MAINSTREAM RENEWABLE POWER

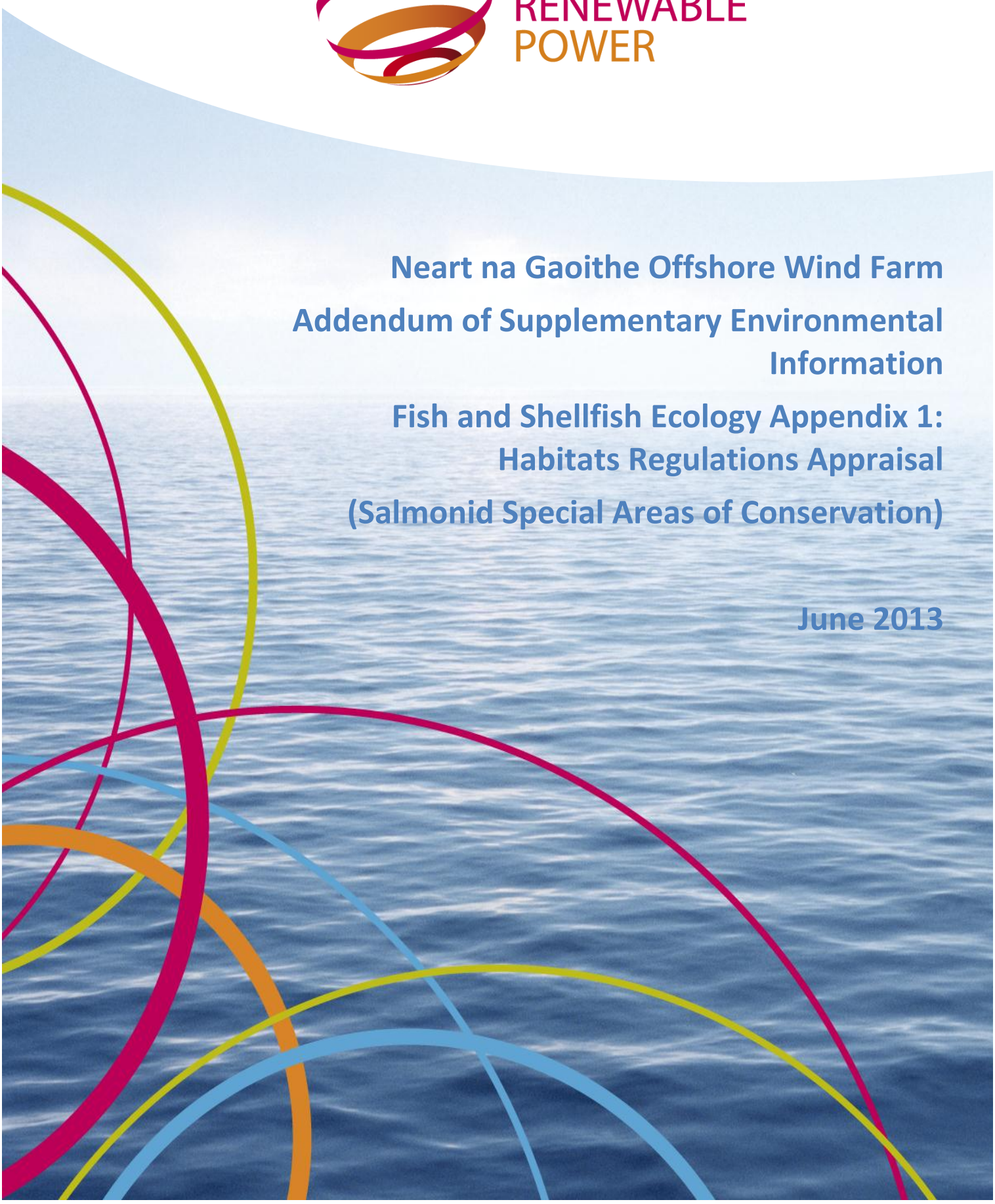
Neart na Gaoithe Offshore Wind Farm

Addendum of Supplementary Environmental Information

Fish and Shellfish Ecology Appendix 1: Habitats Regulations Appraisal

(Salmonid Special Areas of Conservation)

June 2013



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1 Introduction

1 This document presents supplementary environmental information surrounding potential impacts on sites of nature conservation importance (riverine Special Areas of Conservation (SACs)) from the proposed Neart na Gaoithe offshore wind farm. This document has been produced following initial comments and feedback from Marine Scotland Licensing Operations Team (MS-LOT), Scottish Natural Heritage (SNH), e.g., SNH, 2012 and other bodies such as the District Salmon Fisheries Boards. This document accompanies an Addendum of Supplementary Environmental Information.

2 This document clarifies certain information presented in Chapter 11 of the Neart na Gaoithe offshore wind farm Environmental Statement (ES), submitted to MS-LOT supporting the project's application for consent in July 2012 and presents additional information on riverine SACs as requested by the Association of Salmon Fisheries Boards (ASFB) and SNH.

3 Any new data from current strategic work streams (as available in finalised form prior to May 2013), such as those being undertaken by Marine Scotland Science and other academic institutions, into topics such as dynamics of salmon populations (e.g., Thorley, 2013) and physiological impacts of increased electromagnetic fields (EMF) have also been considered in this document.

2 Scope of Document

4 The purpose of this document is to provide verification of the conclusions made in the information to inform HRA that were presented within Chapter 11 of the Neart na Gaoithe Environmental Statement. This document provides clarification on a number of points to inform HRA and/or an Appropriate Assessment (AA) for riverine Special Areas of Conservation (SACs); a requirement for the project given the potential connectivity between the project and SACs.

5 The ES provided the necessary information to inform an Appropriate Assessment (AA) of whether, in view of the relevant European site's conservation objectives, Neart na Gaoithe would have an adverse effect (or risk of adverse effect) on the integrity of a European site.

6 The sites and species identified as being at risk of a likely significant effect are based on advice received during the Environmental Impact Assessment (EIA) consultation process (SNH, 2012; 2010).

3 Legislative and Policy Context

7 Within the European Union (EU) the key international legislative measures requiring the protection of rare and at-risk habitats and species are the Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds) and the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, as amended). These Directives are intended to fulfil the EU's commitment to international conventions and provide a framework for the designation of a network of protected sites for species and features across all EU member states, known as the 'Natura 2000 network'.

8 Species of nature conservation interest not benefitting from protection within the Natura 2000 network but listed within Annex IV of the Habitats Directive receive a different level of protection; these are known as European Protected Species (EPS).

9 Within Scottish territorial waters (STW) the transposing legislation for the Habitats and Birds Directives is as follows;

- The Wildlife and Countryside Act 1981 (as amended);
- The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) ('the Habitats Regulations'); and
- The Nature Conservation (Scotland) Act 2004.

10 The Habitats Regulations allow for the designation of the following Natura 2000 conservation areas: SACs, which act to protect ecologically vulnerable or valuable habitats and Special Protection Areas (SPAs) for sites which are considered important for bird populations. Under these regulations, the Joint Nature Conservation Committee (JNCC) is responsible for the designation of marine SACs and SPAs beyond 12 nautical miles (NM) and SNH is responsible for marine sites within 12 NM, as well as terrestrial sites.

11 The Habitats Regulations implement the Habitats Directive within STW. The Regulations require the competent authority to carry out a Habitats Regulations Appraisal (HRA) if a project is considered to have a likely significant effect on a Natura 2000 site. If this is so, then it is required to assess the likelihood of a significant adverse effect on the site's ecological integrity (characterised by the conservation objectives) occurring, by carrying out an Appropriate Assessment (AA). If the AA finds that such an adverse effect is likely to arise then consent for such a project must, other than in exceptional circumstances, be refused.

12 HRA applies to any plan or project with the potential to affect the qualifying interests of a Natura 2000 site, and subsequently, the conservation objectives and integrity of the site. The competent authority, Marine Scotland, has been advised by SNH that an HRA is required for the Neart na Gaoithe project (see SNH, 2010).

13 The requirement for HRA at a project level is further outlined in the Scottish Government's Plan for offshore wind development in territorial waters ('*Blue Seas - Green Energy: A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters',* see Marine Scotland, 2011a; 2011b; and 2011c), which also had an accompanying plan-level HRA.

14 SNH (2010) advises that the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) require the competent authority to (from SNH, 2010):

- Determine whether the proposal is directly connected with, or necessary to, site management for conservation;
- Determine whether the proposal is likely to have a significant effect on the site, either individually or in combination with, other plans or projects; and
- If so, then make an AA of the implications (of the proposal) for the site in view of that site's conservation objectives. A plan or project can only be consented if it can be ascertained that it will not adversely affect the integrity of a Natura 2000 site (subject to Regulation 49 considerations).

15 Although the proposal is not directly connected with, or necessary to, site management for conservation for any Natura 2000 sites, SNH has advised that as the project may have a Likely Significant Effect (LSE) on certain site features Marine Scotland will therefore carry out an AA of the effects of the proposed development on potentially impacted Natura 2000 sites' features and conservation objectives.

3.1 Habitats Regulation Appraisal

16 The Habitats Regulations require that where a project (or plan) could affect a Natura 2000 site (or its qualifying interests) then the competent authority must consider whether the plan or project is likely to give rise to a significant effect, and if so, make an AA of the implications of the project in view of the site's conservation objectives. This process is known as HRA in the UK, or more widely as an Article 6 Assessment (European Commission (EC), 2002). Marine Scotland, as the competent authority for offshore wind farm developments in STW, and the Scottish Government's statutory nature conservation advisers - SNH - have confirmed that a project level HRA is required (Marine Scotland, 2011a; 2011b; SNH, 2010).

17 The potential significant impacts of the proposed Neart na Gaoithe offshore wind farm development upon these sites, qualifying features and nature conservation objectives, have been assessed and information is summarised in this document to inform the Appropriate Assessment conducted by the competent authority.

4 The Proposed Development

18 It should be noted that the project Design Envelope (formerly referred to as the Rochdale Envelope) has been revised since the original ES submission, as outlined in the Addendum of Supplementary Environmental Information and Technical Appendix 1: Refined Design Envelope. This refinement includes a reduction in the maximum number of turbines and associated parameters such as inter-array cable length. However, these changes have been assessed as not materially affecting the original impact assessment as presented in the EIA within Chapter 15: Fish and Shellfish Ecology and summarised with respect to HRA in Chapter 11: Nature Conservation. The Addendum of Supplementary Environmental Information, of which this HRA forms an appendix, presents the changes to the project Design Envelope in more detail.

5 HRA Approach

5.1 Introduction

19 Information to inform the HRA process was presented in the project ES, as submitted to MS-LOT and its advisers in July 2012. The approach to HRA remains as presented in the project ES.

20 Regulation 61 of the Habitats Regulations sets out the procedure for the assessment of the implications of plans and projects on European sites. Under Regulation 61, if the proposed development is not directly connected with or necessary to the management of a European site and is likely to significantly affect the site, the competent authority must undertake an Appropriate Assessment (AA) of the implications for that site in view of that site's conservation objectives (Regulation 61(1)). The assessment is undertaken as a four stage process:

- Stage 1 Screening: Test of Likely Significance: Determining whether the plan or project "*either alone or in-combination with other plans and projects*" is likely to have a significant effect on a European site(s);
- Stage 2 Appropriate Assessment: Where likely significant effects are identified during screening, determining whether, in view of the European site's conservation objectives, the plan or project would have an adverse effect (or risk of adverse effect) on the integrity of the site. If not, the plan can proceed;
- Stage 3 Alternatives and Compensation: Where the plan or project cannot be shown to avoid an adverse effect on the integrity of a site, there should be an examination of compensation measures and alternative solutions; and
- Stage 4 Assessment of "*imperative reasons of overriding public interest*" (IROPI): If it is not possible to identify mitigation and alternatives that would avoid an adverse effect, it would be necessary to establish IROPI. This is not considered a standard part of the process and will only be carried out in exceptional circumstances.

21 The following section identifies the potential impacts that may arise on qualifying species from the proposed development. The potential impacts arising from the project have been identified within the EIA and reported within the application.

5.2 Habitats Regulations Appraisal Screening for SACs

5.2.1 Summary of Sites, Habitats and Species Screened into the Habitats Regulations Appraisal

22 Screening for SACs that may have connectivity with the proposed development has been undertaken by SNH, who provided a list of sites and information on likely significant effects that required consideration under HRA at the scoping stage of the Environmental Impact Assessment (EIA) (SNH, 2010). Following advice from SNH, the ASFB have requested the screening in of two further sites into the HRA (ASFB, 2012). Screened-in sites are illustrated below in Figure 5.1 and details on the qualifying features of these sites are provided in Table 5.1.

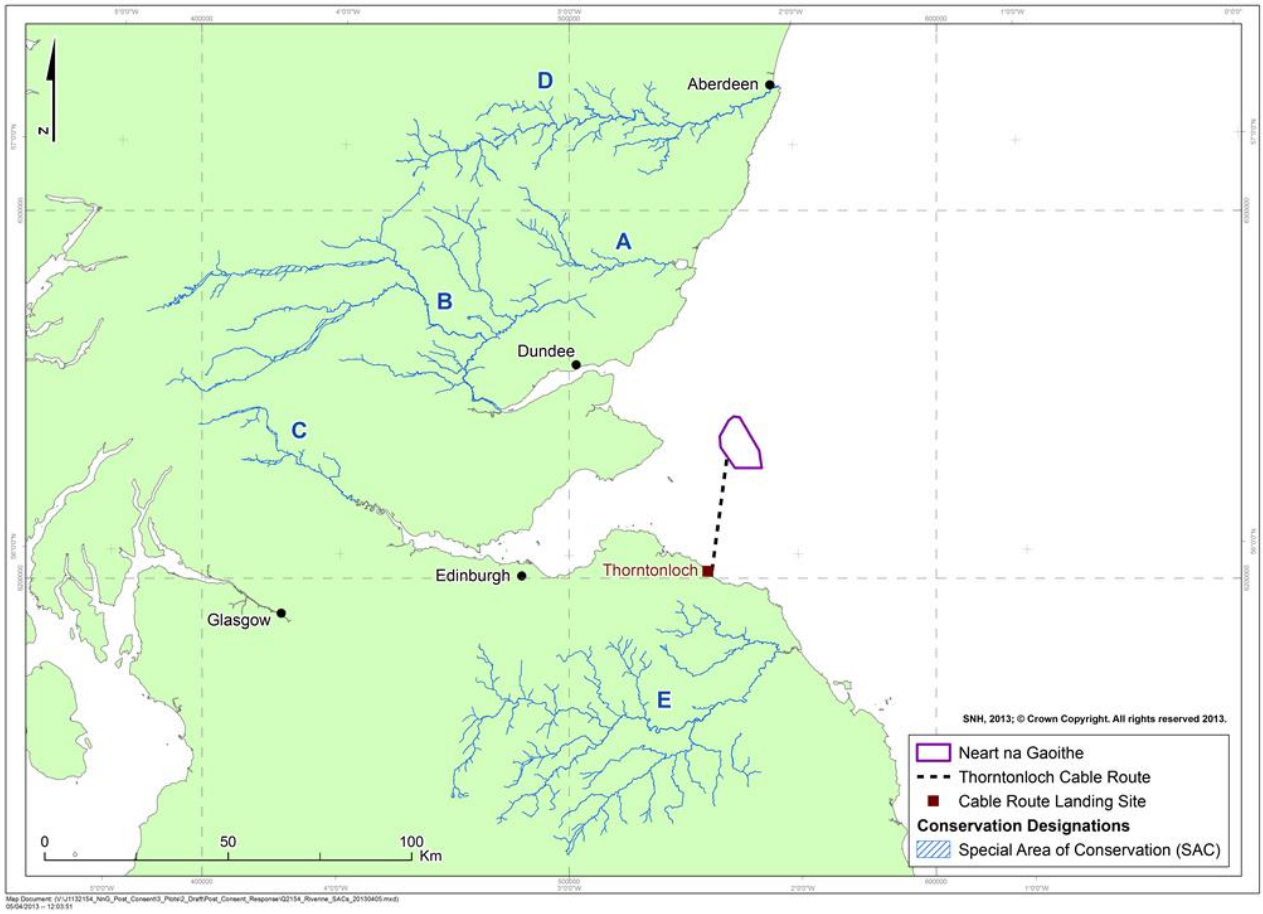

Figure 5.1: Riverine SACs with connectivity to the Neart na Gaoithe site (Source: SNH, 2010; ASFB, 2012).

Table 5.1: Riverine SACs with potential for connectivity to Neart na Gaoithe, including connecting features (Sources: SNH, 2010; ASFB, 2012).

Figure code	Riverine SAC	Site description and reasons for designation (qualifying and other)		Qualifying features with connectivity to Neart na Gaoithe (as advised by SNH, 2010 and ASFB, 2012)
		Habitats	Species	
Sites screened in given advice from SNH (SNH, 2010)				
A	**River South Esk SAC**		*Annex II qualifying species* ● Freshwater pearl mussel (FWPM) *Margaritifera margaritifera*; and ● Atlantic salmon *Salmo salar.*	● Freshwater pearl mussel *M. margaritifera;* and ● Atlantic salmon *S. salar.*
B	**River Tay SAC**	*Other Annex I habitats:* ● Oligotrophic to mesotrophic standing waters	*Annex II qualifying species:* ● Freshwater pearl mussel *M. margaritifera;* and ● Atlantic salmon *S. salar* *Other Annex II species:* ● Sea lamprey *Petromyzon marinus*; ● Brook lamprey *Lampetra planeri*; ● River lamprey *Lampetra fluviatilis*; and ● Otter *Lutra lutra*.	● Freshwater pearl mussel *M. margaritifera;* ● Atlantic salmon *S. salar;* ● Sea lamprey *P. marinus;* and ● River lamprey L. fluviatilis.
C	**River Teith SAC**		*Annex II qualifying species* ● Sea lamprey *P. marinus*; and ● Brook lamprey *Lampetra planeri*. *Other Annex II species:*	● Sea lamprey *P. marinus;* ● River lamprey *L. fluviatilis;* and ● Atlantic salmon *S. salar.*

Figure code	Riverine SAC	Site description and reasons for designation (qualifying and other)		Qualifying features with connectivity to Neart na Gaoithe (as advised by SNH, 2010 and ASFB, 2012)
		Habitats	Species	
			• Atlantic salmon *S. salar.*	
Additional sites screened in given advice from ASFB (ASFB, 2012)				
D	**River Dee SAC**		*Annex II qualifying species* • Freshwater pearl mussel *M. margaritifera;* • Atlantic salmon *S. salar;* and • Otter *L. lutra.*	• Atlantic salmon *S. salar*
E	**River Tweed SAC**	*Annex I habitats:* • Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation.	*Annex II qualifying species:* • Atlantic salmon *S. salar*; • Otter *L. lutra*; • Sea lamprey *P. marinus;* • Brook lamprey *L. planeri; and* • River lamprey *L. fluviatilis.*	• Atlantic salmon *S. salar*.

6 Summary of Information to Support Appropriate Assessment

23 For the purposes of HRA, the following section summarises the assessed impacts for riverine SACs and associated qualifying features and forms the basis of the information to inform an AA.

24 This includes information on the appraisal methodology, a summary of potential physical effects arising from the development and operation of the project, and SAC feature vulnerabilities or sensitivities, as outlined in the project ES, all included here to provide context.

25 Within Section 7: Designated Sites – SACs, sections 7.1 to 1.1 provide a summary of information for each screened-in SAC. The nature of the sites results in the potential impact on each SAC being very similar. However for completeness information for each SAC is presented in full.

6.1 Appraisal Methodology

26 The approach to assessing possible impacts on riverine SACs is as presented in the original July 2012 documentation.

27 Where there is connectivity between a given site and the proposed project, each effect, or physical change, is considered against each relevant qualifying features. In the case of Neart na Gaoithe, SNH considered the potential connectivity for the identified sites and the proposed project was on qualifying species rather than habitats. The potential for impact on a given species' regional population is assessed according to the source-pathway-receptor approach to EIA i.e. where there is a clear pathway between a given physical change and a qualifying species. This concept is explained in more detail in ES Chapter 6: The Approach to Environmental Impact Assessment.

28 The Habitats Regulations refer to the term 'likely significant effect' as distinct HRA terminology and this term is used within this document. However the terms 'effect' and 'impact' are broadly used as in the project ES under EIA terminology to mean 'physical change' and 'resultant impact on receptor' respectively. The term 'likely significant effect' under HRA is considered to mean the same as 'impact' in EIA terminology.

29 Impacts (or likely significant effects) on qualifying features are then assessed against the overall integrity of the protected site, including consideration of the wider SAC population, exposure to other activities and risks and the conservation objectives of the SAC. Conclusions are presented for each impact type and also as a whole for each SAC, for impacts arising from the Neart na Gaoithe project alone, as well as from the project in-combination with other plans and projects (also referred to as consideration of cumulative impacts). Sections 7.1 to 1.1 provide a summary of information for each screened-in SAC. The nature of the sites results in the potential impact on each SAC being very similar. However, to ensure all information is available for each SAC, there may be some duplication between sites as information is presented in full.

30 The appraisal of impacts on riverine SACs, under HRA, is based on best available evidence and data available in finalised form prior to May 2013. Information as presented in the ES was that available in final format prior to Spring 2013. In addition, any new data from current strategic work streams, such as those being undertaken by Marine Scotland Science and other academic institutions, into topics such as dynamics of salmon populations (e.g., Thorley, 2013) and physiological impacts of increased electromagnetic fields (EMF) are considered in this document.

6.2 Summary of Potential Effects that may Impact Screened-In SACs

31 Given the screening outlined above and advice from SNH (2010) and the ASFB (2012), and as outlined in the project ES of July 2012, the following physical effects have been considered to have possible impacts on the qualifying features of riverine SACs due to the presence of a pathway to the features as receptors. In this way these physical effects may have an impact or likely significant effect on the feature and therefore potentially adversely affect the resultant SAC.

32 Physical effects are based on modelling undertaken for the ES, which included the following:

- Metocean and hydrodynamic modelling to estimate changes to scour, suspended sediment concentrations (SSCs) and plumes during installation and operation and maintenance stages; and
- Underwater noise propagation modelling to estimate changes in underwater noise and noise profiles for relevant fish species during installation activities (piling).

33 Following submission of the ES in July 2012, an Electro-Magnetic Field (EMF) propagation study has been undertaken to verify the potential effect of increases in ambient EMF. This is also appended to the Addendum of Supplementary Environmental Information as Fish and Shellfish Ecology Appendix 2: HVAC EMF studies, and a summary of this report is presented below in Section 6.2.2.3: Increase in Ambient EMF

6.2.1 Installation Effects

34 Please note: The following information is summarised from the Neart na Gaoithe Environmental Statement as submitted in July 2013 and uses EIA terminology.

6.2.1.1 Increase in Suspended Sediment Concentrations

35 An increase in suspended sediment concentration (SSCs) will occur as a result of the installation of turbines, subsea cables and associated infrastructure. Physical processes and hydrodynamic modelling (refer to Chapter 9: Physical Processes of the ES) predict elevated SSCs with peaks of up to 300 mg/l (depth averaged) very close to the release location. However, the resulting plumes will be advected (diluted and dispersed) by tidal currents beyond the immediate vicinity of the dredging site with concentrations predicted to be less than 10 mg/l within 1 km of the gravity base. These concentrations will be negligible in severity when compared against natural background levels (3 to 8 mg/l). The modelling further indicates that a suspended sediment plume (>1 mg/l) is predicted to extend up to 4 km from the release location and will settle out of the water column within one day . In addition, the duration over which the activity will take place will be short and limited to the proximity of the release location.

6.2.1.2 Increase in Underwater Noise from Installation Activities

36 There will be an increase in underwater noise levels, particularly during pile driving associated with the installation of jacket foundations.

37 The potential impact of pile driving operations associated with the construction of the Neart na Gaoithe offshore wind farm was investigated by means of subsea noise modelling using the modelling software package INSPIRE (See Appendix 13.1 of the ES). This considered the likely range at which injury and behavioural response might be expected for selected fish species, i.e., dab, trout, salmon, sandeel and herring, the latter known to be particularly sensitive to noise.

38 Outputs are presented in the ES and show the potential zone of influence of increased underwater noise for key fish species, such as salmonids. The dBht (species) perception unit, corresponding to the sound level above a species' hearing threshold (Nedwell *et al*., 2007), was used for modelling the assessment, which considers the following impact ranges or zones of influence for the 3.5 m diameter pile (worst (realistic) case scenario) and the 2.5 m (most likely scenario):

- 130 dBht: traumatic hearing loss;
- 90 dBht: strong avoidance behaviour; and

- 75 dBht: significant avoidance behaviour.

39 The use of a 130 dBht level provides a suitable criterion for predicting the onset of traumatic hearing damage, taking into account the hearing sensitivity of the species (Nedwell *et al*., 2007). Based on a large body of measurements of fish avoidance of noise, a level of 90 dBht was used as the level at which a strong likelihood of disturbance to the majority of individuals of a species would be expected (Nedwell *et al*., 2007). A lower level of 75 dBht was used to indicate that a significant behavioural impact in approximately 85% of individuals is likely to occur, although the response from individuals within a species will vary, i.e., one individual may react, whereas another individual may not. In addition, there is some evidence indicating that fish become habituated to lower level noise (Nedwell *et al*., 2007).

6.2.2 Operation and Maintenance Effects

6.2.2.1 Presence of Offshore Structures during Operation and Maintenance

40 The wind farm will represent an increase in the presence of underwater structures such as turbine foundations and turbines, as well as those associated with other infrastructure such as substations.

6.2.2.2 Increase in Underwater Noise from Operation and Maintenance Activities

41 Increases in underwater noise from the operation of wind turbines are likely to be generated by the gearbox and generator and transferred into the water and sediment through the tower and foundations. Vessel movements during operation and maintenance activities may also increase underwater noise.

6.2.2.3 Increase in Ambient EMF

42 Wind farms transmit the energy produced along a network of cables. As energy is transmitted, the cables emit low energy EMF (Boehlert and Gill, 2010).

43 EMF refers to both the electric (E) field, measured in volts per metre (V m 1) and the magnetic field measured in tesla (T). Background measurements of the magnetic (B) field are approximately 50 µT in the North Sea , and the naturally occurring electric field in the North Sea is about 25 µV m 1 (Tasker *et al*., 2010).

44 On behalf of Mainstream, Sinclair Knight Merz (SKM) has conducted a study to calculate the maximum EMF densities that are likely to be emitted by the offshore cable sections of the Neart na Gaoithe project (SKM, 2013, see Fish and Shellfish Ecology Appendix 2: HVAC EMF studies of the Addendum of Supplementary Environmental Information). This report provides information on predicted EMF densities produced by the inter-array cable sections, the offshore High Voltage Alternating Current (HVAC) connection and the HVAC Intertidal/sea defence sections of the circuit; a summary is provided below.

6.2.2.3.1 Inter-array Cables EMF

45 The maximum EMF density predicted to be produced by the inter-array cable sections is calculated as 3.3 µT directly above the centre of the cable, dissipating rapidly to 0.13 µT within 5 m from the cable, as shown in Figure 6.1 (SKM, 2013).

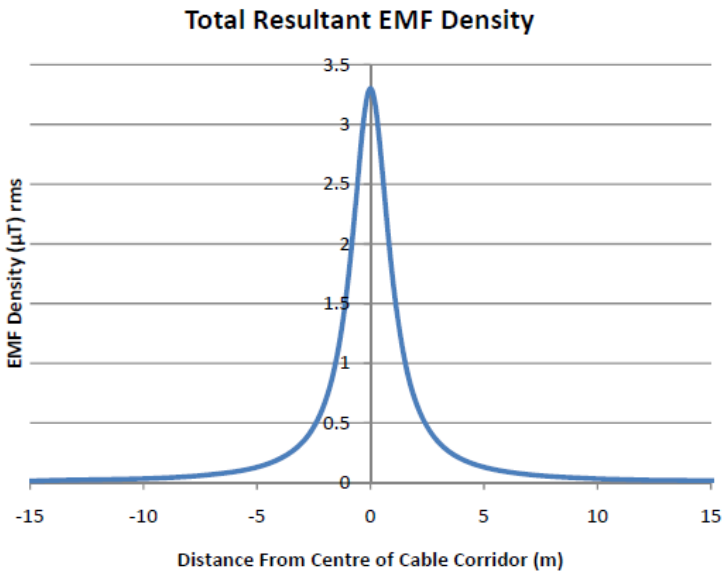

Figure 6.1: EMF density produced by the inter-array cable (Source: SKM, 2013).

6.2.2.3.2 Export Cables EMF

46 The offshore HVAC cables (i.e., from the offshore substation to the intertidal area) have a minimum of 70 m spacing between adjacent circuits, so there is no interaction of EMF fields predicted between circuits. The maximum calculated EMF density produced by each of these cables is 7.99 µT, dissipating to 0.33 µT within 5 m from the cables (Figure 6.2) (SKM, 2013).

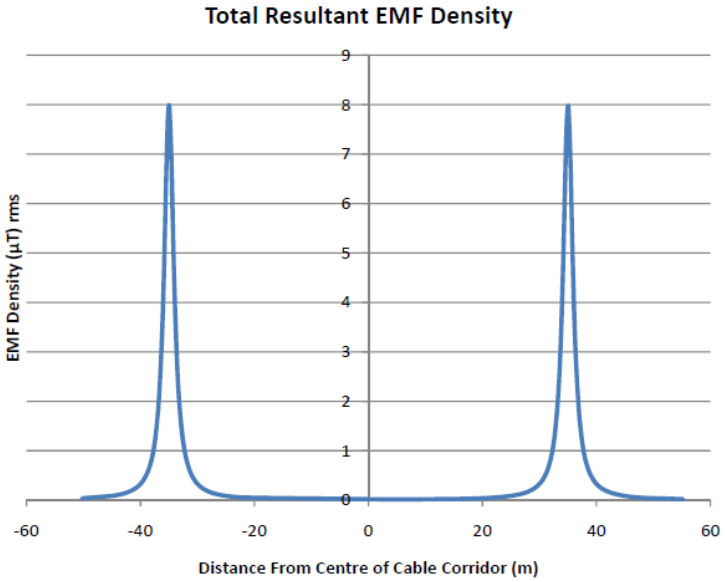

Figure 6.2: EMF density produced by the offshore HVAC cables (Source: SKM, 2013).

6.2.2.3.3 In-Combination Effects

47 Projects, programmes or plans have the potential to affect qualifying features of SACs, in combination with impacts arising from Neart na Gaoithe. The plans and projects assessed as having potential to impact in combination with the Neart na Gaoithe project are taken from SNH (2010) and Blue Seas - Green Energy HRA AA Information Review (Marine Scotland, 2011c).

48 The development of two further offshore wind projects (Inchcape offshore wind farm and the Firth of Forth (Seagreen) Round 3 offshore wind farm Zone 2 developments) will result in a magnitude of effect for both installation and operational phases that will be greater than those of the current development in isolation because of the increased spatial extent and duration of physical changes.

49 In-combination (or cumulative) changes (i.e., those from Neart na Gaoithe, along with those arising from other wind farms) to the far field suspended sediment transport pathways were subject to numerical modelling (refer to ES Chapter 9: Physical Processes). The modelling assumed a continuous discharge of a neutrally buoyant plume over a spring neap cycle with an 'all developments' scenario hydrodynamic mode. Comparison of the results of the predicted in-combination/cumulative effects with those generated using the baseline model shows no noticeable differences. This result indicated that the proposed offshore wind farm developments will not cause net changes to the regional sediment transport regime or sediment dynamics along the nearby coastline, even when the three sites are considered together.

50 The combined effect of the pile driving noise will result in a larger radius of the zone of influence for key species such as salmon, and was also modelled in the study undertaken on underwater noise to inform the ES (refer to Chapter 15: Fish and Shellfish Ecology).

51 Combined effects of increased EMF from export and inter-array cables will be greater than those at a project specific level although, based on the estimated EMF density emissions for Neart na Gaoithe (refer to 6.3.1.3.5 Increase in Ambient EMF) effects will be highly localised (within a few metres) around individual cables.

6.3 Summary of Screened-In SAC Features / Species and Vulnerabilities

52 SAC features (species) assessed as having potential connectivity with the development are common to most, or all, of the SACs that have been screened-in within this assessment. This section provides an overview of relevant qualifying species, including their ecology and population distributions, as well as their likely sensitivities and vulnerabilities to the effects outlined above.

6.3.1 Atlantic Salmon

6.3.1.1 Life Cycle

53 Atlantic salmon *S. salar* spawn in freshwater where the young fish spend the first part of their lives. The young fish (fry, then parr) live and develop in the freshwater habitats of their birth (SNH, 2013). After 1 to 3 years the parr adapt for migration by changing their appearance and becoming smolt (SNH, 2013). Smolt head out to sea in shoals during late spring (SNH, 2013). Adult salmon travel thousands of kilometres to rich feeding grounds in the cold northern waters. The salmon return to the rivers where they were spawned after 1 to 4 years out at sea. Grilse are adults that return after 1 year of being at sea. After the adults have spawned they become known as kelts. It is estimated that only 5% of kelts that survive the return journey to the sea make it back to their home rivers to spawn again (SNH, 2013).

6.3.1.2 Population Dynamics

54 Salmon populations are not explicitly monitored, however catch rates for rivers around Scotland are collected under the provisions of Section 64 of the Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act 2003. These data are combined geographically into 109 districts and aggregated into 11 regions and collected and collated by Marine Scotland.

55 Catch statistics for rivers surrounding the Firth of Forth region were presented in the ES (refer to Chapter 16: Commercial Fisheries) and are summarised in Figure 6.3 below.

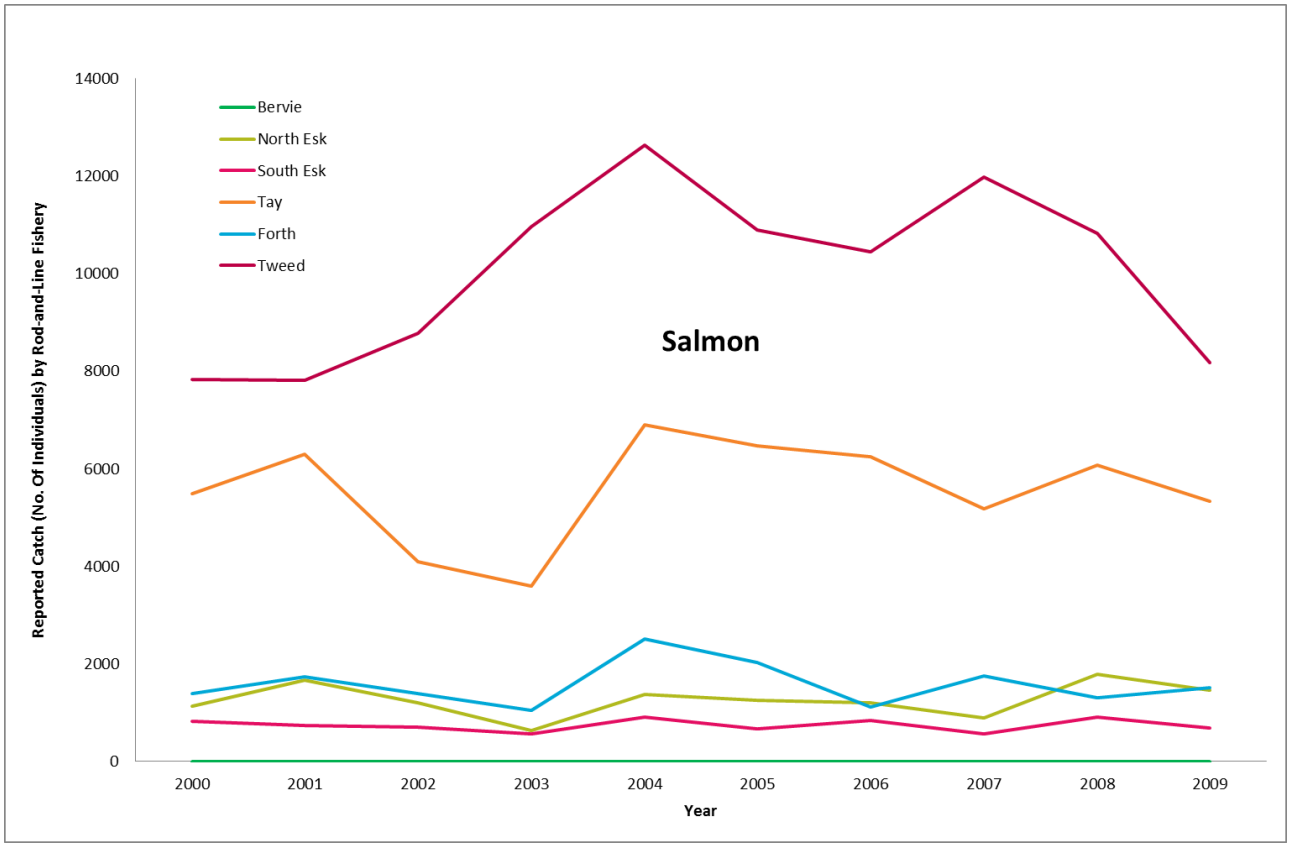

Figure 6.3: Reported catches of Atlantic salmon *S. salar* in rivers surrounding the Firth of Forth by the rod and line fishery (Source: Marine Scotland).

56 More widely, despite major conservation efforts and catch and release programmes by anglers, over the past 40 years the north Atlantic salmon population has declined by approximately 50% and monitoring indicates that it is at the marine stage of their life-cycle where the fish are most affected (Malcolm *et al.*, 2010). Many factors are likely to have contributed to this decline and these are outlined in Table 6.1 below.

Table 6.1: Threats to Atlantic salmon (Source: The Atlantic Salmon Trust, 2013).

Atlantic salmon location/stage of life cycle		
Freshwater	Coastal	Ocean
• Obstructions such as dams and weirs associated with power generation; • Water abstraction schemes; • Pollution; • Bad riverbank management; • Poor management and maintenance of spawning burns; • The existence of open-cage smolt farms in freshwater lochs; • Excessive and damaging recreational use of rivers; • Excessive take by anglers, poor	• Obstructions associated with power generation; • Pollution from various man-made sources; • Open cage salmon farms which inadvertently release fish, and which cause epizootics of sea lice larvae, as well as acting as vectors for disease transfer; • Mixed stock net fisheries, targeting fish from several rivers where natural population levels may be unknown;	• Interception by commercial fisheries; • Climate change: relocation/disappearance/reduction of prey species; changes in currents; changes in water temperature & salinity; • Competition for food from other pelagic species; and • Predation.

Atlantic salmon location/stage of life cycle		
Freshwater	Coastal	Ocean
catch & release handling; • Excessive dependence on artificial stocking; • Climate change, leading to reduced river flows at critical periods, raised water temperature, wash-out of redds by spates after torrential rain; and • Predation.	• Climate change - impacts on feeding for sea trout, on water temperature & salinity in estuaries for both species; and • Predation.	

57 Salmon occupy freshwater, estuarine and marine environments at certain stages of their life cycle and will be affected by one or more of the risks and scenarios described in Table 6.1. Climate change is a concern in both freshwater and marine environments, with increased temperatures influencing extreme weather conditions including droughts and flooding. Localised changes in the water table may also occur and this may have an effect on water quality in natal rivers, and include changes to ocean currents at sea which may affect migration as well as the food chain upon which salmon rely. There is the concern that these effects may include changes in run timings for salmon resulting in smolt going to sea when ocean conditions are unfavourable (Malcolm *et al*., 2010). Increased predation by expanding grey seal populations, as well as the lack of suitably sized prey, may also be contributing to the decline of salmon in Scottish waters as it is in the Baltic Sea (Butler *et al.*, 2008). A Canadian tagging study found that the highest mortality of smolts occurs in the estuary or freshwater (Malcolm *et al*., 2012). Smolt migration was also found to be synchronised with other rivers in the vicinity and with returning kelts (Malcolm *et al*., 2010). It is likely that this synchronisation of the migration results in safety of numbers and may also enable smolt to learn migration routes from returning kelts (Malcolm *et al*., 2010).

58 Other factors affecting salmon survival at sea include the by-catch of salmon in pelagic fisheries, the introduction of disease and increased parasite load as a result of aquaculture activities in coastal waters, and increased marine predation, some of which may be linked to global warming (The Atlantic Salmon Trust, 2013).

59 Man-made obstacles such as dams between the ocean and natal rivers can lead to reduced spawning. Salmon smolt can be killed in large numbers as by-catch from fishing boats and high seas fisheries can target the adult fish returning to the rivers. Disease can have a devastating effect on salmon populations, such as Ulcerative Dermal Necrosis (UDN) which was caught by almost all Scottish salmon in the 1970s (ASFB/RAFTS, 2013).

60 The increase in fish farming has come at a cost to the wild salmon population as it has introduced high numbers of sea lice, pollution of the water environment by medication or uneaten food and the interbreeding of escaped farmed salmon with wild salmon which reduces the fitness of local stocks for their local environment (The Atlantic Salmon Trust, 2013).

61 Alongside this, the species does not have a linear stock recruitment relationship and adult abundance can have little or no effect on juvenile abundance, further leading to inherent variability in the species populations (as noted by Thorley, 2013).

6.3.1.3 Vulnerabilities to Effects Arising from Development / Operation of Offshore Wind Farms

62 One of the most recent concerns of the Salmon Fisheries Boards and Trusts are the impacts that offshore renewable energy projects may have on migratory salmonids, for example those arising as a result of the physical effect that may occur through installation and operation of offshore wind farms, as outlined in section 6.2: Summary of Potential Effects that may Impact Screened-In SACs: (ASFB/RAFTS, 2013).

6.3.1.3.1 Increased SSC

63 Raised SSCs may cause population fragmentation through individual avoidance behaviour (Thorstad *et al*., 2005; Wilber and Clarke, 2001) and have the potential to affect migration and movement of fish and survival of fish larvae (Birkuland and Wijsman, 2005). Adults would normally be able to detect significantly elevated levels of suspended sediment and avoid the affected area (EMU, 2004), although juveniles (e.g., smolt) may be comparatively more susceptible.

6.3.1.3.2 Increase in Underwater Noise (Installation Activities – Piling)

64 Salmonids are not considered to be hearing specialists (Nedwell, 2003). Salmon do not have any specific connection between the swim bladder and the auditory apparatus and therefore have a limited ability to discriminate between sounds, and as a result have a poor response to sound pressure. The species is believed to have a low overall sensitivity to sound and has a limited hearing bandwidth, as outlined in the project ES (Mainstream Renewable Power, 2012).

65 There are some inherent uncertainties associated with behavioural response ranges, with the response likely to be influenced by the fishes' sex, age, condition and behaviour at the time. For instance, herring have been known to show a behavioural response to vessel noise, however when engaged in spawning activity the fish showed no such response (Skareta *et al*., 2005). This led to the assessment of salmon parr in the ES as opposed to adults returning for spawning. It is presumed that the innate drive to spawn that is present in adult salmon, famous for conditioning them to leap waterfalls and other obstacles, would override inhibitions to effects such as a behavioural response to noise.

66 Studies on Atlantic salmon behaviour in Scottish waters suggest that the species migrate along the coast, spending most of their time in shallow waters (40 m) (Malcolm *et al*., 2010). The predicted contours of maximum behavioural response (zone of influence, as outlined in Chapter 15:Fish and Shellfish Ecology in the ES) therefore do not present a barrier to migration across the entire Firth of Forth. If salmon do use coastal environments during migrations to and from riverine spawning grounds, any potential noise impacts during construction at Neart na Gaoithe offshore wind farm would be further reduced as salmon would be migrating in areas outside of the behavioural response ranges.

6.3.1.3.3 Presence of Offshore Structures

67 Salmon are reported to be vulnerable to structures which could act as a barrier, preventing movement to their foraging or nursery grounds. The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures. For example, structures placed in a highly confined estuary are likely to be more of an issue than those placed in the open coast (Maitland, 2003). Therefore there is likely to be very low vulnerability of the species to structures in an open environment such as the Firth of Forth.

6.3.1.3.4 Increase in Noise (Operational)

68 Fish species sensitive to particle motion (including salmon) will only be able to sense the measured particle acceleration at distances of about 10 m from the foundation. Further away, many species are limited by either their hearing threshold or the ambient sound masking the wind farm noise. At distances greater than this the ambient noise will mask out the wind farm noise (Sigray and Andersson, 2011).

69 Wahlberg and Westerberg (2005) evaluated the possible effect on fish of underwater noise from wind farms in operation. The study found that Atlantic salmon can detect offshore wind turbines at a maximum distance of about 0.4 to 25 km at wind speeds of 8 and 13 m/s but found no evidence that wind farms cause temporal or permanent hearing loss. The wind turbines produce sound intensities that may cause permanent avoidance by fish within ranges of around 4 m, but only at high wind speeds (13 m/s).

6.3.1.3.5 Increase in Ambient EMF

70 The main stakeholder concern with regards to increased EMF is the perception that localised changes in EMF will interfere with the navigation of sensitive migratory species by affecting the speed and/or the course of their migration and resulting in adverse impacts if the salmon do not reach essential feeding, spawning and nursery grounds (e.g., ASFB, 2012).

71 Salmonids, like other teleost fish, show some sensitivity to the electric field, but this is orders of magnitude lower than that exhibited by some elasmobranchs (Fisher and Slater, 2010). To date no detrimental effect from EMF has been attributed to elasmobranchs in wind farms built throughout the UK (Cefas, 2010). Post construction surveys undertaken at Burbo Bank, Kentish Flats and Barrow offshore wind farms showed that elasmobranchs still feed within operational wind farms, and in the case of Barrow and Kentish Flats, that their numbers have increased since construction within the wind farm (Cefas, 2010). Therefore it is possible to infer that less sensitive species, including salmon, are unlikely to show a population level response. Furthermore, salmonid migration around the UK, as outlined in recent Marine Scotland Science commissioned papers (e.g. Malcolm *et al*., 2010), covers multiple areas where there are known to be existing electrical cables. For example, interconnector cables from the Scottish mainland to island communities have been operational for a number of decades with no reported ill effects on the salmon migration.

72 Salmon possess magnetite in their lower jaws, a magnetic material suitable for magneto-reception (Gill and Bartlett, 2010). As a result, there is the potential for them to be influenced by EMF if in close vicinity to areas of increased EMF, resulting in disruption to navigation and migration. Empirical evidence supporting this hypothesis is scant and limited to experimental studies. The minimum electric fields detected by salmon are reported as being much lower than those by other species, such as elasmobranchs and furthermore it is uncertain whether salmon could detect the time-varying magnetic field from an AC cable (Normendeau *et al*., 2011).

73 Experiments in the Baltic sea showed that tagged European eels (a migratory species which also possesses magnetite) briefly changed direction when exposed to Alternating Current (AC) cables but that their overall direction of travel was unaffected and so it was considered unlikely that a population level effect on this species would occur (Westerberg and Langenfelt, 2008). To date, there is no clear evidence as to whether EMF from subsea cables has an effect on the migration and movement of fish.

74 Gill and Bartlett (2010) and Gill *et al.* (2012) conclude that EMF may interact with migratory eels (and perhaps salmonids) if their migration routes take them over cables, particularly in shallow waters (<20 m) where there is a greater possibility of encountering high voltage cables. Ohman *et al*. (2007) reported that if a migration route lies parallel to a cable orientation then there is likely to be no influence on the direction of their migration. If, however, the cable lies at right angles or obliquely to the migration route, as does the proposed Neart na Gaoithe offshore wind farm export cable, then a limited effect may occur (Westerberg and Langenfelt, 2008). The Neart na Gaoithe ES concluded that whilst there is uncertainty with regards to salmon responses to EMF, any impacts are likely to be behavioural and of short term duration. There are no recorded long term effects on the migration behaviour of salmon from subsea cables from offshore wind farms, however the presence of existing power cables along known salmon migration routes implies that there is little discernible effect on these fish (Mainstream Renewable Power, 2012).

75 The majority of post-smolt Atlantic salmon inhabit the upper water column in depths of 10 m or less and data suggest that adults of the species spend the majority of their time at shallow water depths, although they are capable of diving to substantial depths (Malcolm *et al*., 2010). As salmon spend the majority of their time hunting in the upper water column, the potential for an impact from EMF is considered small. EMF would not be detectable to salmon at distances much greater than 10 m from the cable. Burial of the cable to a depth of 1.5 m excludes fish and the majority of other biota in the area at which the EMF emissions are highest. Where cable burial is not possible, rock armouring would be put in place to provide similar distance between the cable and fish receptors. Salmon are believed to rely on multiple senses including visual, olfactory and geomagnetic to guide their migration, and as such are very likely to be able to compensate for local and slight changes to the naturally occurring magnetic field.

76 Atlantic salmon are believed to migrate from the North Sea to feeding grounds in the Atlantic. On passage from the east coast of the UK, it is considered likely that some fish will pass through existing wind farms as well as over interconnector power cables, without changes being reported in the migration of these species.

6.3.2 Freshwater Pearl Mussel

6.3.2.1 Life Cycle

77 The freshwater pearl mussel (FWPM) *M. margaritifera* is one of the longest-lived invertebrates known with individuals living for over 100 years (SNH, 2013). The mussels live buried or partly buried in coarse sand and fine gravel in clean, oligotrophic, fast-flowing and unpolluted rivers and streams (SNH, 2013). They inhale water through their exposed siphons to filter out minute organic particles on which they feed. Where the species was formerly abundant, it is possible that this filtration acted to clarify river water to the benefit of other species, including juvenile Atlantic salmon *S. salar* and brown or sea trout *S. trutta* (SNH, 2013).

78 The freshwater pearl mussel is typically dioecious, in common with other freshwater bivalves. It matures at 10-15 years, when the length generally exceeds 65 mm. In early summer (June to July), the males shed sperm into the water which is inhaled by the females. The fertilised eggs develop in a pouch on the gills of salmon or trout for several weeks, and are released from July to September as tiny larvae, measuring 0.6-0.7 mm, known as glochidia. These resemble tiny mussels, but their shells are held apart until they encounter a suitable host, when they snap shut on to the host's gill filaments (Skinner *et al.*, 2003).

79 Each female ejects between 1 and 4 million glochidia in a sudden, highly synchronised event, usually over 1 to 2 days (Hastie and Cosgrove, 2001). It is likely that a threshold temperature, or other environmental cue, may trigger glochidial release. The proportion of adults producing glochidia is relatively high, varying from 30-60%, even in sparse populations. Almost all the glochidia are swept away and die, but a few are inhaled by juvenile Atlantic salmon and brown or sea trout. Infective glochidia can remain viable for up to 6 days, but most attachments probably occur within a few hours. Glochidia attached to the gills of juvenile fish encyst, live and grow in the hyper-oxygenated environment until the following spring. They drop off in May and early June, and must land in clean, sandy or gravelly substrates to settle and start to grow. This association does not appear to harm the fish, and enables young mussels to colonise new areas upstream. Young mussels are typically yellowish-brown, becoming darker with maturity (Skinner *et al.*, 2003).

80 The life span and maximum size reached are highly variable between populations, depending on environmental conditions, particularly hydrochemistry and water temperature. Populations tend to be faster growing and shorter lived in the southern part of their range, with a lower reproductive output than those in the upper (cooler) reaches of catchments and more northerly latitudes. The mussels can re-bury themselves if dislodged, and can also move slowly across sandy sediments. Most have about a third of their shells exposed, but some adults and virtually all juveniles burrow completely into the substrate and under loose stones. The huge losses involved in this unusual life cycle make the freshwater pearl mussel particularly vulnerable to adverse conditions (Skinner *et al.*, 2003).

6.3.2.2 Population Dynamics

81 Scotland is now a global stronghold for the freshwater pearl mussel, having up to half the world's known recruiting populations, but it has declined substantially in the last 100 years due to human activities such as:

- Habitat removal and alteration through development, drainage schemes, flow regulation and fisheries management;
- Destructive pearl fishing and illegal pearl trade, aided by improved accessibility;
- Poor water quality, including nutrient enrichment (which also affects the numbers of host fish);
- Conifer planting, exacerbating the effects of river acidification;
- Sedimentation from soil erosion, affecting the suitability of gravel and sand beds for juvenile mussels; and
- Climate change.

82 However despite these direct impacts, the main threat to the FWPM population is considered to be the steady decline of the Atlantic salmon population which acts as a host to the glochidia (SNH, 2013).

6.3.2.3 Vulnerabilities to Effects Arising from Development / Operation of Offshore Wind Farms

83 The vulnerability of the FWPM to effects arising from offshore wind farms is considered to be equal to those of Atlantic salmon given the inextricable link between the two species.

6.3.3 Sea Lamprey

84 Lamprey belong to an ancient order of vertebrates, the Agnathans or 'jawless fishes'. The skeleton of lamprey consists of strong flexible cartilage. A round, sucker-like disc surrounds the mouth which, in adults, holds rasping teeth. Most species of lamprey are parasitic on other fish (Maitland, 2003).

6.3.3.1 Life Cycle

85 The sea lamprey *P. marinus* is by far the largest of the British lamprey and may reach 100 cm and 2.5 kg. Adults of this anadromous species migrate up rivers in March and April, but spawning actually takes place the following year between May and July. Mating occurs in pairs, unlike other lamprey species in which a female is mated by a succession of males (SNH, 2013). The female lays up to 300,000 eggs into a depression in the river bed created by the male. After hatching, the larvae, known as ammocoetes, burrow into the sediment where they live for 3 to 5 years, feeding by filtering organic particles from the water (Arkive, 2013). During metamorphosis, the eyes and the sucker-like mouth develop and the adults then migrate to the sea where they adopt a parasitic lifestyle, feeding by attaching to the bodies of large fish with the mouth and rasping away at the flesh. They remain in the sea for a few years and then return to freshwater in order to spawn. They do not feed during this return trip because the digestive organs degenerate, and shortly after spawning they die (Arkive, 2013).

6.3.3.2 Population Dynamics and Impacts

86 Sea lamprey populations are in decline due to water pollution, eutrophication which can smother spawning gravels and nursery silts and physical barriers such as dams which can affect migration and predation on larvae during spawning periods (Maitland, 2003).

6.3.3.3 Vulnerabilities to Effects Arising from Development / Operation of Offshore Wind Farms

6.3.3.3.1 Increased SSC

87 Increased SSCs may present a barrier to migration of sea lamprey although some tolerance would be expected given their natural exposure to highly turbid environments, such as estuaries, during their life cycle. Estuarine fish generally show tolerance to variations in suspended sediment loadings and turbidity as a result of natural adaptation to living in a dynamic and environmentally variable habitat such as an estuary (ABPmer, 2005).

88 Sea lamprey in the River Suir in Ireland are understood to migrate through areas of high turbidity where suspended solids levels can be more than 100mg/l in concentration (ASU, 2006).

6.3.3.3.2 Increase in Underwater Noise

89 There are no reported audiograms for lamprey species. However, given that they lack any specialist hearing structures, they are considered to be hearing generalists (Marine Scotland, 2011c). There is potential however that lamprey may be able to hear infrasound. The hearing of lamprey is complicated by the fact that they do not have otolith organs and no known work has been undertaken on the response of lamprey to sound in relation to their statoliths or labyrinth organs (Marine Scotland, 2011c). While it might be argued that lamprey may use the “auditory scene” to learn about their environment outside the range of vision, olefaction or chemical cues, their behavioural repertoire is generally limited, and so it may be possible that sound is not relevant to them at all (Popper, 2005).

6.3.3.3.3 Presence of Offshore Structures

90 Sea lamprey is a highly mobile species that undergoes large seasonal movements and migrations to forage and breed (Maitland, 2003). It can, therefore, be particularly vulnerable to any structures which could act as a barrier, preventing movement to foraging or nursery grounds. The degree of impact of barrier effects on this species will depend on its ability to move and avoid barrier structures. Structures placed in a highly confined estuary are likely to be more of an issue than in the open coast (Maitland, 2003).

6.3.3.3.4 Increase in Ambient EMF

91 River lamprey and sea lamprey are considered to be magnetically and electrically sensitive (Gill *et al*., 2005) and use their electro-magnetic senses for feeding, predation and conspecific detection. In addition, Chung-Davidson *et al*. (2008) report that differing responses to Direct Current (DC) electric fields among male and female sea lamprey at various life-stages may suggest a role for electro-reception in reproduction.

92 Normandeau *et al.* (2011) reported that the sensory range of river lamprey is within 0.1 to 20 uV/cm and sea lamprey 1-10 uV/cm. This is at the lowest end of the scale for electro-sensitive fish species in the UK (Gill and Bartlett, 2010). Lamprey is hundreds of times less responsive than other species such as elasmobranchs (Fisher and Slater, 2010). Evidence indicates that no detrimental effect from EMF has been attributed to elasmobranchs in wind farms built throughout the UK (Cefas, 2010).

6.3.4 River Lamprey

6.3.4.1 Life Cycle

93 River lamprey *L. fluviatilis* are anadromous and migrate from their coastal feeding grounds into freshwater to prepare for spawning during the autumn and spring. On reaching their spawning ground, lamprey construct a nest comprising a pit in the river bed with excavated material piled up at the downstream end, into which they lay their eggs. River lamprey spawn in a ball which may comprise up to 50 individuals. After hatching, the young lamprey larvae, known as ammocoetes, drift downstream with the current. These larvae settle in suitable areas of nursery habitat including areas of fine, soft substrate in well oxygenated, slow flowing water. The ammocoetes feed on fine particulate matter such as diatoms, algae and bacteria. Ammocoetes may stay in this substrate for up to 5 years before they transform into pre-adults and start their migration to the sea during late winter-early summer (JNCC, 2013).

6.3.4.2 Population Dynamics

94 The river lamprey has been in decline for the last 100 years, mainly due to habitat degradation such as pollution or obstacles (e.g., in stream structures) that adults cannot tolerate or navigate during the spawning migration (Maitland, 2003).

6.3.4.3 Vulnerabilities to Effects Arising from Development / Operation of Offshore Wind Farms

95 There are very little data and evidence available on the vulnerability of river lamprey to the effects arising from the development of offshore wind farms. However, as river lamprey has a propensity to remain within river and estuarine/nearshore waters, it is considered unlikely that river lamprey will be significantly influenced by barrier or noise/vibration effects in offshore locations.

96 The species is therefore only considered vulnerable to increases in EMF and the vulnerability of the species to this effect, taking a precautionary approach, is considered to be similar to that of the sea lamprey *P. marinus*, as outlined in section 6.3.3.3.4: Increase in Ambient EMF.

7 Designated Sites – SACs

7.1 River South Esk SAC

7.1.1 River South Esk SAC Site Information

97 Site overview information for the River South Esk SAC is provided in Table 7.1 below.

Table 7.1: Summary of information on River South Esk SAC.

Topic	Information
Qualifying feature with connectivity to Neart na Gaoithe	• Atlantic salmon *S. salar;* and • Freshwater pearl mussel *M. margarifera* (FWPM). **Note:** FWPM remain in the River South Esk and are not present in the Firth of Forth, however salmon are integral to the life cycle of FWPM. Therefore any potential impacts on FWPM relate to those directly on salmon that could then indirectly affect FWPM.
Conservation objectives of qualifying feature	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving Favourable Conservation Status for each of the qualifying features. To ensure for the qualifying species that the following are established then maintained in the long term: • Population of the species, including range of genetic types for salmon, as a viable component of the site; • Distribution of the species within site; • Distribution and extent of habitats supporting the species; • Structure, function and supporting processes of habitats supporting the species; • No significant disturbance of the species; • Distribution and viability of freshwater pearl mussel host species; and • Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.
Current status of qualifying feature	The salmon population is currently considered to be unfavourable recovering. The FWPM population is currently considered to be unfavourable declining. No salmon were noted in site-specific surveys for the Neart na Gaoithe project. The currently available information on the migratory routes of trout and salmon is scarce, as a result of this uncertainty the precautionary approach has been taken to assume salmon are present offshore.

7.1.2 River South Esk SAC - Impacts on Atlantic Salmon

7.1.2.1 Impact from Increase in SSC

98 Adult salmonids would normally be able to detect elevated levels of suspended sediment and avoid the localised affected area (EMU, 2004), although juveniles (smolt) may be more susceptible. It is likely that salmon in the area will be adapted to temporary increases in SSC as a result of storm events and therefore have a natural tolerance and low vulnerability to the increased SSCs predicted to arise as a result of the construction of the wind farm. Furthermore, the SCC produced by the construction works will be less than

that generated during a storm and so will be within the natural variation (refer to Chapter 9: Physical Processes in the ES).

99 The impact of increased SSC and turbidity on salmon is thus assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES) and is not anticipated to be of a level to adversely affect the salmon population of the River South Esk SAC.

7.1.2.2 Impact from Increase in Underwater Noise (Installation Activities – Piling)

100 During underwater noise modelling undertaken for the project ES, Subacoustech reported that unweighted Sound Exposure Level (SEL) of 240 dB 1 uPa would occur within 10 m of the piling event and that unweighted noise of 220 dB re 1 uPa would occur within 60 m of source (refer to Chapter 15: Fish and Shellfish Ecology for further information). At 240 dB the impact of the noise exposure was considered to be lethal on all fish receptors, and those noise sources of 220 db re 1 uPa were considered loud enough to cause physical injury. Modelling using the audiogram profile for Atlantic salmon indicates that salmon may strongly avoid an area out to a maximum of 2.6 km (3.5 m diameter pile); or for a 2.5 m diameter pile 1.5 km; the radius of significant avoidance behaviour is likely to extend up to 14 km for salmon (3.5 m diameter pile) and 9.2 km (2.5 m diameter pile). The magnitude of the effect of increased underwater noise on salmon is considered to be negligible for the strong avoidance behaviour and medium for the significant avoidance behaviour. This is based on the spatial extent of the respective zones of influence and the temporary and intermittent nature of the effect which will last for the duration of the construction phase only (refer to Chapter 15: Fish and Shellfish Ecology in the ES).

101 As a hearing 'generalist' (or 'non-specialist'), salmon are not considered to be a species with particularly high vulnerability to increases in underwater noise (refer to section 6.3.1.3.2: Increase in Underwater Noise (Installation Activities – Piling)) (Nedwell, 2003). Also, physiological damage or mortality from underwater noise generated from the project have a very low probability of occurring given the likely migration routes of salmon close to the coast and away from the zone of influence of higher levels of underwater noise (e.g., following Gill and Bartlett, 2010).

102 Given Atlantic salmon's low vulnerability to increases in underwater noise, combined with near- coast migration routes and so low possibility of an impact, the overall impact of increased underwater noise from installation activities has been assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES). This effect is not therefore anticipated to cause an adverse impact on the salmon population of the River South Esk SAC. This assessment carries high uncertainty because of the lack of information on behavioural responses of salmon to increases in underwater noise.

7.1.2.3 Impact from Presence of Offshore Structures

103 Salmon are reported to be vulnerable to structures (e.g., areas which could act as a barrier, preventing movement to their foraging or nursery grounds (Marine Scotland, 2011c). The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures, thus for example, structures placed in a highly confined estuary are likely to be more of an issue than in the open coast.

104 Neither the magnitude of this effect nor the vulnerability of salmon to this change are anticipated to be of a high level given the migration routes of salmon (as outlined above), and the available sea space in the region surrounding the Firth of Forth. As a result the impact on salmon is not anticipated to be significant, and there is no adverse effect anticipated on the River South Esk SAC salmon population.

7.1.2.4 Impact from Increase in Noise during the Operational Phase

105 The magnitude of the effect of increased underwater noise during the operational phase will be considerably less than that of the installation phase. Furthermore background levels of underwater noise are relatively high given the use of the area by shipping and other vessels, as well as industrial activities surrounding the wider Forth region, which may increase the levels of low frequency noise above background levels of approximately 130 dB re 1 µPa in UK coastal waters (Nedwell *et al.,* 2003).

106 Given the low vulnerability of salmon to underwater noise the impact of operational noise on the regional salmon population is considered to be of minor significance when assessed under EIA (refer to Chapter 15:

Fish and Shellfish in the ES). As a result, no adverse effect is anticipated on the River South Esk SAC salmon population.

7.1.2.5 Impact from Increase in Ambient EMF

107 Modelling of predicted EMF densities indicates that EMF values will increase in close vicinity to the export and inter-array cables, though densities will decrease rapidly within 5-10 m of each of the cables (refer to section 6.2.2.3: Increase in Ambient EMF and Fish and Shellfish Ecology Appendix 2: HVAC EMF studies of the Addendum of Supplementary Environmental Information).

108 Salmon may interact with EMF if the fish migration route coincides with the cables particularly in shallow waters (<20 m) where there is greater probability of encountering the cables (and associated EMF) coming to shore. In deeper waters, the likelihood of interaction with EMF from seabed cables is comparatively reduced as the salmon will typically occupy the upper water layers.

109 Salmonids, like other teleost fish, show some vulnerability to changes in the ambient electric field (as outlined in section 6.3.1.3.5: Increase in Ambient EMF). To date no detrimental effect from EMF has been attributed to elasmobranchs in wind farms built throughout the UK (Cefas, 2010) suggesting negligible effects of offshore wind farms on electro and magneto sensitive species. Furthermore, salmonid migration around the UK covers multiple areas where there are known to be existing electrical cables, as outlined in recent Marine Scotland Science commissioned papers (e.g., Malcolm *et al*., 2010).

110 The overall effect of EMF on the regional salmon population is assessed to be of minor significance at the EIA level, based on the relatively small footprint of the cables within the Neart na Gaoithe offshore works area and export cable. Furthermore, as outlined in the ES, the current view within the scientific community is that there is no evidence that this capability will translate into any significant effect.

111 Given the potential importance of the Firth of Forth to salmon from the River South Esk SAC as well as the relative uncertainty of the impacts of EMF, a precautionary approach has been taken. It is predicted that a low magnitude effect on high value receptors is likely to occur resulting in a potential impact of minor significance, with high uncertainty. As a result no adverse effect is anticipated on the River South Esk SAC salmon population.

7.1.3 River South Esk SAC - Cumulative and In-Combination Impacts

112 The Habitats Regulations Appraisal of the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review (Marine Scotland, 2011) recommends that consideration of cumulative or in-combination impacts at a project assessment level should cover impacts from the other wind farm developments in the Forth and Tay region, namely the development of the Inch Cape offshore wind farm and the Firth of Forth Round 3 offshore wind farm Zone 2 project developments.

113 The cumulative effect of pile driving noise from all three developments will result in a zone of influence with a radius that is larger than that of the individual Neart na Gaoithe development in isolation. In comparison, this larger cumulative zone of influence may be energetically more costly for migrating species to avoid as the distance required to avoid adverse noise impacts will be greater. However, given the typical distances over which these species migrate then any additional distance required to avoid adverse cumulative noise impacts in the outer Firth of Forth is expected to be negligible. Given the low vulnerability of the species as outlined above, the overall impact on salmon is assessed to be of minor to moderate significance.

114 The cumulative effects of the proposed Neart na Gaoithe, Inch Cape and Firth of Forth Round 3 Zone 2 offshore wind farms on the sediment regime have been modelled in combination with analysis of the seabed sediment characteristics (see Chapter 9: Physical Processes in the ES). Results of the modelling study indicate that the predicted cumulative changes to sediment transport processes due to the Neart na Gaoithe and other surrounding developments are likely to be small, (the predicted frequency of exceedance of the critical shear stress changes typically by 1-3%, with a maximum difference of 6%, and is restricted to the immediate vicinity of the development sites.

115 Cumulative effects from export and inter-array cables are of relevance to electro-sensitive species that will have the potential to detect EMF emitted by these cables, although over very small areas and local only to the area where the cables are buried.

116 The increase in offshore wind farms in an operational phase will increase the amount of subsea cables and their associated EMF emissions. However, the cables for each individual wind farm will be some distance apart and there is not anticipated to be any overlap between areas of increased EMF densities arising from different offshore wind farm cables.

7.1.4 River South Esk SAC - Conclusions

7.1.4.1 Neart na Gaoithe Site Specific Assessment

117 Given the individual assessments outlined above, and taking into account the conservation objectives for the site, there is not anticipated to be an adverse impact on the integrity of the River South Esk SAC. There are anticipated to be impacts of minor significance on salmon arising from effects such as increased SSC, increased underwater noise, presence of the offshore structures and increased EMF, both at a project level and also from the project in-combination with effects from other projects in the Forth and Tay region.

118 Monitoring carried out of salmon rivers surrounding the Solway Firth, examining changes in salmon fisheries catches related to the development of the Robin Rigg offshore wind farm, did not detect a statistically significant effect on salmon abundance from the offshore wind farm (Thorley, 2013). Alongside this, salmon and lamprey species' populations are subject to numerous variables and populations fluctuate considerably, as outlined in section 6.3: Summary of Screened-In SAC Features / Species and Vulnerabilities. As such, effects arising from the installation and operation of the Neart na Gaoithe project are not anticipated to affect the salmon population of the River South Esk SAC to an extent that the integrity of the site will be adversely affected.

119 Additionally, given that the FWPM lifecycle is intrinsically linked to the salmon population, and also affected by a number of other factors, effects are also not anticipated to affect the FWPM population of the River South Esk SAC to an extent that the integrity of the site will be adversely affected.

7.1.4.2 Cumulative and In-Combination Impact Assessment

120 Given the proposed development of other wind farms in the Forth and Tay region, the magnitude of effects may increase above those anticipated from the development of Neart na Gaoithe alone. Therefore, given salmon, sea lamprey and river lamprey vulnerabilities to these effects, resultant impacts in-combination may be exacerbated to a degree.

121 However, the significance of these impacts on salmon is not anticipated to increase substantially beyond those anticipated at a project level, given the inherent variability and sensitivities of the regional salmon population (including that from the River South Esk SAC), the migration routes of the species (following Malcolm *et al.,* 2010) and the relatively low magnitudes of change anticipated. Nevertheless, such impacts retain a high degree of uncertainty, particularly with regard to the impacts of increased EMF.

122 In conclusion, the impact of development of other Forth and Tay wind farm projects in combination with those arising from development of the Neart na Gaoithe project are not anticipated to have an adverse effect on the salmon (or FWPM) population of the River South Esk SAC nor affect the site's integrity.

7.2 River Tay SAC

7.2.1 River Tay SAC Site Information

123 Site overview information for the River Tay SAC is provided in Table 7.2 below.

Table 7.2: Summary of information on River Tay SAC.

Topic	Information
Qualifying feature with connectivity to Neart na Gaoithe	• Atlantic salmon *S. salar;* • Freshwater pearl mussel *M. margaritifera;* • Sea lamprey *P. marinus*; and • River lamprey *L. fluviatilis*. **Note:** FWPM remain in the River Tay and are not present in the Firth of Forth, however salmon are integral to the life cycle of FWPM. Therefore, any potential impacts on FWPM relate to those directly on salmon that could then indirectly affect FWPM.
Conservation objectives of qualifying feature	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving Favourable Conservation Status for each of the qualifying features. To ensure for the qualifying species that the following are established then maintained in the long term: • Population of the species, including range of genetic types for salmon, as a viable component of the site; • Distribution of the species within site; • Distribution and extent of habitats supporting the species; • Structure, function and supporting processes of habitats supporting the species; and • No significant disturbance of the species.
Current status of qualifying feature	All qualifying features, including those with potential connectivity with Neart na Gaoithe, are considered to be at a favourable maintained condition. No individuals of the species outlined were noted in site-specific surveys for the Neart na Gaoithe project. Information available shows that some diadromous species have been observed on previous surveys may be assumed to be present around the export cables route area rather than the offshore development. However, overall migratory route and distribution data in the Firth of Forth (and elsewhere) are currently limited and species are known to be present, although their presence is in small numbers and transient. The currently available information on the migratory routes of qualifying species outlined is scarce. As a result of this uncertainty, the precautionary approach has been taken to assume salmon and sea lamprey are present offshore. River lamprey has a propensity to remain within river and estuarine/nearshore waters. It is considered unlikely that river lamprey will be significantly influenced by barrier or noise/vibration effects. River lamprey is therefore assessed in terms of potential operational effects of EMF emissions only.

7.2.2 River Tay SAC - Impacts on Atlantic Salmon

7.2.2.1 Impact from Increase in SSC

124 Adult salmonids would normally be able to detect elevated levels of suspended sediment and avoid the localised affected area (EMU, 2004), although juveniles (smolt) may be more susceptible. It is likely that salmon in the area will be adapted to temporary increases in SSC as a result of storm events and therefore have a natural tolerance and low vulnerability to the increased SSCs predicted to arise as a result of the construction of the wind farm. Furthermore, the SCC produced by the construction works will be less than that generated during a storm and so will be within the natural variation (refer to Chapter 9: Physical Processes in the ES).

125 The impact of increased SSC and turbidity on salmon is thus assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES) and is not anticipated to be of a level to adversely affect the salmon population of the River Tay SAC.

7.2.2.2 Impact from Increase in Underwater Noise (Installation Activities – Piling)

126 During underwater noise modelling undertaken for the project ES, Subacoustech reported that unweighted Sound Exposure Level (SEL) of 240 dB 1 uPa would occur within 10 m of the piling event and that unweighted noise of 220 dB re 1 uPa would occur within 60 m of source (refer to Chapter 15: Fish and Shellfish Ecology for further information). At 240 dB the impact of the noise exposure was considered to be lethal on all fish receptors, and those noise sources of 220 db re 1 uPa were considered loud enough to cause physical injury. Modelling using the audiogram profile for Atlantic salmon indicates that salmon may strongly avoid an area out to a maximum of 2.6 km (3.5 m diameter pile); or for a 2.5 m diameter pile 1.5 km; the radius of significant avoidance behaviour is likely to extend up to 14 km for salmon (3.5 m diameter pile) and 9.2 km (2.5 m diameter pile). The magnitude of the effect of increased underwater noise on salmon is considered to be negligible for the strong avoidance behaviour and medium for the significant avoidance behaviour. This is based on the spatial extent of the respective zones of influence and the temporary and intermittent nature of the effect which will last for the duration of the construction phase only (refer to Chapter 15: Fish and Shellfish Ecology in the ES).

127 As a hearing 'generalist' (or 'non-specialist'), salmon are not considered to be a species with particularly high vulnerability to increases in underwater noise (refer to section 6.3.1.3.2: Increase in Underwater Noise (Installation Activities – Piling)) (Nedwell, 2003). Also, physiological damage or mortality from underwater noise generated from the project have a very low probability of occurring given the likely migration routes of salmon close to the coast and away from the zone of influence of higher levels of underwater noise (e.g., following Gill and Bartlett, 2010).

128 Given Atlantic salmon's low vulnerability to increases in underwater noise, combined with near- coast migration routes and so low possibility of an impact, the overall impact of increased underwater noise from installation activities has been assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES). This effect is not therefore anticipated to cause an adverse impact on the salmon population of the River Tay SAC. This assessment carries high uncertainty because of the lack of information on behavioural responses of salmon to increases in underwater noise.

7.2.2.3 Impact from Presence of Offshore Structures

129 Salmon are reported to be vulnerable to structures (e.g., areas which could act as a barrier, preventing movement to their foraging or nursery grounds (Marine Scotland, 2011c). The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures, thus for example, structures placed in a highly confined estuary are likely to be more of an issue than in the open coast.

130 Neither the magnitude of this effect nor the vulnerability of salmon to this change are anticipated to be of a high level given the migration routes of salmon (as outlined above), and the available sea space in the region surrounding the Firth of Forth. As a result the impact on salmon is not anticipated to be significant, and there is no adverse effect anticipated on the River Tay SAC salmon populations.

7.2.2.4 *Impact from Increase in Noise during the Operational Phase*

131 The magnitude of the effect of increased underwater noise during the operational phase will be considerably less than that of the installation phase. Furthermore background levels of underwater noise are relatively high given the use of the area by shipping and other vessels, as well as industrial activities surrounding the wider Forth region, which may increase the levels of low frequency noise above background levels of approximately 130 dB re 1 µPa in UK coastal waters (Nedwell *et al.,* 2003).

132 Given the low vulnerability of salmon to underwater noise the impact of operational noise on the regional salmon population is considered to be of minor significance when assessed under EIA (refer to Chapter 15: Fish and Shellfish in the ES). As a result, no adverse effect is anticipated on the River Tay SAC salmon population.

7.2.2.5 *Impact from Increase in Ambient EMF*

133 Modelling of predicted EMF densities indicates that EMF values will increase in close vicinity to the export and inter-array cables, though densities will decrease rapidly within 5-10 m of each of the cables (refer to section 6.2.2.3: Increase in Ambient EMF and Fish and Shellfish Ecology Appendix 2: HVAC EMF studies of the Addendum of Supplementary Environmental Information).

134 Salmon may interact with EMF if the fish migration route coincides with the cables particularly in shallow waters (<20 m) where there is greater probability of encountering the cables (and associated EMF) coming to shore. In deeper waters, the likelihood of interaction with EMF from seabed cables is comparatively reduced as the salmon will typically occupy the upper water layers.

135 Salmonids, like other teleost fish, show some vulnerability to changes in the ambient electric field (as outlined in section 6.3.1.3.5: Increase in Ambient EMF). To date no detrimental effect from EMF has been attributed to elasmobranchs in wind farms built throughout the UK (Cefas, 2010) suggesting negligible effects of offshore wind farms on electro and magneto sensitive species. Furthermore, salmonid migration around the UK covers multiple areas where there are known to be existing electrical cables, as outlined in recent Marine Scotland Science commissioned papers (e.g., Malcolm *et al*., 2010).

136 The overall effect of EMF on the regional salmon population is assessed to be of minor significance at an EIA level, based on the relatively small footprint of the cables within the Neart na Gaoithe offshore works area and export cable. Furthermore, as outlined in the ES, the current view within the scientific community is that there is no evidence that this capability will translate into any significant effect.

137 Given the potential importance of the Firth of Forth to salmon from the River Tay SAC as well as the relative uncertainty of the impacts of EMF, a precautionary approach has been taken. It is predicted that a low magnitude effect on high value receptors is likely to occur resulting in a potential impact of minor significance, with high uncertainty. As a result no adverse effect is anticipated on the River Tay SAC salmon population.

7.2.3 River Tay SAC – Impacts on Sea (and River) Lamprey

7.2.3.1 *Impact from Increase in SSC*

138 Sea lamprey has the potential to be affected by increased SSC as it could constitute a barrier to migration. However, as outlined in section 6.3.1.3.1: Increased SSC, estuarine fish generally show tolerance to variations in suspended sediment loadings and turbidity as a result of natural adaptation to living in a dynamic and environmentally variable habitat such as an estuary (ABPmer, 2005). Effects of SSCs will also be within the natural variation.

139 The impact of increased SSC and turbidity on the regional sea lamprey population is therefore assessed as being not significant, and therefore not anticipated to be of a level to adversely affect the sea lamprey population of the River Tay SAC.

7.2.3.2 Impact from Increase in Underwater Noise (Installation Activities – Piling)

140 There is no specific audiogram available for sea lamprey and a prediction of the zone of influence of underwater noise has not been made.

141 Sea lamprey lack specialist hearing structures and are therefore considered to be hearing generalists similar to salmonids (refer to section 6.3.3.3.2: Population Dynamics and Impacts). Furthermore, it may be possible that sound is not relevant to them at all (Popper, 2005)

142 They are therefore anticipated to have low vulnerability to underwater noise arising from the construction of the wind farm. Accordingly, the impact of increased underwater noise on the sea lamprey regional population is assessed as being not significant. Therefore no adverse impact is anticipated on the River Tay sea lamprey population.

7.2.3.3 Impact from Presence of Offshore Structures

143 The presence of offshore structures results in an increase in potential physical barriers to migrating fish species such as salmon or sea lamprey. Salmon are reported to be vulnerable to structures (e.g., areas which could act as a barrier) preventing movement to their foraging or nursery grounds (Marine Scotland, 2011c). The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures, thus for example, structures placed in a highly confined estuary are likely to be more of an issue than in the open coast.

144 Both the magnitude of this likely significant effect and the vulnerability of salmon or sea lamprey are anticipated to be low based on the near-coast migration routes of salmon and sea lamprey (as outlined above), and the available sea space in the region surrounding the Firth of Forth. Accordingly, impacts on salmon and sea lamprey are expected to be not significant, and no adverse effects are anticipated on the River Tay SAC salmon or sea lamprey populations.

7.2.3.4 Impact from Increase in Noise during the Operational Phase

145 As outlined above, lamprey is anticipated to have a low vulnerability to underwater noise. Furthermore, underwater noise in the operational phase is anticipated to be limited (refer to section 6.2.2.2 Increase in Underwater Noise from Operation and Maintenance Activities). The impact of increased underwater noise on the sea lamprey regional population is assessed as being not significant. Therefore no adverse impact is anticipated on the River Tay sea lamprey population.

7.2.3.5 Impact from Increase in Ambient EMF

146 Both river lamprey and sea lamprey are considered to be magnetically and electrically sensitive (Gill *et al*., 2005) and as such have a degree of vulnerability to the predicted increase in EMF densities (refer to section 906.2.2.3: Increase in Ambient EMF and Fish and Shellfish Ecology Appendix 2: HVAC EMF Studies of the Addendum of Supplementary Environmental Information).

147 It has been recorded that they use their electro-magnetic senses for feeding, predation and conspecific detection. Chung-Davidson *et al*. (2008) report that differing responses to DC electric fields among male and female sea lamprey at various life stages may suggest a role for electro-reception in reproduction. However, like most UK species that are electro-magnetically sensitive, knowledge of their interaction with anthropogenic EMF is very limited.

148 Despite the species' potential vulnerability, their reported sensory range is at the lower end of the scale for electro-sensitive fish species in the UK (Gill and Bartlett, 2010). Furthermore, no detrimental effect of EMF from offshore wind farms on electro-sensitive species has been recorded (Cefas, 2010).

149 Effects will be highly localised (within a few metres around the cable) so that the magnitude of effect of increased EMF densities will be low. The vulnerability of sea lamprey to EMF is also low. The potential impact of increased EMF is therefore judged to be not significant, though it is noted that there is high uncertainty associated with this conclusion. Additionally, the SAC populations of the species are considered to be in favourable maintained conditions. Therefore, no adverse effect of EMF on the River Tay SAC sea lamprey or river lamprey populations is predicted.

7.2.4 River Tay SAC - Cumulative and In-Combination Impact Assessment

150 The Plan level HRA recommends that consideration of cumulative or in-combination impacts should cover impacts from the other wind farm developments in the Forth and Tay region, namely the development of the Inch Cape offshore wind farm and the Firth of Forth Round 3 offshore wind farm Zone 2 project developments.

151 The cumulative effect of pile driving noise from all three developments will result in a zone of influence with a radius that is larger than that of the individual Neart na Gaoithe development in isolation. In comparison, this larger cumulative zone of influence may be energetically more costly for migrating species to avoid as the distance required to avoid adverse noise impacts will be greater. However, given the typical distances over which these species migrate then any additional distance required to avoid adverse cumulative noise impacts in the outer Firth of Forth is expected to be negligible. Given the low vulnerability of the species as outlined above, the overall impact on salmon is assessed to be of minor to moderate significance.

152 The cumulative effects of the proposed Neart na Gaoithe, Inch Cape and Firth of Forth Round 3 Zone 2 offshore wind farms on the sediment regime have been modelled in combination with analysis of the seabed sediment characteristics (see Chapter 9: Physical Processes in the ES). Results of the modelling study indicate that the predicted cumulative changes to sediment transport processes due to the Neart na Gaoithe and other surrounding developments are likely to be small, (the predicted frequency of exceedance of the critical shear stress changes typically by 1-3%, with a maximum difference of 6%, and is restricted to the immediate vicinity of the development sites.

153 Cumulative effects from export and inter-array cables are of relevance to electro-sensitive species that will have the potential to detect EMF emitted by these cables, although over very small areas and local only to the area where the cables are buried.

154 The increase in offshore wind farms in an operational phase will increase the amount of subsea cables and their associated EMF emissions. However, the cables for each individual wind farm will be some distance apart and there is not anticipated to be any overlap between areas of increased EMF densities arising from different offshore wind farm cables.

7.2.5 River Tay SAC Conclusions

7.2.5.1 Neart na Gaoithe Site Specific Assessment

155 Monitoring carried out of salmon rivers surrounding the Solway Firth, examining changes in salmon fisheries catches related to the development of the Robin Rigg offshore wind farm, did not detect a statistically significant effect on salmon abundance from the offshore wind farm (Thorley, 2013). Alongside this, salmon and lamprey species' populations are subject to numerous variables and populations fluctuate considerably, as outlined in section 6.3: Summary of Screened-In SAC Features / Species and Vulnerabilities. As such, effects arising from the installation and operation of the Neart na Gaoithe project are not anticipated to affect the salmon, sea lamprey and river lamprey population of the River Tay SAC to an extent that the integrity of the site will be adversely affected.

156 Additionally, given that the FWPM lifecycle is intrinsically linked to the salmon population, and also affected by a number of other factors, effects are also not anticipated to affect the FWPM population of the River Tay SAC to an extent that the integrity of the site will be adversely affected.

7.2.5.2 Cumulative and In-Combination Impact Assessment

157 Given the proposed development of other wind farms in the Forth and Tay region, the magnitude of effects may increase above those anticipated from the development of Neart na Gaoithe alone. Therefore, given salmon, sea lamprey and river lamprey vulnerabilities to these effects, resultant impacts in-combination may be exacerbated to a degree.

158 However, the significance of these impacts is not anticipated to increase substantially beyond those anticipated at a project level, given the inherent variability and sensitivities of the regional salmon, sea and river lamprey populations (including that from the River Tay SAC), the migration routes of the species

(following Malcolm *et al.,* 2010) and the relatively low magnitudes of change anticipated. Nevertheless, such impacts retain a high degree of uncertainty, particularly with regard to the impacts of increased EMF.

159 In conclusion, the impact of development of other Forth and Tay wind farm projects, in combination with those arising from development of the Neart na Gaoithe project, are not anticipated to have an adverse effect on the salmon, sea lamprey, river lamprey or FWPM populations of the River Tay SAC nor affect the site's integrity.

7.3 River Teith SAC

7.3.1 River Teith SAC Site Information

160 Site overview information for the River Teith SAC is provided in Table 7.3 below.

Table 7.3: Summary of information on River Teith SAC.

Topic	Information
Qualifying feature with connectivity to Neart na Gaoithe	• Atlantic salmon *S. salar;* • Sea lamprey *P. marinus;* and • River lamprey *L. fluviatilis*.
Conservation objectives of qualifying feature	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving Favourable Conservation Status for each of the qualifying features. To ensure for the qualifying species that the following are established then maintained in the long term: • Population of the species, including range of genetic types for salmon, as a viable component of the site; • Distribution of the species within site; • Distribution and extent of habitats supporting the species; • Structure, function and supporting processes of habitats supporting the species; and • No significant disturbance of the species.
Current status of qualifying feature	The salmon population is currently considered to be unfavourable recovering. The sea and river lamprey populations are considered to be favourable maintained. No individuals of the species outlined were noted in site-specific surveys for the Neart na Gaoithe project. Information available shows that some diadromous species have been observed on previous surveys may be assumed to be present around the export cables route area rather than the offshore development. However, overall migratory route and distribution data in the Firth of Forth (and elsewhere) are currently limited and species are known to be present, although their presence is in small numbers and transient. The currently available information on the migratory routes of species outlined is scarce. As a result of this uncertainty, the precautionary approach has been taken to assume salmon and sea lamprey are present offshore. River lamprey has a propensity to remain within river and estuarine/nearshore waters. It is considered unlikely that river lamprey will be significantly influenced by barrier or noise/vibration effects. River lamprey is therefore assessed in terms of potential operational effects of EMF emissions only.

7.3.2 River South Esk SAC - Impacts on Atlantic Salmon

7.3.2.1 Impact from Increase in SSC

161 Adult salmonids would normally be able to detect elevated levels of suspended sediment and avoid the localised affected area (EMU, 2004), although juveniles (smolt) may be more susceptible. It is likely that salmon in the area will be adapted to temporary increases in SSC as a result of storm events and therefore have a natural tolerance and low vulnerability to the increased SSCs predicted to arise as a result of the

construction of the wind farm. Furthermore, the SCC produced by the construction works will be less than that generated during a storm and so will be within the natural variation (refer to Chapter 9: Physical Processes in the ES).

162 The impact of increased SSC and turbidity on salmon is thus assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES) and is not anticipated to be of a level to adversely affect the salmon population of the River Teith SAC.

7.3.2.2 Impact from Increase in Underwater Noise (Installation Activities – Piling)

163 During underwater noise modelling undertaken for the project ES, Subacoustech reported that unweighted Sound Exposure Level (SEL) of 240 dB 1 uPa would occur within 10 m of the piling event and that unweighted noise of 220 dB re 1 uPa would occur within 60 m of source (refer to Chapter 15: Fish and Shellfish Ecology for further information). At 240 dB the impact of the noise exposure was considered to be lethal on all fish receptors, and those noise sources of 220 db re 1 uPa were considered loud enough to cause physical injury. Modelling using the audiogram profile for Atlantic salmon indicates that salmon may strongly avoid an area out to a maximum of 2.6 km (3.5 m diameter pile); or for a 2.5 m diameter pile 1.5 km; the radius of significant avoidance behaviour is likely to extend up to 14 km for salmon (3.5 m diameter pile) and 9.2 km (2.5 m diameter pile). The magnitude of the effect of increased underwater noise on salmon is considered to be negligible for the strong avoidance behaviour and medium for the significant avoidance behaviour. This is based on the spatial extent of the respective zones of influence and the temporary and intermittent nature of the effect which will last for the duration of the construction phase only (refer to Chapter 15: Fish and Shellfish Ecology in the ES).

164 As a hearing 'generalist' (or 'non-specialist'), salmon are not considered to be a species with particularly high vulnerability to increases in underwater noise (refer to section 6.3.1.3.2: Increase in Underwater Noise (Installation Activities – Piling)) (Nedwell, 2003). Also, physiological damage or mortality from underwater noise generated from the project have a very low probability of occurring given the likely migration routes of salmon close to the coast and away from the zone of influence of higher levels of underwater noise (e.g., following Gill and Bartlett, 2010).

165 Given Atlantic salmon's low vulnerability to increases in underwater noise, combined with near- coast migration routes and so low possibility of an impact, the overall impact of increased underwater noise from installation activities has been assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES). This effect is not therefore anticipated to cause an adverse impact on the salmon population of the River Teith SAC. This assessment carries high uncertainty because of the lack of information on behavioural responses of salmon to increases in underwater noise.

7.3.2.3 Impact from Presence of Offshore Structures

166 Salmon are reported to be vulnerable to structures (e.g., areas which could act as a barrier, preventing movement to their foraging or nursery grounds (Marine Scotland, 2011c). The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures, thus for example, structures placed in a highly confined estuary are likely to be more of an issue than in the open coast.

167 Neither the magnitude of this effect nor the vulnerability of salmon to this change are anticipated to be of a high level given the migration routes of salmon (as outlined above), and the available sea space in the region surrounding the Firth of Forth. As a result the impact on salmon is not anticipated to be significant, and there is no adverse effect anticipated on the River Teith SAC salmon populations.

7.3.2.4 Impact from Increase in Noise during the Operational Phase

168 The magnitude of the effect of increased underwater noise during the operational phase will be considerably less than that of the installation phase. Furthermore background levels of underwater noise are relatively high given the use of the area by shipping and other vessels, as well as industrial activities surrounding the wider Forth region, which may increase the levels of low frequency noise above background levels of approximately 130 dB re 1 µPa in UK coastal waters (Nedwell *et al.,* 2003).

169 Given the low vulnerability of salmon to underwater noise the impact of operational noise on the regional salmon population is considered to be of minor significance when assessed under EIA (refer to Chapter 15:

Fish and Shellfish in the ES). As a result, no adverse effect is anticipated on the River Teith SAC salmon population.

7.3.2.5 Impact from Increase in Ambient EMF

170 Modelling of predicted EMF densities indicates that EMF values will increase in close vicinity to the export and inter-array cables, though densities will decrease rapidly within 5-10 m of each of the cables (refer to section 6.2.2.3: Increase in Ambient EMF and Fish and Shellfish Ecology Appendix 2: HVAC EMF studies of the Addendum of Supplementary Environmental Information).

171 Salmon may interact with EMF if the fish migration route coincides with the cables particularly in shallow waters (<20 m) where there is greater probability of encountering the cables (and associated EMF) coming to shore. In deeper waters, the likelihood of interaction with EMF from seabed cables is comparatively reduced as the salmon will typically occupy the upper water layers.

172 Salmonids, like other teleost fish, show some vulnerability to changes in the ambient electric field (as outlined in section 6.3.1.3.5: Increase in Ambient EMF above). To date no detrimental effect from EMF has been attributed to elasmobranchs in wind farms built throughout the UK (Cefas, 2010) suggesting negligible effects of offshore wind farms on electro and magneto sensitive species. Furthermore, salmonid migration around the UK covers multiple areas where there are known to be existing electrical cables, as outlined in recent Marine Scotland Science commissioned papers (e.g., Malcolm *et al*., 2010).

173 The overall effect of EMF on the regional salmon population is assessed to be of minor significance at an EIA level, based on the relatively small footprint of the cables within the Neart na Gaoithe offshore works area and export cable. Furthermore, as outlined in the ES, the current view within the scientific community is that there is no evidence that this capability will translate into any significant effect.

174 Given the potential importance of the Firth of Forth to salmon from the River Teith SAC as well as the relative uncertainty of the impacts of EMF, a precautionary approach has been taken. It is predicted that a low magnitude effect on high value receptor is likely to occur resulting in a potential impact of minor significance, with high uncertainty. As a result no adverse effect is anticipated on the River Teith SAC salmon population.

7.3.3 River South Esk SAC – Impacts on Sea (and River) Lamprey

7.3.3.1 Impact from Increase in SSC

175 Sea lamprey has the potential to be affected by increased SSC as it could constitute a barrier to migration. However, as outlined in section 6.3.1.3.1: Increased SSC, estuarine fish generally show tolerance to variations in suspended sediment loadings and turbidity as a result of natural adaptation to living in a dynamic and environmentally variable habitat such as an estuary (ABPmer, 2005). Effects of SSCs will also be within the natural variation.

176 The impact of increased SSC and turbidity on the regional sea lamprey population is therefore assessed as being not significant, and therefore not anticipated to be of a level to adversely affect the sea lamprey population of the River Teith SAC.

7.3.3.2 Impact from Increase in Underwater Noise (Installation Activities – Piling)

177 There is no specific audiogram available for sea lamprey and a prediction of the zone of influence of underwater noise has not been made.

178 Sea lamprey lack any specialist hearing structures and are therefore considered to be hearing generalists similar to salmonids (refer to section 6.3.3.3.2: Increase in Underwater Noise). Furthermore, it may be possible that sound is not relevant to them at all (Popper, 2005).

179 They are therefore anticipated to have low vulnerability to underwater noise arising from the construction of the wind farm. Accordingly, the impact of increased underwater noise on the sea lamprey regional population is assessed as being not significant. Therefore no adverse impact is anticipated on the River Teith sea lamprey population.

7.3.3.3 *Impact from Presence of Offshore Structures*

180 The presence of offshore structures results in an increase in potential physical barriers to migrating fish species such as salmon or sea lamprey. Salmon are reported to be vulnerable to structures (e.g., areas which could act as a barrier) preventing movement to their foraging or nursery grounds (Marine Scotland, 2011c). The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures, thus for example, structures placed in a highly confined estuary are likely to be more of an issue than in the open coast.

181 Both the magnitude of this likely significant effect and the vulnerability of salmon or sea lamprey are anticipated to be low based on the near-coast migration routes of salmon and sea lamprey (as outlined above), and the available sea space in the region surrounding the Firth of Forth. Accordingly, impacts on salmon and sea lamprey are expected to be not significant, and no adverse effects are anticipated on the River Teith SAC salmon or sea lamprey populations.

7.3.3.4 *Impact from Increase in Noise during the Operational Phase*

182 As outlined above, lamprey is anticipated to have a low vulnerability to underwater noise. Furthermore, underwater noise in the operational phase is anticipated to be limited (refer to 6.2.2.2Increase in Underwater Noise from Operation and Maintenance Activities). The impact of increased underwater noise on the sea lamprey regional population is assessed as being not significant. Therefore no adverse impact is anticipated on the River Teith sea lamprey population.

7.3.3.5 *Impact from Increase in Ambient EMF*

183 Both river lamprey and sea lamprey are considered to be magnetically and electrically sensitive (Gill *et al*., 2005) and as such have a degree of vulnerability to the predicted increase in EMF densities (refer to section 6.3.3.3.4: Increase in Ambient EMF and Fish and Shellfish Ecology Appendix 2: HVAC EMF Studies of the Addendum of Supplementary Environmental Information).

184 It has been recorded that they use their electro-magnetic senses for feeding, predation and conspecific detection. Chung-Davidson *et al*. (2008) report that differing responses to DC electric fields among male and female sea lamprey at various life stages may suggest a role for electro-reception in reproduction. However, like most UK species that are electro-magnetically sensitive, knowledge of their interaction with anthropogenic EMF is very limited.

185 Despite the species' potential vulnerability, their reported sensory range is at the lower end of the scale for electro-sensitive fish species in the UK (Gill and Bartlett, 2010). Furthermore, no detrimental effect of EMF from offshore wind farms on electro-sensitive species has been recorded (Cefas, 2010).

186 Effects will be highly localised (within a few metres around the cable) so that the magnitude of effect of increased EMF densities will be low. The vulnerability of sea lamprey to EMF is also low. The potential impact of increased EMF is therefore judged to be not significant, though it is noted that there is high uncertainty associated with this conclusion. Therefore, no adverse effect of EMF on the River Teith SAC sea lamprey or river lamprey populations is predicted.

7.3.4 River Teith SAC - Cumulative and In-Combination Impact Assessment

187 The Habitats Regulations Appraisal of the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review (Marine Scotland, 2011) recommends that consideration of cumulative or in-combination impacts should cover impacts from the other wind farm developments in the Forth and Tay region, namely the development of the Inch Cape offshore wind farm and the Firth of Forth Round 3 offshore wind farm Zone 2 project developments.

188 The cumulative effect of pile driving noise from all three developments will result in a zone of influence with a radius that is larger than that of the individual Neart na Gaoithe development in isolation. In comparison, this larger cumulative zone of influence may be energetically more costly for migrating species to avoid as the distance required to avoid adverse noise impacts will be greater. However, given the typical distances over which these species migrate then any additional distance required to avoid adverse

cumulative noise impacts in the outer Firth of Forth is expected to be negligible. Given the low vulnerability of the species as outlined above, the overall impact on salmon is assessed to be of minor to moderate significance.

189 The cumulative effects of the proposed Neart na Gaoithe, Inch Cape and Firth of Forth Round 3 Zone 2 offshore wind farms on the sediment regime have been modelled in combination with analysis of the seabed sediment characteristics (see Chapter 9: Physical Processes in the ES). Results of the modelling study indicate that the predicted cumulative changes to sediment transport processes due to the Neart na Gaoithe and other surrounding developments are likely to be small, (the predicted frequency of exceedance of the critical shear stress changes typically by 1-3%, with a maximum difference of 6%, and is restricted to the immediate vicinity of the development sites.

190 Cumulative effects from export and inter-array cables are of relevance to electro-sensitive species that will have the potential to detect EMF emitted by these cables, although over very small areas and local only to the area where the cables are buried. The increase in offshore wind farms in an operational phase will increase the amount of subsea cables and their associated EMF emissions. However, the cables for each individual wind farm will be some distance apart and there is not anticipated to be any overlap between areas of increased EMF densities arising from different offshore wind farm cables.

7.3.5 River Teith SAC Conclusions

7.3.5.1 Conclusions for Project Level Impacts

191 Given the individual assessments outlined above, and taking into account the conservation objectives for the site, there is not anticipated to be an adverse impact on the integrity of the River Teith SAC. There are anticipated to be impacts of minor significance on regional salmon and sea lamprey populations (and to an extent, river lamprey populations) arising from effects such as increased SSC, increased underwater noise, presence of the offshore structures and increased EMF, both at a project level and also from the project in-combination with effects from other projects in the Forth and Tay region.

192 Monitoring carried out of salmon rivers surrounding the Solway Firth, examining changes in salmon fisheries catches related to the development of the Robin Rigg offshore wind farm, did not detect a statistically significant effect on salmon abundance from the offshore wind farm (Thorley, 2013). Alongside this, salmon and lamprey species' populations are subject to numerous variables and populations fluctuate considerably, as outlined in section 6.3: Summary of Screened-In SAC Features / Species and Vulnerabilities.

193 Furthermore, the River Teith SAC populations of the sea and river lamprey are considered to be in favourable maintained condition, and the salmon population unfavourable recovering. As such, effects arising from the installation and operation of the Neart na Gaoithe project are not anticipated to affect the salmon, sea lamprey or river lamprey populations of the River Teith SAC to an extent that the integrity of the site will be affected.

7.3.5.2 Conclusions for Impacts In-Combination with those from other Offshore Wind Farms

194 Given the proposed development of other wind farms in the Forth and Tay region, the magnitude of effects may increase above those anticipated from development of Neart na Gaoithe alone. Therefore, given salmon, sea lamprey and river lamprey vulnerabilities to these effects, resultant impacts in-combination may be exacerbated to a degree.

195 However, the significance of these impacts is not anticipated to increase substantially beyond those anticipated at a project level, given the inherent variability and sensitivities of the regional salmon, sea and river lamprey populations (including that from the River Teith SAC), the migration routes of the species (following Malcolm *et al.,* 2010) and the relatively low magnitudes of change anticipated. Nevertheless, such impacts retain a high degree of uncertainty, particularly with regard to the impacts of increased EMF.

196 In conclusion, the impact of development of other Forth and Tay wind farm projects in combination with those arising from development of the Neart na Gaoithe project, are not anticipated to have an adverse effect on the salmon, sea lamprey or river lamprey populations of the River Teith SAC nor affect the site's integrity.

7.4 River Tweed SAC

7.4.1 River Tweed SAC Site Information

197 Site overview information for the River Tweed SAC is provided in Table 7.4 below.

Table 7.4: Summary of information on River Tweed SAC.

Topic	Information
Qualifying feature with connectivity to Neart na Gaoithe	• Atlantic salmon *S. salar.*
Conservation objectives of qualifying feature	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving Favourable Conservation Status for each of the qualifying features. To ensure for the qualifying species that the following are established then maintained in the long term: • Population of the species, including range of genetic types for salmon, as a viable component of the site; • Distribution of the species within site; • Distribution and extent of habitats supporting the species; • Structure, function and supporting processes of habitats supporting the species; and • No significant disturbance of the species.
Current status of qualifying feature	The salmon population is currently considered to be unfavourable recovering. No salmon were noted in site-specific surveys for the Neart na Gaoithe project. The currently available information on the migratory routes of trout and salmon is scarce, as a result of this uncertainty the precautionary approach has been taken to assume salmon are present offshore.

7.4.2 River Tweed SAC - Impacts on Atlantic Salmon

7.4.2.1 Impact from Increase in SSC

198 Adult salmonids would normally be able to detect elevated levels of suspended sediment and avoid the localised affected area (EMU, 2004), although juveniles (smolt) may be more susceptible. It is likely that salmon in the area will be adapted to temporary increases in SSC as a result of storm events and therefore have a natural tolerance and low vulnerability to the increased SSCs predicted to arise as a result of the construction of the wind farm. Furthermore, the SCC produced by the construction works will be less than that generated during a storm and so will be within the natural variation (refer to Chapter 9: Physical Processes in the ES).

199 The impact of increased SSC and turbidity on salmon is thus assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES) and is not anticipated to be of a level to adversely affect the salmon population of the River Tweed SAC.

7.4.2.2 *Impact from Increase in Underwater Noise (Installation Activities – Piling)*

200 During underwater noise modelling undertaken for the project ES, Subacoustech reported that unweighted Sound Exposure Level (SEL) of 240 dB 1 uPa would occur within 10 m of the piling event and that unweighted noise of 220 dB re 1 uPa would occur within 60 m of source (refer to Chapter 15: Fish and Shellfish Ecology for further information). At 240 dB the impact of the noise exposure was considered to be lethal on all fish receptors, and those noise sources of 220 db re 1 uPa were considered loud enough to cause physical injury. Modelling using the audiogram profile for Atlantic salmon indicates that salmon may strongly avoid an area out to a maximum of 2.6 km (3.5 m diameter pile); or for a 2.5 m diameter pile 1.5 km; the radius of significant avoidance behaviour is likely to extend up to 14 km for salmon (3.5 m diameter pile) and 9.2 km (2.5 m diameter pile). The magnitude of the effect of increased underwater noise on salmon is considered to be negligible for the strong avoidance behaviour and medium for the significant avoidance behaviour. This is based on the spatial extent of the respective zones of influence and the temporary and intermittent nature of the effect which will last for the duration of the construction phase only (refer to Chapter 15: Fish and Shellfish Ecology in the ES).

201 As a hearing 'generalist' (or 'non-specialist'), salmon are not considered to be a species with particularly high vulnerability to increases in underwater noise (refer to section 6.3.1.3.2: Increase in Underwater Noise (Installation Activities – Piling)) (Nedwell, 2003). Also, physiological damage or mortality from underwater noise generated from the project have a very low probability of occurring given the likely migration routes of salmon close to the coast and away from the zone of influence of higher levels of underwater noise (e.g., following Gill and Bartlett, 2010).

202 Given Atlantic salmon's low vulnerability to increases in underwater noise, combined with near- coast migration routes and so low possibility of an impact, the overall impact of increased underwater noise from installation activities has been assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES). This effect is not therefore anticipated to cause an adverse impact on the salmon population of the River Tweed SAC. This assessment carries high uncertainty because of the lack of information on behavioural responses of salmon to increases in underwater noise.

7.4.2.3 *Impact from Presence of Offshore Structures*

203 Salmon are reported to be vulnerable to structures (e.g., areas which could act as a barrier, preventing movement to their foraging or nursery grounds (Marine Scotland, 2011c). The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures, thus for example, structures placed in a highly confined estuary are likely to be more of an issue than in the open coast.

204 Neither the magnitude of this effect nor the vulnerability of salmon to this change are anticipated to be of a high level given the migration routes of salmon (as outlined above), and the available sea space in the region surrounding the Firth of Forth. As a result the impact on salmon is not anticipated to be significant, and there is no adverse effect anticipated on the River Tweed SAC salmon population.

7.4.2.4 *Impact from Increase in Noise during the Operational Phase*

205 The magnitude of the effect of increased underwater noise during the operational phase will be considerably less than that of the installation phase. Furthermore background levels of underwater noise are relatively high given the use of the area by shipping and other vessels, as well as industrial activities surrounding the wider Forth region, which may increase the levels of low frequency noise above background levels of approximately 130 dB re 1 µPa in UK coastal waters (Nedwell *et al.,* 2003).

206 Given the low vulnerability of salmon to underwater noise the impact of operational noise on the regional salmon population is considered to be of minor significance when assessed under EIA (refer to Chapter 15: Fish and Shellfish in the ES). As a result, no adverse effect is anticipated on the River Tweed SAC salmon population.

7.4.2.5 *Impact from Increase in Ambient EMF*

207 Modelling of predicted EMF densities indicates that EMF values will increase in close vicinity to the export and inter-array cables, though densities will decrease rapidly within 5-10 m of each of the cables (refer to

section 6.2.2.3: Increase in Ambient EMF and Fish, and Shellfish Ecology Appendix 2: HVAC EMF studies of the Addendum of Supplementary Environmental Information).

208 Salmon may interact with EMF if the fish migration route coincides with the cables particularly in shallow waters (<20 m) where there is greater probability of encountering the cables (and associated EMF) coming to shore. In deeper waters, the likelihood of interaction with EMF from seabed cables is comparatively reduced as the salmon will typically occupy the upper water layers.

209 Salmonids, like other teleost fish, show some vulnerability to changes in the ambient electric field (as outlined in section 6.3.1.3.5: Increase in Ambient EMF). To date no detrimental effect from EMF has been attributed to elasmobranchs in wind farms built throughout the UK (Cefas, 2010) suggesting negligible effects of offshore wind farms on electro and magneto sensitive species. Furthermore, salmonid migration around the UK covers multiple areas where there are known to be existing electrical cables, as outlined in recent Marine Scotland Science commissioned papers (e.g., Malcolm *et al*., 2010).

210 The overall effect of EMF on the regional salmon population is assessed to be of minor significance at an EIA level, based on the relatively small footprint of the cables within the Neart na Gaoithe offshore works area and export cable. Furthermore, as outlined in the ES, the current view within the scientific community is that there is no evidence that this capability will translate into any significant effect.

211 Given the potential importance of the Firth of Forth to salmon from the River Tweed SAC as well as the relative uncertainty of the impacts of EMF, a precautionary approach has been taken. It is predicted that a low magnitude effect on high value receptors is likely to occur resulting in a potential impact of minor significance, with high uncertainty. As a result no adverse effect is anticipated on the River Tweed SAC salmon population.

7.4.3 River Tweed SAC - Cumulative and In-Combination Impacts

212 The Habitats Regulations Appraisal of the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review (Marine Scotland, 2011) recommends that consideration of cumulative or in-combination impacts should cover impacts from the other wind farm developments in the Forth and Tay region, namely the development of the Inch Cape offshore wind farm and the Firth of Forth Round 3 offshore wind farm Zone 2 project developments.

213 The cumulative effect of pile driving noise from all three developments will result in a zone of influence with a radius that is larger than that of the individual Neart na Gaoithe development in isolation. In comparison, this larger cumulative zone of influence may be energetically more costly for migrating species to avoid as the distance required to avoid adverse noise impacts will be greater. However, given the typical distances over which these species migrate then any additional distance required to avoid adverse cumulative noise impacts in the outer Firth of Forth is expected to be negligible. Given the low vulnerability of the species as outlined above, the overall impact on salmon is assessed to be of minor to moderate significance.

214 The cumulative effects of the proposed Neart na Gaoithe, Inch Cape and Firth of Forth Round 3 Zone 2 offshore wind farms on the sediment regime have been modelled in combination with analysis of the seabed sediment characteristics (see Chapter 9: Physical Processes in the ES). Results of the modelling study indicate that the predicted cumulative changes to sediment transport processes due to the Neart na Gaoithe and other surrounding developments are likely to be small, (the predicted frequency of exceedance of the critical shear stress changes typically by 1-3%, with a maximum difference of 6%, and is restricted to the immediate vicinity of the development sites.

215 Cumulative effects from export and inter-array cables are of relevance to electro-sensitive species that will have the potential to detect EMF emitted by these cables, although over very small areas and local only to the area where the cables are buried.

216 The increase in offshore wind farms in an operational phase will increase the amount of subsea cables and their associated EMF emissions. However, the cables for each individual wind farm will be some distance apart and there is not anticipated to be any overlap between areas of increased EMF densities arising from different offshore wind farm cables.

7.4.4 River Tweed SAC - Conclusions

7.4.4.1 Neart na Gaoithe Site Specific Assessment

217 Given the individual assessments outlined above, and taking into account the conservation objectives for the site, there is not anticipated to be an adverse impact on the integrity of the River Tweed SAC. There are anticipated to be impacts of minor significance on salmon arising from effects such as increased SSC, increased underwater noise, presence of the offshore structures and increased EMF, both at a project level and also from the project in-combination with effects from other projects in the Forth and Tay region.

218 Monitoring carried out of salmon rivers surrounding the Solway Firth, examining changes in salmon fisheries catches related to the development of the Robin Rigg offshore wind farm, did not detect a statistically significant effect on salmon abundance from the offshore wind farm (Thorley, 2013). Alongside this, salmon and lamprey species' populations are subject to numerous variables and populations fluctuate considerably, as outlined in section 6.3: Summary of Screened-In SAC Features / Species and Vulnerabilities. As such, effects arising from the installation and operation of the Neart na Gaoithe project are not anticipated to affect the salmon population of the River Tweed SAC to an extent that the integrity of the site will be adversely affected.

7.4.4.2 Cumulative and In-Combination Impact Assessment

219 Given the proposed development of other wind farms in the Forth and Tay region, the magnitude of effects may increase above those anticipated from the development of Neart na Gaoithe alone. Therefore, given salmon's vulnerabilities to these effects, resultant impacts in-combination may be exacerbated to a degree.

220 However, the significance of these impacts on salmon is not anticipated to increase substantially beyond those anticipated at a project level, given the inherent variability and sensitivities of the regional salmon population (including that from the River Tweed SAC), the migration routes of the species (following Malcolm *et al.,* 2010) and the relatively low magnitudes of change anticipated. Nevertheless, such impacts retain a high degree of uncertainty, particularly with regard to the impacts of increased EMF.

221 In conclusion, the impact of development of other Forth and Tay wind farm projects in combination with those arising from development of the Neart na Gaoithe project are not anticipated to have an adverse effect on the salmon population of the River Tweed SAC nor affect the site's integrity.

7.4.5 River Tweed SAC Conclusions

7.4.5.1 Conclusions for Project Level Impacts

222 Given the individual assessments outlined above, and taking into account the conservation objectives for the site, there is not anticipated to be an adverse impact on the integrity of the River Tweed SAC. There are anticipated to be impacts of minor significance on salmon arising from effects such as increased SSC, increased underwater noise, presence of the offshore structures and increased EMF, both at a project level and also from the project in-combination with effects from other projects in the Forth and Tay region.

223 Monitoring carried out of salmon rivers surrounding the Solway Firth, examining changes in salmon fisheries catches related to the development of the Robin Rigg offshore wind farm, did not detect a statistically significant effect on salmon abundance from the offshore wind farm (Thorley, 2013). Alongside this, salmon are subject to numerous variables and populations fluctuate considerably, as outlined in section 6.3 above.

224 As such, effects arising from the installation and operation of the Neart na Gaoithe project are not anticipated to affect the salmon population of the River Tweed SAC to an extent that the integrity of the site will be affected.

7.5 River Dee SAC

7.5.1 River Dee SAC Site Information

225 Site overview information for the River Dee SAC is provided in Table 7.5 below.

Table 7.5: Summary of information on River Dee SAC.

Topic	Information
Qualifying feature with connectivity to Neart na Gaoithe	• Atlantic salmon *S. salar.*
Conservation objectives of qualifying feature	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving Favourable Conservation Status for each of the qualifying features. To ensure for the qualifying species that the following are established then maintained in the long term: • Population of the species, including range of genetic types for salmon, as a viable component of the site; • Distribution of the species within site; • Distribution and extent of habitats supporting the species; • Structure, function and supporting processes of habitats supporting the species; and • No significant disturbance of the species.
Current status of qualifying feature	The salmon population is currently considered to be favourable maintained. No salmon were noted in site-specific surveys for the Neart na Gaoithe project. The currently available information on the migratory routes of trout and salmon is scarce, as a result of this uncertainty the precautionary approach has been taken to assume salmon are present offshore.

7.5.2 River Dee SAC - Impacts on Atlantic Salmon

7.5.2.1 Impact from Increase in SSC

226 Adult salmonids would normally be able to detect elevated levels of suspended sediment and avoid the localised affected area (EMU, 2004), although juveniles (smolt) may be more susceptible. It is likely that salmon in the area will be adapted to temporary increases in SSC as a result of storm events and therefore have a natural tolerance and low vulnerability to the increased SSCs predicted to arise as a result of the construction of the wind farm. Furthermore, the SCC produced by the construction works will be less than that generated during a storm and so will be within the natural variation (refer to Chapter 9: Physical Processes in the ES).

227 The impact of increased SSC and turbidity on salmon is thus assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES) and is not anticipated to be of a level to adversely affect the salmon population of the River Dee SAC.

7.5.2.2 *Impact from Increase in Underwater Noise (Installation Activities – Piling)*

228 During underwater noise modelling undertaken for the project ES, Subacoustech reported that unweighted Sound Exposure Level (SEL) of 240 dB 1 uPa would occur within 10 m of the piling event and that unweighted noise of 220 dB re 1 uPa would occur within 60 m of source (refer to Chapter 15: Fish and Shellfish Ecology for further information). At 240 dB the impact of the noise exposure was considered to be lethal on all fish receptors, and those noise sources of 220 db re 1 uPa were considered loud enough to cause physical injury. Modelling using the audiogram profile for Atlantic salmon indicates that salmon may strongly avoid an area out to a maximum of 2.6 km (3.5 m diameter pile); or for a 2.5 m diameter pile 1.5 km; the radius of significant avoidance behaviour is likely to extend up to 14 km for salmon (3.5 m diameter pile) and 9.2 km (2.5 m diameter pile). The magnitude of the effect of increased underwater noise on salmon is considered to be negligible for the strong avoidance behaviour and medium for the significant avoidance behaviour. This is based on the spatial extent of the respective zones of influence and the temporary and intermittent nature of the effect which will last for the duration of the construction phase only (refer to Chapter 15: Fish and Shellfish Ecology in the ES).

229 As a hearing 'generalist' (or 'non-specialist'), salmon are not considered to be a species with particularly high vulnerability to increases in underwater noise (refer to section 6.3.1.3.2: Increase in Underwater Noise (Installation Activities – Piling)) (Nedwell, 2003). Also, physiological damage or mortality from underwater noise generated from the project have a very low probability of occurring given the likely migration routes of salmon close to the coast and away from the zone of influence of higher levels of underwater noise (e.g., following Gill and Bartlett, 2010).

230 Given Atlantic salmon's low vulnerability to increases in underwater noise, combined with near- coast migration routes and so low possibility of an impact, the overall impact of increased underwater noise from installation activities has been assessed as being of minor significance at an EIA level (refer to Chapter 15: Fish and Shellfish Ecology of the ES). This effect is not therefore anticipated to cause an adverse impact on the salmon population of the River Dee SAC. This assessment carries high uncertainty because of the lack of information on behavioural responses of salmon to increases in underwater noise.

7.5.2.3 *Impact from Presence of Offshore Structures*

231 Salmon are reported to be vulnerable to structures (e.g., areas which could act as a barrier, preventing movement to their foraging or nursery grounds (Marine Scotland, 2011c). The degree of impact of barrier effects on these species will depend on their ability to move and avoid barrier structures, thus for example, structures placed in a highly confined estuary are likely to be more of an issue than in the open coast.

232 Neither the magnitude of this effect nor the vulnerability of salmon to this change are anticipated to be of a high level given the migration routes of salmon (as outlined above), and the available sea space in the region surrounding the Firth of Forth. As a result the impact on salmon is not anticipated to be significant, and there is no adverse effect anticipated on the River Dee SAC salmon population.

7.5.2.4 *Impact from Increase in Noise during the Operational Phase*

233 The magnitude of the effect of increased underwater noise during the operational phase will be considerably less than that of the installation phase. Furthermore background levels of underwater noise are relatively high given the use of the area by shipping and other vessels, as well as industrial activities surrounding the wider Forth region, which may increase the levels of low frequency noise above background levels of approximately 130 dB re 1 µPa in UK coastal waters (Nedwell *et al.,* 2003).

234 Given the low vulnerability of salmon to underwater noise the impact of operational noise on the regional salmon population is considered to be of minor significance when assessed under EIA (refer to Chapter 15: Fish and Shellfish in the ES). As a result, no adverse effect is anticipated on the River Dee SAC salmon population.

7.5.2.5 *Impact from Increase in Ambient EMF*

235 Modelling of predicted EMF densities indicates that EMF values will increase in close vicinity to the export and inter-array cables, though densities will decrease rapidly within 5-10 m of each of the cables (refer to

section 6.2.2.3: Increase in Ambient EMF and Fish and Shellfish Ecology Appendix 2: HVAC EMF studies of the Addendum of Supplementary Environmental Information).

236 Salmon may interact with EMF if the fish migration route coincides with the cables particularly in shallow waters (<20 m) where there is greater probability of encountering the cables (and associated EMF) coming to shore. In deeper waters, the likelihood of interaction with EMF from seabed cables is comparatively reduced as the salmon will typically occupy the upper water layers.

237 Salmonids, like other teleost fish, show some vulnerability to changes in the ambient electric field (as outlined in section 6.3.1.3.5: Increase in Ambient EMF). To date no detrimental effect from EMF has been attributed to elasmobranchs in wind farms built throughout the UK (Cefas, 2010) suggesting negligible effects of offshore wind farms on electro and magneto sensitive species. Furthermore, salmonid migration around the UK covers multiple areas where there are known to be existing electrical cables, as outlined in recent Marine Scotland Science commissioned papers (e.g., Malcolm *et al*., 2010).

238 The overall effect of EMF on the regional salmon population is assessed to be of minor significance at an EIA level, based on the relatively small footprint of the cables within the Neart na Gaoithe offshore works area and export cable. Furthermore, as outlined in the ES, the current view within the scientific community is that there is no evidence that this capability will translate into any significant effect.

239 Given the potential importance of the Firth of Forth to salmon from the River Dee SAC as well as the relative uncertainty of the impacts of EMF, a precautionary approach has been taken. It is predicted that a low magnitude effect on high value receptors is likely to occur resulting in a potential impact of minor significance, with high uncertainty. As a result no adverse effect is anticipated on the River Dee SAC salmon population.

7.5.3 River Dee SAC - Cumulative and In-Combination Impacts

240 The Habitats Regulations Appraisal of the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Appropriate Assessment Information Review (Marine Scotland, 2011) recommends that consideration of cumulative or in-combination impacts should cover impacts from the other wind farm developments in the Forth and Tay region, namely the development of the Inch Cape offshore wind farm and the Firth of Forth Round 3 offshore wind farm Zone 2 project developments.

241 The cumulative effect of pile driving noise from all three developments will result in a zone of influence with a radius that is larger than that of the individual Neart na Gaoithe development in isolation. In comparison, this larger cumulative zone of influence may be energetically more costly for migrating species to avoid as the distance required to avoid adverse noise impacts will be greater. However, given the typical distances over which these species migrate then any additional distance required to avoid adverse cumulative noise impacts in the outer Firth of Forth is expected to be negligible. Given the low vulnerability of the species as outlined above, the overall impact on salmon is assessed to be of minor to moderate significance.

242 The cumulative effects of the proposed Neart na Gaoithe, Inch Cape and Firth of Forth Round 3 Zone 2 offshore wind farms on the sediment regime have been modelled in combination with analysis of the seabed sediment characteristics (see Chapter 9: Physical Processes in the ES). Results of the modelling study indicate that the predicted cumulative changes to sediment transport processes due to the Neart na Gaoithe and other surrounding developments are likely to be small, (the predicted frequency of exceedance of the critical shear stress changes typically by 1-3%, with a maximum difference of 6%, and is restricted to the immediate vicinity of the development sites.

243 Cumulative effects from export and inter-array cables are of relevance to electro-sensitive species that will have the potential to detect EMF emitted by these cables, although over very small areas and local only to the area where the cables are buried.

244 The increase in offshore wind farms in an operational phase will increase the amount of subsea cables and their associated EMF emissions. However, the cables for each individual wind farm will be some distance apart and there is not anticipated to be any overlap between areas of increased EMF densities arising from different offshore wind farm cables.

7.5.4 River Dee SAC - Conclusions

7.5.4.1 Neart na Gaoithe Site Specific Assessment

245 Given the individual assessments outlined above, and taking into account the conservation objectives for the site, there is not anticipated to be an adverse impact on the integrity of the River Tweed SAC. There are anticipated to be impacts of minor significance on salmon arising from effects such as increased SSC, increased underwater noise, presence of the offshore structures and increased EMF, both at a project level and also from the project in-combination with effects from other projects in the Forth and Tay region.

246 Monitoring carried out of salmon rivers surrounding the Solway Firth, examining changes in salmon fisheries catches related to the development of the Robin Rigg offshore wind farm, did not detect a statistically significant effect on salmon abundance from the offshore wind farm (Thorley, 2013). Alongside this, salmon and lamprey species' populations are subject to numerous variables and populations fluctuate considerably, as outlined in section 6.3: Summary of Screened-In SAC Features / Species and Vulnerabilities. Furthermore, the River Dee SAC salmon population is considered to be in favourable maintained condition.

247 As such, effects arising from the installation and operation of the Neart na Gaoithe project are not anticipated to affect the salmon population of the River Tweed SAC to an extent that the integrity of the site will be adversely affected.

7.5.4.2 Cumulative and In-Combination Impact Assessment

248 Given the proposed development of other wind farms in the Forth and Tay region, the magnitude of effects may increase above those anticipated from the development of Neart na Gaoithe alone. Therefore, given salmon's vulnerabilities to these effects, resultant impacts in-combination may be exacerbated to a degree.

249 However, the significance of these impacts on salmon is not anticipated to increase substantially beyond those anticipated at a project level, given the inherent variability and sensitivities of the regional salmon population (including that from the River Tweed SAC), the migration routes of the species (following Malcolm *et al.,* 2010) and the relatively low magnitudes of change anticipated. Nevertheless, such impacts retain a high degree of uncertainty, particularly with regard to the impacts of increased EMF.

250 In conclusion, the impact of development of other Forth and Tay wind farm projects in combination with those arising from development of the Neart na Gaoithe project are not anticipated to have an adverse effect on the salmon population of the River Tweed SAC nor affect the site's integrity.

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