are designated for seahorses.

9.5.4.16. A number of spawning areas for these VER marine fish have been identified along the Marine Cable Corridor, these include spawning grounds for cod, plaice, sole, sandeel (Ellis *et al*., 2012; Coull *et al*., 1998), bass (Cefas, 2016) and according to local anglers black bream at the Bullock Patch. In addition, it is likely that herring spawning takes place on the Marine Cable Corridor particularly in ICES sub rectangle 29F02, (based on IHLS data (2007-2017) and herring sediment suitability as per MarineSpace *et al.,* 2013 methodology). The Marine Cable Corridor also passes through nursery grounds whiting and sole (as well as elasmobranch species (see below).

Elasmobranchs

9.5.4.17. There is a large diversity of sharks and rays in the Channel. Commercial fisheries data confirms that 18 different species were landed during the period 2013 – 2017 (MMO, 2018), with 29 elasmobranch species captured in ICES Division VII.7.d. The greatest diversity occurs in the two inshore rectangles of 30E8 and 30E9 where all 18 species are landed. This includes thornback ray, undulate ray, spotted ray, tope, smooth-hound and spurdog.

9.5.4.18. In addition, part of the Marine Cable Corridor overlaps nursery grounds for thornback ray, tope and undulate ray (Ellis *et al*., 2012) (Figure 9.4). The thornback ray is known to occur in inshore waters on the south coast of the UK (Shark Trust, 2009). Juvenile thornback and undulate rays have been recorded in the Solent, Langstone and Chichester Harbours (Rogers *et al*., 1998).

Migratory Fish

9.5.4.19. A number of migratory fish species have been identified in the study area by both surveys and commercial landings data (Sussex IFCA, 2017a; Southern IFCA, 2017c and RSK, 2012). The migratory nature of this group of fish identifies them as potentially being present in the vicinity of the Proposed Development at certain times of the year.

9.5.4.20. Commercial fisheries data shows that 'shad' are caught in both the coastal and offshore ICES rectangles, confirming their presence in the Channel. It should be noted however that highest landing are low (five-year average 0.13 and 0.21 tonnes respectively) and from the inshore rectangles of 30E9 and 30E8. Surveys for the Rampion OWF, 12 km east of the Proposed Development, confirm the presence of both the allis shad and twaite shad, where one specimen of each was captured (RSK, 2012). In addition, allis shad are an interest feature of the Plymouth Sound and Estuaries SAC.

9.5.4.21. While salmon and sea trout are not generally captured in great numbers in commercial landings, the location of both the River Itchen and River Avon SACs (both designated for salmon) suggest this species may use areas within and around the Proposed Development during their migration (adult and smolt) to and from these rivers. The presence of sea trout is confirmed in Chichester Harbour by surveys (Sussex IFCA, 2017a).

9.5.4.22. Sea lamprey were recorded within ICES Division landings data and are also a feature of the River Avon SAC which is less than 50 km from the Proposed Development. As their migration routes are not fully understood it must be assumed therefore, that they may be present along the Marine Cable Corridor. River lamprey may also be present at the Landfall due to their estuarine migration, and proximity to Southampton Water and estuaries.

9.5.4.23. The European eel has been recorded as present at survey sites in both Chichester Harbour and Medmerry with both elvers and eels also being found in Langstone Harbour (Sussex IFCA, 2017a; Southern IFCA, 2017c). There are also records of them being landed occasionally in all ICES rectangles along the Entire Marine Cable Corridor.

9.5.4.24. The European smelt is a migratory species which moves into rivers between February and April to spawn. 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). European smelt are recorded in commercial landings data from ICES Division VII.7.d but were absent from surveys undertaken by Cefas and both Sussex and Southern IFCAs. Records of European smelt in Southampton water are scarce with no adults or larvae taken during sampling of Fawley Power station intake (Maitland, 1997; 1998). Although smelt may be in the vicinity of the Proposed Development they are likely to be in very low numbers within Southampton Water and the rivers flowing into it not supporting a spawning population.

9.5.5. LANDFALL

9.5.5.1. Native oyster annual studies confirm the presence of native oysters in Langstone Harbour as well as Chichester Harbour, eastern Solent, western Solent, Portsmouth Harbour, and Southampton Water (Sussex IFCA, 2017b; Southern IFCA, 2017a; Williams *et al*., 2018; Williams and Davies, 2018). However more recent data show no oyster beds are located in any of the harbours (Patrick Cooper, 2019, *pers comm.*). These studies do however reveal that hard, Manila and native clams (*Tapes spp.*) and cockles (*Cerastoderma edule*) are also present in these areas (Williams *et al*., 2018; Williams and Davies, 2018), as well as the grooved carpet shell clam (*Ruditapes decussatus*) in Langstone Harbour, identified during the Solent Bivalve Stock assessment (Southern IFCA, 2017b).

9.5.5.2. Cefas have undertaken pre-recruit bass (1 – 3 year olds) surveys since 1983 (Cefas, 2016). This data set highlights the importance of the Langstone and Chichester Harbours for bass. Surveys are also undertaken off the coast of Eastney and South Hayling which makes these surveys particularly relevant to the Marine Cable Corridor.

9.5.5.3. Sandeels have also been identified in Langstone Harbour through a number of surveys (Rogers *et al*., 1998; Sussex IFCA, 2017a: Southern IFCA, 2017a; and Environment Agency, 2018). As stated above Southern IFCA reported that a small-scale non-commercial fishery for sandeels for use as angling bait for charter vessels can be found within and around the mouth of Langstone Harbour (Figure 12.9), providing evidence of their presence in this area (Patrick Cooper pers. comm). This area overlaps with a small area of preferred sediment for sandeel (as predicted using MarineSpace *et al.* (2013a) methodology) providing further evidence of their presence.

9.5.5.4. The commercial fisheries consultation with Southern IFCA revealed that Cuttlefish and whelk pots are set in the areas close to the Landfall (Chapter 12 (Commercial Fisheries); Figure 12.13 of the ES Volume 2 (document reference 6.2.12.13)), providing evidence of the presence of these species in this location.

9.5.6. FUTURE BASELINE

9.5.6.1. The baseline environment present in the vicinity of the Marine Cable Corridor has remained relatively consistent over time as indicated by commercial landings data.

This is also true for oyster levels across the Solent with reproductive success highlighted at some sites (Fareham). However, populations remain at a low level which is broadly consistent with previous years (Southern IFCA, 2018a).

9.5.6.2. In the absence of the Proposed Development, numbers of fish and shellfish occurring within the study area over the operational period of the project, would likely reflect changes in populations resulting from climatic factors (such as temperature change and subsequent impacts on species' ranges), or anthropogenic activities such as changes in fishing activities. Some fish species of conservation importance which have been identified as present in the study area (e.g. salmon) have shown a nationwide 50 % decrease in spawning population size based on the 10-year average (JNCC, 2019), with increased natural mortality at sea possibly linked to climate change (Cefas, 2018). The European eel is classed as critically endangered, with recruitment in 2017 at 1.6 % of 1960 – 1979 levels (ICES, 2017). Although management practices are in place to aid the recovery of both these species, it is unknown if they will recover to historic levels. With this in mind, their numbers may decrease in future years.

9.5.6.3. Those commercially targeted species of fish and shellfish are likely to become under increasing pressure as the UK and European countries population increases. Despite this, fishing quotas and management practices are in place to help reduce the impact of over fishing.

9.5.6.4. The overarching impact of climate change is one of the largest threats to fish and shellfish. Sea temperature rise and ocean acidification is likely to change species composition in the Channel with cold water species such as cod and herring moving north and warmer water species such as trigger fish and anchovies becoming more established. It is considered however that this will happen gradually with the current baseline remaining similar to that described for the operational period of the Proposed Development. Furthermore, baseline conditions within the study area may also change in relation to other projects/plans which may be implemented during this timeframe. Baseline conditions are therefore not static and are likely to exhibit some degree of change over time, with or without the Proposed Development in place.

9.5.6.5. Therefore, potential impacts have been assessed in the context of the envelope of change that might occur over the operational period of the Proposed Development. Consideration of other projects/plans is undertaken through cumulative effects assessment in Section 9.7 and in doing so, their ability to modify the existing baseline is also considered.

9.6. IMPACT ASSESSMENT

9.6.1.1. This section describes the potential impacts that may arise from the construction, operation (including maintenance and repair) and decommissioning of the

Proposed Development and the effects these activities may have on fish and shellfish.

9.6.1.2. Chapter 3 (Description of the Proposed Development) provides further information regarding decommissioning. The options for decommissioning include leaving the Marine Cables in situ, removal of the entire cables or removal of sections of the Marine Cables. If the best practice guidance at the time is to leave the inert and environmentally benign cable in situ, it is considered that there is no potential for significant effects on fish and shellfish receptors from leaving the inert Marine Cables in place.

9.6.1.3. However, the Crown Estate currently supports removal of cables where practicable for offshore wind farms (Department for Business, Energy and Industrial Strategy ('BEIS'), 2019). If cables are retrieved, decommissioning will be undertaken in line with industry best practice, and any effects are predicted to be equivalent to or lesser in nature than those assessed for activities undertaken during construction. As such, predicted effects from decommissioning the Proposed Development are not assessed individually in the following paragraphs for each feature and impact.

9.6.2. EMBEDDED MITIGATION

9.6.2.1. Embedded mitigation measures are considered to be those included as part of the project or which constitute industry standard plans or best practice.

9.6.2.2. Early on in the optioneering process, the design principles to narrow down the suitable Landfall location and identify the Marine Cable Corridor included avoiding MPAs, where possible.

9.6.2.3. Embedded mitigation measures which are included in the construction stage for the Proposed Development are as follows:

- The use of cable burial techniques which minimise the area of seabed affected;
- Disposal of dredged material is restricted to beyond KP 21 of the Marine Cable Corridor.
- Adoption of plans and procedures for marine pollution prevention, risk reduction and waste management to eliminate and mitigate potential pollution risk. These procedures are outlined in the Marine Outline Construction Environmental Management Plan ('CEMP') (document reference 6.5) submitted with the Application and secured through the dML.

9.6.2.4. Embedded mitigation measures which are included in the operational stage for the Proposed Development are as follows:

- Although this relates more to the protection of the asset, the minimum cable target depth of 1 m will reduce any potential effect of EMF on sensitive species; and

- Minimising the use of cable protection to reduce the effect of permanent habitat loss.

9.6.3. WORST CASE DESIGN ENVELOPE

9.6.3.1. Table 9.10 gives the worst-case design parameters considered for fish and shellfish during construction, operation (including repair and maintenance) and decommissioning of the Proposed Development. Further details regarding the proposed activities and programme are presented in Chapter 3 (Description of the Proposed Development) and Appendix 3.2 (Marine Worst-Case Design Parameters).

Table 9.9 – Worst case design parameters

Potential impact	Worst case parameters used for assessment
Construction (& Decommissioning) Stage	
Temporary habitat disturbance/loss	**Marine Cable Corridor:** Seabed preparation, HDD and cable installation works will take place over 30 months. A maximum of four cables (two bundled pairs) will run from the Landfall at Eastney Beach to the limit of UK Territorial Waters. Maximum length for each cable is approximately 109 km. Each bundled pair of cables will be installed in a separate trench (maximum of two trenches) at a depth below seabed of 1 to 3 m. The area of the Marine Cable Corridor is *c.* 57 km^2 (500 m wide for 8.6 km and 520 m wide for 100.4 km). The worst case subtidal area of seabed disturbed across Marine Cable Corridor (including Landfall works) is approximately 3.6 km^2. This is based on: • a pre-lay grapnel run ('PLGR') along 2 x 108 km of Marine Cable Corridor to a footprint width of 1 m (0.22 km^2), • 15.6 km of an 80 m swathe footprint for boulder clearance (1.25 km^2), • an assumed worst case of sandwave clearance along 4.2 km of the Marine Cable Corridor to a footprint width of 160 m (0.67 km^2) • an assumed worst case of 108 km of the Marine Cable Corridor disturbed through 2 x 6.5 m width of displacement plough trenching (1.41 km^2), • a maximum of two vessels would be grounded at low tides between KP 1.0 and KP 4.7 for up to 4

Potential impact	Worst case parameters used for assessment
	weeks (0.008 km^2); • anchor spreads (0.042 km^2). The depth of penetration of seabed preparation (after bedform clearance) and burial tools will range from 1 m (PLGR) to 3 m (cable burial tools). Trials of cable installation tools may be required prior to cable installation. However, it is considered that any potential effects from tool trials will be significantly reduced in scale and duration such that they would not be measurable against the potential effects from construction activities and have potential to overlap with areas impacted by other seabed preparation / construction activities. **Landfall:** • HDD entry pit(s) (if required for offshore to onshore scenario) excavation works will likely occur in areas that will have already been subject to some level of disturbance between KP 1.0 and 1.6. However, the worst case assumes a single pit approximately 60 m x 15 m (0.0009 km^2) rather than four discrete pits. • HDD temporary mattressing prior to cable pull (0.0009 km^2) which will likely occur within the footprint of the excavated pit(s). • A jack up barge will be used for the HDD works at up to four locations. Typical jack up barge will possess four legs, each leg approximately 1.4 m diameter (totalling 6.16 m^2). Temporary casing support frame comprising of up to four trestles spaced 12 m apart at each location. Each trestle has a footprint of 3 m^2 (totalling 12 m^2). Combined maximum footprint of 0.00002 km^2. The possible impacts from decommissioning are predicted to be equal to or less than construction activities.
Temporary increase in SSC (and smothering)	**Nearshore and Landfall (and within KP 21):** Worst case scenario for increased SSC are considered to be excavation at the HDD pits, and cable installation (due to the potential for the liberation and dispersal of fines identified between KP 5 and 15, and in other isolated locations).

Potential impact	Worst case parameters used for assessment
	The marine HDD exit/entry Landfall location is approx. 1 km off the coast of Eastney (KP 1 – KP 1.6) and will be excavated using a backhoe dredger or Mass Flow Excavator ('MFE'). The total volume to be excavated is up to 2,700 m^3. The finest sediments will potentially be transported up to 10 km in the nearshore area, however it is highly likely that SSCs at these distances will be low (<5 mg/l) and therefore not discernible above natural variation, which ranges from approximately <5 to 75 mg/l in coastal areas, with annual averages of between 5 – 15 mg/l observed within surface waters. It is predicted that peak SSCs of up to 200 mg/l may be observed locally (i.e. within 2 km of the cable trench/HDD pit) and these concentrations could potentially persist for several hours following completion of construction activities. Sediment plumes are also likely to be transported up to 5 km away from the trench/pit at which point concentrations of 5 to 10 mg/l are predicted; SSC is expected to return to background levels within a few days following completion of these activities. It is predicted in the nearshore that coarse material mobilised will deposit rapidly (i.e. within several hundred metres of the cable trench) and finer sediment will be dispersed across a greater spatial extent, transiently depositing throughout the tidal cycle. Due to the volumes of sediment likely to be liberated into the water column and significant dispersion of fine sediment, it is considered that deposition will be negligible with sediments quickly resuspended and redistributed under the forcing of tidal flows. **Marine Cable Corridor (beyond KP21):** Worst case provides for deposition of maximum dredged volume (1,754,000 m^3) within the proposed marine disposal site through surface release (multiple hopper sizes). Worst-case peak SSCs of 1,000 mg/l within 1 km from the release point are predicted with coarser sediments expected to deposit quickly (almost immediately), with significant reductions of SSC within hours of disposal at each location. Beyond 1 km from release, the passive plume is likely to generate

Potential impact	Worst case parameters used for assessment
	SSC in the region of approximately 20 mg/l, transported in the direction of the prevailing flow out to a worst case distance of up to 25 km. SSC is predicted to reduce to background levels (<1 – 6 mg/l) within the timeframe of a few days following completion of these activities. Sediment deposition from disposal activities will be local to the point of release (i.e. within 1,000 m), with deposits of coarser sediments potentially observed to depths of between 10 mm and 1.5 m, with greatest deposition observed across an area of a few hundred metres, elongated in the direction of the prevailing flow at the time of release. Finer sediments will be redistributed and any deposition outside the Marine Cable Corridor will be transient and negligible, with any settled material being quickly redistributed under the forcing of tidal flows.
Noise and vibration	**Marine Cable Corridor:** The worst-case is considered to be cable installation using mechanical trenching equipment, which is considered to generate noise of up to 123 dB re 1 μPa (at a range of 160 m) (Nedwell *et al.,* 2003a). **Landfall:** Marine HDD works at Eastney (KP 1 – KP 1.6) requires the use of a non-percussive Excavator Mounted Vibro-hammer (‘EMV’) to install up to four trestles to support the drill casings, and a pipe driving machine to install the casings themselves. Pipe driving machines also use vibration in order to push in/install casing pipes with an auger inside which removes the sediment. Installation will take 10 x 12 hour shifts at each of the four ducts (this also includes vessel repositioning, setting up the trestles and driving them into the seabed and then setting up the casings on the trestles, welding the casings together and then driving them into the seabed). There are also scheduled long breaks (up to 9-10 weeks) between the vibro-hammering/pipe driving at each duct whilst the drilling and relocating of plant is underway.
Operational Stage (including maintenance and repair)	
Disturbance due to Operational &	The Proposed Development has been designed so that routine maintenance of the Marine Cables is not required during its operational lifetime.

Potential impact	Worst case parameters used for assessment
Maintenance (O&M) activity	During operation the reburial of cables and placement of cable protection may be required but it is predicted that the replacement / repair of sections of marine cable would constitute the worst case. It is assumed that an indicative worst-case failure rate of the Marine Cables would require: • one repair every 10-12 years; • a length of cable up to 3 x water depth to be recovered from the seabed (e.g. in the worst-case, at the maximum water depth of approximately 70 m, this could amount to approximately 1,100 m of cable to typically be recovered and re-laid for each repair of a cable pair); • The actual jointing operation may take up to 5 – 6 days, and the handling of the joint and deployment to the seabed could take 1 – 2 days. Depending on the extent of cable damage, cable repair operations typically have a duration of several weeks to months. It is therefore predicted that should any repair and maintenance works be required that the works would be of shorter duration and smaller in extent than the construction stage.
EMF	**Marine Cable Corridor:** EMF will be present around the cables. Based upon current knowledge, cables will be buried between 1 to 3 m below the seabed. The worst case is therefore considered to be the minimum target burial depth of 1 m. Therefore, the magnetic field from the cables at seabed level is predicted to be 42 micro-Tesla (μT). **Landfall:** EMF will be present around the cables. Based upon current knowledge, cables will be buried between 1 to 3 m below the seabed, and therefore the worst case is therefore the minimum target burial depth of 1 m. Therefore, the magnetic field from the cables is predicted to be 42 μT at seabed level.

Potential impact	Worst case parameters used for assessment
Permanent habitat loss	**Marine Cable Corridor:** Based on worst case non-burial protection for rock placement during construction (0.33 km^2) and maximum footprint for Atlantic crossing protection (0.038 km^2). The maximum footprint also allows an additional 10% rock placement non-burial contingency (0.33 km^2) for if further non-burial protection is required during maintenance/repair activities during a 15-year period post construction. **Landfall:** The worst case considers non burial protection (rock infill) will be used to permanently replace (after removal of temporary rock bags) excavated sediment at HDD entry/exit pit. Total area of protection 0.0009 km^2. **Maximum area/footprint of habitat loss is 0.7 km^2 due to non-burial protection**.

9.6.4. CONSTRUCTION (AND DECOMMISSIONING) IMPACTS

9.6.4.1. During construction there are a number of impacts which have the potential to effect fish and shellfish. These are:

- Temporary habitat disturbance/loss;
- Temporary increase in suspended sediments and smothering;
- Entrainment/removal of eggs and larvae; and
- Noise and vibration.

9.6.4.2. As noted in Sections 9.6.1.2 – 9.6.1.3, the possible effects of decommissioning are considered to be similar (although likely a lesser magnitude and duration than construction).

Temporary Habitat Disturbance/Loss

Marine Cable Corridor

9.6.4.3. The potential impact of temporary habitat disturbance/loss relates to the direct or indirect disruption of the seabed by route preparation and cable laying equipment and activities.

9.6.4.4. The worst-case area for temporary habitat disturbance/loss is considered to be c. 3.6 km^2 resulting in the main, from a combination of boulder clearance (up to 15.6 km), sandwave clearance (up to 4.2 km) and displacement plough trenching (up to 108 km) along the Marine Cable Corridor. Figure 3.5 (sheets 1-4) of the ES Volume 2 (document reference 6.2.3.5), provide the indicative locations of where planned seabed preparation activities will occur along the Marine Cable Corridor. This scenario has been selected as it has the greatest (worst-case) area of disturbance and potentially the biggest impacts on fish and shellfish receptors (although the specific locations are indicative only).

9.6.4.5. As this impact is confined to the physical area of works within the Marine Cable Corridor, only VERs identified as being present within the Marine Cable Corridor are considered. Due to the mobile nature of the majority of fish and shellfish species in the study area, they will be able to avoid areas of habitat disturbance. Therefore, the assessment further refined to concentrate on VERs which, owing to their physiological and biological traits, may be unable to avoid this impact if they are within the affected area. Those receptors include some shellfish species (crabs, lobsters, native oysters, king scallops, and whelks), as well as sediment spawning fish species and a number of elasmobranch species which spawn within the Marine Cable Corridor.

Shellfish

9.6.4.6. Areas of circalittoral rock, boulder and coarse sediment were identified along the Marine Cable Corridor during the benthic survey (Chapter 8 (Intertidal and Benthic Habitats)), many of which corresponded to areas where fishing for crabs and lobsters took place. The worst case for these habitats would be boulder clearance which could result in an 80 m swathe being cleared for sections amounting to 15.6 km along the Marine Cable Corridor. This equates to only 1.25 km^2 of temporary seabed disturbance which represents a tiny proportion of the available habitat for crabs and lobsters in the Channel. Worst case cable installation techniques such as displacement plough will also cause habitat disturbance however this represents a worst-case temporary disturbance to an area of 1.41 km^2.

9.6.4.7. 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. While some individuals may be killed or injured during route preparation and installation activities, it is expected that other crabs and lobsters would recolonise the area quickly and no population level effect would be expected. Due to the limited area and temporary nature of the works, combined with the ability of crabs and lobsters to recolonise, it is considered that effects from this impact would be **not significant** for crabs and lobsters.

9.6.4.8. The king scallop is an important commercial shellfish which is represented in all ICES rectangles along the Marine Cable Corridor. Commercial fisheries landings data highlights the importance of the centre of the Channel for this species. Scallops prefer areas of clean firm sand, fine or sandy gravel and also muddy sand, and therefore will be impacted by construction activities for installation in sediments. The areas where dredging will occur (e.g. sandwaves) therefore, are not ideal habitat for scallop given its dynamic nature.

9.6.4.9. In terms of impact from ploughing and trenching, the king scallop is capable of swimming in response to predators, which highlights its ability to move (Marshall and Wilson, 2008). The MarESA sensitivity assessment by MarLIN (Marshall and Wilson, 2008) identifies that scallops have a low sensitivity and high recoverability to abrasion and physical disturbance. Given the limited spatial extent impacted by cable installation activities and the high recoverability of scallops, it is considered that the effects from temporary habitat disturbance/loss would be **not significant** for king scallop.

9.6.4.10. Whelks are an important commercial species across the entire Marine Cable Corridor. The highest landings are within both the inshore rectangles of 30E9 and 30E8. 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).

9.6.4.11. Although there is potential impact from temporary habitat disturbance/loss on whelk, it is capable of moving away from an impact at 11 cm/minute (Magúnsdóttir, 2010) and therefore, able to recolonise the disturbed area post construction. In addition, given its extensive habitat preferences, alternative habitat is widely available outside the Marine Cable Corridor. Therefore, it is considered that effects from temporary habitat disturbance are **not significant** for whelks.

9.6.4.12. Native oysters are identified as having a high sensitivity to disturbance (Perry & Jackson, 2017), however oyster beds are not present along the Marine Cable Corridor (Southern IFCA, 2017a; Patrick Cooper, 2019, *pers comm*.) therefore their numbers are likely to be low. Effects from temporary habitat disturbance/loss is **not significant** for this species.

9.6.4.13. It is considered unlikely that direct disturbance will occur outside of the Marine Cable Corridor during construction. However, in the unlikely event that this occurs (i.e. potential anchor placement when using cable lay barges), impacts will be highly limited in extent, and as the species found to either side of the Marine Cable Corridor are comparable to those within, it is considered that the assessments presented above include provision for this impact.

Marine Fish

9.6.4.14. Most marine fish species identified as VERs are pelagic spawners i.e. they spawn directly into the water column and will not be significantly affected by temporary habitat disturbance/temporary loss of the seabed. However, substrate spawners or fish that lay their eggs on the seabed may be affected by this impact; namely black seabream, herring and sandeel.

9.6.4.15. Sandwave clearance could result in clearance of a swath 160 m wide over 4.2 km (0.67 km^2). Other than where sandwave clearance would take place, the worst case for these habitats would be boulder clearance which could result in an 80 m swathe being cleared for sections amounting to 15.6 km along the Marine Cable Corridor, with a total foot print of 1.25 km^2. Where boulder clearance does not take place, the next worse case would be cable installation using a displacement plough which would result in 108 km of the Marine Cable Corridor disturbed through two x 6.5 m width of displacement plough trenching (1.41 km^2).

9.6.4.16. Herring are a substrate spawner, choosing to deposit their eggs on coarse sand, gravel, small stones and rock (Scottish Government, 2017). While the Marine Cable Corridor does not pass through the spawning area identified for the Downs stock by Coull *et al*. (1998) and Ellis *et al.* (2012) (Figure 9.3) and the majority of sediments sampled along the Marine Cable Corridor for the AQUIND benthic assessment were identified as preferable for herring spawning (Figure 9.7) and these areas coincide with areas of high herring larvae density (Plates 9.5 and 9.6).

9.6.4.17. Moreover, areas of the Channel through which the Marine Cable Corridor passes was identified in the South Marine Plan (2018) as having various degrees of herring spawning potential.

9.6.4.18. In order to assess the potential impact of temporary habitat disturbance/loss on herring spawning, it is often tempting to assess the size of the impacted area against the total spawning habitat, however, this is not possible for several reasons.

Firstly, the Marine Cable Corridor does not pass through any spawning grounds as defined by Coull *et al.* (1998) or Ellis *et al.* (2012). Secondly, these spawning areas do not fully define the spawning habitat available to herring, and often underestimate the areas of suitable habitat available for spawning (as illustrated by habitat suitability mapping; Figure 9.7); and the IHLS data (Plate 9.5 and 9.6) as spawning areas may vary between years due to a multitude of environmental factors (such as temperature, oxygenation, natural and anthropogenic disturbance) (National Grid, 2017). Conversely, IHLS data may overestimate the area of potential herring spawning habitat due to larval dispersal from the actual egg site/spawning bed. This is also true of habitat sediment classes, as owing to the wide range of environmental parameters that determine herring spawning, will always over-represent the range of habitat with the potential to support spawning events.

9.6.4.19. It is clear from the IHLS data (Plate 9.5 and 9.6) and sediment suitability mapping (Figure 9.6) that the entire Marine Cable Corridor is not suitable for herring spawning, however given difficulties in establishing the exact areas potentially used by herring for spawning, the areas defined by the South Marine Plan for herring spawning have been used in order to put the area of potential habitat disturbance/loss into context of Regional Policy.

9.6.4.20. The South Marine Plan identifies areas within the UK EEZ of the Channel of 'herring spawning potential' based on IHLS data which corresponded to the following categories; Low, Low to Medium, Medium to High, and High. These were identified in order to help determine where potential mitigation should be considered for specific activities such as dredging or piling. The Marine Cable Corridor passes through areas of Low, Low to Medium, and High (Figure 9.2). The area of 'low' spawning potential within the South Marine Plan occupies an area of 2335 km^2, of this the worst-case prediction is a habitat disturbance to 2.24 km^2 (0.1 % of this area). Of the low to medium defined area (totally 4443.7 km^2) only a worse case of 0.44 km^2 of habitat disturbance may occur (0.01 % of the area). Of the area defined as 'high' spawning potential (area of 480.2 km^2) a maximum 1.26 km^2 may be disturbed (0.06 % of this area).

9.6.4.21. Accordingly, due to the small extent of potential impact and temporary nature, and the wide variety of alternative grounds, it is considered that effects from temporary habitat disturbance/loss are **not significant** on herring spawning. Furthermore, it is therefore, considered that no timing restrictions due to herring spawning is required.

9.6.4.22. Sandeels favour a particular type of substrate to lay their eggs (generally clean sands) hence, dredging activities represent the worst case for this receptor. However, there are no high intensity sandeel spawning areas overlapping the Marine Cable Corridor and no dredging disposal is proposed in the Solent where sandeels are known to occur. PSD results from the benthic survey indicate a lack of suitable habitat within the Marine Cable Corridor area and MarineSpace *et al.*

(2013a) confirmed this area as marginal to unsuitable for sandeels (Plate 9.5). Therefore, it is considered that due to the low numbers of sandeels likely to be present, coupled with the significant availability of more suitable spawning substrate outside the Marine Cable Corridor, the small spatial extent of the dredging and its temporary nature, any effect from temporary habitat disturbance/loss is **not significant** for sandeel.

9.6.4.23. Black seabream spawning sites are identified to the south and south east of the Isle of Wight (to the west of the Marine Cable Corridor) and from Bognor Regis to Brighton (to the east of the Marine Cable Corridor). There is no known black seabream spawning sites within the Marine Cable Corridor with the exception a small area of the Bullock Patch. Information on the exact geographical extent of the Bullock Patch spawning area is difficult to ascertain, however according to the admiralty chart the north-east edge of this raised outcrop falls within the south west edge of the Marine Cable Corridor (Figure 9.4). While adult fish will be able to swim away, construction activity on Bullock Patch could result in damage/destruction of active black seabream nests if the cable route installation occurred on the Bullock Patch and coincided with spawning season (May to June). Despite this potential damage, there are many other spawning areas available for the black seabream outside the Marine Cable Corridor (including those afforded protection through designation as MCZs namely Kingmere, Southbourne Rough, Purbeck Coast) and any loss of habitat (extent of impact) will be **not significant** against the overall availability of suitable habitat. Hence, effects from temporary habitat disturbance/loss is considered to be **not significant** for black seabream. It is worth noting that wherever possible the cable route would be micro-sited around areas of hard seabed, as such, seabed features which more likely to act as seabream nests will be avoided.

Elasmobranchs

9.6.4.24. A number of elasmobranch species identified as VERs may also use the seabed within the Marine Cable Corridor to lay their eggs. These species include undulate ray, dogfish, spurdog, thornback ray and spotted ray. However, Ellis *et al*. (2012) reports insufficient data on the occurrence of egg cases or egg-bearing females to delineate spawning grounds for these species. However, nursery areas are defined (Figure 9.4) for undulate ray, thornback ray and tope and show overlapping low intensity nursery areas with the Marine Cable Corridor (Ellis *et al*., 2012). It should be noted that despite this overlap, thornback ray have widely distributed nursery areas around the UK so the spatial extent of disturbance is negligible in comparison. The same can be said for spurdog which is understood to have nursery habitat within the Channel. Regarding dogfish and spotted ray the Proposed Development does not overlap with any known nursey areas for these species. Therefore, the effects from temporary habitat disturbance/loss on spurdog, thornback ray, dogfish and spotted ray are considered **not significant**.

9.6.4.25. The undulate ray is commonly encountered in the 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. The nursery area for this species encapsulates the sea along the south coast of the UK including the Isle of Wight, Solent, harbours and Southampton Water. The Marine Cable Corridor passes through this area. The extent of the potential impact is however small (80 m wide corridor) in comparison with the available nursery/spawning area. In addition, the works are short in duration and habitat will recover quickly post construction. It is considered that as undulate ray are highly mobile, other nursery/spawning areas will be utilised during this temporary impact and population size will not be affected. Any effect from temporary habitat disturbance/loss is **not significant** on undulate ray.

9.6.4.26. Tope and smooth-hounds are ovoviviparous and viviparous respectively, meaning they both give birth to live young (Shark Foundation, 2005), hence adults and pups will be able to avoid areas subject to habitat loss/disturbance leading to negligible effects.

9.6.4.27. Direct disturbance occurring outside the Marine Cable Corridor is unlikely but, in any event, should it occur (i.e. due to anchor placements) impacts will be highly limited in extent, and as the species found to either side of the Marine Cable Corridor are comparable to those within, it is considered that the assessments presented above include provision for this.

9.6.4.28. Cable installation tool trials may be required prior but, it is considered that any potential effects from tool trials will be significantly reduced in extent and duration (when compared to other construction activities) and it is considered that the assessments presented above include provision for this impact.

Landfall

Marine fish

9.6.4.29. At the Landfall at Eastney, HDD will be used with the entry/exit point location expected to be between approximately 1 to 1.6 km from MHWS. The worst-case scenario considered is the installation of temporary cable protection (e.g. mattressing or rock bags) with a total area of 900 m^2 (0.0009 km^2) to protect the four HDD ducts prior to cable pull. The potential disturbance from jack up barges (and up to four trestles (approx. combined maximum footprint of 0.00002 km^2) is smaller in extent when compared to works that include the HDD pit excavation and temporary cable protection at the HDD location, as well as the disturbance potentially caused by pre-lay grapnel run or boulder clearance that will have already occurred. Therefore, the potential effects from HDD plant at the entry/exit point is considered to be negligible and is not considered further.

9.6.4.30. Sandeels are present at the Landfall, as evidenced by the presence of a small non-commercial sandeel fishery for angling bait (Figure 12.9), which coincides with sediment identified as preferred through sediment (PSD data) and BGS data analysis (Figure 9.8). This area overlaps with the HDD exit point. Therefore, although sandeels are present, the area affected from HDD pit excavation and the temporary cable protection (0.0009 km^2) represents a very small proportion of the area of sediment predicted to be 'preferable' and the extent of the fishery. On the basis of the small extent of impact and that other habitats are available for sandeel in this area, any effect from temporary habitat disturbance/loss is therefore **not significant** for sandeels at the Landfall.

Elasmobranchs

9.6.4.31. Coelho & Erzini (2006) reported that undulate ray may spawn in the winter on sandy or muddy flats, which correspond with sediments found at the Landfall. It is considered however that, as the impact of the Landfall works is temporary, small in extent and with a wide availability of alternative habitat, that the population will not be significantly affected. Therefore, any effects from this impact are **not significant** for undulate ray at the Landfall.

9.6.4.32. In addition to HDD related works, the grounding of cable lay vessels/barges may also be required in the shallow water around KP 1.0 and KP 4.7 in the Marine Cable Corridor. The total area potentially affected could be up to 0.008 km^2 per vessel with a maximum of two vessels grounded at any one time. This is not considered to affect fish as they are highly mobile and will move out of the way before the vessel makes contact with the seabed. In addition, sediment spawning fish in this area are limited to undulate ray. Impacts to this species are expected to be negligible due to the small spatial extent of the impact and the availability of other suitable in the area and are not considered further. Shellfish however, are generally sedentary or slow moving and may be at risk.

Shellfish

9.6.4.33. The grounding of vessels can only occur on softer sediments (without rocks or boulders) to avoid damage to the hull of the vessels. Therefore, only shellfish which inhabit these softer sediments are considered. The VER species that could be affected therefore are native oyster. The 2018 Solent Oyster Fishery stock survey report (Southern IFCA, 2018a) identifies oyster beds within the Solent, Southampton Water and harbours. The surveys were undertaken at known oyster beds. The highest densities of oysters were found to be in the central Solent at Ryde Middle. Although oysters were found in Langstone Harbour, no surveys were undertaken in the vicinity or within the Marine Cable Corridor. This would indicate that there are no current or historic oyster beds in the area of where vessels may choose to ground on the seabed. Despite this, oysters are able to inhabit a range of substrate types and it is therefore possible that they may be present where the grounding of vessels may occur. It is considered however, that as the numbers of oysters will be low and the area affected (*circa* 0.008 km^2) is small, effects from the grounding of vessels are expected to be **not significant.**

9.6.4.34. Whelks are important commercial species across the entire Marine Cable Corridor and have the potential to be located around the Landfall site and in locations where grounding of vessels may take place. Although there is potential impact from temporary habitat disturbance/loss on whelk, which might lead to injury or mortality, it is capable recolonising disturbed areas post construction. In addition, given its extensive habitat preferences, alternative habitat is widely available outside the extent of impact. Therefore, given the small extent of impact when compared to existing available habitat and recoverability of whelk populations from the impact, it is considered that effects from temporary habitat disturbance are **not significant** for whelks.

9.6.4.35. Cuttlefish are another species that are known to be captured around the Landfall. Cuttlefish are highly mobile shellfish hence will be able to move away from any disturbed area and utilise the wide extend of alternative habitats in the area. Therefore, given the low magnitude and extent of the impact it is predicted that effects from temporary habitat disturbance are **not significant**.

Temporary Increase in Suspended Sediments and Smothering

Marine Cable Corridor

9.6.4.36. Cable installation and associated works such as dredging, the deposit of dredged material, route clearance and rock placement will result in a temporary increase in SSCs and subsequent deposition resulting in smothering.

9.6.4.37. The worst case for increased SSC is considered to arise through the disposal/deposit of dredged material resulting from sandwave clearance (Chapter 6 (Physical Processes)). Plume dispersion modelling (Appendix 6.2 (Modelling Technical Report) of the ES Volume 3 (document reference 6.3.6.2)) has revealed a worst-case peak SSC of 1000 mg/l within 1 km from the release point but coarser sediment is expected to deposit quickly (almost immediately) with significant reductions of SSC within hours of disposal at each location. Beyond 1 km from release, the passive plume is likely to generate SSC in the region of approximately 20 mg/l, transported in the direction of the prevailing flow out to a worst-case distance of 25 km. The SSC is expected to return to back ground levels within a few days following completion of disposal activities. It should be noted that this worst case is based on the location of bedforms (i.e. sandwaves) known to date. Accordingly, at the moment the plume modelling has assessed the plume from disposal events between KP 21 and KP 80 as these are the areas where disposal is most likely to occur (due to shorter transit times of disposal vessels from dredger locations) based on the current information. However, disposal may also occur anywhere between KP 21 and KP 109, and it is considered that the sediment plume modelling undertaken represents a realistic worst-case scenario

9.6.4.38. In terms of smothering (sediment deposition) coarse material (sand from sandwaves) is expected to settle out of the water column quickly local to the point of release (i.e. within 1000 m) with the greatest deposition directly under the disposal vessel (up to 1500 mm depth), reducing to depths *c.* 10 mm further away from release. Finer sediments will be readily redistributed and any deposition beyond 1000 m will be transient and negligible.

9.6.4.39. Other seabed preparation and installation activities will result in resuspension and deposition of sediments, however maximum levels arising, and the area over which they will be distributed this will be highly limited. In addition, this will be lower in all cases than those arising from dredge deposition (as informed by the modelling undertaken; see Appendix 6.2 (Modelling Technical Report) for more detail). However, given that disposal will only take place outside of KP 21 (within the Marine Disposal Site), the installation of cables and excavation of HDD pit(s), represents the worst case inside of KP 21 towards shore. Maximum SSC from other seabed preparation and installation activities will up to a maximum of 200 mg/l with a plume of concentrations of between 5 - 10 mg/l extending no further than 5 km, and background levels established within a few days following completion of the activity (Chapter 6 (Physical Processes)). The resultant sediment deposition is not expected to be significant, with coarser sediment depositing rapidly, while finer sediment is dispersed over larger areas and redistributed under forcing tidal flow resulting in negligible deposition.

9.6.4.40. Chapter 6 (Physical Processes) describes that background levels of SSC (10-35 mgl^{-1}) within the coastal areas of the Solent are naturally higher than that of the Channel, resulting in a spatial zonation in the Channel between highly turbid coastal waters and waters further offshore with lower concentrations (2 to 3 mgl^{-1}). Storm events can reportedly raise SSC in nearshore naturally turbid environments by a factor of 10-20 (Guillou *et al.* 2017).

9.6.4.41. The temporary increase in SSC and smothering could therefore potentially affect fish and shellfish receptors within and beyond the Marine Cable Corridor. However, given the mobile nature of most fish and some shellfish it is recognised that these species will be able to avoid the affected area. In addition, most fish and shellfish are able to tolerate a degree of suspended sediment owing to frequent exposure to storm induced fluctuations in sediment concentrations. Those species which are considered to be most sensitive to increased SSC and sediment deposition are a number of shellfish species, seahorses, substrate spawning fish and migratory fish.

Shellfish

9.6.4.42. The native oyster cements itself to the seabed and is therefore unable to move to avoid an impact such as smothering or increases in SSC. It is associated with highly productive estuarine and shallow coastal water habitats on firm mud, rocks, muddy sand, muddy gravel with shells and hard silt (Perry & Jackson, 2017). It is identified by Perry & Jackson (2017) to have low resistance and high sensitivity to these impacts.

9.6.4.43. Deposition of sediment from disposal events will be limited to beyond KP 21 of the Marine Cable Corridor as disposal will not occur landward of KP 21. Oyster beds are generally within coastal areas such as the Solent, Southampton Water and harbours with no beds identified along the Marine Cable Corridor (Southern IFCA, 2018a). However, for any oysters that may be present within the Marine Cable Corridor in deeper water, the greatest deposition will be directly below the disposal vessels (up to 1500 mm in depth), although a degree of deposition may occur up to 1000 m away. Oysters that may be present on the Marine Cable Corridor will not survive this level of deposition however, the area affected will be small in extent. In general, peak sediment deposition will remain within, or in close proximity to the Marine Cable Corridor with reducing levels of deposition outside this area, as distance from release point increases. Accordingly, it is recognised that although oysters may be present in areas where disposal occurs and are therefore considered to be impacted, numbers of oysters are predicted to be low and therefore, the effects from sediment deposition will be **not significant**.

9.6.4.44. While there are no oyster beds present along the Marine Cable Corridor (Southern IFCA, 2017a; Patrick Cooper, 2019, *pers comm.*), there may be some individuals present within and close proximity to the Marine Cable Corridor they may be subject to increases in SSC. Given their low numbers in the area and their tolerance to a degree of SSC given the natural variation of suspended sediment in the Channel resulting from storm, combined with short duration of the impact (e.g. SSC reduces to background levels within days of completion) and the small spatial extent of the impact it is predicted that the effects of SSC will be negligible.

9.6.4.45. Whelks inhabit a range of sediments including muddy sand. Their ability to utilise the finer sediment fractions suggests they are not significantly affected by a degree of suspended sediment, as these finer sediments are often suspended during storms or current induced sediment mixing. While peak SSC may exceed those levels induced by storm events, SSC levels will reduce down to background within a short period of time (hours to days). Little information is available on common whelk however, other whelk species (*Busycon carica* and *Busycohypus canaliculatus*) are known to burrow into sediment and remain dormant for extended periods (MMS, 2009). This study also showed that whelks can be naturally buried to depths of 14.4 cm and can dig themselves out quickly. Although mortality of whelks is possible from sediment deposition particularly directly below and very close to the disposal vessel, the spatial extent of deposition is small, and the levels of deposition expected (less than 10 mm) at distances greater than 1000 m from the point of sediment release predicted to be negligible. SSC from activities within KP 21 is less than those generated from dredge disposal, while sediment deposition impacts are considered to be negligible. Given the whelks tolerance to smothering and elevated suspended sediment, the small extent of the impact, and its short duration, it is considered that effects from increased SSC and sediment deposition are **not significant**.

9.6.4.46. Edible crabs are highly tolerant of increases in SSC. It is highlighted by MarESA (Neal & Wilson, 2008) that they have a low sensitivity and high recoverability to this impact. Given that SSC from disposal activities are only expected to exceed the levels experienced during natural storm events for a short period of time with substantial reductions within hours of disposal, and low sensitivity of crabs to suspended sediment, it is predicted that there will be no significant effect on crabs from the Proposed Development. As previously mentioned, sediment deposition is greatest directly under the disposal vessels and crabs in these areas are not likely to survive such magnitude of impact. However, the spatial extent of deposition will be small, and the number of crabs potentially impacted is expected to be low. In addition, negligible levels of sediment deposition are expected beyond 1000 m from the sediment release point for disposal activities and according to Neal & Wilson (2008), crabs have a very low sensitivity and very high recoverability to smothering. It is therefore considered that due to the small extent and short duration of the impact, the effects from increased SSC and smothering are **not significant** for crabs.

9.6.4.47. There is no MarESA assessment for the European lobster, however the European spiny lobster (*Palinurus elephas*) is classified as having a medium sensitivity to changes in suspended solids and is not sensitive to light smothering and siltation. Given the similarity in size and ecology of spiny lobster, these assessments are likely to be similar for the European lobster. It is expected therefore that any lobsters directly under, and within a few hundred metres from the disposal vessel, will not survive the levels of deposition predicted. However, given the small spatial extent of the impact, only low number of individuals are predicted to be affected. As negligible levels of sediment deposition are expected at distances greater than 1000 m from sediment releases (e.g. close to the Proposed Development), effects from sediment deposition are considered to be **not significant** for European lobster. The worst case for SSC is expected to be 1000 mg/l for 1 km from the release point for dredge disposal (and 200 mg/l within 2 km of activities within KP0 and KP21). Coarser sediment is expected to deposit quickly (almost immediately) with significant reductions of SSC within hours of disposal at each location. Beyond 1 km from sediment release, the passive plume is likely to generate SSC in the region of approximately 20 mg/l. The Channel is often subject to storm induced SSC increases which are equivalent or higher than 20 mg/l. Lobsters, possess a medium sensitivity to SSC and are naturally subjected to levels of increased SSCs which builds resilience. Therefore, it is considered that as the highest levels of SSC are highly localised (small extent of impact), reduce quickly and are of short duration, any effects from increased SSC would be temporary and therefore **not significant** to lobsters.

9.6.4.48. Scallops are assessed by MarESA as having a low sensitivity to both smothering and increases in SSC with a high recoverability for both (Marshall and Wilson, 2008). Given the depth of sediment deposition that may result from possible dredge disposal in the Marine Cable Corridor, individual scallops directly under, or within hundreds of metres of the disposal vessel, are unlikely to survive as a burial depth of 50 mm is conservatively considered to be fatal (Marshall and Wilson, 2008). Beyond this, as scallops are capable of swimming away from threats and can dig their way out of deposits of under 50 mm, some scallops are likely to survive (Marshall and Wilson, 2008). Accordingly, outside of a predicted maximum of 1000 m from sediment releasee (i.e. within and in close proximity of the Marine Cable Corridor) scallops are unlikely to be significantly affected, as the depth of sediment deposition is expected to be negligible and will happen gradually over time. It should be noted that this 50 mm fatality depth is considered to be highly conservative and some larger scallops can dig their way out of deeper sediment (Marshall and Wilson, 2008). 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; Agri-Food and Biosciences Institute – Fisheries and Aquatic Ecosystems Branch (AFBI), 2017), which can originate from unaffected scallop beds in the vicinity of the Proposed Development and re-populate smothered areas.

9.6.4.49. The low sensitivity of scallops to SSC correlates with their native habitat, which is naturally high in sediments. Scallops exhibit specialised behaviours which mitigate potential negative effects of increases in SSC, such as increased clapping rate (Last *et al*., 2011), food selectivity and particle excretion (Macdonald and Ward, 1994; Shumway *et al*., 1997). Reproductive and larval life stages have the potential to be impacted in the short term, however increased SSC will not have any long-lasting effects with adult spawning behaviour and recruitment cycles returning to normal soon after cessation of the works.

9.6.4.50. Given the high recoverability of scallops to SSC and smothering and the short duration of the impact, it is therefore predicted that effects from temporary increases in SSC and smothering are **not significant** for scallops.

Marine Fish

9.6.4.51. This impact is most relevant to substrate spawning fish receptors in this group and seahorse.

9.6.4.52. Sediment deposition depths will be greatest (up to 1500 mm) directly under, or in close proximity to the disposal vessel following deposit of dredged material, and the majority of the coarser material will remain within the Marine Cable Corridor. Sediment deposition occurring at distances greater than 1000 m away from disposal activities (i.e. close to the Marine Cable Corridor) is expected to be negligible.

9.6.4.53. As defined in the South Marine Plan, the Marine Cable Corridor passes directly through areas defined as having high herring spawning potential (Figure 9.6). As herring are substrate spawners the impact of smothering as a result of temporary suspended sediment has the potential to effect eggs and larvae. However, Messieh *et al*. (1981) were unable to detect any deleterious effect on herring eggs hatching at SSC as high as 7000 mg/l. In addition, Forewind (2014) concluded that the impact of SSC and sediment redepositing on herring eggs, larvae and adult herring from export cable installation (using a range of techniques including jetting, ploughing, trenching, cutting, mass flow excavation and dredging) for the Dogger Bank OWF was a minor adverse effect.

9.6.4.54. It is considered that given this evidence, the prediction that the majority of deposited dredged material will remain within or in close proximity to the Marine Cable Corridor (small extent of impact), the resilience of adult herring, eggs and larvae to both suspended sediment and smothering, and the short-term nature of the impact, effects will be **not significant**.

9.6.4.55. Sandeels use the sand as spawning substrate, predation cover and also in which to hibernate during the winter. Behrens *et al*. (2007) found that when buried sandeels were exposed to decreasing oxygen tensions, they gradually approached the sediment surface highlighting their ability to regulate their depth based on oxygen availability. Due to this ability to survive in sediment for long periods of time, there is little potential for sediment deposition to prevent respiration in buried adult sandeels other than directly under and in close proximity to disposal activities. Due to the lack of prime habitats for sandeels within the Marine Cable Corridor, it is unlikely that sandeel are present in large numbers. Hence, any mortality resulting from deposition of sediment is only likely to affect relatively few individuals.

9.6.4.56. Sandeel eggs adhere to grains of sand and are often covered by sediments to a depth of several centimetres. Winslade (1971) showed that despite this, eggs are still capable of developing normally and hatch when they are uncovered again. Pėrez-Dominguez & Vogel (2010) found increased SSC and smothering to be inconsequential to larval and juvenile sandeels. With this in mind it is considered that due to the wide spatial extent of sandeel spawning and lack of high intensity spawning grounds in the vicinity of the Proposed Development, coupled with the tolerance of eggs and juveniles to suspended sediment and smothering, effects from sediment deposition are **not significant** to these life stages.

9.6.4.57. Black seabream spawning sites occur to the south and south east of the Isle of Wight and from Bognor Regis to Brighton, as well as on the Marine Cable Corridor between KP12-13 at Bullock Patch. No dredge disposal will occur within the Solent (inside of KP21) and the potential impact of sediment from dredge disposal outside KP21 drifting into the Bullock Patch or other spawning sites was also examined.

However, plume dispersion modelling highlights a worst-case SSC of approximately 20 mg/l traveling up to 25 km in a predominately east-west direction, with SSC reducing to background levels within a few days. As a result, no significant increases in SSC is expected to reach any potential nesting areas, hence the Bullock Patch spawning ground will not be subject to sediment depositions and SSC associated with these works.

9.6.4.58. Therefore, the worse-case arising at the Bullock Patch will be from other construction activities (i.e. cable installation and HDD excavation). Such activities result in a predicted maximum SSCs of up to 200 mg/l within 2 km of activities which reduce significantly within hours of completion activities, with a plume extending no further than 5 km at which point concentrations are approximately 5 – 10 mg/l, background levels established within a few days following completion of the activity. Deposition is not predicted to be significant with any coarse material mobilised being deposit rapidly (i.e. within several hundred metres of the cable trench). Finer sediment will be dispersed across a greater spatial extent, transiently depositing throughout the tidal cycle. However, due to the low volumes of sediment likely to be liberated into the water column and significant dispersion of fine sediment, it is considered that deposition will be negligible with sediments quickly resuspended and redistributed under the forcing of tidal flows (Chapter 6 (Physical Processes)).

9.6.4.59. Black seabream, like most marine fish, are able to tolerate a degree of suspended sediment and it is considered no significant increases in SSC or deposition will occur at any potential nesting sites other than Bullock Patch. It should be noted that bream nests being impacted from suspended sediment from nearby aggregate extraction work (EMU, 2012). Regarding Bullocks Patch, while it may be subject to elevated SSC from installation activities, given the relatively short duration of elevations (hours to days), the ability for seabream to tolerate increases of SSC, and relatively high natural levels of SSC in the Solent, the effects of SSC increases on black seabream are predicted to be **not significant**.

9.6.4.60. Seahorse are known to be present on the South coast of the UK. Most species of seahorse live at depths of 1-15 metres, but they move to deeper water in winter (Sabatini & Ballerstedt, 2007). They are assessed by MarESA to have a very low sensitivity to SSC and smothering. Given that seahorse species are known to migrate into deeper waters it cannot be ruled out that they may be affected by SSC and smothering from dredge disposal. The depth of sediment deposition that may result from dredge disposal in the Marine Cable Corridor, individual seahorses directly under, and in close proximity to the disposal vessel are unlikely to survive. However, numbers will be low given the distance from shore and their limited swimming ability. Outside of this area seahorses are unlikely to be affected given their very low sensitivity and as deposition will be less. The worst case for SSC (1000 mg/l up to 1 km) will reduce substantially within hours with the passive plume

(20 mg/l) extending up to 25 km, seahorses within this area are unlikely to be affected given their very low sensitivity and temporary nature of this effect. Therefore, the effects of SSC and smothering are predicted to be **not significant** for seahorse.

Elasmobranchs

9.6.4.61. A number of elasmobranch species may use the area overlapping with the Marine Cable Corridor as nursery areas.

9.6.4.62. The thornback ray has a widely available low intensity nursery areas along the southern coast of the Channel. There are no spawning areas identified although they are expected to broadly overlap with nursery areas (Ellis *et al*., 2012). Eggs are laid on sandy or muddy substrate close to the shore (ADW, 2014). Despite lack of evidence on spawning sites for this species there is potential for eggs to be laid in the nearshore area of the Marine Cable Corridor. As stated previously, the suspended sediment levels in the Solent can be naturally high (Guillou, *et al*., 2017), hence thornback ray eggs are tolerant of this natural turbidity. It is therefore considered that effects to thornback ray eggs from suspended sediment and smothering are **not significant**.

9.6.4.63. Ellis *et al*. (2012) identifies nursery grounds of low intensity for the undulate ray along the southern coastal fringe of the UK and both French and English sides of the eastern Channel. No other nursery areas are identified. Despite this, Ellis *et al*. (2012) found that the highest occurrence of juveniles was around the Channel Islands. Due to the dynamic nature of the inshore waters in the Solent, undulate ray eggs are likely to be tolerant to a degree of suspended sediment and smothering as a result of natural sediment movement. As smothering is predicted only to occur in a across a small spatial extent (within or in close proximity to the Marine Cable Corridor), it is considered that any effect from suspended sediment and smothering is **not significant** on undulate ray eggs.

9.6.4.64. There is a low intensity nursery area for tope around the Isle of Wight and Solent (Ellis *et al*. 2012), and smooth-hound are also reported by anglers to use this area as a nursery. Tope and smooth-hounds give birth to live young (Shark Foundation, 2005). Live young have the advantage of being able to avoid predation from birth. Given the advanced development of pups it is likely that they will be able to avoid smothering from sediment for more favourable conditions. In addition, suitable habitat is widely available outside of the Marine Cable Corridor. Therefore, effects are considered as **not significant** on tope and smooth-hound pups.

Migratory Fish

9.6.4.65. Given the highly mobile nature of migratory fish and their freshwater spawning lifecycle, they are not considered to be susceptible to smothering. Therefore, for these species, only increases in SSC will be assessed.

9.6.4.66. Salmon and sea trout are known to use the coast for migration. Due to the proximity of the Proposed Development to Southampton water and estuaries for both the River Itchen SAC and River Avon SAC, there is potential for interaction with these species. There is the possibility that an increase in SSC could pose a barrier to their migration. However, both salmon and sea trout (adults and smolts), given their life cycle are inherently tolerant of naturally high and variable background levels of suspended sediment (Heard, 2007). Given that the worst-case peaks in SSC from disposal activities are predicted to only last hours and, the spatial extent of the Solent and Southampton waters provide alternative routes, it is considered that effects from temporary increases in SSC is **not significant** for salmon and sea trout.

9.6.4.67. The catadromous life cycle of the eel means that juvenile eels (elvers) return to riverine environments to mature. Due to the proximity of a number of rivers to the Marine Cable Corridor, it is possible that elvers will be present at the time of construction. Both elvers and adults are highly tolerant to elevated levels of suspended sediment (Avant, 2007). Therefore, it is considered that effects from any temporary increase in suspended sediments which are of short duration and extent is **not significant** for European Eel.

9.6.4.68. Sea and river lamprey spawn in freshwater and after hatching, the juvenile lamprey (ammoceotes) live buried in sediment where they grow over a number of years until they are ready to migrate downstream to sea (Hopkins, 2008). At this point they are known as transformers. Both sea and river lamprey are inherently tolerant of naturally high and variable levels of suspended sediments as a result of their riverine migration (Maitland, 2003). With this in mind, elevated levels of SSC as a result of deposit of dredged material will be unlikely to have a significant effect on transformers or adults in the marine environment. It is therefore considered that effects from temporary increases in SSC is **not significant** for both lamprey species.

9.6.4.69. Both twaite and allis shad spawn on clean gravel in upper river catchments, therefore spawning for this species will not be affected by this impact. Adults may be present in (and in proximity to) the Marine Cable Corridor in low numbers. However, both species are active swimmers and have the ability to avoid areas of high suspended sediment. As the potential increase in SSC produced by disposal activities will be temporary (expected to return to background levels after a number of days following completion of activities) and low numbers shad are likely to be in the area, any effects are considered to be **not significant** for allis and twaite shad.

9.6.4.70. European smelt maybe in the vicinity of the Marine Cable Corridor, due to its proximity to the rivers flowing into Southampton Water. It is considered however, that numbers are likely to be low as these rivers do not support a spawning population. Therefore, effects from temporary increases in SSC are considered **not significant** for European smelt.

Landfall

9.6.4.71. Dredging of the HDD exit/entry pit by excavator and cable installation in the nearshore will produce a temporary increase in SSC and subsequent sediment deposition. These activities may produce SSC of up to 200 mg/l locally (up to 2 km) for several hours, SSC levels beyond this extent are *c.* 5 – 10 mg/l within 5 km of release will reducing to background levels within a few days. Deposition of sediments will be low with coarse sediments deposited rapidly within several hundred metres of the cable trench. Deposition of finer sediments will be negligible.

9.6.4.72. Those species likely to be affected in this area those which are sensitive to SSC and smothering and are unable to move away from the potential impacts such as oysters.

9.6.4.73. Oysters are known to be present in the Solent, Southampton Water and harbours. The highest densities of oysters were found to be in the central Solent at Ryde Middle (Southern IFCA, 2018a). The worst case is that SSC of up to 200 mg/l could extend up to 2 km from inshore activities such as dredging of HDD entry/exit pit and also cable installation. As there are no oyster beds identified within 2 km of the Proposed Development, the greatest levels of SSC are unlikely to affect large aggregations of this species. It is recognised however, that outside of known oyster beds, oysters may be present. Despite the oyster's sensitivity, this species is likely to be tolerant of a degree of SSC given the natural variation of suspended sediment in the Solent resulting from storm events and the dynamic nature of the tidal and wave regimes in this region. In addition, any increase in SSC resulting from excavation works or cable installation will be temporary (persists for several hours) following completion of works.

9.6.4.74. The effect of smothering from these inshore activities is expected to be highly localised (several hundred metres from source) and therefore is expected to be mainly contained within the Marine Cable Corridor. Therefore, only oysters within this small area will be affected. Therefore, any effects from increases in SSC and smothering from inshore construction activities on oysters is considered to be low in magnitude and extent, temporary in duration and **not significant**.

9.6.4.75. Sandeels are present at the Landfall, however they are able to survive in sediment for long periods of time, and there is little potential for sediment deposition from the Proposed development to prevent respiration in buried adult sandeels other than directly under and in close proximity to disposal activities, of which there are none at the landfall. Sandeel eggs are often covered by sediments to a depth of several centimetres and have been shown to be capable of developing normally and hatch when they are uncovered again (Winslade, 1971). Pėrez-Dominguez & Vogel (2010) found increased SSC and smothering to be inconsequential to larval and juvenile sandeels. Therefore, the effects of increased SSC and smothering on sandeels at all stages of life is considered to be **not significant** at the Landfall.

9.6.4.76. Other marine fish, such as bass; migratory fish species such as salmon, sea trout, lamprey (sea and river), eels and shad (twaite and allis) as well as cuttlefish, although present in this coastal area, are highly mobile and tolerant of increased SSC with no barrier to migration expected.

Entrainment/removal of eggs and larvae

Marine Cable Corridor

9.6.4.77. The dredging of sediments has the potential to entrain larvae and eggs. Those species most at risk are species such as sandeel and herring which use the seabed for spawning.

9.6.4.78. The rates of entrainment depend on the depth, dredger type, speed and strength of the suction field created by the dredger. The suction fields from a hydraulic dredger are greater than mechanical dredging methods (e.g. backhoe) (Todd *et al*., 2015).

9.6.4.79. There is more risk to sandeel and herring eggs and larvae from removal and entrainment due to their lack of swimming ability and inability to avoid the suction field. The entrainment of adult fish has minimal population level effects given their ability to actively swim away from the affected area (Reine and Clarke, 1998; Drabble, 2012).

9.6.4.80. Dredging of the Marine Cable Corridor will be required in areas where sandwaves and ripples occur which cannot be avoided (e.g. by re-routing). Of the bedforms that are currently considered a constraint so as to require dredging, large ripples occupy 0.7 km (<1% of the Marine Cable Corridor) at one location (KP 47.7-47.8), and sandwaves occupy 3.5 km (3.2% of the Marine Cable Corridor) across seven locations (Figure 3.5 Sheets 1-4). The worst case (based on our current knowledge of bedform feature locations) for these areas combined is 4.2 km at a 160 m (includes batter slopes) width which equates to 0.67 km^2. It should be noted that the sandwave and ripple locations where dredging is required (based upon current information on seabed feature location) are between KP 30 and 55 (Figure 3.5 Sheet 2) approximately 5 km distant from the herring spawning area identified by IHLS data (2007-2017) shown in Figure 9.6. Therefore, it is considered that although some herring eggs and larvae may be entrained any effect from dredging activities be will **not significant**. However, it is possible that dredging for seabed clearance may also be required in additional areas due to migration of seabed forms prior to commencement of construction. However, given the relatively short duration and small magnitude and extent of the impact (when considered in the wider context of available herring spawning habitat within the Channel), it is considered that effect of entrainment of herring eggs and larvae will be **not significant**.

9.6.4.81. The potential of entrainment on sandeel, their eggs and larvae, along the Marine Cable Corridor is likely to be low given the sub optimal nature of sediments present for this species identified by PSA samples. It should also be noted that a study on the Nash Bank in 1995 (ABP Research and Consultancy Ltd, 1995) found that while sandeels were collected during aggregate extraction all individuals were returned alive to the water column. This was due to the standard screening processes employed by dredgers. Therefore, although some eggs and larvae may be entrained effects from dredging activities are considered to be **not significant**.

Noise and Vibration

Marine Cable Corridor

9.6.4.82. The impact of noise and vibration may occur as a result of construction activities such as cable laying and cable protection activities. The worst-case scenario is expected to be cable laying by mechanical trenching.

9.6.4.83. Generally, the maximum sound pressure levels relating to installation of a marine cable are moderate to low (OSPAR, 2012). Nedwell *et al*. (2003a) found that the noise emitted from cable trenching at North Hoyle OWF was 123 dB re 1 µPa (at a range of 160 m). Popper *et al*. (2014) recommended guidelines for shipping and other continuous noises, with cable laying considered to fall within this category. It is recognised that underwater noise and vibration from cable installation activities is low (compared to percussive piling for example) and will only affect fish which have the capacity to hear. Therefore, this assessment concentrates on hearing specialist fish.

9.6.4.84. There are a number of hearing specialist fish in the vicinity of the Proposed Development which may be affected by noise during construction activities. These include herring, shad and cod.

9.6.4.85. Hearing specialist fish are sensitive to underwater noise due to the presence of a swim bladder and intricate connections to the inner ear. These connections are not developed in both egg and larval stages with Bolle *et al*. (2014) finding no statistical differences in mortality between control larvae and those exposed to piling noise.

9.6.4.86. Popper *et al*. (2014) identified that there is a low potential for mortality and mortal injury from the noise produced from continuous noise sources, although there is a high risk of behavioural changes for fish with swim bladders 'near' to the source. In addition, fish with swim bladders are identified as being subjected to recoverable injury at 170 dB re 1 µPa with temporary threshold shift ('TTS') occurring at 158 dB re 1 µPa.

9.6.4.87. Herring are known to inhabit the Channel, and the Marine Cable Corridor passes areas identified as having spawning potential (South Marine Plan, 2018). As herring are substrate spawners, they will spend time near the seabed, and potentially in the vicinity of construction activities. The noise level of a trenching tool measured by Nedwell *et al*. (2003a) (123 dB re 1 µPa @ 160 m) is substantially below both injury and TTS for fish with swim bladders so herring are likely to produce only a mild behavioural response. In addition, as cable burial machinery is a continuous noise, a startle response is unlikely, herring will have time to move to a more suitable area. Given the herring's mobile nature and the predicted low noise emissions from cable burial equipment, there is low risk of mortal, injury and behavioural effects. Accordingly, it is considered that effects from noise and vibration on herring is **not significant**.

9.6.4.88. Both allis and twaite shad spawn in freshwater so are unlikely to be in large aggregations in the marine environment, with shoaling occurring within river systems prior to spawning. Shad are also pelagic and unlikely to be in the vicinity of the seabed (and therefore cable laying equipment) for any length of time. Given the low numbers of this species likely to be within or in the vicinity of the Marine Cable Corridor and due to their highly mobile nature they can move away from an impacted area, it is considered that any effect from underwater noise and vibration is **not significant** for these species.

9.6.4.89. Cod have been shown to detect sound pressure at higher frequencies within their hearing range with its swim bladder appearing to serve as an accessory hearing structure (Chapman and Hawkins, 2004). Although there is no apparent specialised anatomical link to the inner hear, oscillations are transmitted through the surrounding tissue to the inner ear. This hearing capability puts cod at risk of injury from anthropogenic noise. Cod are likely to be present within and in the vicinity of the Marine Cable Corridor, and as a demersal species may frequent the seabed where cable burial equipment will operate. However, given that noise and vibration emissions from cable burial equipment is well below the threshold for mortal injury, recoverable injury and TTS, any effects are likely to be exhibited as avoidance behaviour. This avoidance behaviour is not considered to detrimental (low magnitude effect) to key stages for this species (e.g. spawning) as the area of effect will be very limited (small spatial extent), and considerable areas suitable for such activities will be present surrounding the affected area. Therefore, it is considered any effect from noise and vibration on cod is **not significant**.

9.6.4.90. In addition to hearing specialist fish key migratory species have been assessed, as well as black seabream due to the presence of the Bullock Patch on/adjacent to the Marine Cable Corridor.

9.6.4.91. Black seabream are classed as hearing generalists, given the that noise and vibration emissions from cable burial equipment is well below the threshold for mortal injury, recoverable injury and TTS, the only effects which could be exhibited is the potential avoidance behaviour. Due to the relative low levels of sound emitted from cable installation equipment any possible effects will be concentrated within or in close proximity to the Marine Cable Corridor. Outside the Marine Cable Corridor the levels of noise and vibration are expected to low enough that any avoidance behaviour is predicted to be negligible. Should this work be undertaken in spawning season, this could result in adults avoiding or being displaced from a small area of the Bullock Patch, which effectively results in temporary habitat loss, although cable installation activities taking place in proximity to Bullock Patch will be short in duration. Given the temporary nature and short duration of the work and the alternative areas for spawning (including at three designated MCZs), The effect of noise and vibration on black seabream with be **not significant**.

9.6.4.92. Salmon are classed as hearing generalists with the swim bladder playing no part in hearing. Hawkins & Johnstone (1978) showed that salmon have a relatively low sensitivity to noise with a narrow frequency span and limited ability to discriminate between sounds. Harding *et al*. (2016) found an absence of stress response in captive salmon exposed to piling playback in tank-based experiments. Sea trout (*salmo trutta*) also possess a swim bladder but like salmon, there is no connection to the internal ear. With this in mind and given the low noise emission from cable burial equipment, and the temporary, short duration of the work, any effect from noise and vibration on salmon and sea trout is predicted to be **not significant**.

9.6.4.93. The presence of a swim bladder in European eels suggests an ability to perceive underwater noise. However, although this species possesses a swim bladder it lacks the specialised anatomical adaptions for the purposes of hearing. As such, given their low sensitivity, short and temporary nature of the works any effects from noise and vibration on European eel are considered as **not significant**.

Landfall

9.6.4.94. HDD methods will be used within Langstone Harbour and in the nearshore area at Eastney with the HDD exit/entry point expected to be located approximately 1 to 1.6 km from shore. It is possible that noise and vibration produced by HDD will disturb hearing specialist fish directly close to the seabed where the drill is operating or in the vicinity of the exit point. As migratory species use the coastal zone for migration they may be in this area, however salmon, sea trout and eel are not considered sensitive to this potential impact and are not considered further.

9.6.4.95. Nedwell *et al*. (2012) found that underwater noise monitoring of HDD operating below a river resulted in levels of 129.5 dB re 1 μPa on the river bed. It was noted however, that due to the shallow water conditions the sound attenuated rapidly, in addition there was no shipping noise present. It is likely that HDD operations for the Proposed Development will be result in similar noise levels. Based on guidelines by Popper *et al*. (2014), HDD noise is substantially below both injury and TTS for fish with swim bladders.

9.6.4.96. It is likely that noise levels when the drill exits the seabed will be elevated as the drill head will not be insulated by sediment. Once the drill reaches the surface it is likely to be turned off as no more drilling is required. The elevated noise will therefore be of very short duration. In addition, this will be a gradual continuous noise increase as the drill ascends to the seabed, thus giving any fish receptors adequate chance to move away before the drill reaches the surface. At worst, this will elicit avoidance behaviour by individuals in the immediate vicinity.

9.6.4.97. Therefore, it is considered that the effect of noise and vibration on fish (hearing specialists, salmon, eel and seatrout) from HDD operations is **not significant**.

9.6.4.98. To facilitate HDD operations at the entry/exit point, four 36” steel casings will be required as well as up to four trestles to hold the casings. The casings and trestle legs driven into the seabed. The works will employ a non-percussive EMV to install the trestles to support the drill casings, and a pipe driving machine to install the casings themselves. Pipe driving machines also use vibration in order to push in/install casing pipes with an auger inside which removes the sediment.

9.6.4.99. Although vibro-installation methods which produce continuous (rather than percussive noise) is proposed, a degree of underwater noise and vibration may be produced from these activities which is potentially harmful to fish.

9.6.4.100. Vibro-hammering and pile pushing (i.e. vibro-installation methods) are methods which relies on vibration to push an object into the seabed, it is normally accepted as being substantially less impactful than percussive piling.

9.6.4.101. In addition, Nedwell *et al*. (2003a) found no discernible increase in underwater noise at a distance of 417.4 m from an active vibro-piling rig against the background noise of Town Quay, Southampton. Nedwell *et al*. (2003b) also showed that caged brown trout (*Salmo trutta*) showed no reaction to active vibro-piling even at close range (<50 m). In light of this and considering the use of vibro-hammer and pile driver for installation of the casings and trestles will be temporary and short in duration, any effect from noise and vibration resulting from these works on hearing specialist fish is considered as **not significant**.

9.6.5. OPERATION (INCLUDING REPAIR AND MAINTENANCE) IMPACTS

Seabed Disturbance (and associated increases in SSC and sediment deposition)

9.6.5.1. The Proposed Development has been designed so that maintenance of the Marine Cables is not required during its operational lifetime. Should maintenance or repair works be required, it is anticipated that the relevant section of the marine cable will be recovered using methods like those employed during installation/construction stage. As such, the activities described above in relation to cable installation are relevant for the operational repair and maintenance of the Marine Cable Corridor although works would be of shorter duration and smaller in extent.

9.6.5.2. No specific locations for repair activities are possible to define at this time. However, as any such repair work will be infrequent and will only affect a very small and localised area, considering the assessment of effects during construction, **no significant effects** are predicted to arise through seabed disturbance, increased SSC or resultant sediment deposition due to operations and maintenance activity.

EMF

9.6.5.3. The potential impact of EMF could occur as a result of the operation of a marine cable. The Proposed Development will comprise 4 cables (2 bundled pairs) with a carrying capacity of 320 kv per cable. The predicted field strength for EMF around the cables is 42 µT at 1 m depth (Chapter 3 (Description of the Proposed Development), Section 3.2.9). As 1 m is the minimum target depth of lowering of the cables it is considered to be the worst case.

9.6.5.4. Elasmobranchs are considered to be potentially sensitive to EMF with a number of different species present along the Marine Cable Corridor. Those which have been identified as VERs include undulate ray, tope (and smooth-hound), spurdog, thornback ray, spotted ray and dogfish. The ability of elasmobranch species to detect electric fields is well known. Most species within this large group of fishes possess anatomical structures called ampullae of Lorenzini which are used for the detection of prey, predators, conspecific detection and in some species navigation (Tricas & Gill, 2011).

9.6.5.5. A study commissioned by the MMO (2014) evaluated the results of environmental data associated with post-consent monitoring of licence conditions of UK Round 1 and Round 2 OWFs, and some and European sites. The largest cables assessed were for Thanet OWF with four cables of 220 kv each. The report concluded that from the results of post-consent monitoring conducted to date, there is no evidence to suggest that EMF pose a significant risk to elasmobranchs at a site or population level, and little uncertainty remains (MMO, 2014).

9.6.5.6. Furthermore, NPS EN-3 Renewable Energy Infrastructure (2011) makes reference to EMF and concludes that when cable burial methods are employed the residual effects of EMF on sensitive species are not likely to be significant, and where burial depths greater than 1.5 m below the seabed impacts are likely to be negligible and EMF is not of sufficient range or strength to create a barrier to fish movement.

9.6.5.7. In some areas, cable burial depth for the Proposed Development may not be attained due to seabed conditions or existing infrastructure. In these areas, cable protection will be used to protect the cable. 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. It should be noted that cable protection is proposed along the Marine Cable Corridor, but cable burial is the preferred option and is anticipated to be achieved for approximately 90% of the Proposed Development. Although elasmobranchs may be able to detect EMF from a buried or protected cable, effects are likely to be subtle such as attraction, inquisitiveness and possible feeding responses. In addition, the NPS EN-3 Renewable Energy Infrastructure (2001) and MMO (2014) both conclude that effects from EMF are not predicted significant for fish and more specifically, elasmobranchs. Therefore, it is considered that effects from EMF on elasmobranchs are **not significant** however, it is acknowledged that some uncertainty still remains on the effects of EMF on elasmobranchs from larger subsea cables.

9.6.5.8. There is a lack of publicly available literature on the effects of EMF on other fish species such as cod. However, Hvidt *et al*., (2003) showed no effect on cod from EMF around the cables of the Vindeby OWF. It is also considered that as the level of EMF from the Proposed Development is so low (42 μT) the effects of EMF on cod is considered to be **not significant**.

9.6.5.9. The effects of EMF on salmonids is more understood with Armstrong *et al*. (2015) showing no identifiable behavioural response in salmon from mains frequency magnetic fields at EMF levels of 95 μT and below. As the worst-case EMF from the Proposed Development are predicted to be approximately 42 μT, the effects on salmon and sea trout from EMF are **not significant**.

Permanent Habitat loss

9.6.5.10. Permanent habitat loss will result where cable protection is placed on sediment habitats. Thus, habitat is lost and replaced by hard substrate. The use of cable protection will occur where the cable needs to be surface laid, crossing other cables, at HDD entry/exit points and in areas where target burial depths cannot be attained. The locations where remedial cable protection might be required (i.e. locations where the cable cannot be adequately buried) are yet to be determined however, a worst case assumes cable protection may be required up to 23 km along the Marine Cable Corridor with a total footprint of 0.7 km^2. This footprint also allows for some cable protection contingency to cover the use of cable protection for maintenance and repair activities post construction and for the cable crossing and HDD duct protection.

9.6.5.11. Figure 3.5 (Sheets 1-4) in Chapter 3 (Description of the Proposed Development) identifies the indicative locations for different seabed preparation activities along the corridor including where already planned rock placement/mattressing will take place (i.e. Atlantic crossing and uneven seabed preparation).

9.6.5.12. Non burial protection (i.e. rock infill) will be used to permanently replace excavated sediment at the HDD entry/exit after removal of the temporary rock bags/mattressing prior to cable pull. This represents a permanent habitat loss of approximately 0.0009 km^2 in this area.

9.6.5.13. Fish and shellfish receptors that would be most susceptible to the loss of habitat are species which rely on soft sediment. They include shellfish that live on sediment, substrate spawning fish, and flatfish.

Shellfish

9.6.5.14. The king scallop is an important commercial shellfish with the highest landings in the ICES rectangles of 29F0 and 29E9. It prefers areas of clean firm sand, fine or sandy gravel and also muddy sand, although Brand (1991) found that the highest abundances are usually found in areas with little mud. The MarESA sensitivity assessment by MarLIN (Marshall and Wilson, 2008) identifies that scallops have a high recoverability and moderate sensitivity to substratum loss. In addition, the sediments that scallops inhabit are widely available in the Channel and the area affected by cable protection represents only a tiny proportion of this (0.7 km^2). Given the low magnitude and spatial extent of impact, it is considered that effects from permanent habitat loss is **not significant** for king scallop.

9.6.5.15. Native oysters are known to be present in the Solent, Southampton Water and harbours with the highest densities found to be in the central Solent at Ryde Middle (Southern IFCA, 2018a). No oyster beds were found to be in the vicinity or within the Marine Cable Corridor (Patrick Cooper, 2019, *pers comm.*) This would indicate that there are no current or historic oyster beds in the vicinity of the HDD exit/entry pit. Although the presence of oysters in this area cannot be ruled out, the numbers are likely to be low with preferred habitat for this species located to the west (in the Solent, Southampton Water and harbours). In addition, the area of habitat loss is small in comparison with alternative available habitat. Therefore, considering the small extent and magnitude of impact, it is considered that effects will be **not significant** for oysters.

Marine Fish

9.6.5.16. Herring are a pelagic species but rely spawn and lay their eggs on certain types of seabed sediment. It is this stage where a possible route to impact exists from permanent habitat loss. As previously mentioned, the central Channel is an area of very high potential for herring spawning (Coull *et al*.,1998; Ellis *et al*., 2012 and RPS, 2013). The area of 'low' spawning potential within the South Marine Plan occupies an area of 2335 km^2; low to medium equate to 4443.7 km^2, and 'high' occupies an area of 480.2 km^2. Therefore, the worst-case habitat loss is resulting from cable protection of 0.7 km^2 is considered to be very small. Given the extensive spawning habitat available in the Channel, the small extent of the impact and Herrings ability to choose other suitable habitat in the immediate vicinity no significant effects on population size are expected. Therefore, it is considered that potential effects from permanent habitat loss on herring will be **not significant**.

9.6.5.17. Sandeels use clean sand on which to lay their eggs, predation cover and also to hibernate during the winter. They favour a particular type of substrate to lay their eggs. It is recognised that although sandeels may be present in areas where cable protection might be used, the impacted area is so small (including when considering it in total with all possible habitat loss), and with alternative habitat widely available, this effect is considered to be **not significant** on sandeel.

9.6.5.18. Black seabream is reported to spawn within the Marine Cable Corridor at the Bullock Patch. This species seeks specific grounds for laying eggs on with substrate types including open gravel areas, gravel areas adjacent to chalk reefs, sandstone reefs and ship's wreckage, therefore the presence of cable protection could reduce the availability of gravel substrate on which to nest, but conversely could increase preferable areas by providing additional reef areas. Given the small proportion of potential spawning / nesting area within the Marine Cable Corridor compared to alternative areas within the Solent and south coast of England, this effect is **not significant**.

9.6.5.19. Flatfish such as plaice and sole are adapted for living on the seabed and it is this characteristic that places them at potential risk from habitat loss. Both species are pelagic spawners with eggs and larvae drifting on residual currents. As the seabed is not required for spawning, no route to impact therefore exists for either species spawning.

9.6.5.20. Adult plaice have a preference for sandy sediments with older age groups having a preference for coarser sand (ICES, 2017a), whilst sole prefer shallow, sandy and sandy/muddy habitats (ICES, 2017b). Cable burial is most likely to be achieved in these types of sediments, so cable protection is unlikely to be required in these areas. It is recognised that suitable sediment for burial may overlay harder substrates where burial depth may not be possible and in some cases repair or maintenance activities may require the use of cable protection in these areas, however it is considered, that due to the wide availability of suitable sediments and high mobility of these species that the effects on plaice and sole are **not significant**.

Elasmobranchs

9.6.5.21. Given the wide variety of alternative nursery areas for elasmobranchs and the small footprint of potential habitat loss from cable protection (including at the HDD entry/exit) combined with mobile nature of adults, it is considered that any effect from permanent habitat loss on elasmobranch species will be **not significant**.

9.7. CUMULATIVE EFFECTS ASSESSMENT

9.7.1. INTER-PROJECT EFFECTS

9.7.1.1. Cumulative effects on fish and shellfish ecology may arise from the interaction of impacts from the Proposed Development during installation, operation (including maintenance and cable repair) or decommissioning and impacts from other planned or consented projects in the wider region.

9.7.1.2. It has generally been considered that the potential for cumulative effects will be greatest during the construction phase of the Proposed Development. Decommissioning is assumed to have similar (or lesser) impacts than construction. In the event that cables need to be repaired or maintained, the activities required to undertake the works are considered similar to the effects that may arise during construction although much lower in magnitude due to the considerable reduced scale and shorter duration of works.

9.7.1.3. A list of projects within the wider vicinity of the Proposed Development that have the potential to give rise to cumulative effects on fish and shellfish receptors has been considered (Appendix 9.2 (Fish and Shellfish Cumulative Assessment Matrix) of the ES Volume 3 (document reference 6.3.9.2)). This included major projects (offshore wind farms, interconnector cables, oil and gas), aggregate dredging projects, dredging and disposal projects, and coastal projects. This long list was agreed with the MMO (see Table 9.1). The locations of projects within this list in relation to the Proposed Development are shown in Figures 29.1 to 29.5 of the ES Volume 2 (document reference 6.2.29.1 to 6.2.29.5). As detailed in Chapter 29 (Cumulative Effects) of the ES Volume 1 (document reference 6.1.29), the cumulative effects assessment ('CEA') is to be undertaken with regards to PINS Advice Note 17 – Cumulative Effects Assessment (PINS, 2019). The long list of projects presented in Appendix 9.2 (Fish and Shellfish Cumulative Assessment Matrix) was refined for fish and shellfish as follows:

- First, a spatial assessment was conducted. Any project identified in the list of projects falling within the ZOI for fish and shellfish ecology (25 km from the Marine Cable Corridor as this is maximum extent of sediment plume) was screened in for further consideration;
- A temporal, scale and nature-based assessment was then conducted for those projects where a potential spatial overlap was identified; and
- Taking the above into account, any projects then considered likely to affect fish or shellfish receptors, and/or likely to result in significant effects due to their scale and nature have been identified.

9.7.1.4. The sections below consider the potential for effects to arise cumulatively with other projects. Those that have been taken forward for further consideration are assessed in detail in Sections 9.7.2 and 9.7.3.

Construction (and Decommissioning) impacts considered

Temporary habitat disturbance/loss

9.7.1.5. The assessment for the Marine Cable Corridor alone identified no significant effects on all fish and shellfish receptors from temporary habitat disturbance/loss. This was, in part, due to the lack of sensitivity of species to this impact, the temporary nature of the impact and the small spatial extent disturbed in comparison with alternative available habitat.

9.7.1.6. Sediment spawning fish are most sensitive to habitat disturbance (black seabream, sandeels, elasmobranchs and herring). It is considered that there will be no effect on black seabream as although there are nesting sites are located along the Marine Cable Corridor, no other projects overlap known spawning sites. Similar conclusions can be made for sandeels and elasmobranchs as no optimal sandeel habitat is identified along the Marine Cable Corridor and spawning habitat for those elasmobranchs assessed is widely available outside the Marine Cable Corridor. Therefore, it is considered that there is no potential for cumulative effects from temporary habitat disturbance/loss for these species.

9.7.1.7. The Proposed Development overlaps a known herring spawning area (IHLS data 2007-2017) and although effects were considered to be **not significant** for the Proposed Development alone, when considered cumulatively with those other projects operating in the same herring spawning area a significant effect may exist. Therefore, this effect has been assessed cumulatively for herring in Sections 9.7.2 and 9.7.3 below.

Temporary increase in suspended sediment and smothering

9.7.1.8. The assessment for the Proposed Development alone identified no significant effects on any fish and shellfish receptors resulting from increased SSCs given their tolerance to increased SSC in coastal areas, the limited extent and temporary nature (hours) of peak SSCs resulting from the Proposed Development and the limited extent of sediment deposition (within and in close proximity to the Marine Cable Corridor).

9.7.1.9. Effects to those species which inhabit the Solent (e.g. oyster) are **not significant** as disposal activities will occur beyond KP 21 which is outside this area. In addition, migratory fish (salmon, sea trout, shad, eels and lamprey) are highly tolerant to increased SSC as are the majority of fish and shellfish in the Channel. Effects to sediment spawning species like black seabream are **not significant** as greatest magnitude and extent of increased SSC and smothering occur beyond KP21 (due to sediment disposal) where there are no known spawning/nesting site. Similar conclusions can be made where no optimal sandeel habitat is identified along the Marine Cable Corridor and spawning habitat for those elasmobranchs assessed is widely available outside the Marine Cable Corridor where SSC is expected to be a maximum of 20 mg/l following the initial peak SSC (i.e. within natural variation). Therefore, it is considered that there is no potential for cumulative effects from increased SSC and smothering on these species.

9.7.1.10. Given that the Proposed Development overlaps a known herring spawning site cumulative effects from increased SSC and smothering from other projects operating in the same area may exist. Therefore, this effect has been assessed cumulatively with other projects for herring in Sections 9.7.2 and 9.7.3.

Noise and Vibration

9.7.1.11. The assessment for the Proposed Development alone concluded that any effect from noise and vibration was **not significant** for all hearing specialist fish such as herring, shad and cod as well as hearing generalists' salmon, sea trout and European eel.

9.7.1.12. Noise levels will be low and will not result in injury or mortality to these species (all receptors); low numbers of individuals are expected in the vicinity of the Marine Cable Corridor (shad), these fish are all highly mobile so they can avoid any noise or vibration (all receptors) or they are simply not sensitive to underwater noise (salmon, trout, European eel). Therefore, it is considered that there is no potential for cumulative effects from noise and vibration on these species. It is recognised however that, as the Proposed Development overlaps a known herring spawning site, cumulative effects from noise and vibration from other projects operating in the same area may exist. Therefore, this effect has been assessed cumulatively with other projects for herring in Sections 9.7.2 and 9.7.3 below.

Operation (including repair and maintenance) impacts considered

EMF

9.7.1.13. The assessment for the Proposed Development alone concluded effects from EMF for elasmobranchs, cod and salmon was **not significant**. This was due to the cable being buried or protected, or that the species were not sensitive to EMF.

9.7.1.14. In addition, as the levels of EMF are predicted to be so low and not even be detectable within metres of the cable, it is considered that there is no potential for cumulative effects with other projects.

Permanent Habitat Loss

9.7.1.15. The assessment for the Proposed Development alone concluded effects from permanent habitat loss would be **not significant** for all receptors. This conclusion was based on the tiny proportion of seabed that will be affected in the context of available alternative habitat in the Channel. Therefore, it is considered that there is no potential for cumulative effects from permanent habitat loss on all receptors.

9.7.1.16. Table 9.10 provides a summary of the potential for cumulative effects and the receptors carried forward for detailed assessment.

Table 9.10 – Effects and species to be assessed cumulatively with other projects

Effect	Receptor	Phase	Area considered
Temporary Habitat disturbance/loss	Herring	Construction	Within herring spawning grounds
Temporary increase in SSC and smothering	Herring	Construction	Within herring spawning grounds
Noise and vibration	Herring	Construction	Within herring spawning grounds

9.7.1.17. Those projects where cumulative effects may result are selected based on the effects and receptors which are identified in Table 9.10. The cumulative projects that have been assessed are summarised in Table 9.12. Their locations are illustrated in Figures 29.1, 29.2 and 29.3.

9.7.1.18. In summary, the projects that have been assessed cumulatively with the Proposed Development are as follows:

- AQUIND Interconnector (France);
- IFA2;
- DEME Building Material aggregate extraction (Area 478);

- Hanson Aggregates Marine Ltd aggregate extraction (Areas 473, 474, 475);
- Volker Dredging Ltd aggregate extraction (Area 461);
- Saint Nicolas West aggregate extraction (France); and
- Saint Nicolas East aggregate extraction (France).

9.7.1.19. As only herring are being assessed, all projects that are located within the herring spawning area identified by IHLS data (2007-2017) have been included (see Figures 29.1, 29.2, and 29.3). To ensure the worst case is assessed, all projects have been considered to be under construction or undergoing aggregate dredging works at the same time.

Table 9.11 – Description of cumulative projects assessed (n/a = not available)

Description	AQUIND Interconnector (France)	IFA2	DEME Building Materials - (Area 478)	Hanson Aggregates Marine Ltd - (Area 473, 474, 475)	Volker Dredging Ltd (Area 461	Saint Nicolas West – (France)	Saint Nicolas East – (France)
Distance from Proposed Development	0 km	0.4 km	4.1 km	6.37 km	1.93 km	2.81 km	4.16 km
Dredging required	Yes - TSHD but dredging is *c.*60 km distant from the Proposed Development	Yes TSHD	Yes TSHD	Yes TSHD	Yes TSHD	Yes TSHD	Yes TSHD
Expected SSCs	Worst case SSC is 1000mg/l at release point, passive plume up to 20 mg/l for 7-15 km reducing to background within days.	Approx. 20mg/l for a period of minutes/hour; deposition up to 6 km	n/a in licence application documents	n/a in licence application documents	n/a in licence application documents	n/a	n/a

Description	AQUIND Interconnector (France)	IFA2	DEME Building Materials - (Area 478)	Hanson Aggregates Marine Ltd - (Area 473, 474, 475)	Volker Dredging Ltd (Area 461	Saint Nicolas West – (France)	Saint Nicolas East – (France)
Construction method	Plough, jet trench or mechanical trenching	Plough, jet trench or mechanical trenching	n/a Aggregate dredging (not construction)	Aggregate dredging (not construction)	n/a Aggregate dredging (not construction)	n/a Aggregate dredging (not construction)	n/a Aggregate dredging (not construction)
Area of site	Length – 109 km Cable corridor width – 0.5 km Working corridor width – 0.08 km	Length – 240 km Cable corridor width – 0.25 km Working corridor width – 0.02 km	30 km^2	16 km^2	10 km^2	10 km^2	15.5 km^2
Area disturbed	5.84 km^2	4.8 km^2	Four areas of 9.5 km^2	n/a	Four areas of 2.5 km^2	n/a	n/a
Seasonal restrictions	no	No	No dredging Jan-Feb inclusive (herring spawning)	No dredging Nov-Feb inclusive (herring spawning)	No dredging Nov-Feb inclusive (herring spawning)	n/a	n/a

9.7.2. CONSTRUCTION (AND DECOMMISSIONING) CUMULATIVE EFFECTS ASSESSMENT

9.7.2.1. As described above only effects resulting from activities during construction (and decommissioning) have been considered in the cumulative assessments.

Temporary habitat Disturbance/Loss

Marine Cable Corridor

9.7.2.2. Temporary habitat disturbance/loss relates to cable preparation and cable laying practices with a worst case of 3.6 km^2 within areas identified as being of herring spawning potential within the South Marine Plan. The Marine Cable Corridor has the potential to contribute to a cumulative effect when considered with those projects above (Table 9.11), as all of these projects overlap the mid Channel herring spawning grounds.

9.7.2.3. Effects from temporary habitat disturbance/loss on herring for the Proposed Development alone was assessed as **not significant**. Within the EIA for the AQUIND Interconnector (France) the same effect was assessed as minor and not significant. The effect of 'seabed disturbance' was assessed as negligible to minor for herring for IFA2. There are no environmental statements or current supporting information available for those aggregate sites identified (both UK and French).

9.7.2.4. IFA2, according to information in the ES, should have completed construction by 2020 and therefore, there is no overlap of construction between the Proposed Development and IFA2 (although there will be overlap of operational stages). However, to ensure the worst case is considered, it is assumed that all of these projects are constructing/dredging at the same time. Therefore, the temporary disturbance/loss of habitat will occur at the same time within the herring spawning grounds. As this effect relates to the disturbance or loss of substrate, the spawning area identified by Ellis *et al.* (2012) is most applicable as it is based on substrate type rather than larval densities (Figure 9.3).

9.7.2.5. The worst-case area disturbed by the Marine Cable Corridor is 3.6 km^2 of all areas identified as having spawning potential in the South Marine Plan. This equates to 1.3 % low to medium and 7.6 % of high potential area.

9.7.2.6. For the AQUIND Interconnector (France) project, the area disturbed is 2.22 km^2 (0.03 % of the total spawning area) (80 m width).

9.7.2.7. For IFA2, based on a width of disturbance of 15 m, the area disturbed is 0.024 km^2 and this interconnector in the UK passes through almost entirely areas identified as low to medium spawning potential of which the area disturbed by the installation amounts to only 0.0005% of this area.

9.7.2.8. The UK aggregate sites occupy much larger areas than the interconnectors with;

- DEME Building Materials (Area 478) disturbing 30 km^2 (0.34 % of areas of low to medium and 0.93% medium to high UK spawning potential);

- Hanson Aggregate Marine Ltd (Area 473, 474 and 475) disturbing 40 km^2 (0.13% of low to medium, 1.59% of medium to high and 1.78% of very high UK spawning potential areas); and
- Volker Dredging Ltd (Area 461) disturbing 2.7 km^2 (0.56% of very high UK spawning potential areas).

9.7.2.9. In addition, the two French aggregate sites are Saint Nicolas West and Saint Nicolas East which possess areas of disturbance of 10 km^2 and 15.5 km^2 respectively.

9.7.2.10. The total potentially disturbed area for all projects considered is 98.2 km^2 which equates to 1.1% of the area identified as potential herring spawning potential areas in the South Marine Plan.

9.7.2.11. It is important to note that this area of temporary disturbance is considered to be highly conservative as it assumes disturbance over the entire aggregate areas. In reality, the disturbed area will be substantially less as aggregate dredging will only occur in discrete areas within each site at any one time.

9.7.2.12. In addition, the aggregate sites have a seasonal herring restriction due to the large areas licensed, possess long term licences (issued for 30 years versus a much shorter construction period for the Proposed Development) and a different nature of activities (i.e. direct removal sediments / spawning substrate as well as associated habitat disturbance). Due to this aggregate extraction for UK site will not take place across the peak spawning periods and therefore there is reduced potential for significant cumulative effects to occur, while the effects resulting from the Proposed Development are likely to be of lower magnitude than aggregate dredging (due the reduced spatial extent and that it results in disturbance only – not aggregate extraction).

9.7.2.13. It is also worth noting that the conclusion of the regional cumulative assessment of aggregate extraction in the Southern region (i.e. Channel) concluded that the distribution and extents of seabed sediments able to support Atlantic herring spawning, and which are within the known range of spawning populations, is such that marine aggregate extraction is unlikely to significantly restrict recruitment to the adult population (MarineSpace et. al., 2013b).

9.7.2.14. In light of the small spatial extent of disturbance by all projects combined within with the availability of other spawning areas, the effect on herring is considered to be **not significant**.

Temporary Increases in SSC (and smothering)

Marine Cable Corridor

9.7.2.15. An increase in suspended sediments as a result of dredging, disposal and cable burial for the Proposed Development has the potential to contribute to cumulative effects when considered with those projects highlighted above (Table 9.12). As all of these projects overlap herring spawning grounds and this species is considered to have the greatest sensitivity to this impact.

9.7.2.16. Effects from increased SSC and smothering on herring for the Proposed Development alone was assessed as **not significant**. Within the EIA for the AQUIND Interconnector (France) the same effect was assessed the same effect was assessed as minor and not significant for all stages of herring development (eggs, larvae and adults). The effect on herring from ‘sediment deposition’ and ‘increased suspended sediment concentrations’ was not assessed for IFA2. There are no environmental statements or current supporting information available for those aggregate sites identified (UK and French).

9.7.2.17. The results from the plume dispersion modelling for the Proposed Development show peak levels of SSC (1000 mg/l within 1 km of sediment release point) with significant reductions in SSC within hours of disposal. The remaining plume is shown to extend up to 25 km however SSC are low (up to 20 mg/l) and the plume is expected to return to background levels within a few days following completion of the works. For the AQUIND Interconnector (France) project, similar levels of SSC are predicted however passive plumes are expected to only extend for 15 km. Increased SSC for IFA2 is not expected to exceed 20 mg/l with a maximum extent of 6 km.

9.7.2.18. In light of the lack of sediment modelling for each of the aggregate dredging sites considered, the ‘East English Channel Herring Spawning Assessment’ (RPS, 2013), which discusses the same aggregate areas, has been considered. The report highlights that the majority of suspended sediments related to aggregate dredging extraction settled on the seabed within 500 m to 1 km of an Active Dredge Zone (‘ADZ’). In addition, Hayes *et al*. (1984) showed that the highest levels of SSC from aggregate dredging is in the immediate vicinity of the dredger with a maximum of up to 900 mg/l (with overflow) and increases in SSC outside an aggregate extraction area is less than 20 mg/l, unless dredging occurs close to the boundary when levels of 50 mg/l are likely for up to 250 m. These parameters are also likely to be similar for the French aggregate areas.

9.7.2.19. IFA2, according to information in the ES, should have completed construction by 2020 and therefore, there is no overlap of construction between the Proposed Development and IFA2 (although there will be overlap of operational stages). However, to ensure the worst case is considered it is assumed that all of these projects are constructing/dredging at the same time. Therefore, SSC plumes will be created for each project within the herring spawning grounds.

9.7.2.20. When considering this worst case and given the distances between these projects (maximum 6.37 km) the individual plumes are likely to interact. In this instance, the individual plumes would not be additive but simply create a larger plume with regions of varying concentrations (Hanson Aggregates Ltd, 2015). The maximum levels of SSC within this larger plume will occur near to the source (e.g. dredger and dredge disposal vessel) and be limited in area (e.g. approx. 1000 m as identified by sediment modelling for the Proposed Development) before returning to levels comparable with background levels in the Channel.

9.7.2.21. Herring eggs, larvae and adults were found not to be sensitive to elevated levels of SSC for the Proposed Development alone. However, those areas of higher SSC around dredgers and disposal vessels may initiate avoidance of multiple spawning areas by gravid adults.

9.7.2.22. The maximum number of vessels from the Proposed Development, AQUIND Interconnector (France) project, IFA2 and the five UK and two French aggregate sites combined equates to a total of 13 vessels, either actively dredging or disposing of sediment within the herring spawning area. Due to lack of project specific information for the French aggregate sites two vessels per site is assumed. A conservative estimate is that the highest levels of SSC, and therefore potentially most disturbing to gravid herring will be within a 500 m radius of the vessels (1000 m diameter). This gives a combined area of 10.27 km^2 (0.79 km^2 around each vessel).

9.7.2.23. Given the availability of alternative spawning grounds in the Channel and the temporary nature of this impact (with SSC falling to background levels within days), it is considered that although a cumulative effect is possible, it is small in spatial extent and temporary in nature. In addition, the area of elevated SSC considered in this assessment is highly conservative with levels of SSC potentially harmful to herring reducing within a very short distance from the disposal vessel/dredger, while restrictions are in place for herring spawning periods for aggregate dredging at Areas 478, 473, 474, 475 and 461 (and therefore plumes of SSC from these areas will not occur over these spawning periods). Therefore, the cumulative effects of increased SSC from all projects on spawning herring (larvae and eggs) is predicted not to be **not significant**.

9.7.2.24. Smothering resulting from the Marine Cable Corridor alone was assessed as **not significant** for herring with IFA2 concluding a negligible significance for the same species. There is no publicly available data on the effect of smothering on herring from the aggregate sites, which is likely due to the fact that dredged material is not re-deposited. Deposition is only likely to occur due to sediment disturbance by the drag head and overflow and therefore, is likely to be very small in magnitude and extent.

9.7.2.25. Herring prefer a certain type of sediment on which to spawn, as a result, the potential for a cumulative effect from smothering from other projects may render areas of the seabed unsuitable for spawning by changing the sediment type. In addition, eggs and larvae already present may be smothered by the additional sediment.

9.7.2.26. Plume dispersion modelling for the Marine Cable Corridor shows that smothering is at its greatest directly below (and up to 1 km away) from the dredge disposal vessel with deposit levels between 1500 mm and 10 mm expected within this area (greatest deposits expected within a couple hundred metres of disposal). Smothering beyond 1 km is considered to be negligible. Sediment deposition for the IFA2 project has not been modelled but is likely to be highly localised around the vicinity of the cable installation method. If dredge disposal is required for IFA2 it is assumed that levels are likely to be comparable to that of the Proposed Development. In light of the lack of an ES, and sediment modelling, for the aggregate dredging sites (UK and French) a study by Gajewski & Uscinowicz (1993) has been used. The study found that sediment deposition by aggregate dredging recorded a narrow band 100 m on each side of the dredge area with deposition levels beyond 50 m decreasing rapidly.

9.7.2.27. Sediment deposition, unlike suspended sediment which drifts with the prevailing currents, is more localised as heavier fractions fall from suspension rapidly. As the areas of greatest sediment deposition from each project are smaller (up to a few hundred metres from the vessel) than the areas of elevated SSC (500 m from the vessel), the total area of the available herring spawning affected will be less.

9.7.2.28. It is unlikely that eggs and larvae will survive the in areas subject to greatest levels of sediment deposition directly below (and within a few hundred metres) from a disposal vessel. Birklund *et al*. (2005) suggesting that smothering is likely to be detrimental to herring eggs unless the material is removed rapidly. The plume modelling undertaken for the Proposed Development identifies that sediment deposition is temporary and transient with redistribution by tidal forcing. However, on a precautionary basis it must therefore be assumed that all eggs and larvae in the area of sediment deposition will not survive. It should be noted however that the total areas for all projects combined is small (smaller than that assessed for SSC) and when considered in relation to availably of spawning grounds the impacted area will be tiny.

9.7.2.29. In light of this and although a cumulative effect on herring spawning, eggs and larvae exists, the magnitude and spatial extent of the impact is small and is considered to be **not significant**.

Landfall

9.7.2.30. Dredging/excavation of the HDD exit point at the Landfall has the potential to produce a degree of SSC and in turn, a level of smothering. Due to the shallow depths in this area, an excavator (i.e. backhoe dredger) or MFE will be used with disposal of the dredged material occurring at approximately KP 21 offshore (where a dredger /excavator is used). Therefore, the levels of SSC and sediment deposition from disposal at KP 21 are expected to be negligible to those levels assessed for the Marine Cable Corridor. This area is also well outside the herring spawning grounds so no cumulative effects on herring are predicted at the Landfall or from construction activities undertaken for Landfall.

Noise and vibration

Marine Cable Corridor

9.7.2.31. Noise and vibration as a result of cable installation (mechanical trenching being the worst case) for the Proposed Development has the potential to contribute to cumulative effects with those projects identified in Table 9.12.

9.7.2.32. Herring are hearing specialists and as all of the cumulative projects considered (Table 9.12) overlap the herring spawning grounds (as identified by South Marine Plan), a potential for cumulative effects from underwater noise exists as large aggregations of herring (including gravid herring) may be present during construction/dredging activities.

9.7.2.33. The assessment of underwater noise on herring for the Marine Cable Corridor alone was considered to be **not significant**. The same impact for the AQUIND Interconnector (French) project was assessed as minor and not significant. The impact of noise and vibration from any marine installation activity was not assessed for IFA2 and no ES was available for those aggregate sites identified (UK and France).

9.7.2.34. Although no underwater noise modelling was undertaken for the Proposed Development, AQUIND Interconnector (France) or IFA2 (it is unknown if this was undertaken for the aggregate sites), Nedwell *et al*. (2003a) identified that underwater noise from continuous sources such as mechanical trenching was 123 dB re 1 µPa @ 160 m. As all these interconnector projects specify mechanical trenching as a cable burial method it is considered the worst case. This level of underwater noise will not cause mortality or injury to herring (Popper *et al.,* 2014).

9.7.2.35. No project specific sound levels are available for the aggregate sites included in this cumulative assessment, however, Robinson *et al*. (2011) found that underwater noise from TSHD engaged in aggregate dredging was approximately 160 dB re 1 $\mu Pa^2 m^2$ (at source). When considered in the context of guidelines by Popper *et al*. (2014) there is low potential for mortality or mortal injury from this level of continuous noise. Given the above, it is considered that the levels of underwater noise produced by these projects individually will not cause mortality or injury to herring. However, in the unlikely event that all projects were constructing/dredging at the same time (the UK aggregate sites have restrictions to avoid herring spawning periods), the potential for cumulative effects may exist. However, it is considered that given the distance between each project, an additive effect would not be created (i.e. higher combined noise level) but simply pockets of elevated noise around each operation. Furthermore, the UK aggregate dredging sites have timing restrictions to avoid key spawning periods, and therefore, will not act cumulatively with the Proposed Development. Although these levels of underwater noise may result in some mild avoidance behaviour by herring in close proximity to the area, no injury or mortality is expected. As these areas of elevated noise will be highly localised the cumulative effect will be **not significant** on herring.

Landfall

9.7.2.36. HDD and vibro-hammering and pile driving of casings and trestles at the exit/entry point will create a degree of underwater noise. However, the levels of noise predicted are low and these works are outside the herring spawning area so no cumulative effects on herring are predicted.

9.7.3. SUMMARY OF CUMULATIVE EFFECTS

9.7.3.1. Table 9.12 presents a summary of the cumulative effects assessment undertaken in Section 9.7.4.

Table 9.12 – Summary of cumulative assessment

ID	Tier	Project Name and Reference	Assessment of cumulative effect	Proposed mitigation	Residual cumulative effect
1	2	AQUIND Interconnector (France)	**Temporary Habitat Disturbance/Loss:** The total potentially disturbed area for all projects considered is 85.5 km^2 which equates to a tiny percentage (1.1%) of the area identified as having spawning potential in the South Marine Plan) It is important to note that this temporary disturbed area is considered to be highly conservative as it assumes disturbance over the entire aggregate areas. In reality, the disturbed area will be substantially less as aggregate dredging will only occur in discrete areas within each site at any one time, and the UK aggregate licenses have a range of restrictions in place prevent operations over the herring spawning season. In light of the small spatial extent disturbed by all projects combined within the herring spawning area the effect on herring is considered to be not significant.	None	**Not significant**
7	1	IFA2			
22	1	DEME Area 478			
23	1	Volker Area 461			
24 and 25	1	Hanson Areas 473, 474 and 475			
32	1	Saint Nicolas West aggregate			
33	1	Saint Nicolas East aggregate			
1	2	AQUIND Interconnector (France)	**Temporary increases in SSC (and smothering):** A conservative estimate is that the highest levels of SSC, and therefore potentially most disturbing to gravid herring will be within a 500 m radius of the vessels (1000 m diameter). This gives a combined area of 10.27 km^2 (0.79 km^2 around each vessel). This combined area is considered to be tiny in the	None	**Not significant**
7	1	IFA2			
22	1	DEME Area 478			

ID	Tier	Project Name and Reference	Assessment of cumulative effect	Proposed mitigation	Residual cumulative effect
23	1	Volker Area 461	context of the total spawning area, and the areas of elevated SSC only represent just tiny percentage of the higher larval density sub-rectangles. It should be noted, however that these areas of elevated SSC are temporary with plume modelling for the Proposed Development predicting a return to background levels within a number of days. In addition, the area of elevated SSC considered is highly conservative as restrictions are in place during herring spawning periods for aggregate dredging at Areas 478, 473, 474, 475 and 461 (and therefore plumes of SSC from these areas will not occur over these spawning periods). Therefore, the cumulative effects of increased SSC from all projects on spawning herring (larvae and eggs) is predicted to be not significant. Sediment deposition, unlike suspended sediment which drifts with the prevailing currents, is more localised as heavier fractions fall from suspension rapidly. As the areas of greatest sediment deposition from each project are smaller, the total area of the available herring spawning affected will be less. It is unlikely that eggs and larvae will survive the in areas subject to greatest levels of sediment deposition directly below (and within a few hundred metres) from a disposal vessel. The plume modelling undertaken for the Proposed Development identifies that sediment deposition is		
24 and 25	1	Hanson Areas 473, 474 and 475			
32	1	Saint Nicolas West aggregate			
33	1	Saint Nicolas East aggregate			

ID	Tier	Project Name and Reference	Assessment of cumulative effect	Proposed mitigation	Residual cumulative effect
			temporary and transient with redistribution by tidal forcing. However, on a precautionary basis it is assumed that all eggs and larvae in the area of sediment deposition will not survive. It should be noted however that the total areas for all projects combined is small (smaller than that assessed for SSC) and when considered in relation to the areas of high spawning potential, the impacted area will be tiny. In light of this and although a cumulative effect on herring spawning, eggs and larvae exists, the spatial extent and magnitude of effect is considered to be small and is considered to be not significant. At Landfall, the levels of SSC and sediment deposition are expected to be negligible to those levels assessed for the Marine Cable Corridor. This area is also well outside the herring spawning grounds so no cumulative effects on herring are predicted at the Landfall or from construction activities undertaken for Landfall.		
1	2	AQUIND Interconnector (France)	**Noise and Vibration:** Given the information provided in Section 9.7.4, the levels of underwater noise produced by these projects individually will not cause mortality or injury to herring. However, in the unlikely event that all projects were constructing/dredging at the same time a cumulative effect may exist. However, it is	None	**Not significant**
7	1	IFA2			
22	1	DEME Area 478			

ID	Tier	Project Name and Reference	Assessment of cumulative effect	Proposed mitigation	Residual cumulative effect
23	1	Volker Area 461	considered that given the distance between each project, an additive effect would not be created (i.e. higher combined noise level) but simply pockets of elevated noise around each operation. Furthermore, the UK aggregate dredging sites have timing restrictions to avoid key spawning periods, and therefore, will not act cumulatively with the Proposed Development. Although these levels of underwater noise may result in some mild avoidance behaviour by herring, no injury or mortality is expected. As elevated noise levels are low in magnitude and highly localised the cumulative effect will be not significant on herring. At Landfall, HDD and vibro-hammering and pile driving of casings and trestles at the exit/entry point will create a degree of underwater noise. However, the levels of noise predicted are low and these works are outside the herring spawning area so no cumulative effects on herring are predicted.		
24 and 25	1	Hanson Areas 473, 474 and 475			
32	1	Saint Nicolas West aggregate			
33	1	Saint Nicolas East aggregate			

9.7.4. INTRA-PROJECT EFFECTS

9.7.4.1. As detailed in Chapter 4(EIA Methodology) of the ES Volume 1 (document reference 6.1.4), Chapter 29 (Cumulative Effects) presents consideration of potential intra-project effects on fish and shellfish receptors.

9.7.5. TRANSBOUNDARY EFFECTS

9.7.5.1. The possibility for transboundary effects exists where the impacts of the Proposed Development extend beyond the UK Marine Area, either in isolation or cumulatively. This has been assessed within this chapter.

9.7.5.2. Given the location, nature and scale of the Proposed Development, it is considered that potential impacts are unlikely to lead to any significant transboundary effects on fish or shellfish receptors. The fish and shellfish on the French and UK sides of the Channel are similar in composition, and as no significant effects have been identified in UK waters, it is considered that transboundary effects will be **not significant**.

9.7.5.3. While there is potential for any sediment plume arising from construction and disposal activities to extend into French waters, the possible impact is considered to temporary, of low magnitude and small spatial extent, and transboundary effects from this are not considered to have the potential to be significant.

9.7.5.4. In addition, due to the nature of noise and vibration from the Proposed Development (low noise levels and small zones of potential impact) there will be negligible overlap with French waters and therefore the potential for transboundary effects is considered to be not significant. Therefore, it is considered that there will be no significant transboundary effects resulting from the Proposed Development.

9.7.5.5. Furthermore, the potential effects on French SACs where Annex II migratory fish are a feature and for which there is potential for connectivity to the Proposed Development have been considered. Accordingly, the potential effects from the Proposed Development on the integrity and conservation status of these sites have been considered as part of the HRA Report (document reference. 6.8.1) and it was concluded that there will be no LSE or adverse effects on site integrity for migratory fish features of French SACs.

9.8. PROPOSED MITIGATION

9.8.1.1. The approach to assessment in this chapter assumes that mitigation measures embedded into the design (e.g. routing the cable to avoid constraints, use of appropriate construction techniques, pollution prevention measures) or which constitute industry standard environmental plans and best practice will be in place.

9.8.1.2. Given that no significant effects were predicted for fish and shellfish receptors, no further mitigation measures are proposed.

9.8.1.3. It is noted that S-FISH-4-HER of the South Marine Plan requires that projects consider herring spawning mitigation during the period 01 November to the last day of February annually. It is also noted that while the Marine Cable Corridor does pass through areas identified as having potential for herring spawning (i.e. those highlighted in Figure 26 of the plan, which corresponds to Figure 9.6) these have not been proposed as the mitigation is only specified for:

- Aggregate extraction:
  - in the yellow 'low to medium' and orange 'medium to high' areas whereby–spatial, temporal and extraction intensity mitigation should be considered during peak herring spawning period – (1 December to 31January); and
  - in red high herring spawning potential where no extraction should occur in the peak spawning period from the 1 December to 31 January annually and spatial, temporal and extraction intensity mitigation should be considered during (1 November to 30 November and 1 February – last day of February annually).
- Piling:
  - In the low herring spawning potential. No herring spawning mitigation required if it is demonstrated that there will be no noise impacts from pilling activity in the yellow, orange and red areas.
  - Yellow, orange and red areas – no piling activity during the period of 1 November to January 31 annually.

9.8.1.4. The effects of the Proposed Project are predicted to be significantly less than aggregate extraction and have been assessed as **not significant** to herring as they are localised and temporary in nature; and that the noise of cable installation is significantly less than piling hence noise and vibration impacts were also assessed as being not significant, therefore these mitigation measures are not required to safeguard the herring stock.

9.9. RESIDUAL EFFECTS

9.9.1.1. Taking into consideration embedded mitigation, no further mitigation requirements have been identified and there are no residual effects.

9.9.1.2. Table 9.13 details summarises the significance of effects of all impacts assessed as part of this chapter.

Table 9.13 – Summary of Effects

Potential Impact	Receptor	Significance of effect	Mitigation	Significance of Residual Effect
Construction & Decommissioning				
Temporary Habitat Disturbance/Loss	Crabs and lobsters	Not significant	None	Not significant
	King scallop	Not significant	None	Not significant
	Whelks	Not significant	None	Not significant
	Native oysters	Not significant	None	Not significant
	Cuttlefish	Not significant	None	Not significant
	Herring	Not significant	None	Not significant
	Sandeel	Not significant	None	Not significant
	Black seabream	Not significant	None	Not significant
	Elasmobranch (tope, spurdog, thornback ray, dogfish, smooth-hound and spotted ray)	Not significant	None	Not significant
	Undulate ray	Not significant	None	Not significant
Temporary increase in suspended sediments (and smothering)	Native oyster	Not significant	None	Not significant
	Whelks	Not significant	None	Not significant
	Edible crabs	Not significant	None	Not significant
	Cuttlefish	Not significant	None	Not significant
	European lobster	Not significant	None	Not significant

Potential Impact	Receptor	Significance of effect	Mitigation	Significance of Residual Effect
	Scallop	Not significant	None	Not significant
	Sandeels	Not significant	None	Not significant
	Herring	Not significant	None	Not significant
	Black seabream	Not significant	None	Not significant
	Tope and smooth-hound	Not significant	None	Not significant
	Thornback ray	Not significant	None	Not significant
	Undulate ray	Not significant	None	Not significant
	Salmon and sea trout	Not significant	None	Not significant
	Eel	Not significant	None	Not significant
	Sea and river lamprey	Not significant	None	Not significant
	Twaite and allis shad	Not significant	None	Not significant
	European smelt	Not significant	None	Not significant
	Bass	Not significant	None	Not significant
Entrainment of eggs and larvae	Herring	Not significant	None	Not significant
	Sandeels	Not significant	None	Not significant
Noise and Vibration	Herring	Not significant	None	Not significant
	Twaite and allis shad	Not significant	None	Not significant
	Cod	Not significant	None	Not significant
	Black bream	Not significant	None	Not significant
	Salmon	Not significant	None	Not significant
	Sea Trout	Not significant	None	Not significant

Potential Impact	Receptor	Significance of effect	Mitigation	Significance of Residual Effect
	European eels	Not significant	None	Not significant
Operation (including maintenance and repair)				
Disturbance, SSC and deposition	All receptors	Not significant	None	Not significant
EMF	Elasmobranchs	Not significant	None	Not significant
	Cod	Not significant	None	Not significant
	Salmon	No effect	None	Not significant
Permanent Habitat Loss	King scallop	Not significant	None	Not significant
	Native oyster	Not significant	None	Not significant
	Herring	Not significant	None	Not significant
	Sandeel	Not significant	None	Not significant
	Elasmobranches	Not significant	None	Not significant
	Plaice and sole	Not significant	None	Not significant
	Black bream	Not significant	None	Not significant

REFERENCES

ABP Research and Consultancy Ltd. (1995). Nash Sands Environmental Assessment Baseline Surveys. Report for ACR Marine. Report No. R.529. pp.31.

ADW (2014) *Raja clavata* Maiden Ray. Available from: http://animaldiversity.org/accounts/Raja_clavata/ [Accessed: 5/10/2018].

Ager, O.E.D. (2008). *Buccinum undatum* Common whelk. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/1560Barnes [Accessed: 16/10/2018].

Agri-Food and Biosciences Institute – Fisheries and Aquatic Ecosystems Branch (AFBI) (2017). Scallop Larval Dispersal Background Study. Available at: www.seafish.org/media/Publications/Scallop_reseeding_report_Final.pdf.

Armstrong, J. D., Hunter, D. C., Fryer, R. J., Rycroft, P., & Orpwood, J. E. (2015). Behavioural Response of Atlantic Salmon to Mains Frequency Magnetic Fields. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/progress-report/2015/09/scottish-marine-freshwater-science-vol-6-9-behavioural-responses-atlantic/documents/00484957-pdf/00484957-pdf/govscot%3Adocument/00484957.pdf [Accessed: 22/7/2019].

Avant, P. (2007). *Anguilla anguilla* Common eel. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/1782 [Accessed: 1/12/2018].

Barnes, M.K.S. (2008). *Osmerus eperlanus* European smelt. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/146 [Accessed: 3/12/2018].

Beaumont, A.R. & Gjedrem, T. (2007). Scallops — *Pecten maximus* and *P. jacobaeus*. Genetic impact of aquaculture activities on native populations. Genimpact final scientific report (EU contract n. RICA-CT-2005– 022802). Edited by T. Svåsand, D. Crosetti, E. García-Vázquez, and E. Verspoor. pp. 83–90. Available from: www.imr.no/genimpact/filarkiv/2007/07/scallops.pdf/en [Accessed: 20/10/2018].

Behrens, J. W., Stahl, H. J., Steffensen, J. F. & Glud, R. N. (2007). Oxygen dynamics of buried lesser sandeel *Ammodytes tobianus* (Linnaeus 1785): mode of ventilation and oxygen requirements. J. Exp. Mar. Biol. Ecol. 210 (6), pp.1006-14.

BEIS (2019). Decommissioning of offshore renewable energy installations under the Energy Act 2004. Guidance notes for industry (England and Wales). March 2019. Available at: https://www.gov.uk/government/publications/decommissioning-offshore-renewable-energy-installations.

Birklund, J. & Wijsman, J. W. M. (2005). Aggregate extraction: A review on the effect of ecological functions. Sandpit project report WL Z3297.

Bolle, L.J., de Jong, C.A.F., Blom, E., Wessels, P.W., Van Damme, C.J.G. & Winter, H.V. (2014). Effect of pile-driving sound on the survival of fish larvae. Report by IMARES - Wageningen UR and TNO. pp 33.

Brand, A.R. (1991). Scallop ecology: Distributions and behaviour. In Scallops: biology, ecology and aquaculture (ed. S.E. Shumway), pp. 517-584. Amsterdam: Elsevier. [Developments in Aquaculture and Fisheries Science, no.21.].

Cefas (2011). Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Cefas contract report: ME5403 – Module 15.

Cefas (2016). Solent bass pre-recruit survey. Available from: https://data.gov.uk/dataset/e425c713-d2a2-41c2-9abc-63d4bd2d5492/1983-centre-for-environment-fisheries-aquaculture-science-cefas-solent-bass-pre-recruit-survey-fss-solent [Accessed: 3/7/2018].

Cefas (2018) Assessment of salmon stocks and fisheries in England and Wales. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/806274/SalmonBackgroundReport-2017-final.pdf [Accessed: 1/7/2019].

CIEEM (2019) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. Chartered Institute of Ecology and Environmental Management, Winchester.

Chapman, C. & Hawkins A. D (2004). A field study of hearing in the cod, *Gadus morhua* L. Journal of comparative physiology 147-167.

Coelho, R. & Erzini, K. (2006). Reproductive aspects of the undulate ray, *Raja undulata*, from south coast of Portugal. Fisheries Research 81, 80-85.

Collins, K.J. & Mallinson, J.J. (2012). Surveying black bream, *Spondyliosoma cantharus* (L.) nesting sites using sidescan sonar. Underwater Technology, 30 (4), 183-188.

Coull, K.A., Johnstone, R. & Rogers, S.I. (1998). Fisheries Sensitivity Maps in British Waters. Published and distributed by UKOOA Ltd.

Ellis, J. R., Milligan, S. P., Readdy, L., Taylor, N. & Brown, M.J. (2012) Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56pp.

Drabble, R. (2012). Project entrainment of fish resulting from aggregate dredging. Marine Pollution Bulletin, 64: 373-381.

EMU (2003). Survey of Black Bream Nesting Sites Offshore of Littlehampton, using Sidescan Sonar and Video (ROV) Techniques 2002. Report No. 02/J1030474/0298. Report to Hanson Aggregates Marine Ltd.

EMU (2009), Area 435/396 Seabed Monitoring Survey, Report No. 09/1/02/1377/0899.

EMU (2011). Area 435/396 Monitoring report 2011. Hanson Heidelberg Cement Group; Tarmac. [Ref: 11/J/1/02/1843/1184 and 11J/1/06/1850/1232].

EMU (2012). Black Bream in the Eastern English Channel off the Sussex Coast.

English Nature (2003). The status of smelt *Osmerus eperlanus* in England. English nature research reports. [Report number 516].

Environment Agency (2018). TraC fish counts for all species for all estuaries and all years. Available from: https://data.gov.uk/dataset/41308817-191b-459d-aa39-788f74c76623/trac-fish-counts-for-all-species-for-all-estuaries-and-all-years [Accessed: 3/7/2018].

Forewind (2014.) Appendix 22 – Forewind and JNCC and Natural England – Herring clarification note. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010021/EN010021-001229-Forewind%20-%20Appendix%2022%20of%20SoCG%20with%20JNCC%20and%20NE%20(Offshore).pdf [Accessed: 23/10/2018].

Fugro EMU (2015). Kingsmere MCZ Bream Nest Interpretation 2014. Sussex IFCA.

Gajewski, L. S. & Uscinowicz, S. (1993). Hydrologic and sedimentologic aspects of mining marine aggregate from the Slupsk Bank (Baltic Sea). Marine Georesources and Geotechnology 11,229-44.

Greenstreet, S. P. R., Holland, G. J., Guirey E. J., Armstrong, E., Fraser, H. M. & Gibb I. M. (2010). Combining hydroacoustic seabed survey and grab sampling techniques to asses “local” sandeel population abundance. ICES Journal of Marine Science [Vol. 67:971-984].

Guillou, N., Rivier, A., Chapalain, G. & Gohin, F. (2017). The impact of tides and waves on near-surface suspended sediment concentrations in the English Channel. Oceanologia. Jan 1;59(1):28-36.

Hampshire Biodiversity Partnership (2018) Biodiversity Action Plan for Hampshire Species. Available at: http://www.hampshirebiodiversity.org.uk/species.htm. [Accessed: 27/7/2018].

Hanson Aggregates Marine Ltd. & Tarmac Marine Ltd. (2015). Licence Application Environmental Statement for Area 500. Volume 1. Project Reference R/3964/4. Report Number R2197.

Harding, H., Radford, A. N., & Simpson, S. D. (2016). Measurement of Hearing in the Atlantic salmon (*Salmo salar*) Part 2. The Impact of Pile-Driving Playback on the Behaviour and Physiology of Atlantic salmon (*Salmo salar*). Scottish Government.

Hawkins, A. D. & Johnstone A. D. F. (1978). The hearing of the Atlantic salmon. J. Fish. Biol., (13), pp 655-673.

Hayes, D. F., Raymond, G. L. & McLellan, T. N. (1984) Sediment resuspension from dredging activities, p. 72-82. Dredging and dredged material disposal, Vol. I, ed. By R.L. Montgomery and J.W. Leach. Proc. Of Conf. Dredging, Florida, USA.

Heard, J.R. (2007). *Salmo salar* Atlantic salmon. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/2096 [Accessed:1/12/2018].

Heessen, H.J., Daan, N. & Ellis, J.R. (eds). (2015). Fish Atlas of the Celtic Sea, North Sea and Baltic Sea: Based on International Research-vessel Surveys. Wageningen: Wageningen Academic Publishers; 2015.

Hopkins, D. (2008). River lamprey brief summary of Humber basin information. Institute of Fisheries Management. Available at: https://ifm.org.uk/wp-content/uploads/2016/01/River-lamprey-Summary-2008.pdf.

ICES (2017a). European eel (*Anguilla anguilla*) throughout its natural range. Available from: http://ices.dk/sites/pub/Publication%20Reports/Advice/2017/2017/ele.2737.nea.pdf [Accessed: 1/6/2019].

ICES (2017b). Sole. ICES-FishMap. Available from: http://www.ices.dk/explore-us/projects/EU-RFP/EU%20Repository/ICES%20FIshMap/ICES%20FishMap%20species%20factsheet-sole.pdf [Accessed: 11/10/2018].

ICES (2018a). Dataset Collections. Available from: http://www.ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx [Accessed: 27/6/2018].

ICES (2018b). Eggs and larvae. Available from: www.ices.dk/marine-data/data-portals/Pages/Eggs-and-larvae.aspx [Accessed: 3/6/2018]. Institute of Environmental Management and Assessment, 2015. Shaping Quality Development. s.l.:s.n.

JNCC (2019) Vertebrate species: fish. Available from: http://jncc.defra.gov.uk/ProtectedSites/SACselection/species.asp?FeatureIntCode=S1106 [Accessed: 1/7/2019].

Langstone Harbour Board (2018). Fishing in Langstone Harbour. Available from http://www.langstoneharbour.org.uk/environment-fishing.php [Accessed: 21/6/2018]

Last, K.S., Hendrick, V.J., Beveridge, C.M. & Davies, A.J. (2011). Measuring the effects of suspended particulate matter and smothering on the behaviour, growth and survival of key species found in areas associated with aggregate dredging. Marine Aggregate Levy Sustainability Fund, Project MEPF 08/P76.

Magúnsdóttir, H. (2010) The common whelk (Buccinum undatum L.): Life history traits and population structure. Available from: https://www.researchgate.net/publication/266404038_The_common_whelk_Buccinum_undatum_L_Life_history_traits_and_population_structure [Accessed: 16/10/2018].

Maitland, P.S. (1997) Fish entrainment in the Firth of Forth at Longannet and Cockenzie Power Stations. Report to Scottish Power, Kincardine-on-Forth.

Maitland, P.S. (1998) Fish entrainment at power stations on the Firth of Forth. Report to Scottish Power. Kincardine-on-Forth.

Maitland, P.S. (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd & Marine Ecological Surveys Ltd. (2013a). Environmental Effect Pathways between Marine Aggregate Application Areas and Sandeel Habitat: Regional Cumulative Impact Assessments. A report for BMAPA.

MarineSpace Ltd, ABPmer Ltd, ERM Ltd, Fugro EMU Ltd & Marine Ecological Surveys Ltd. (2013b). Environmental Effect Pathways between Marine Aggregate Application Areas and Atlantic Herring Potential Spawning Habitat: Regional Cumulative Impact Assessments. Version 1.0. A report for the British Marine Aggregates Producers Association.

Marshall, C.E., & Wilson, E. (2008). *Pecten maximus* Great scallop. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/1398 [Accessed: 12/10/2018].

Messieh, S. N. Wildish, D. J. an&d Peterson, R. H. (1981). Possible impact from dredging and soil disposal on the Miramichi Bay Herring Fishery. Can. Tech. Rep. Fish. Aquat. Sci. 1008, 33p.

MMO (2013). South Inshore and South Offshore Marine Plan Areas: South Plans Analytical Report (SPAR). Available from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/312581/south_draftspar.pdf [Accessed: 27/7/2018].

MMO (2014). Review of post-consent offshore wind farm monitoring data associated with licence conditions. A report produced for the Marine Management Organisation, pp 194. MMO Project No: 1031.

MMO (2018). UK sea fisheries annual statistics.

MMO (2018) The South Marine Plans. Available from: https://www.gov.uk/government/collections/south-marine-plans#the-south-marine-plans-documents [Accessed 24/10/2019]

MMS (2009). Cape Wind Energy Project; Final Environmental Impact Assessment. Appendix A. Available from: https://books.google.fr/books?id=N0E3AQAAMAAJ&pg=PA408&lpg=PA408&dq=whelks+and+smothering&source=bl&ots=-NxV8q6LZc&sig=_ekKfQFgo2XEUAybPa-CroBxJV8&hl=en&sa=X&ved=2ahUKEwiS5qi8iY3eAhWpD8AKHRhrD80Q6AEwDHoECAAQAQ#v=onepage&q=whelks%20and%20smothering&f=false [Accessed: 17/10/2018].

National Grid (2017). Viking Link: Appendix F - Herring and Sandeel. Impact Assessment

Navitus Bay Development Ltd. (2014). Navitus Bay Wind Park. Environmental Statement. Volume B – Offshore. Chapter 10 – Fish and shellfish ecology. Document 6.1.2.10.

Neal, K.J. & Wilson, E. (2008). *Cancer pagurus* Edible crab. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/1179. [Accessed: 5/9/2018].

Nedwell. J., Langworthy, M., & Howell, D. (2003a). Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms, and comparison with background noise. Available from: http://www.subacoustech.com/information/downloads/reports/544R0424.pdf. [Accessed: 8/10/2018].

Nedwell, J., Turpenny, A., Langworthy, J. & Edwards, B. (2003b). Measurements of underwater noise during piling at the Red Funnel Terminal, Southampton, and observations of its effect on caged fish. Subacoustics LTD. Report 558 R 0207. Bishops Waltham: Subacoustic Ltd.

Nedwell, J.R., Brooker A.G., & Barham R.J. (2012). Assessment of Underwater Noise During the Installation of Export Power Cables at the Beatrice Offshore Wind Farm. Report No. E318R0106.

NPS for Renewable Energy Infrastructure (EN-3) (2011). Department of Energy and Climate Change. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf [Accessed: 9/11/2018].

Orr, P. (2013). Spawning of the Downs herring component in the vicinity of the Rampion Offshore Wind Farm. Technical report prepared by Brown & May Marine Ltd., for E.ON Climate & Renewables UK Rampion Offshore Wind Ltd.

OSPAR (2009). Assessment of the environmental impacts of cable. OSPAR commission. Available from: https://qsr2010.ospar.org/media/assessments/p00437_Cables.pdf [Accessed 4/9/2018].

OSPAR (2012). Guidelines on Best Environmental Practice (BEP) in Cable Laying and Operation. Available from: https://www.gc.noaa.gov/documents/2017/12-2e_agreement_cables_guidelines.pdf [Accessed: 8/10/2018].

Le Pennec, M., Paugam, A. & Le Pennec, G., 2003. The pelagic life of the pectinid Pecten maximus—a review. ICES Journal of Marine Science, 60(2), pp.211-233.

Perry, F. & Jackson, A. (2017). *Ostrea edulis* Native oyster. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: https://www.marlin.ac.uk/species/detail/1146 [Accessed: 4/10/2018].

PINS (2015). Advice Note Seventeen: Cumulative Effects Assessment. Available from: https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2015/12/Advice-note-17V4.pdf [Accessed 17/01/2019].

Popper A.N., Hawkins A.D., Fay R.R., Mann D.A., Bartol S., Carlson T.J., Coombs S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B. & Løkkeborg, S. (2014). Sound Exposure Guidelines. In ASA S3/SC1. 4 TR- (2014) Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI, pp. 33–51. Springer, New York.

Reine, K. J., & Clarke, D. G. (1998). Entrainment by hydraulic dredges – a review of potential impacts. US Army Engineers Research and Development Center Technical Notes DOER-E1.14pp.

Robinson, S. P., Theobald, P. D., Hayman, G., Wang, L. S., Lepper, P. A., Humphrey, V. & Mumford, S. (2011). Measurement of noise arising from marine aggregate dredging operations. Marine Aggregate Levy Sustainability Fund (MALSF). MEPF Ref no. 09/P108.

Rogers, S. I., Miller, R. S. and Mead, T. A. (1998). The distribution and abundance of young fish on the east and south coast of England (1981 to 1997). Sci.Ser.,Tech. Rep., CEFAS, Lowestoft, (108), 130pp.

RPS (2013). The East Channel Association: East English Channel Herring Spawning Assessment. Available from: https://www.eastchannel.info/documents/EOR0632R130517KLUpdatedECRHerringSpawningv3.pdf [Accessed: 30/8/2018].

RSK (2012). Rampion Offshore Wind Farm Environmental Statement – Section 8: Fish and shellfish ecology. RSK Environment Ltd.

RSK (2016). IFA2 UK Offshore Development Environmental Statement. Chapter 7 – Fish and Shellfish Ecology.

Sabatini, M. & Ballerstedt, S. (2007). *Hippocampus hippocampus* Short snouted seahorse. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 03-09-2019]. Available from: https://www.marlin.ac.uk/species/detail/1788.

Scottish Government (2017) Herring. Available from: https://www.gov.scot/Topics/marine/marine-environment/species/fish/pelagic/herring [Accessed: 6/9/2018].

Shark Foundation (2005). Tope Shark: *Galeorhinus galeus*. Available from: www.sharkfoundation .org [Accessed: 5/10/2018].Shark Trust; 2009. An Illustrated Compendium of Sharks, Skates, Rays and Chimaera. Chapter 1: The British Isles. Part 1: Skates and Rays. Available from: https://www.sharktrust.org/shared/downloads/factsheets/thornback_ray_st_factsheet.pdf [Accessed: 9/7/2017].

Shumway, S.E., Cucci, T.L., Lesser, M.P., Bourne, N., Bunting, B. (1997). Particle clearance and selection in three species of juvenile scallops. Aquaculture International. Jan 1;5(1):89-99.

Southern IFCA (2014). Black Bream Status Report. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/Black_Bream_Report.pdf. [Accessed: 2/7/2018]. Southern IFCA (2017a).

Southern IFCA (2017a). Solent Oyster Fishery Stock Report. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/PC-SolOys-Stock-Survey-Rpt-2017-Final.pdf [Accessed: 21/6/2018].

Southern IFCA (2017b) Southampton Water Bivalve Stock Survey 2017. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/SB-Soton-Water.pdf [Accessed: 21/6/2018].

Southern IFCA (2017c). Fish Monitoring – 2017. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/PC-Fish-Monitoring-2017v2.pdf. [Accessed: 3/7/2018].

Southern IFCA (2017d) Solent Oyster Management Plan. Available from: http://www.southern-ifca.gov.uk/fisheries-management-plans [Accessed 28/6/2019].

Southern IFCA (2018a) Solent Oyster Fishery; 2018 stock survey report. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/Solent-OSS-Report-2018-Draft.pdf. [Accessed: 11/7/2019].

Southern IFCA (2018b) Solent Manila Clam Management Plan. Available from: http://www.southern-ifca.gov.uk/fisheries-management-plans [Accessed 28/6/2019].

Sussex Biodiversity Partnership (2007) www.biodiversitysussex.org.uk. [Accessed: 27/7/2018].

Sussex IFCA (2011) Species Guide. Available at: https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/SUSSEX-IFCA-Marine-Species-Guide.pdf. [Accessed: 21/6/2018].

Sussex IFCA (2017a). Small Fish Surveys. Summary of all 2017 small fish surveys. Available from https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/Research/SxIFCA-Small-Fish-Surveys-2017.pdf [Accessed: 20/6/2018] .

Sussex IFCA (2017b). Oyster Stock Monitoring. Summary of Oyster Fishery- November 2017. Available from: https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/Research/Summary-of-Oyster-Fishing-2017.pdf [Accessed: 20/6/2018].

Sussex IFCA (2017c). Sussex IFCA Shellfish Permit Catch Returns Data Summary. October 2016 to September 2017) Available from: https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/Research/2016-2017-Shellfish-Data-Analysis.pdf [Accessed: 20/6/2018].

Todd, V.L.G., Todd, I.B., Gardiner, J.C., Morrin, E. C. N., MacPherson, N. A., DiMarzio, N. A. & Thomsen, F. (2015). A review of impacts of marine dredging on marine mammals. ICES Journal of Marine Science, 72: 328-340.

Tricas, T. & Gill, A. (2011). Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

Vause, B.J. & Clark, R.W.E. (2011). Sussex Inshore Fisheries and Conservation Authority - Species Guide. 33pp. Available at: http://www.sussex-ifca.gov.uk/repository/Species_Guide_2011.pdf. [Accessed: 10/10/2018].

Watson & Hillhouse Ltd. (2019). ICE EMV Technical Data Sheet. Available from: https://www.w-h.co.uk/fleet/ice-excavator-mounted-resonance-free-emvs/ [Accessed: 20/8/2019].

Williams, C., Davies, W., & Kuyer. J. (2018). A valuation of the Chichester Harbour Provisioning Ecosystem Services provided by shellfish. Available from: https://secure.toolkitfiles.co.uk/clients/34087/sitedata/files/Research/Chichester-Shellfish-Valuation-Report-2018.pdf [Accessed: 20/6/2018].

Williams, C. & Davies, W. (2018). A valuation of the Provisioning Ecosystem Services provided by shellfish for priority shellfish waters in the Solent. Available from: https://secure.toolkitfiles.co.uk/clients/25364/sitedata/files/PC-SolShellfish-val-mod-007-April-2018.pdf [Accessed: 21/6/2018].

Winslade, P. R. (1971) The Behavioural and Embryological Investigations of the lesser sandeel, *Ammodytes marinus* Raitt. PhD Thesis. University of East Anglia.