5 FISH AND SHELLFISH ECOLOGY

5.1 INTRODUCTION

1. This section of the ES Addendum presents an evaluation of the likely significant effects of the Amended Project on fish and shellfish ecology associated with the amendments presented in Section 4: Amended Project Description. This section also presents further information requested by consultees and further cumulative assessment information. In addition, this section discusses the effects that may arise as a result of the most likely scenario. The assessment has been undertaken by Brown and May Marine Ltd.

2. Specifically, this section of the ES Addendum addresses:

- The Amended OfTW Corridor;
- Changes to the OfTW cable installation timescales;
- Comments in respect of potential effects on key fish receptors raised by stakeholders in their responses to Section 11: Fish and Shellfish Ecology and Section 23: OfTW Fish and Shellfish Ecology of the Original ES;
- Further information on cumulative developments, in particular, the proposed adjacent Moray Firth Round 3 Zone wind farm development; and
- Consideration of the most likely scenario for the Amended Project.

3. This section of the ES Addendum is supported by the following documents from Volume 4: Technical Annexes of the Original ES:

- Annex 11A: Fish and Shellfish Ecology Technical Report; and
- Annex 16B: Salmon and Sea Trout Technical Report.

4. This section presents an addendum to Section 11: Fish and Shellfish Ecology and Section 23: OfTW Fish and Shellfish Ecology of the Original ES. Where this section updates and replaces conclusions made in the Original ES, this is made clear. Where appropriate, reference is made in this assessment to the Original ES.

5. This section includes the following elements:

- Consultation;
- Scope of Assessment;
- Baseline;
- Assessment Methodology;
- Assessment of Potential Effects:
- Mitigation Measures and Residual Effects;
- Monitoring;
- Assessment of Cumulative Effects;
- Statement of Significance;
- Habitats Regulations Assessment; and
- References.

5.2 CONSULTATION

6. Following the submission of the Original ES in April 2012 Beatrice Offshore Windfarm Ltd (BOWL) has received consultation responses, via Marine Scotland Licensing Operations Team (MS-LOT) from various statutory and non-statutory consultees. A summary of these responses in relation to fish and shellfish ecology is presented in Table 5.1. Reference is also provided as to where these issues are addressed within this Addendum, if applicable.

Table 5.1: Summary of Original ES Consultation Responses and Project Response

Consultee	Summary of Consultation Response	Project Response	Response Addressed
Marine Scotland Science (MSS)	Due to the sensitivity of sandeels, the potential area of impact from gravity base infrastructure and the lack of knowledge of density and distribution of patches of sandeels, we do not agree that this impact can be assessed as negligible (Section 11: Fish and Shellfish Ecology of the Original ES para.98). A more conservative approach should be taken and the impact assessed at least as minor and probable rather than negligible and probable.	Further discussion on the potential effect of loss of habitat on sandeels has been provided. Further information on the potential distribution of sandeels in the Wind Farm Site together with seabird integration data is shown in Volume 10, Part 1, Biological Environment Technical Appendices, Annex 4.3 C, Sandeel Survey of the ES for the Moray Firth Round 3 Zone Wind Farm (MORL, 2012).	Section 5.6.1.1 Section 5.4.2. See also environmental information contained in MORL (2012).
	Due to the significance this species has in the food chain, it would be pertinent for the developer to establish the distribution of sandeels to identify the key areas (most dense patches) used by the species. We would recommend the developer try and carry out some further sampling between now and construction to improve the knowledge of distribution. This will help when micrositing the devices to enable the developer to avoid damaging key patches as these may be the most important in terms of the food chain links.	Consultation will be undertaken with MSS to discuss the proposal to undertake a pre-construction sandeel survey.	Section 5.8 Section 5.4.2. See also environmental information contained in MORL (2012).
	It would be useful for this extra sandeel sampling to be similar in methodology to that carried out by the MORL development to allow for the two data sets to be comparable and help identify/monitor cumulative impacts as well as impacts at the individual site level.	Sandeel survey methodology will be in line with that used by the Moray Firth Round 3 Zone development to ensure that the results are comparable.	Section 5.8
	There may also be an opportunity to use the bird data to help identify sandeel patches. If species of bird that are known to prey on sandeels are present and shown to be feeding, this may indicate the presence of important/dense sandeel patches.	Bird data presented in the Original ES has been taken into account to further describe the potential for the Wind Farm to support sandeel populations.	Section 5.4.2, see also MORL (2012).
	The developer has appropriately identified the potential issues for herring	Two different worst case scenarios for	Section 5.5.1.1

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	with regards to sedimentation and habitat loss. The developer has identified that herring may be affected by noise from construction and that soft start piling will be used to mitigate against physical damage from noise. However the duration of construction and the periods at which this noise activity will occur is of concern as this may restrict herring from spawning at the site. If this spans consecutive spawning periods for several years in a row it may have the potential of displacing these fish permanently form the area. This is of concern because of the proximity to the Orkney/Shetland stock which is the least stable of the herring stocks and this stock has not recovered to the same extent as the other stocks, as a result would be more susceptible to added pressures upon it. It is difficult to see how this impact can be assessed as unlikely and again we would suggest this impact would be probable.	assessment of construction noise have been presented in the Addendum. The probability of the effect of construction noise on herring and cod has been revised. Information on both worst case and most likely piling durations has been provided.	 Section 5.6.1.1 Section 5.5.1.1 and Section 5.5.2.1
	Although some consideration to changes in fishing activity has been shown, there has been little mention of displacement. Is it realistic that the same level of activity will continue during the operational phase? The cumulative impact of displaced fishing activity on sandeels for example has not be assessed here.	The assessment of changes to fishing activity has been revised and the uncertainties in relation to displacement of fishing have been acknowledged (including potential effects on sandeels).	Section 5.6.1
	Section 11 Paragraph 48. It should be noted that the position of this wind farm puts it on potential migratory routes for all east coast salmon SAC rivers, not just those listed in table 11.8.	The potential for salmon from other rivers to transit the area has been acknowledged. Salmon SAC populations included for assessment are as advised by SNH.	Section 5.4.2
	Paragraph 80 (Chapter 11) states that the magnitude of noise effects is considered to be small, with salmon classified as medium sensitivity, with an overall expected outcome of probable negative, but minor impacts. The developers have carried out modelling to show that a relatively small area of sea is affected by noise levels that will be detectable to salmon when compared to other species. They have based their assessment of hearing on the best available (but very limited) information that there is on this topic. However, I am unclear how they are able to decide that the effects will be small. This is because they don't really know how fish will respond to the	The uncertainties in relation to the current knowledge on the implication of behavioural responses in salmon and sea trout triggered by noise have been acknowledged. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea	Section 5.6.1.1 Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	noise or what the consequences are for migrating salmon. For example, will migrating fish be permanently shifted from their regular migratory routes such that it affects homing, or will they be forced to migrate additional distance thereby compromising energy reserves and survival or would the activities only result in small and very short term changes in direction with no long-term consequences? Given the uncertainty over migratory routes (acknowledged by the E.S.), the limited information on behavioural responses to noise and the lack of robust previous monitoring of wind farm construction activities, it should be recognised that any assessment of likely impact will be highly uncertain.	trout monitoring strategy.	
	Paragraph 118 states that EMF effects will be small due to the area affected by EMF. However, this ignores the fact that the cables are linear features requiring migrating fish to pass over them. As such the total area affected seems unimportant.	The linear nature of cables has been noted in relation to migratory fish.	Section 5.6.1
	The ES correctly notes that there is evidence of eels, salmon and sea trout responding to EMF's, that the field strength is greatest close to the bed and that burying the cables reduces the chance of fish coming into close proximity to the cables. However, the ES also states that salmon will not come into proximity with the cables because they swim at shallow depths. This remains uncertain and is the subject of research by MSS. Furthermore, the power will eventually be exported to land at which point the cables will come into shallower water. We note that although the ES states the magnetic field strengths expected from the cables, it does not also state the values that diadromous fish can be expected to respond to. We presume this is because this information is not reliably available. We also note that this is the subject of additional research by MSS. Nevertheless, the values presented in Table 11.7 (which are very low compared to the earth's background magnetic field) generally support the assertion of a minor negative but probable impact for salmon, sea trout and eels.	The uncertainties in relation to the effects of EMFs on salmon and sea trout, given the lack of information on their behaviour at sea have been acknowledged. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Section 5.6.1 Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	The ES seems to suggest that salmon could detect noise from operational wind farms (turbines?) at distances of 0.4-25km based on work by Walhberg and Westerberg (2005), but that other studies suggest noise levels are insufficient to cause any behavioural reaction (Vella et al., 2001). The ES then goes on to conclude that operational noise would constitute a negative, minor, but unlikely impact. Operational noise is one of the greatest concerns for this development because it is a potentially long term and large scale impact. Previous studies have suggested that salmon could use the noise of waves breaking on the shore to orientate them offshore, thereby assisting migration. If the noise coming from operational wind farms confuses this signal it could have knock on consequences for migratory routes and behaviour. One of the main problems with assessment of this risk is the lack of robust field based data on the movements of diadromous fish in offshore wind farm areas, compounded by relatively poor information on hearing and behavioural responses to noise. Therefore there must remain considerable uncertainty in the effects of operational noise at present that is perhaps under reflected in the "unlikely" classification that cannot be resolved at this time.	The lack of species specific information in relation to the effects of operational noise has been noted in the assessment. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Section 5.6.1 Section 5.8
	We note that no mitigation is proposed for the construction phase and that burial of cables is proposed for the operational phase. Burial seems to be a sensible precaution in the absence of further information on fish responses to EMF. The developers could explore options for construction outside of peak migration periods for smolts.	BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Section 5.8
	Given the unknown consequences of operational wind farms on fish migration and behaviour MS LOT may wish to consider the opportunities for assessing salmonid movement through the wind farm, funded either by the developer, groups of developers or a combination of developers and MSS. This could help inform future ES assessment. One option would potentially involve the deployment of acoustic receivers on wind farm structures with tagging of smolts in rivers and adults from coastal nets.	BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	We note that the cumulative assessment has considered the impact of other developments and concludes that a negative moderate cumulative effect is possible. This seems a reasonable assessment given the large number of uncertainties in the assessment.	Further detail on potential cumulative effects between the BOWL and Moray Firth Round 3 Zone developments has been provided.	Further environmental information included in the ES Addendum Section 5.9.
	Given all the uncertainties we are not clear that a likely significant effect of SAC rivers would not occur for the project alone, but agree that in combination a likely significant effect seems appropriate. However, we once again emphasise the large number of uncertainties which can affect this assessment in either direction.	The Report to Inform an Appropriate Assessment is included in Annex 3B of this ES Addendum. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Annex 3B of this ES Addendum Section 5.8
Scottish Natural Heritage / Joint Nature Conservation Committee (SNH/JNCC)	Inclusion of clearly defined windfarm development scenarios, including that 'most likely' to be developed.	A qualitative discussion based on the most likely scenario has been provided.	Section 5.6.2
	The assessment of construction impacts (primarily underwater noise) on diadromous SAC fish are among the key HRA requirements.	The Report to Inform an Appropriate Assessment is included in Annex 3B of this Addendum. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Annex 3B of this ES Addendum Section 5.8
	Mitigation of construction impacts to key receptors also requires consideration. Discussion of 'total impacts', where required, for receptors of concern.	BOWL is engaged in on-going consultation with MSS in relation to suitable monitoring and mitigation measures that may be required for key receptors.	Section 5.7 and Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	Raised concerns regarding the cumulative spatial worst case zone of underwater noise impacts particularly in relation to receptors which require consideration in the HRA. Key receptors – including diadromous fish, cod and herring – there is a clear requirement to consider mitigation across both MFOWDG windfarms.	BOWL is engaged in on-going consultation with MSS in relation to suitable monitoring and mitigation measures that may be needed where likely significant effects have been identified on fish receptors. In addition a qualitative discussion of the potential effects on key receptors based on the most likely scenario has been provided in this Addendum	Section 5.7 and Section 5.8 Section 5.6.2
	The modelling presented in Technical Annex 7A illustrates a spatial 'worst case' for the receptors of concern, the ES does not consider the duration or timing of such noise impacts. Also there is no consideration of mitigation options, even when the ES clearly identifies significant impacts to key receptors arising from underwater noise during construction (particularly from piling)	Further consideration of the temporal aspect of piling has been provided.	Section 5.6.1.1
	In respect of piling activity, it would be useful to have information on the total number of piling hours / days both for Beatrice and cumulatively with MORL Round 3. Provision of information on the planned / expected distribution and duration of piling activity in different months –accounting for expected weather conditions and technical limitations during inclement weather– would allow a risk-based assessment of the potential for disturbance of key receptors	Information on both worst case and most likely piling durations has been provided. The cumulative impact assessment with the Moray Firth Round 3 Zone development has been updated.	Section 4, Section 5.6.1.1 and Section 5.6.2 Further environmental information included in the ES Addendum Section 5.9.
	The ES does not assess suspended sediment and re-deposition in the context of the seasonality of natural suspended sediment concentration (SSC) peaks or the seasonality in the sensitivity of some receptors (e.g. spawning herring / sandeels / sprat) to elevated SSC.	Further clarification on the SSCs modelled and the independence of the modelled values from background conditions has been provided.	Section 5.6.1.1

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	We are concerned that the Beatrice ES does not properly acknowledge the MORL Round 3 zone, lying adjacent. The very broad Rochdale (design) envelope that is presented in the Beatrice ES creates particular problems in considering cumulative impacts, and there is key information missing from the ES which is needed to be able to consider Beatrice alone, as well as in combination with MORL Round 3.	The Rochdale Envelope of the Moray Firth Round 3 Zone was refined following submission of the ES. This new Rochdale Envelope is assessed in this Addendum.	Further environmental information included in the ES Addendum Section 5.9.
SNH comments on Draft Report to Inform an Appropriate Assessment	We advise that Beatrice will have likely significant effects, alone, on the qualifying fish interests and associated species of the SACs listed in Table 5.2. We agree that River Borgie SAC and River Dee SAC (as listed in our scoping advice) do not need further consideration. It is Beatrice that will have the greater impact to these qualifying interests, compared to MORL, due to its closer proximity to shore and the proposed location of the export cable and landfall in proximity to the River Spey SAC. We are in current discussion with Marine Scotland over consenting issues and how to deal with uncertainty in the impact assessment process, including HRA, introduced by use of design (Rochdale) envelopes. There will need to be continuing discussion with Marine Scotland, as the competent authority, over potential construction impacts to diadromous fish and associated species, and to agree the required conditions for consenting.	The Report to Inform an Appropriate Assessment is included in Annex 3B of this ES Addendum.	Annex 3B of this ES Addendum
Moray Firth Sea Trout Project (MFSTP)	Marine Scotland Science (MSS) have outlined that when inadequate information exists on the use of the development area by anadramous fish then a suitable monitoring strategy should be deployed. MSS also go on to say monitoring undertaken at existing offshore developments such as Robin Rigg has been inadequate. However, despite the ES concluding that in the absence of detailed information on salmonid migratory routes it is assumed that Salmonids do use the development area there is still no monitoring strategy in the ES and inadequate mitigation proposed. In light of the MSS guidance we find this completely inadequate and unacceptable.	BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	The assessment of the impact of sediment on herring and sandeel eggs as minor seems inadequate considering their relative importance as a prey species. Little consideration seems to have been given to the very specific nature of sediment required by sandeels (Holland et al 2005) and that despite being mobile species any long term changes in the benthic sediment composition will have long term impacts on this very important prey species' habitat. In addition the assessment of fine sediment on mobile fish species has been based on a on a single study which only considered the effects of sediment in freshwater and seems inappropriate for this environment (Bertwell 1999).	Further information has been provided in relation to the localised impact of elevated increased SSCs and sediment re-deposition in the addendum.	Section 5.6.1.1
	The impact of subsea noise on sea trout is poorly understood as outlined in the SNH report (Gill & Bartlett 2010) but it also highlights the significant potential impact of subsea piling. Although soft start piling is suggested as a mitigation to allow avoidance of harmful noise level there is no indication of how long this "soft start" will last and whether it is long enough for sea trout adults or post smolts to leave the critical area. Furthermore although the use of soft start piling will allow of harmful levels of noise it does not take into account that sea trout will be "avoiding" the potentially key feeding habitat of the Smith Bank (development area) at key times of year. The scenarios outlined in Annex 7A show salmon (sea trout surrogate) exhibiting "significant avoidance" (75 dBht) over significant parts of the Smith Bank (Figure 10.17 2.4m pile) and a significant part of the Moray Firth (Figure 10.32 5m pile). Over prolonged periods of time for multiple years this could have significant impacts on Moray Firth sea trout populations. MSS advised in their comments (annex 5A) that it needed to be established what species were present and where. If adequate monitoring was conducted to determine where and when sea trout use the Smith Bank then adequate mitigation could be designed to not pile at key migratory or feeding times of year. Furthermore the impact of noise from piling on sea trout prey species is likely to be significant, particularly on herring and sprat which both were modelled to show large areas of avoidance (Annex 7A) but have been assessed as negative, moderate and unlikely.	The uncertainties in relation to the current knowledge on the implication of behavioural responses in salmon and sea trout triggered by noise have been acknowledged. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy. BOWL is engaged in on-going consultation with MSS in relation to suitable monitoring and mitigation measures that may be needed where likely significant effects have been identified on fish receptors.	Section 5.6.1.1 Section 5.8 Section 5.7 and 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	The loss of habitat effect on Herring has been assessed as negligible and probable, largely it seems in comparison to the larger Shetland / Orkney stock. Although the impacts on the wider herring population may be negligible any impact on the local herring population could have serious negative implications for locally feeding sea trout. The risk of habitat loss to sandeels which rely on specific habitat that is located on discreet patches of seabed that are present within the site has been assessed as negligible and probable. When the ES itself concludes that there is a lack of current data on the distribution of sandeels within the site there can be very little confidence in this conclusion. Furthermore the impact has been assessed as negligible on the assumption that there is potentially other Moray Firth habitat available despite also stating they rely on a very specific habitat type and consequently is limited in availability. Given the significance of sandeels as prey to both sea trout and the wider marine ecosystem and a Priority Marine Feature in their own right we have very little confidence in this assessment and consider further monitoring and mitigation essential.	Further information on the potential for the Wind Farm area to support sandeel populations has been provided. BOWL is committed, in consultation with Marine Scotland, to undertake the appropriate additional surveys as a condition of consent. These may include; • Sandeel survey; and • Cod survey. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Section 5.6 takes account of the information available in MORL, 2012 in providing further information on the likely importance of the Wind Farm Site for sandeels. Section 5.8
	The lack of knowledge of sandeel distribution within the site leaves us lacking any confidence in this assessment of impact on this species in cumulative terms.	Further information on the potential for the Wind Farm area to support sandeel populations has been provided. BOWL is committed, in consultation with Marine Scotland, to undertake the appropriate additional surveys as a condition of consent. These may include; • Sandeel survey; and	Section 5.6 takes account of the information available in MORL, 2012 in providing further information on the likely importance of the Wind Farm Site for sandeels. Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
		• Cod survey.	
	As described the construction of subsea structures and associated armouring will likely result in long term changes in overall diversity and productivity of the benthic environment within the development area. More specifically the subsea structures are likely to act as fish aggregation devices (FADs) but little consideration has been given to the fact that FADs will in turn attract predators and consequently increase predation risk to sea trout while on their feeding grounds.	Further clarification on the potential for likely significant effects on fish species associated with the introduction of hard substrate has been provided.	Section 5.6.1.2
	As summarised in the SNH Report (Gill Bartlett 2010) sea trout are potentially sensitive to EMF but the level of impact is poorly understood. Until further MSS research is completed into the sensitivity of salmon and sea trout the precautionary approach should be adopted. Assuming that sea trout will only be migrating near the surface (paragraph 131) and hence not affected is not adequate as the site is likely an important feeding habitat and sea trout will be feeding throughout the water column and near the sea bed. This highlights the need for pre deployment monitoring to understand how sea trout use the site and help ensure adequate mitigation is implemented. As a bare minimum ALL cables should be shielded or buried to an adequate depths as determined by ongoing MSS research, and not "only where feasible" as suggested in the ES.	Given that the expected magnetic fields produced by the cables will be below the Earth's magnetic field the assessment of minor negative effects it is considered to be appropriate. The uncertainties in relation to the effects of EMFs on salmon and sea trout, given the lack of information on their behaviour at sea have however been further acknowledged. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	Section 5.6.1.2 Section 5.6.1.2 Section 5.8
	It is not clear when the overpass trials will take place. Is this a rolling task or will it be completed at the end of the installation process?	A post installation survey is likely to be undertaken following completion of cable installation and protection works trenching and rock dumping, depending on the final construction plans	No further environmental information required

Consultee	Summary of Consultation Response	Project Response	Response Addressed
Association of Salmon Fishery Boards (ASFB)	Guidance issued by Marine Scotland Science relating to information requirements on diadromous fish of freshwater fisheries interest states that an Environmental Statement should provide information on the use of the development area by such fish and that if such information was lacking then a suitable monitoring strategy should be devised. Indeed, Marine Scotland Science regard the monitoring undertaken at existing offshore developments such as Robin Rigg as being inadequate. No monitoring strategy is set out in the application and indeed, the ES states, 'In the absence of detailed information on the migratory routes of salmon and sea trout it is assumed that they transit the Wind Farm as part of their normal migration. In addition, they are assumed to transit the site as part of their foraging activity (particularly sea trout)'. We therefore believe that the lack of meaningful monitoring in the present proposal is extremely disappointing and completely inadequate. We note that Section 11.6 states that BOWL will work with key stakeholders and Marine Scotland to identify any future monitoring programmes considered necessary. We welcome this undertaking, but we would emphasise that any monitoring strategies must include pre-construction monitoring in order that baseline information on salmon and sea trout movement, abundance, swimming depth, feeding behaviour etc. can be collected. We also note that it is very difficult to assess risk to migratory salmonids as there is little detailed information on: the likely size of the scheme; the type of devices to be deployed; and the degree of confidence attached to the assessment of impacts.	BOWL is engaged in on-going consultation with MSS for the implementation of a satisfactory salmon and sea trout monitoring strategy. A qualitative discussion based on the most likely scenario has also been provided.	Section 5.8 Section 5.6.2
	This increased SSCs section appears to be based on a single study by Bertwell (1999) which only assesses the effects of sediment on fish in freshwater. We are unclear of the relevance of this study to the effect of sediments in the marine environment.	The increased SSCs has been revised and further references in relation to the sensitivity of fish to SSCs have been added to support the assessment	Further environmental information included in the ES Addendum at section 5.6.1.1
	Paragraph 70 makes reference to soft piling, in order to trigger avoidance reactions in mobile species in the immediate vicinity of piling locations (where the noise levels are likely to be above the tolerance limit of sound and potentially damaging). The underwater noise modelling technical report (Annex 7A) assumes a swim speed of 1.5m/sec. However, no information is provided on the duration of such soft piling, nor has such duration been related to the swimming speeds of fish (at different life stages), in order to	The pile driving is envisaged to use a 'soft start' procedure, in which the strike energy is increased in steps as the pile is driven. Table 10.12 in Annex 7A of the Original ES sets out the assumptions which have been made in the modelling to account for	

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	assess the possibility of such fish swimming out of the zone of effect. Given that swim speeds for juvenile fish are lower than those of adult fish, the conclusion in paragraph 71 (that juveniles are assessed using the same criteria as adults with regard to hearing) may be incorrect with regard to avoidance responses of different life stages of fish. Indeed, this assertion is based on assumptions from studies on sea bream, damselfishes and labyrinth fish and not on salmonid fish. Given the paucity of information on noise effects, we do not believe that soft piling alone is an appropriate mitigation. The ES sets out a number of options for turbine design (including gravity bases) of which the worst case scenario for noise is impact piling of pin piles. We believe that, given the sensitivity of early running returning spring salmon, and the uncertainty of effects on juvenile fish, that it is appropriate, should consent be granted for the development, that a condition of consent is that no impact pilling occurs during the period from March to June (inclusive). Such a condition is consistent with the precautionary principle and would still allow other forms of construction to continue during this period. Figure 11.3 demonstrates an expected strong avoidance reaction only in close proximity to the foundations. However, at the lower threshold level of 75 dBht (representing significant avoidance) the area which salmon would avoid (Figure 11.5) is much greater. Whilst Annex 7A states that the this effect is probably transient and limited by habituation, 85% of fish were found to react to this level of noise, and we believe it is possible that noise at this threshold level has the potential to at least delay smolt migration over a significant proportion of the NW Moray Firth. Such a delay could, for example, make smolts more susceptible to predation. It must also be noted that salmonid smolts are physiologically stressed in adapting to the environmental challenge of movement between freshwater and seawater. Simultaneous challenge from noise, EMFs etc. during this transition will constitute a significant additional stressor. Stress leads to increased plasma levels of the stress hormone cortisol. Corticosteroids cause a range of secondary effects, including hydromineral imbalance and changes in intermediary metabolism (Wendelaar Bonga, 1997)3. In addition, tertiary responses extend to a reduction in the immune response and reduced capacity to tolerate subsequent or additional stressors (Wendelaar Bonga, 1997).	this process The duration of the soft-start piling would be not less than 20 minutes per pile in accordance with JNCC guidelines. Further information on the temporal aspect of piling has been provided. The uncertainties in relation to the current knowledge on the implication of behavioural responses in salmon and sea trout triggered by noise have been acknowledged. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy. BOWL is engaged in on-going consultation with MSS in relation to suitable monitoring and mitigation measures that may be needed where likely significant effects have been identified on fish receptors.	 Section 5.6.1.1 Section 5.6.1.1 Section 5.8 Section 5.7 and Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	Paragraph 78: Given the acknowledged lack of information as to the migratory routes of Atlantic salmon and the marine habitat of sea trout, we are unclear as to the relevance of the location of SAC rivers with regard to providing an indication of the ecological significance of the predicted effect. During pre-application discussions with the developers we have continually stressed the need for information on migratory routes and habitat usage for migratory salmonids. In the absence of such data (and the ES simply assumes that they are present – paragraph 80), ASFB and DSFBs, in assessing the risks of the development to migratory fish, have no alternative but to assume that the entire run of each river will use the area under development. We note that the comments attributed to Marine Scotland in Annex 5A, state that 'it needs to be categorically established which species are present on the site, and where, before the application is considered for consent'. We agree with the statement in Annex A (10.17) when considering relatively low levels of noise: The significance of the effect requires an understanding of its consequences. For instance, avoidance may be significant if it impedes the migration of a species. However, in other cases the movement of species from one area to another may be of no consequence. The ES assumes that the displacement and the adoption of avoidance behaviour by individual or aggregations of salmon and sea trout from their original locations as a result of underwater noise has no implications in respect of fitness or survival. We do not believe that this assertion can be substantiated (Please see out comments above relating to stress and increased risks of predation).		
	Paragraph 182 makes clear that there is potential for a negative moderate cumulative effect on the SAC populations of Atlantic salmon. Annex 7A, models a number of scenarios whereby differing numbers of different diameter piles driven simultaneously across the BOWL and MORL developments are assessed. However, no information is provided as to the likelihood of these scenarios should these developments be consented. The last page of Annex 7A, states that, "The area of sea affected by noise from simultaneous piling generally is not much greater than if the piling was undertaken at separate times. Indeed, the total area is often less due to the overlap of the insonified areas". However, this is not the case for Atlantic	The cumulative effects assessment has been revised and includes the findings of the impact assessment undertaken by MORL. Further information has been provided in relation to worst case and most likely scenario piling durations for the Wind Farm Site.	Further environmental information included in the ES Addendum Section 5.9. Section 5.6.1.1 and Section 5.6.2

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	salmon and indeed the area of sea potentially affected by simultaneous piling at the lower threshold level of 75 dB_{ht} (representing significant avoidance) is significantly greater. Whilst we understand that the availability of vessels to undertake this piling work is limited, we would expect to see a clear indication of the number of pilling sites likely to be developed at one time, in order that the possible effects on migratory fish can be assessed. We therefore restate that there should be no impact piling, either in the BOWL or the MORL development during the period from March to June (inclusive). It may also be appropriate to ensure, as a condition of consent, that there is a limit on the number of piling sites that can be used simultaneously during construction		
	Paragraph 97 and 98 suggest that, despite a lack of current data on the distribution of sand eels within the site and the wider area to the spatial scale required for this assessment, the effect of habitat loss is assessed to be negligible and probable. Given the importance of sandeel as a prey species for a wide range of species (including Atlantic salmon and sea trout), and a priority marine feature in their own right, we find it very hard to have any confidence in this assessment. Paragraph 99 suggests that habitat loss will result in a negligible and probable effect on Atlantic salmon. However, we would highlight that our concerns relating to habitat loss would primarily be on prey species, such as sandeel, and we would again highlight our lack of confidence in the assessment of sandeel.	Further information on the potential distribution of sandeels has been provided. BOWL is committed, in consultation with Marine Scotland, to undertake the appropriate additional surveys as a condition of consent. These may include; • Sandeel survey; and • Cod survey The assessment of effects on sandeels has been revised and the degree of uncertainty acknowledged.	Section 5.6 takes account of the information available in MORL, 2012 in providing further information on the likely importance of the Wind Farm Site for sandeels. Section 5.8 Section 5.6.1.1
	We lack confidence in the assessment of cumulative loss of habitat on sandeels, due to the considerable uncertainty in relation to the distribution of sand eels in the area.	Further information on the potential distribution of sandeels has been provided.	Section 5.6 takes account of the information available in MORL, 2012 in

Consultee	Summary of Consultation Response	Project Response	Response Addressed
		The assessment of effects on sandeels has been revised and the degree of uncertainty acknowledged. BOWL is committed, in consultation with Marine Scotland, to undertake the appropriate additional surveys as a condition of consent. These may include; • Sandeel survey; and • Cod survey.	providing further information on the likely importance of the Wind Farm Site for sandeels. Section 5.6.1.1 Section 5.8
	Paragraph 100 states that localised, long term positive changes on the overall diversity and productivity of the seabed communities are expected to occur as a result of the introduction of hard substrate. It is likely that such structures will act as fish aggregation devices (FADs), rather than actually increasing biomass. However, if the structures do act as FADs we would also be concerned that such areas may in fact represent new 'pinch points' for predation of migrating smolts and returning adults, in an area which we must consider as a key migration route for salmon and a key feeding area for sea trout. This possibility is alluded to in paragraph 112, but does not appear to be considered further.	Further clarification on the potential for likely significant effects associated to the introduction of hard substrate has been provided.	Section 5.6.1.2
	This section makes reference to research by Normandeau et al. (2011) and indeed quotes averaged predicted magnetic fields above and horizontally along the sea bed for AC cables (Table 11.17). However, the figures quoted in Table 11.17 assume a burial depth of 1m, whereas the document makes frequent reference to burial of cables to a minimum depth of 0.6m. There appears to have been no effort to assess the predicted magnetic field values at this burial depth. Paragraph 116 highlights the depths of the wind farm site and states that strength of magnetic field decreases with distance from source, concluding	Given that the expected magnetic fields produced by the cables will be below the earth's magnetic field the assessment of minor negative effects it is considered to be appropriate. The uncertainties in relation to the effects of EMFs on salmon and sea trout, given the lack of information on	Section 5.6.1.2 Section 5.6.1.2

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	that the position of the particular species in the water column and water depth will influence the potential effects of EMFs. We agree – however this again highlights the vital importance of a monitoring strategy to determine swimming depth of migratory salmonids in the development area. In the absence of such monitoring, it is difficult to assess the risks of the development to migratory fish. We would note that the differing life strategies of Atlantic salmon and sea trout mean that these species must be treated differently in this respect (see below). Paragraph 131 states that salmon and sea trout transiting the area of the wind farm will for the most not be exposed to the strongest EMFs are they normally swim in the upper meters of the water column during migration. We also note that the SALSEA project has shown that Atlantic salmon are capable of diving to considerable depths. The ES suggests that migration and feeding are mutually exclusive activities for salmon, a suggestion that is contradicted on page 10 of the 16B Annex of the ES which states: Malcolm et al (2010) concluded based on research undertaken to date (Jakupsstovu, 1986; Holm et al, 2005; Starlaugsson, 1995) that in general terms salmon spend most of the time close to the surface although dives to greater depths of up to 280m have often been observed. Dives do not appear restricted to offshore areas, persisting late into the migration on the return to home waters. Early studies (Jakupsstovu, 1986) suggest an association between diving and feeding. The ES does not take into account the foraging behaviour of sea trout, which we (and the developers) assume use the area in question. No information is presented as to the depths at which such fish forage. Sea trout are also apparently more likely to be benthic feeders than salmon as on page 15 of Annex 16B it is stated that: In addition, Pemberton (1976b) suggested a diel feeding pattern, with bottom feeding being greatest during the day and mid-water and surface feeding increasing between sunset and sunrise. We are aware that Marine Scotland Science are currently undertaking a research programme which aims to investigate electro-magnetic force impacts on salmonids. Until this work is completed, we are unable to assess the relative magnitude of this impact, or relate the figures quoted in Table 11.17 to those magnetic fields likely to initiate a behavioural response in salmonids. Again, until the research currently being undertaken by Marine Scotland	their behaviour at sea have however been further acknowledged. BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy.	 Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	Science is complete, we are unable to assess the relative magnitude of the cumulative impacts, or relate the figures quoted in Table 11.17 to those magnetic fields likely to initiate a behavioural response in salmonids. Until this work is completed, there is at least a theoretical risk that EMFs arising from both inter-array cables and offshore transmission cables could present a barrier to fish migration.		
	We are very disappointed to see that no mitigation measures are included other than inter-array cable burial/protection, where feasible, are proposed to reduce the effects associated with the construction/decommissioning and operation phase of the development. We believe that all inter-array cabling should be buried to a suitable depth (and in the absence of any other information, we believe that the minimum depth should be 1m) or have a suitable shielding material placed over them. We do not believe that there should be any exceptions to this, irrespective of the technical difficulties involved. In addition, we would highlight our comments regarding mitigation in our response to section 11.4.12 (above).	BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy. BOWL is engaged in on-going consultation with MSS in relation to suitable monitoring and mitigation measures that may be applicable.	Section 5.8 Section 5.7 and Section 5.8
	We do not consider the information presented to be sufficiently robust to draw the conclusion that there are not likely to be significant effects, particularly with regard to Atlantic salmon and sea trout. We therefore consider that an appropriate assessment, based on pre-construction monitoring will be required. Clearly, the appropriate assessment must take into account the cumulative and in combination likely significant effects arising from the MORL and other developments.	The Report to Inform an Appropriate Assessment is included in Annex 3B of this ES Addendum.	Annex 3B of this Addendum
	The ES concludes that the construction/decommissioning and operation phase of the development will in general terms not result in significant effects in relation to EIA regulations. However, as highlighted above, we do not consider the information presented to be sufficiently robust to draw this conclusion, particularly with regard to Atlantic salmon and sea trout.	The Report to Inform an Appropriate Assessment is included in Annex 3B of this ES Addendum. The uncertainties of the assessment on salmonids have been recognised throughout this ES Addendum.	Annex 3B of this ES Addendum
	We note the recognition of the proximity of the proposed cable landfall to the	BOWL will liaise with the relevant	Section 5.6.1

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	River Spey and the possibility for fish to be disturbed prior to river entry and/or immediately after leaving the river if transiting the southern sections of the OfTW corridor. Paragraph 66 notes that works in close proximity to the shore should only be undertaken over a limited period of time, and that the seasonality or river entry and the diversity of runs should be noted. We would expect that, should the development be consented, close liaison with the Spey Fishery Board on the timing of such work should be a requirement of consent.	authorities to ensure that the potential for effects on diadromous species is minimised during the undertaking of installation works in the cable landfall.	
	This section recognises that, given the central location of the OfTW corridor in the context of the Moray Firth area, the uncertainties in relation to migratory patterns not only for fish originating in the Moray Firth rivers but also in other areas of Scotland, and the proximity of the proposed cable landfalls to salmon and sea trout rivers (particularly the Spey), it is likely that salmon and sea trout will transit the OfTW area. This assumption is backed up by Annex 16B, which refers to the recent review by Marine Scotland Science, which suggests that these species migrate in both an easterly and westerly direction along the Moray coast. As stated earlier, we are aware that Marine Scotland Science are currently undertaking a research programme which aims to investigate electro-magnetic force impacts on salmonids. Until this work is completed, we are unable to assess the relative magnitude of the impact of EMFs arising from either an AC or DC cable.	Given that the expected magnetic fields produced by the cables will be below the earth's magnetic field the assessment of minor negative effects is considered to be appropriate. The uncertainties in relation to the effects of EMFs on salmon and sea trout, given the lack of information on their behaviour at sea have however been further acknowledged.	Section 5.6.1 Section 5.6.1.2
Public Response in Relation to Diadromous Fish Species	The application contains limited information regarding the type of structures likely to be deployed if consent is granted and in turn the methodology likely to be adopted during construction. This renders a proper assessment of the risks likely to be posed by the scheme to diadromous fish extremely difficult.	Information on the most likely case has been provided in this ES Addendum.	Section 5.6.2
	It is clear from the ES provided in support of the application that the initial scoping response received from MSS in respect of diadromous fish has not been adhered to. In particular, the need to produce detailed information in respect of the usage of the proposed development area by diadromous species, or, alternatively, develop an appropriate monitoring strategy receives scant attention. As an alternative the ES adopts the methodology of assuming that the fish are present within the proposed development site. This would be an appropriate methodology if the risks posed to migratory fish species such as	BOWL is engaging with Marine Scotland and other developers to define an adequate salmon and sea trout monitoring strategy. BOWL is engaged in on-going consultation with MSS for the implementation of adequate	Section 5.8 Section 5.7

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	salmon and sea trout as well as other important diadromous fish such as eels and lamprey, were well understood and readily quantifiable. It is clear from research commissioned by SNH, particularly in respect of underwater noise resulting from the construction phase of the operation and the creation of electromagnetic fields resulting from the cabling array, that this is far from being the case. This is of particular concern given that a number of rivers within the area are SACs for Atlantic salmon, pearl mussels and sea lamprey. Given the paucity of information in the ES with regards to the usage of the proposed development site by salmon and sea trout we have no option but to assume that the area involved is the key migration route for both adult salmon returning to our rivers and salmon smolts migrating to the main feeding grounds as well as the key feeding ground for our sea trout populations. Indeed, a precautionary approach dictates that the application should be considered with the assumption that all salmon and sea trout entering or leaving the rivers utilise the proposed development area. Given the inherent uncertainties regarding the potential impacts of the proposed development and the paucity of information regarding the utilisation of the proposed development area by diadromous fish species it is particularly concerning that potential mitigation measures such as the avoidance of piling operations within key migration periods has apparently been ignored.	mitigation on fish receptors where deemed necessary.	

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	Increased Suspended Sediment Concentrations: We question the use of the parameters to ascertain the effects of increased suspended sediment concentrations as outlined in Table 11.12 (page 11-20). The parameters are identified as those reported by Birtwell (1999) but examination of the report in question suggests that the research itself was conducted in fresh water and not the marine environment. As such we question the validity of directly transposing research findings based in the freshwater environment to the marine environment. Paragraph 64 includes the *sentence In the case of migratory species, assuming fish are migrating through the site, increased SSC would result in localised disturbance to migratio*n. The ES appears to assume that delays in migration, forced movement from preferred migration pathways, disorientation, potential increases in stress et as a result of this localised disturbance to not influence ultimate survival and fitness rates particularly as an individual fish may experience such disturbance at several locations within the development area thus leading to cumulative effects. The primary literature contains numerous examples of increased predation risk of salmonids due to various stressors in both the freshwater (e.g. Mesa) and marine environment (e.g. Handeland et al). Given the close proximity of the proposed development to the coastline (13.5 km at its closest point) and therefore the mouths of rivers and burns coupled with the speed at which smolts are known to travel in the marine environment (e.g. Lacroix et al) there is also the potential for smolts already suffering markedly reduced anti-predator responses due to osmotic stress to experience further increased stress levels, disorientation with concomitant implication in respect of mortality.	The increased SSCs has been revised and further references in relation to the sensitivity of fish to SSCs have been added to support the assessment	Further environmental information included in the ES Addendum in Section 5.6.1
	Electromagnetic Fields; The conclusions of the SNH commissioned review regarding information available in respect of electromagnetic fields and noise resulting from offshore renewable energy developments have previously been referenced in this response. We understand that research to better understand the response of salmonids fish and eels to electromagnetic fields by MSS is ongoing. Given the paucity of information currently available it is not possible to form an informed view as to whether the proposed mitigation is adequate particularly in respect of the depth of burial that will be ultimately required to fully	Given that the expected magnetic fields produced by the cables will be below the earth's magnetic field the assessment of minor negative effects is considered to be appropriate. The uncertainties in relation to the effects of EMFs on salmon and sea trout, given the lack of information on	Section 5.6.1.2 Section 5.6.1.2

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	mitigate for any potential adverse effects. It is suggested that the results of peer-reviewed science should dictate the depths to which cables are buried rather than a depth be chosen by the developer on an apparently arbitrary basis. Furthermore, the intention of the developer to bury or shield the cable where feasible is clearly unacceptable. No cables should be left unburied if any diadromous fish species is experimentally shown to exhibit any response to electromagnetic fields. We also note that the statement (P11-38 paragraphs 131 and 132) *Salmon and sea trout transiting the area of the Wind Farm will for the most not be exposed to the strongest EMFs as they normally swim in the upper metres of the water column during migration (water depths in the Wind Farm range from 38 to 68 m)* appears to give the impression that the proposed development site will be used almost exclusively as a migration pathway. This statement appears to suggest that migration and feeding are mutually exclusive activities for salmon, a suggestion that is contradicted on page 10 of 16B Annex of the ES which states: *Malcolm et al (2010) concluded base on research undertaken to date (Jakupssovu, 1986; Holm et al, 2005; Starlaugsson, 1995) that in general terms salmon spend most of the time close to the surface although diver to greater depths of up to 280m have often been observed. Divers to not appear restricted to offshore areas, persisting late into the migration on the return to home waters. Earlier studies (Jakipssovu, 1986) suggest and association between diving and feeding*. We also believe the ES underplays the potential of the development are as a sea trout feeding ground, particularly if the area supports a sandeel population and/or is an important area for juvenile herring. Sea trout are also *apparently more likely to be benthic feeders than salmon as witnessed on page 15 of Annex 16B it is stated that: In addition, Pemberton (1976b) suggested a diel feeding pattern, with bottom feeding being greatest during the day and mid-water and surface feeding increasing between sunset and sunrise.*	their behaviour at sea have however been further acknowledged. BOWL is engaging with Marine Scotland and other developers to determine the need for salmon and sea trout monitoring.	 Section 5.8

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	Underwater Noise: The ES highlights that a considerable area of potential migratory routes and feeding grounds for salmon and sea trout within the Moray Firth will potentially be impacted principally by the piling operations. Again we draw attention to the lack of detailed information of the effects of underwater sound on salmonids behaviour as previously referenced in the SNH commissioned review in respect of electromagnetic fields and noise. Furthermore, the uncertainty regarding the effects of piling noise is intensified due to the assertion in Annex 7A page 10-14 of the modelling exercise that: *Due to the current lack of information on potential lethal and physical injury effects from impact piling, this study has used the data from blast exposures to estimate impact zones. ..There is therefore, a level of uncertainty as to whether a blast wave criterion can be directly applied to a transient waveform arising from an impact piling operation.* We concur with the assertion on 10-17 when considering relatively low levels of noise: *The significance of the effect requires and understanding of its consequences. For instance, avoidance may be significant if it impeded the migration of a species. However, in other cases the movement of species from on area to another may be of no consequence.* We contend that the ES assumes that the displacement and the adoption of avoidance behaviour by individual or aggregations of salmon and sea trout from their original locations as a result of underwater noise has no implications in respect of fitness or survival. Given that the marine ecology of salmon and trout are so poorly understood we suggest that a precautionary approach would dictate that it should be assumed that the potential alterations in behaviour will negatively impinge on survival and fitness of the fish in question and as such piling operations should not be undertaken in periods when juvenile salmon and sea trout are migrating and when populations of adult salmon believed to be numerically depressed are likely to be transiting the area.	Given that the expected magnetic fields produced by the cables will be below the earth's magnetic field the assessment of minor negative effects is considered to be appropriate. The uncertainties in relation to the effects of EMFs on salmon and sea trout, given the lack of information on their behaviour at sea have however been further acknowledged. The Report to Inform an Appropriate Assessment is included in Annex 3B of this ES Addendum. Further information has been provided in relation to worst case and likely worst case piling durations for the Wind Farm Site. The uncertainties in relation to the current knowledge on the implication of behavioural responses in salmon and sea trout triggered by noise have been acknowledged.	Section 5.6.1.2 Section 5.6.1.2 Annex 3B of this ES Addendum Section 5.6.1 and Section 5.6.2 Section 5.6.1.1

Consultee	Summary of Consultation Response	Project Response	Response Addressed
	Loss of Habitat and Potential Damage to Prey Species: We believe that there is considerable potential for reduced abundance in key prey species such as sandeels and juvenile herring which are likely to form an important component of the diet of juvenile salmon and sea trout if the proposals are granted a licence. The assertion *that despite a lack of current data on the distribution of sand eels within the site and the wider area to the spatial scale required for this assessment, the effect of habitat loss is assessed to be negligible and probable* does not instil confidence.	Further discussion on the potential effect of loss of habitat on sandeels has been provided. Further information on the potential distribution of sandeels in the Wind Farm has been provided. BOWL is committed, in consultation with Marine Scotland, to undertake the appropriate additional surveys as a condition of consent. These may include; • Sandeel survey; and • Cod survey.	Section 5.6.1.2 Section 5.6 takes account of the information available in MORL, 2012 in providing further information on the likely importance of the Wind Farm Site for sandeels. Section 5.8
	Creation of New Habitat: We contend that the introduction of hard substrate as a result of the development accompanied by the presence of the turbine towers has the potential to locally increase the abundance of certain species and therefore act as predator aggregation locations for migrating juvenile salmon and feeding sea trout. Of particular concern would be aggregations of gadoids such as cod which are known to be predators of Atlantic salmon (e.g. Hvdsten and Mokklgjer)	Further clarification on the potential for likely significant effects on fish species associated with the introduction of hard substrate has been provided.	Section 5.6.1.2

5.3 SCOPE OF ASSESSMENT

7. This Section considers the changes to the Project presented in Section 4: Amended Project Description. Specifically, as stated in Section 5.1, the effects associated with:

- The Amended OfTW Corridor; and
- Changes to the OfTW cable installation timescales.

8. Changes to the jack-up vessel footprints included in the Amended Project have been scoped out of this assessment as they do not affect the worst case scenario for habitat loss. As presented in Table 5.2, loss of habitat is included for assessment during the operation phase as this is a long term effect. This is when the greatest loss of habitat is expected, both in terms of duration and total area affected. As a result, jack-up barge footprints during the construction phase are not considered further in this section of the Addendum.

9. As detailed in Table 5.1, consultation responses have required further information and revised assessments including the following:

- Reference to seabird distribution data to provide further context in relation to the potential presence of sandeels within Wind Farm Site (as shown in MORL, 2012);
- Further discussion in relation to increased suspended sediment concentrations and sediment re-deposition. A special focus in this respect has been given to the effects of increased SSCs on salmonids, as requested in a number of responses to the Original ES;
- Provision of further information on piling duration and further integration and clarification in relation to the temporal aspect of piling noise; and
- Provision of further information relating to the Moray Firth Round 3 Zone.

10. There are no amendments to methodologies presented in this section. It should be noted, however, that for the purposes of this section of the ES Addendum, a revised assessment has been provided for receptors for which likely significant effects (above minor) were identified in the Original ES and for which concern has been raised in the stakeholders' responses to the Original ES. These are salmon (*Salmo salar*), sea trout (*Salmo trutta*), cod (*Gadus morhua*), herring (*Clupea harengus*) and sandeels (*Ammodytidae spp.).* All the potential effects given in Table 5.2 have been taken into account. In the particular case of sandeels, however, a revised assessment has only been provided in relation to increased SSCs, sediment re-deposition, changes to fishing activity and loss of habitat, as these are the potential effects to which the responses of stakeholders refer.

11. Therefore, the scope of this section covers the potential effects detailed in Table 5.2 for the species described in previous paragraph. The types of potential effects remain unchanged from those included in Section 11: Fish and Shellfish Ecology and Section: 23 OfTW Fish and Shellfish Ecology of the Original ES.

Table 5.2: Potential Effects Included for Assessment on Fish and Shellfish in this ES Addendum

Potential Effect	Phase	Wind Farm	OfTW
Direct Effects			
Increased suspended sediment concentrations and sediment re-deposition	Construction/ Decommissioning	Clarification only provided	Clarification only provided
Underwater noise and vibration	Construction/ Decommissioning and Operation	✓	✓
Loss of habitat	Operation	✓	-
Electromagnetic Fields (EMFs)	Operation	✓	✓
Indirect Effects			
Introduction of new habitat	Operation	✓	-
Changes to fishing activity	Operation	✓	-

12. The conclusions of this assessment replace those of the Original ES for the receptors and effects for which a revised assessment has been undertaken. For the remaining fish and shellfish receptors, this section is supplemental and should be read alongside Section 11: Fish and Shellfish Ecology and Section: 23: OfTW Fish and Shellfish Ecology of the Original ES.

5.4 BASELINE

5.4.1 STUDY AREA

13. The Study Areas for the assessment of effects on fish remain unchanged from those presented in Section 11.2.2.1 and Section 23.2.2.1 and Annex 11A of the Original ES. These are shown in Figure 11.1 of the Original ES and Figure 5.1 of this ES Addendum, respectively.

5.4.2 BASELINE CONDITIONS

14. The baseline conditions relating to the Study Areas remain unchanged with the exception of sandeels, for which their potential abundance and distribution within the Wind Farm is discussed in MORL, 2012. This integrates the information given in Section 11: Fish and Shellfish of the Original ES and seabird distribution data provided in Section 13: Ornithology, of the Original ES with a focus on seabird species recorded in boat based surveys which are known to heavily rely on sandeels during the breeding season. Arctic tern and Arctic skua were recorded in very low numbers in the Wind Farm. Other species such as kittiwakes were recorded in relatively higher numbers, particularly in the southern western area of the Wind Farm, coinciding with an area characterised by the presence of sandy sediment. Atlantic puffin and razorbill were also recorded in relatively high numbers within the area surveyed. In the particular case of razorbill, they were also

found in relatively high numbers in the southern section of the Wind Farm site and its vicinity from February to April.

15. In the particular case of salmon and sea trout, the baseline conditions relating to the Study Area presented in Section 11.3 and 23.3 of the Original ES remain unchanged. As mentioned in Annex 16B of the Original ES, and noted by MSS in their response, the potential for salmon from any east coast river to transit the site is further acknowledged.

16. The amendment to the Original OfTW Corridor is described in Section 4: Project Description. The amendment results in a small increase in the width of the OfTW Corridor within a discrete sea area.

17. The Amended OfTW Corridor is shown in the context of the Study Area considered in the Original ES Chapter is illustrated in Figure 5.1. As shown, the area added to the Original OfTW Corridor falls within the Study Area used for assessment in Section 23: OfTW Fish and Shellfish Ecology of the Original ES. As a result, it is considered that the baseline information provided from the Original OfTW Corridor also applies to the Amended OfTW Corridor.

5.5 ASSESSMENT METHODOLOGY

18. The assessment methodology remains unchanged from that presented in Section 11.2.4 and Section 23.2.4 of the Original ES. The potential effects included for assessment in this ES Addendum are as detailed in Table 5.2.

19. The potential effects as described in Table 5.2 are separately assessed for the construction/decommissioning phases and the operational phase of the Wind Farm and the OfTW. In the absence of detailed information on decommissioning schedules and methodologies, it is assumed that any effects derived from the decommissioning phase will, at worst, be of no greater significance than those derived from the construction phase.

20. Similarly, the limitations of the assessment of effects are recognised; these are a result of the lack of current knowledge on the sensitivity of particular species to certain potential effects but also of uncertainties in relation to the distribution of some species and the use that they make of the area of the Wind Farm and the OfTW. Where data and information are limited, the assessment has been based on conservative assumptions. Where applied these are detailed in the following sections.

21. The significance criteria used in this section remains unchanged from that presented in Section 11.2.4.5 and Section 23.2.7 of the Original ES. The significance of an effect is determined taking account of the magnitude of the effect and the sensitivity of the receptor following the matrix shown in Table 5.3.

Table 5.3: Assessment Significance Criteria Matrix

Sensitivity of Receptor	Magnitude of Effect			
	Negligible	**Small**	**Medium**	**Large**
Low	Negligible	Negligible	Minor	Moderate
Medium	Negligible	Minor	Moderate	Major
High	Negligible	Moderate	Major	Major

22. Whether the predicted effect is considered to be of "positive" or "negative" nature is also described. As set out in Section 3: EIA Process and Methodology of this ES Addendum, Section 11: Fish and Shellfish Ecology and Section 23: OfTW Fish and Shellfish Ecology of the Original ES, effects which are of moderate and major significance are considered to be significant in relation to the EIA Regulations, and those of minor and negligible significance are considered to be not significant.

23. Taking the limitations of the assessment described above, and the uncertainties in relation to the relative importance of the area of the Wind Farm to some species, the probability for each predicted effect to occur has been assessed as 'certain', 'probable', 'unlikely' and 'extremely unlikely'. The probability categories used in this assessment are given below as defined in the IEEM (2010) guidelines:

- Certain/near certain: probability estimated at 95% or higher;
- Probable: probability estimated above 50% but below 95%;
- Unlikely: probability estimated above 5% but less than 50%; and
- Extremely Unlikely: probability estimated at less than 5%.

24. It should be noted that these categories do not infer a level of confidence in the assessment but present the likelihood of the effect occurring.

25. Where there is limited information on which to base the assessment of potential effects on specific receptors, the uncertainty of the assessment has been acknowledged in this ES Addendum.

5.5.1 WORST CASE SCENARIO

5.5.1.1 Wind Farm

26. In general terms, the worst case parameters considered for assessment remain unchanged from those provided in Section 11.2.4.3 of the Original ES. An exception to this is the worst case scenario in relation to construction noise; the Original ES considered one worst case construction noise scenario based on the potential maximum total area affected by construction noise at a given time (where piling takes place concurrently at two locations). A further worst case scenario is also presented and discussed in this document, based on the use of only one piling vessel. This would result in a smaller area being affected by construction noise at a given time and in an increase in the total duration of piling and of the overall construction period (up to 3 years). In addition, further information in terms of total worst case piling durations has been provided in this document.

27. A summary of the worst case parameters taken into account for assessment is given in Table 5.4. The worst case scenario for assessment of the effects of the OfTW is given in Table 5.5. See Section 4 describes the Amended Project itself. It explains the approach of using a Rochdale Envelope which sets out maximum and minimum parameters within which the final design of the Amended Project will fall.

28. In order to ensure that the EIA has taken account of the worst case likely significant effects arising from the Amended Project, a set of parameters were developed for the Original ES. These parameters are collectively referred to as the Rochdale Envelope as defined in Section 3: EIA Process and Methodology of this ES Addendum. As stated previously, the worst case parameters for the Wind Farm considered for assessment in this section of the ES Addendum remains unchanged from those provided in Section 11.1.4.3 of the Original ES. An exception to this is the worst case scenario in relation to construction noise.

Table 5.4: Worst Case Design Parameters used for Assessment of Effects on Fish and Shellfish Ecology

Potential Effect	Wind Farm Design Parameters	Worst Case
Construction/Decommissioning		
Increased in suspended sediment concentrations and sediment re-deposition	Turbine type Foundation type Max. no of turbines Max. length of inter-array cable buried	3.6 MW Gravity bases 277 325 km (total length of inter array cable is 350 km)
Noise	**Scenario 1** Turbine type Max no of turbines Max pile diameter Max no of piles per foundation Max no of simultaneous piling events Construction period Active piling time **Scenario 2** Turbine type Max no of turbines Max pile diameter Max no of piles per foundation Max no of simultaneous piling events Construction period Active Piling Time	 3.6 MW 277 2.4 m 4 1 3 years 5 hours per pile 3.6 MW 277 2.4 m 4 2 2 years 5 hours per pile
Operation		
Loss of habitat and introduction of new habitat	Turbines type Foundation type Max no of turbines Inter-array cabling	3.6 MW Gravity bases 277 Up to 50% of inter-array cable length is protected
Noise*	Max no of turbines	277
EMFs	Max length of inter-array cabling Cable post installation status Minimum burial depth	350 km Buried/protected where feasible 0.6 m where buried or protected
Changes to Fishing Activity*	Max number of turbines	277

*Limited information available for detailed worst case definition. The maximum number of turbines is assumed to constitute worst case.

5.5.1.2 OfTW

29. The worst case scenario for assessment of the effects of the OfTW remains unchanged from that identified in Section 23.2 of the Original ES. An exception to this is the duration of OfTW cable installation which was stated to take approximately 40 days per trench (120 days in total) in of the Original ES. Since the submission of the Original ES further information, as outlined in Section 4: Amended Project Description has become available relating to the construction processes for the Amended Project. OfTW cable installation is estimated to be 140 days each year for a three year period, which results in 420 days in total over three years. In addition, there will be 90 days per year required for cable protection work, which totals 270 days over the same period. Combined, this results in a worst case of 690 days in total over a three year period.

30. The worst case scenario for assessment of the effects of the OfTW is given in Table 5.5.

Table 5.5: Worst Case Design Parameters used for Assessment of Effects on Fish and Shellfish Ecology

Potential Effect	**Worst Case**
Increased in suspended sediment concentrations and sediment re-deposition	AC cables in 3 trenches
	Cable laying takes approx. 140 days per year for three years plus 90 days per year for cable protection
	55% cable buried and 45% protected
Noise	AC cables in 3 trenches
	1.5 km of cable installed per day
	Operations take place constantly over a 24 hours period
Operation	
EMFs	AC Cables in 3 Trenches or DC cables in 3 trenches
	55% cable buried and 45% of cable protected

5.5.2 MOST LIKELY SCENARIO

5.5.2.1 Wind Farm

31. The most likely scenario for the Wind Farm is provided in Table 5.6. See Section 4.3.2 which describes the most likely scenario. This most likely scenario has been used for illustrative purposes throughout this ES Addendum to present the probable environmental effects of what BOWL considers may be the most appropriate representation of the Amended Project.

Table 5.6: Most Likely Case Design Parameters for Discussion of Effects of Fish Ecology

Potential Effect	Wind Farm Design Parameters	Most Likely Scenario
Construction/Decommissioning		
Increased in suspended sediment concentrations and sediment re-deposition	Turbine type Foundation type No. of turbines Length of inter-array cable buried	TBC Pin piles 140 230 km
Noise	Turbine type No. of turbines Pile diameter No of piles per foundation No of simultaneous piling events Construction period Active piling time	TBC 140 1.8 m 4 1 3 years (piling during one year only) 3-5 hours per pile
Operation		
Loss of habitat and introduction of new habitat	Turbines type Foundation type Max no of turbines	TBC Jackets on pin piles 140
Noise	Max no of turbines	140
EMFs	Max length of inter-array cabling Cable post installation status Burial depth	260 km Buried/protected where feasible 1 m
Changes to Fishing Activity	No. of turbines	140

5.5.2.2 OfTW

32. The worst case assumptions presented in Table 5.5 also apply in general terms for discussion of the most likely scenario. Exceptions to this are as follows:

- The length of cabling requiring protection, is likely to be 10.7 km as opposed to the conservative worst case presented originally where 45% of the cable was considered to be protected; and
- The most likely scenario in relation to installation time is expected to be 187 days of installation in Year 1, and 100 days of installation in Year 2, resulting in 287 days in total over two years. Additionally, cable protection is anticipated to take 128 days in Year 1 and 64 days in Year 2, giving a total protection time of 192 days over two years.

5.6 ASSESSMENT OF POTENTIAL EFFECTS

5.6.1 WORST CASE SCENARIO – WIND FARM

33. A revised assessment of the potential effects of the Wind Farm worst case scenario is given below in relation to those receptors and potential effects specified in Section 5.3

34. As described in Section 5.5.1.1, the worst case scenario used for assessment of the Wind Farm remains unchanged from that presented in Section 11.2.4.3 of the Original ES, with the exception of construction noise for which a further scenario has been included in this ES Addendum.

35. Taking the above into account, the significance of the effects of the construction/decommissioning and operational phases of the Wind Farm on fish and shellfish receptors, other than those for which a revised assessment has been provided, remains unchanged from that provided in Section 11.4 of the Original ES.

5.6.1.1 Construction and Decommissioning

36. The following potential effects are assessed for the construction/decommissioning phase of the Wind Farm.

- Increased suspended sediment concentrations and sediment re-deposition; and
- Noise.

Increased Suspended Sediment Concentrations (SSCs) and Sediment Re-deposition

37. As described in detail in Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES and summarised below, a number of construction activities will result in re-suspension and dispersion of sediment into the water column and subsequent re-deposition of sediment. This includes the following:

- Dredging as part of bed preparation for installation of gravity base foundations;
- Drilling to install jacket pin piles; and
- Cable trenching by energetic means (e.g. ploughing and jetting).

38. As summarised in Table 5.1 concern in relation to the potential effects of increased SSC and sediment re-deposition has been raised by stakeholders after review of the Original ES. Further information to this respect is therefore given below together with a review of the Original ES.

39. The maximum localised increase in SSC expected in the immediate vicinity of construction vessels (50 to 100 m) is 21 mgl^{-1} for dredging as part of seabed preparation for gravity bases and 25 mgl^{-1} for drilling for the installation of pin piles, lowering down to 10 mgl^{-1} or less in the main plume. These effects are expected to only occur during and up to one hour after dredging/drilling, after which time SSC are reduced to less than 4 mgl^{-1} due to dispersion and deposition on the seabed (Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES). In general terms, the effects of dredging and drilling are consistent with the natural range of variability in the area. Local effects around construction vessels may be potentially in excess of this, however, very localised and temporary.

cable installation will have a relatively higher magnitude effect on suspended sediment, however, the effect will be short term (order of seconds to minutes) and will be largely localised to the cable installation location (main effect within 10's of metres) (Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES). It should be noted that the SSCs given above represent the expected increase above background levels at any given time (i.e. whether background conditions are those of storm events or calm weather conditions) and are therefore independent of natural seasonal variations in background SSCs.

40. An example image showing the distribution of SSC after consecutive installation of nine gravity base foundations is illustrated in Figure 9.7 of the Original ES. This shows the typical footprint of increase in SSC during active dredging and demonstrates that the SSC signature of all preceding foundation installations is no longer evident (Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES). The visual appearance of the SSC plume associated with drilling to facilitate pin pile installation would be similar to that presented for dredging in Figure 9.7 of the Original ES.

41. In light of the small spatial extent and persistency of elevated increased SSCs, its effect is considered to be of small magnitude.

42. In addition to increased SSCs, accumulation of fine material (silts and clays) is expected to occur approximately 5 to 25 km outside of the Wind Farm Site, near to or within the south-western end of the Moray Firth Round 3 Zone Western Development Area (WDA). In the unlikely scenario that all fine material from all 277 foundations is released on a very short time scale, and is very poorly sorted, the maximum local accumulation thickness could be of 0.5 to 0.6 mm but more typically 0.01 to 0.10 mm for dredging and 0.7 to 0.9 mm but more typically 0.01 to 0.15 mm for drilling. In the case of drilling associated with the installation of jacket pin piles, a localised accumulation of sandy material in the near vicinity of each foundation (within 50 to 100 m) is also expected. The thickness of the sand deposits has been conservatively predicted to be up to 5 m (Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES). Taking the small areas affected by elevated sediment re-deposition, and the short term nature of the effect, sediment re-deposition during the construction phase is considered to result in an effect of small magnitude.

43. The resulting spatial patterns of accumulation of fine material (silts and clays) arising from consecutive seabed preparation for installation of gravity bases are illustrated in Figure 9.8 of the Original ES, as presented in Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES. As shown the maximum deposition thickness is expected to be less than 0.01 mm in the majority of the Wind Farm.

44. The sensitivity of key receptors and the likely significance of the effects derived from increased SSCs and sediment re-deposition are described in the following sections, taking account of the magnitude of the effects identified above. This is given for eggs and larvae and adult and juvenile fish separately.

Eggs and Larvae

45. As stated in the Original ES, early life stages such as eggs and larvae are considered to be less tolerant to suspended sediments than adults, with larvae being generally considered to be more sensitive than eggs (Appleby and Scarratt, 1989). Being of limited mobility, eggs and larvae may not be able to avoid areas disturbed by increased SSCs, as they passively drift through (if pelagic) or remain (if demersal) in areas where construction works are taking place.

46. The survival of pelagic eggs is dependent upon their ability to remain in the upper parts of the water column where abiotic parameters such as oxygen concentration are ideal for survival and development of eggs. The settlement of sediment particles might cause pelagic eggs to sink to deeper depths increasing the risk of oxygen deficiency. In addition, if eggs sink to the bottom a high mortality may be expected, primarily due to benthic predation or mechanical or physiological stress (Engell-Sørensen and Skyt, 2001).

47. Eggs and larvae of six species of anadromous and estuarine fish indigenous to the Chesapeake Bay (United States) were exposed to concentrations of suspended sediment ranging from a few mgl^{-1} to 1,000 mgl^{-1} to determine the effects of different concentrations on hatching success and short term survival. The egg experiments indicated that concentrations of up to 1,000 mgl^{-1} did not significantly affect the hatching success of yellow perch (*Perca flavescens*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*) or American shad (*Alosa sapidissima*) eggs. Concentrations of 1,000 mgl^{-1} significantly reduced the hatching success of white perch (*Morone americana*) and striped bass (*Morone saxatilis*), but lower concentrations did not. Experiments with larvae indicated that concentrations of 500 mgl^{-1} significantly reduced the survival of striped bass and yellow perch larvae exposed for 48−96 h. American shad larvae appeared to be less tolerant than the other two species tested. Concentrations of 100 mgl^{-1} significantly reduced the survival of shad larvae continuously exposed for 96 h (Auld and Schubel, 1978). Messieh et al. (1981) were unable to detect any deleterious effect on herring eggs hatching at SSCs as high as 7,000 mgl^{-1}, whilst Griffin et al. (2009) suggest that the attachment of sediment particles on herring eggs may lead to retarded development and reduced larval survival rates at sediment concentrations as low as 250 mgl^{-1}. Sandeel eggs have an adhesive surface, and material released as a result of construction activities may stick to the eggs and thus reduce the diffusion of oxygen into the eggs, and potentially increasing mortality (Engell-Sørensen and Skyt, 2001).

48. In many species of fish, larvae use their sight to locate their prey. There is therefore potential for increased SSCs to result in disturbance to larval feeding. Larvae of species such as herring, plaice, sole, turbot, and cod sight their prey at a distance of only a few millimetres (Bone and Moore, 2008). Herring and plaice larvae can survive for about a week without food when they are small and plaice can withstand starvation for as long as three weeks as they approach metamorphosis (Bone and Moore, 2008). Johnston and Wildish (1982) investigated the effect of increased levels of suspended sediment on the feeding rate of larval herring of different ages. Larval herring consumed significantly fewer food items at

concentrations of 20 mgl^{-1} and smaller larvae were more affected by increased levels of suspended sediment than were larger larvae. Boehlert & Morgan (1985) found that maximum feeding incidence and intensity of Pacific herring larvae, which were exposed to suspensions of estuarine sediment and volcanic ash at concentrations ranging from 0 to 8,000 mgl^{-1}, occurred at levels of suspension of either 500 mgl^{-1} for sediment or 1,000 mgl^{-1} for volcanic ash. Feeding decreased at greater concentrations. It was suggested that suspensions may have enhanced feeding by providing visual contrast of prey items on the small perceptive scale used by the larvae. Boehlert & Morgan (1985) also suggested that larval residence in turbid environments such as estuaries may serve to reduce predation from larger visual planktivores, while searching ability in the small larval perceptive field is not decreased.

49. In addition, as the water becomes more turbid, fine silt may adhere to the gills of larvae and cause suffocation (De Groot, 1980). Rönnbäck and Westerberg (1996) found that yolk sac cod larvae had a higher mortality than cod eggs, when exposed to suspended sediment and suggested that this could be due to blocking of the gills of the yolk sac larvae.

50. The small maximum localised increase in SSC expected in the immediate vicinity of construction vessels (21 mgl^{-1} for dredging as part of seabed preparation for gravity bases and 25 mgl^{-1} for drilling for the installation of pin piles) and in the main plume (where it lowers down to 10 mgl^{-1} or less) should be noted in this context. Similarly, the very localised and short term of effects in excess of this (i.e. local effects around construction vessels and cable installation activity) also need to be recognised in this context. As described in Section 11.3.2, a number of fish species, including sandeels, herring and cod, have defined spawning grounds within and/or in the vicinity of the Wind Farm. As a result, there is potential for their eggs and larvae to be present in areas where construction works are taking place, and may therefore be subject to the effects of increased SSCs. The extent of these spawning grounds is however very large in comparison to the small areas expected to be affected by increased SSCs, particularly at the highest levels (Figure 9.7 of the Original ES). Taking this into account eggs and larvae are considered receptors of medium sensitivity and the effect of increased SSCs is assessed to be negative, minor and probable. This is not a likely significant effect in terms of the EIA regulations.

51. In addition to the above, eggs and larvae may be subject to smothering as a result of sediment re-deposition. This is of particular relevance for fish species which lay their eggs on the seabed, namely herring and sandeels. Messieh et al (1981) reported that burial of Atlantic herring eggs under thin veneer of sediment caused substantial mortality. Sediment re-deposition could also result in a temporary loss of spawning grounds to these species, in the event that the characteristics of the substrate changed significantly and made the grounds unsuitable for spawning as a result. De Groot (1980) suggests that altering the structure of the spawning grounds of herring may affect stocks because herring in spawning condition may be unable to locate their normal spawning grounds and as a result shed their eggs on less optimal sites. It should be noted in this context that the potential degree of overlap

between the spawning grounds of these species and the localised areas where maximum sediment re-deposition is expected to occur is very small. As previously mentioned, in the majority of the Wind Farm the thickness of sediment re-deposited is expected to be below 0.01 mm (Figure 9.8 of the Original ES). Taking the above into account, sandeels and herring are considered receptors of medium sensitivity and the effect of sediment re-deposition is assessed to be negative, minor and probable. This is not a likely significant effect in terms of the EIA Regulations.

Juvenile and Adult Fish

52. The effect of increased SSCs on juvenile and adult fish varies depending on anatomical parameters such as gill dimensions and on the size and shape of the sediment particles (Engell-Sørensen and Skyt, 2001; Appleby and Scarratt, 1989). Potential effects of suspended sediments on fish include the following:

- Clogging of gills;
- Abrasion of the body surface;
- Reduced sight;
- Avoidance; and/or
- Death.

53. In general terms, concentrations of suspended material have to be on the scale of mgl^{-1} to cause avoidance reactions in juvenile and adult fish. For lethal effects to occur, concentrations of suspended sediment have to be on the scale of grams per litre (gl^{-1}) (Engell-Sørensen and Skyt, 2001).

54. For assessment of effects of suspended concentrations, not only the level of SSCs to which an organism is exposed is of relevance, but also the duration of the exposure time to a given concentration. Newcombe (1986) defined the intensity of suspended sediment concentrations as the product of concentration of suspended sediment multiplied by the duration (hours) of exposure of the organisms. Although not all fish avoid turbid waters, elevated turbidity or levels of suspended solids often induce avoidance reactions and may modify natural movement and migration of fish (Kerr, 1995). The juvenile and adult fish present in the area of the Wind Farm, being mobile, will be able to avoid the localised areas where elevated SSCs are reached and move to adjacent undisturbed areas within their normal distribution range and continue with their normal activity. Taking the above into account, adult and juvenile sandeels, herring and cod are considered receptors of low sensitivity and the effect of increased SSCs is assessed to be negligible and probable. This is not a likely significant effect in terms of the EIA Regulations.

55. In the particular case of salmonids, a wide range of studies have assessed the effect of turbidity levels above natural background on the physiology and behaviour of salmonids. The research indicates that high levels of suspended sediment may be fatal while lower levels of suspended sediment and turbidity may cause chronic sub-lethal effects such as loss or reduction of foraging capability, reduced growth, resistance to disease, increased stress and interference with cues necessary for orientation in homing and migration (Bash and Bernman, 2001). It should be noted,

however, that the majority of these studies, are based on freshwater and experimental settings rather than the marine environment.

56. Newcombe and MacDonald (1991) identified three main categories of effect of suspended sediment on salmonids as behavioural, sub-lethal and lethal:

- Lethal effects kill individual fish, cause overall population reductions, and damage the capacity of the system to produce future populations. This category includes reductions caused by sub-lethal or behavioural effects;
- Sub-lethal effects relate to tissue injury or alteration of the physiology of an organism. Effects are chronic in nature and while not leading to immediate death, may produce mortalities and population decline over time; and
- Behavioural effects are described by any effect that results in a change of activity usually associated with an organism in an undisturbed environment. These changes may lead to immediate death or population decline or mortality over time.

57. Adult and juvenile salmon and sea trout are highly mobile. In the marine environment, not being restricted by geographical features, they will be able to avoid the localised areas where the highest increased SSCs are reached. As a result, they would only be potentially exposed to lethal/sub-lethal SSCs during very short periods of time (i.e. if present in the immediate vicinity of areas where cable installation works are being carried out). Furthermore, taking the relatively small predicted increases in SSCs over background levels (Figure 9.7 of the Original ES) it is expected that effects on salmonids will mainly occur at the behavioural level. This is in line with Wilber and Clark's (2001) review of the biological responses of juvenile and adult salmonids to SSCs associated with dredging, which suggests that most responses in salmonids are behavioural as opposed to sub-lethal or lethal, with avoidance being a frequent response. Increased turbidity may reduce visual acuity, potentially decreasing foraging rates (Barrett et al, 1992) and can increase vulnerability to predation if avoidance reactions are reduced (Gregory, 1993; Robertson et al, 2007). Research on the behaviour of juvenile Atlantic salmon has found that initial introduction of sediment (20 mgl^{-1}) increases foraging activity, however this subsequently declined at sediment levels greater than 180 mgl^{-1} (Robertson et al, 2007). Short term pulses of suspended sediment have been shown to disrupt feeding behaviour in juvenile coho salmon (*Onchyrnchus tshawytscha*) and elicit alarm reactions that may cause fish to relocate downstream to undisturbed areas (Berg and Northcote, 1985). In contrast, increased SSCs can also have the opposite effect, reducing the risk of predation and increasing foraging rates as has been demonstrated in both coho salmon (Gregory and Northcote, 1993) and Atlantic salmon (Robertson et al, 2007). Similarly, Gregory and Levings (1998) suggest that seaward migrating pacific salmon are less likely to encounter and be consumed by piscivorous fish in turbid water than in clear water.

58. The ability of salmonids to be able to cope with some level of turbidity at certain life stages (Gregory and Northcote, 1993) should also be noted in this context. Evidence of this is illustrated by the presence of juvenile salmonids in turbid estuaries prior to starting their marine migration and in the local streams characterised by high

natural turbidity levels (Gregory and Northcote, 1993). The small maximum localised increase in SSC expected in the immediate vicinity of construction vessels (21 mgl^{-1} for dredging as part of seabed preparation for gravity bases and 25 mgl^{-1} for drilling for the installation of pin piles) and in the main plume (where it lowers down to 10 mgl^{-1} or less) should be noted in this context. Similarly, the very localised and short term nature of effects in excess of this (i.e. local effects around construction vessels and cable installation activity) also need to be recognised in this context.

59. Taking the above into account adult and juvenile salmon and sea trout are considered receptors of low sensitivity to the expected increase in SSCs and its effect is assessed to be negligible and probable. This is not a likely significant effect in terms of the EIA Regulations.

Increased SSCs and Sediment Re-deposition Effect Summary

60. Table 5.7 presents a summary of increased SSCs and sediment re-deposition impact assessment described above. The significance ratings given remain unchanged from those provided in the Original ES.

Table 5.7: Increased SSCs and Sediment Re-deposition Assessment Summary

Receptor		Sensitivity of Receptor	Magnitude of Effect	Nature	Assessment of Effect	Probability
Salmon and Sea Trout	Eggs/Larvae	n/a	n/a	n/a	n/a	n/a
	Adults/Juveniles	Low	Small	-	Negligible	Probable
Cod	Eggs /Larvae	Medium	Small	Negative	Minor	Probable
	Adults/ Juvenile	Low	Small	-	Negligible	Probable
Herring	Eggs /Larvae	Medium	Small	Negative	Minor	Probable
	Adults/juveniles	Low	Small	-	Negligible	Probable
Sandeels	Eggs /Larvae	Medium	Small	Negative	Minor	Probable
	Adults/juveniles	Low	Small	-	Negligible	Probable

Noise

61. As presented in Section 11.4.1.2 of the Original ES, impact piling is the noise generating activity with greatest potential to result in likely significant effects on fish receptors. As a result, the noise modelling exercise and the assessment of the effect of construction noise on fish has been based on the piling noise source.

62. The criteria used to assess behavioural effects as a result of piling noise are summarised in Table 5.8.

Table 5.8: Criteria used to Assess Effects on Fish as a Result of Piling Noise

Level of dB_{ht} (Species) Effect	**Effect**
75 and above	85% of individuals will react to noise, although the effect will be probably transient and limited by habituation
90 and above	Strong avoidance reaction by virtually all individuals
Above 110	Tolerance limit of sound; unbearably loud
Above 130	Possibility of traumatic hearing damage from single event

63. As presented in Section 11.4.1.2 of the Original ES, levels above 110 and 130 dB_{ht} (Species) will only occur in the immediate vicinity of where piling operations take place, having very small impact ranges (order of tens to few hundred of metres at the 130 dB_{ht} (Species) level, depending on species specific sensitivities). In addition, soft start piling will be used with the aim of triggering avoidance reactions in mobile species in the immediate vicinity of piling locations in advance of the highest noise levels being reached. This will therefore act as direct mitigation in reducing the potential for injury and lethal effects to occur on fish receptors.

64. In light of the above, the assessment of construction noise is focussed on the potential effects on fish at the behavioural level, being primarily based upon the 90 dB_{ht} (Species) modelling outputs, as this is the level at which the strongest avoidance reactions are expected. Consideration has however also be given to the 75 dB_{ht} (Species) modelling outputs, at which milder effects, probably transient and limited by habituation, are expected to occur.

65. As described in Section 5.5.1.1 two worst case scenarios in relation to construction noise have been used in this assessment. These are summarised in Table 5.9 and Table 5.10. Scenario 1 provides an indication of the worst case duration of the construction phase and total piling duration, being based on the use of one piling vessel; Scenario 2 provides an indication of the worst case spatial effect of piling noise at a given time, being based on the use of two piling vessels concurrently. It should be noted that the latter would result in a reduction of the total duration of the construction phase and total piling time and therefore in a reduction of the overall period of time during which fish receptors may be subject to the effects of construction noise.

Table 5.9: Scenario 1

Species	Locations	dB_{ht}(Species) Level	Simultaneous Piling	Construction Period	Piling Duration
Salmon*	C	90 and 75	No (only one piling operation at any given time)	3 years	Approx. 21% of total construction period
Cod	A	90 and 75			
Herring	D	90 and 75			

* Surrogate for sea trout

Table 5.10: Scenario 2

Species	Locations	dB_{ht}(Species) Level	Simultaneous Piling	Construction Period	Piling Duration
Salmon *	A and B	90 and 75	Yes (up to two piling operations occurring concurrently)	2 years	Between 16% and <32% of total construction period (16% assuming simultaneous piling occurs all the time)
Cod	A and E	90 and 75			
Herring	C and D	90 and 75			

* Surrogate for sea trout

66. The outputs of the noise modelling are illustrated in Figure 5.2 to 5.4 for Scenario 1 and Figure 5.5 to Figure 5.7 for Scenario 2.

67. In order to help the assessment and provide an indication of the ecological significance of the predicted effect using both scenarios, the location of spawning grounds is shown for herring and cod and, in the case of salmon and sea trout, the location of rivers designated as Special Areas of Conservation (SACs). It should be noted that in all cases, the modelled outputs shown represent the worst case piling location for each receptor. In this context, the limited piling activity which may occur at the modelled locations and their immediate vicinity should be recognised (i.e. in the case of 277 turbines, only one pile would be installed at the worst case location modelled).

68. In the particular case of salmon and sea trout, the uncertainties in relation to the migratory routes and behaviour of these species in the marine environment are recognised. The assessment has focused on salmon and sea trout originating in the Moray Firth area, the potential for salmon and sea trout from other areas to transit the area of the Wind Farm should however also be noted.

69. The magnitude of the potential effect associated with Scenarios 1 and 2 is described below:

- Based on the noise modelling outputs for salmon (surrogate for sea trout) (Figure 5.2 and Figure 5.5) and the intermittent and short time nature of piling (assuming a worst case of 5 hours piling per pile) the magnitude of the effect is considered to be small. This is applicable to both Scenario 1 and Scenario 2; and

- Based on the noise modelling outputs for cod and herring (Figures 5.3 and 5.4 and Figures 5.6 and 5.7) and the intermittent and short time nature of piling (assuming a worst case of 5 hours per pile) the magnitude of the effect is considered to be medium. As for salmon, this magnitude is considered to be applicable to both Scenario 1 and Scenario 2.

70. In the absence of detailed information on the migratory routes of salmon and sea trout, it is assumed that they transit the Wind Farm as part of their migration. In addition, they are assumed to transit the Site as part of their foraging activity (particularly sea trout). As shown in Figures 5.2 and 5.5, areas in the immediate vicinity of the rivers will not be affected at the 90 dB_{ht} level, and therefore strong behavioural reactions are not expected in salmon and sea trout immediately prior to river entry or after leaving the rivers. As strong avoidance reactions may only occur in small discrete areas, it is not considered that barrier effects or significant delays in migration may occur in these species. Similarly, where these small areas are avoided during foraging activity, the effect on both salmon and sea trout is considered to be limited, as they will be able to find suitable prey in adjacent areas.

71. Given the importance of salmon and sea trout both from a conservation point of view and as a fishery, and taking into account the relatively larger areas affected at 75 dB_{ht} levels, they are considered receptors of medium sensitivity. This takes account of the uncertainty in relation to the implications of transient avoidance effects on these species and on whether habituation to noise in migrating fish at 75dB_{ht} levels may take place. Taking this into account, together with the small magnitude of effect previously defined, the effect of construction noise is assessed to be negative, minor and probable. This is not a likely significant effect in terms of the EIA Regulations.

72. The cod population of the Moray Firth is genetically distinct from other North Sea cod populations and spawning activity has been low in recent years. In addition they are known to use the Moray Firth as a nursery ground (Original ES, Annex 11A: Fish and Shellfish Ecology Technical Report). Noise contours at the 90 dB_{ht} (Species) level may overlap with a large area of their spawning and nursery grounds (Figures 5.3 and 5.6). It should be noted that the precise location, spatial extent and relative importance of the areas currently used by cod for spawning and as nursery grounds in the Moray Firth is not well defined. These areas are however likely to be currently smaller than those defined in Coull et al, (1998) and Ellis et al. (2010) (see Original ES, Annex 11A: Fish and Shellfish Ecology Technical Report). In addition, cod are pelagic spawners not needing the presence of a specific substrate on which to lay their eggs and hence spawning is not as spatially restricted as for other species (such as herring).

73. Cod has been considered a receptor of medium sensitivity and the effect of construction noise is assessed to be negative, moderate and probable. For an effect of moderate significance to occur the distribution of currently active cod spawning and nursery grounds would have to be limited to the Wind Farm Site and its immediate vicinity. This is a likely significant effect in terms of the EIA Regulations.

74. Herring are known to spawn in the Moray Firth and use the area as a nursery ground. They are important as prey species for a number of other marine organisms. In addition, they are substrate specific spawners needing the presence of an adequate coarse substrate on which to lay their eggs. It should be noted, however, that the highest intensity of herring spawning tends to take place in the area between the Orkney and the Shetlands in most years, and that gravelly substrate is available to the Orkney/Shetland stock in various areas unaffected at the 90 dB_{ht} (*Clupea harengus*) level (Figure 11.7 of Annex 11A: Fish and Shellfish Ecology Technical Report). It is recognised, however, that there is substantial annual variability in the areas used and intensity of spawning in the Moray Firth area, with spawning activity off the Caithness coast also being of relative importance in some years.

75. Taking the uncertainties in relation to exact spawning location and intensity during the construction phase of the Wind Farm, herring are considered receptors of medium sensitivity and the effect is assessed to be negative, moderate and probable. This is a likely significant effect in terms of the EIA Regulations.

Construction Noise Assessment Summary

76. The assessment of the potential effect of construction noise on salmon and sea trout, cod and herring is summarised in Table 5.11 below. This has changed from that provided in the Original ES with the exception salmon and sea trout. These changes relate to the probability of a moderate effect occurring on herring and cod, which has been increased to probable. This takes account of MSS response in this respect, based on the potential for piling noise to add further pressure upon the Orkney/Shetland herring stock which, as mentioned above, is the least stable of the herring stocks. MSS have also stated that due to the uncertainty surrounding the distribution of cod within and around the BOWL site and wider Moray Firth the impacts from noise should, at this stage, be classed as probable.

Table 5.11: Construction Noise Assessment Summary

Receptor	Sensitivity of Receptor	Magnitude of Effect	Nature	Assessment of Effect	Probability
Salmon and sea trout	Medium	Small	Negative	Minor	Probable
Cod	Medium	Medium	Negative	Moderate	Probable*
Herring	Medium	Medium	Negative	Moderate	Probable*

*This has been revised from unlikely to probable following consultation with MSS.

5.6.1.2 Operation

77. A review of the effects assessed in the Original ES Chapter for the operational phase of the Wind Farm is given below. These are as follows:

- Loss of habitat;
- Introduction of new habitat;
- EMFs;

- Noise; and
- Changes to fishing activity.

Loss of Habitat

78. The assessment of the potential impact of loss of habitat remains unchanged from that provided in Section 11.4.2.1 the Original ES. In the particular case of sandeels, further discussion on the assessment is provided below, given the concerns raised by stakeholders in relation to this species (Table 5.1).

79. As defined in the Original ES, the installation of the Wind Farm will result in a loss of habitat proportional to the total footprint of the development. The worst case habitat loss associated with this was estimated to be of approximately 3.8 km², accounting for just under 2.9% of the total seabed within the Wind Farm Site. On the basis of the small worst case area of seabed expected to be lost the magnitude of the effect was considered to be negligible.

80. For a substantial loss of habitat to occur on sandeels, Wind Farm related infrastructure would have to be consistently placed in areas where high densities of sandeel are present. Sandeels are substrate specific and inhabit discreet patches of seabed. They are known to be present in the Smith Bank, however, information in relation to their relative abundance and overall distribution in the Wind Farm Site, as well as in the wider Moray Firth, is currently limited. As shown in MORL, 2012, sandeels were found in the Wind Farm Site in small numbers in grab and beam trawl samples collected during the benthic surveys. In line with this, data on the distribution of seabirds (which are known to rely on sandeels as prey) also presented in MORL, 2012, do not suggest that the Wind Farm Site sustains key sandeel populations. The limitations of these data are however recognised. The number of sandeels caught in beam trawl samples and in grab samples are indicative of presence by species and are not to be used from a quantitative point of view, as sampling methods (i.e. beam trawl) and survey design (i.e. sampling locations and timing of surveys) were not selected taking account of the life cycle and catchability of sandeels. In the particular case of seabird distribution data, whilst this provides further context and information, caution should be taken when inferring the distribution of prey based on predator distribution. The presence of predators in a given area at a given time may not necessarily be a direct result of the presence of prey.

81. The lack of sandeel specific sampling in the area of the Wind Farm Site, and hence the uncertainty in relation to their actual distribution and relative abundance within the Wind Farm Site, is therefore recognised.

82. Sandeels are of conservation importance and key prey to a number of species of seabirds, marine mammals and fish. Taking this into account, as well as their substrate specificity and patchiness in distribution, they were assigned a high level of sensitivity in Section 11.4.2.1 of the Original ES.

83. Whilst their sensitivity was recognised throughout Section 11: Fish and Shellfish Ecology, of the Original ES, the effect of loss of habitat was assessed to be negligible

and probable following the standard impact assessment matrix used in the impact assessment (see Table 5.3).

84. During a post submission consultation meeting with Marine Scotland (MS) and SNH held on 5th October 2012, the need for a more conservative approach to the assessment of the effect of loss of habitat on sandeels was discussed, on the basis of the lack of site specific data on their distribution within the Wind Farm Site. It was agreed that the potential effect of loss of habitat on sandeels should be re-assessed to be negative, of minor significance and probable. This remains not a likely significant effect in terms of the EIA Regulations.

Loss of Habitat Assessment Summary

85. Table 5.12 provides a summary of the assessment of loss of habitat on the receptors relevant to this section. The assessment remains unchanged from that provided in the Original ES, with the exception of the assessment on sandeels, for which a more conservative approach has been taken in recognition of the lack of site specific data and the uncertainty in relation to the potential degree of overlap between Wind Farm infrastructure and sandeels.

Table 5.12: Loss of Habitat Assessment Summary

Receptor	Sensitivity of Receptor	Magnitude of Effect	Nature	Assessment of Effect	Probability
Salmon and sea trout	Low	Negligible	-	Negligible	Probable
Cod	Low	Negligible	-	Negligible	Probable
Herring	Medium	Negligible	-	Negligible	Probable
Sandeels	High	Negligible	Negative	Minor *	Probable

*Assessed as Negligible in the Original ES

Introduction of New Habitat

86. The assessment of introduction of new habitat remains unchanged from that provided in Section 11.4.2.2 of the Original ES. Given the concern raised in stakeholders responses to this respect (Table 5.1) further discussion on the information provided in the Original ES is provided below.

87. As described in the Original ES, the results of monitoring programmes undertaken to date in operational wind farms in the UK and other European countries do not suggest that the introduction of hard substrate has resulted in significant changes in the fish assemblage nor in the presence/absence and relative abundance of individual fish species in the area. Whilst the potential for fish to aggregate around individual turbines potentially exploiting increased food resources and/or finding shelter has been recorded, there is currently no evidence to suggest that likely significant effects on fish are likely to occur. Individual fish species may be subject to increased predation, however, as described above, the current knowledge derived from the results of monitoring work in operational wind farms, does not

indicate that there is potential for likely significant effects associated with this to occur, both to a species specific and fish community level.

88. Whilst the uncertainties in relation to the potential effects on an individual species basis are recognised, taking the current state of knowledge into account, it is considered that, at worst, the potential effects associated with the introduction of hard substrate will be of minor significance and probable. This assessment remains unchanged from that provided in Section 11.4.2.2 of the Original ES Chapter. Whether these are positive or negative in nature will depend on the species under consideration and will likely be subject to change during the operational phase of the Wind Farm, as changes in the benthic communities occur. However, this effect is not a likely significant effect in relation to the EIA Regulations.

Introduction of New Habitat Assessment Summary

89. Table 5.13 provides a summary of the assessment of potential effects of introduction of new habitat on relevant receptors. This remains unchanged from that provided in the Original ES.

Table 5.13: Introduction of New Habitat Assessment Summary

Receptor	Nature	Assessment of Effect	Probability
Salmon and sea trout	Negative/Positive	Minor	Probable
Cod			
Herring			

Electromagnetic Fields (EMFs)

90. The assessment of the potential effects of EMFs remains unchanged from that provided in Section 11.4.2.3 the Original ES. Taking into account the small area where EMF related effects may occur, limited to the area of the Wind Farm and only in close proximity to the cables, the magnitude of the effect of EMFs is considered to be small and cod and herring are considered receptors of low sensitivity. As suggested by the results of monitoring programmes carried out in operational wind farms, there is no evidence to suggest that EMFs have resulted in detrimental effects on fish species. The effect of EMFs on cod and herring is therefore assessed to be negligible and probable. This is not a likely significant effect in terms of the EIA Regulations.

91. In the particular case of salmon and sea trout, their potential exposure to EMFs would be closely linked to the proximity of the fish to the source of EMF. Salmon and sea trout are thought to normally swim in the upper metres of the water column during migration. There are, however, records of salmon diving to considerable depths. This behaviour is considered to be associated with feeding. In the case of sea trout, they may be in the proximity of cables, if feeding on benthic prey in the area of the Wind Farm. Detailed information on the swimming depths of salmonids in the marine environment is currently lacking and is currently the subject of research by MSS. Similarly, information on the magnetic field strength at

which salmon and sea trout may respond to are currently unknown. This is also subject of additional research by MSS.

92. The magnetic fields produced by wind farm cables are very low compared to the earth's background magnetic field. Salmon and sea trout are, however, of importance from a conservation point of view and as a fishery. In addition, given that cables are linear features requiring fish to pass over them, salmon and sea trout are considered receptors of medium sensitivity and the effect of EMFs is assessed to be negative, minor and probable. This is not a likely significant effect in terms of the EIA Regulations. This is in line with the MSS response to the Original ES where it is stated that the very low magnetic fields expected from the cables compared to the Earths' magnetic field generally support the assertion of a minor negative but probable impact for salmon and sea trout (See Table 5.14).

93. The uncertainty in relation to this assessment, given the limited information available in relation to the behaviour of these species in the marine environment, and the lack of species specific data on the magnetic fields strengths at which salmonids may respond, is however recognised.

EMFs Assessment Summary

94. Table 5.14 below provides a summary of the assessment of potential effects of EMFs on relevant receptors. This remains unchanged from that provided in the original ES.

Table 5.14: EMFs Assessment Summary

Receptor	Sensitivity of Receptor	Magnitude of Effect	Nature	Assessment of Effect	Probability
Salmon and sea trout	Medium	Small	Negative	Minor	Probable
Cod	Low	Small	-	Negligible	Probable
Herring					

Noise

95. The assessment of the effect of operational noise on fish remains unchanged from that provided in Section 11.4.2.4 the Original ES, for fish in general (including herring and cod), where it was considered to be negative, minor and unlikely. This is not a likely significant effect in terms of the EIA Regulations. This lack of species specific robust field based data on fish movements in operational wind farms is however noted in this context.

Noise Assessment Summary

96. A summary of the operational noise impact assessment for relevant fish receptors is given below in Table 5.15. The predicted effects are unchanged from those presented in the Original ES.

Table 5.15: Operational Noise Assessment Summary

Receptor	Nature	Assessment of Effect	Probability
Salmon and sea trout	Negative	Minor	Unlikely
Cod	Negative	Minor	Unlikely
Herring	Negative	Minor	Unlikely

Changes to Fishing Activity

97. In the Original ES (Section 11.4.2.5) the potential for benthic communities to benefit as a result of a decrease in fishing activity was noted together with the potential for this to benefit fish species (provided the productivity of the area increased). Similarly, the potential for beneficial effects on target and by-catch species in the area as a result of decreasing fishing effort was also noted.

98. As suggested by the findings of the Section 16: Commercial Fisheries assessment of the Original ES, although reduced to some extent, fishing will be able to continue during the operational phase. The magnitude of the effect associated with this was, on this basis, assessed to be negligible. The principal target species in the area of the Wind Farm, scallops, was assigned a sensitivity of high, whilst the remaining fish receptors (including salmon and sea trout, cod, herring and sandeels) were assigned low/medium sensitivity.

99. Whilst the potential for displacement of fishing activity into sensitive areas is noted, the uncertainty at this stage in relation to the degree to which fishing may be reduced in the Wind Farm and the areas where fishing effort may be potentially displaced should be recognised. Furthermore, in the case of some species (particularly sandeels) the lack of information on their distribution, not only within the Wind Farm Site but also in the wider Moray Firth, it is not possible for a detailed assessment to be made, although the conservative assumption that sandeels are present within the Wind Farm Site has been made. On the basis of the limited magnitude of the effect (as identified above) it is, however, not considered that there is potential for likely significant effects to occur as a result of changes to fishing activity. The assessment therefore remains as provided in the Original ES, where changes to fishing activity were assessed to be negligible and probable. This is not a likely significant effect in terms of the EIA Regulations.

100. The uncertainty of this assessment particularly on a species specific basis is, however, fully recognised.

Changes to Fishing Activity Assessment Summary

101. Table 5.16 below provides a summary of the assessment of changes to fishing activity on relevant receptors. This remains unchanged from that provided in the Original ES.

Table 5.16: Changes to Fishing Activity Assessment Summary

Receptor	Sensitivity of Receptor	Magnitude of Effect	Nature	Assessment of Effect	Probability
Salmon and sea trout	Low/Medium	Negligible	-	Negligible	Probable
Cod					
Herring					
Sandeels					

5.6.2 WORST CASE SCENARIO - OFTW

102. Section 4: Amended Project Description details the amendment to the Original OfTW corridor which is assessed within this Addendum.

103. As described in the Section 23: Fish and Shellfish Ecology of the Original ES, likely significant effects associated with the construction, operational and decommissioning phases of the OfTW were not identified during the assessment.

104. It is not considered that the additional area resulting from the amendment to the Original OfTW Corridor will result in effects materially different to those assessed in Section 23: OfTW Fish and Shellfish Ecology of the Original ES.

5.6.2.1 Electromagnetic Fields (EMFs)

105. Regarding EMF, the amendment to the Original OfTW Corridor would not result in effects of greater significance than those assessed in Section 23: OfTW Fish and Shellfish Ecology of the Original ES. Therefore the assessment of effects regarding EMF remains unchanged from that detailed in the Original ES Section 23.4.2.1.

5.6.2.2 Increased Suspended Sediment Concentrations (SSCs) and Sediment Re-Deposition

106. In the case of the change in the duration of OfTW cable installation activities, this could have an effect in terms of increased SSCs and sediment re-deposition and underwater noise. As described in Section 23.4.1.1 and further detailed in Section 21: OfTW Physical Processes and Geomorphology of the Original ES, the magnitude of increased SSCs and sediment re-deposition was considered to be small, taking the very localised areas which will be disturbed and the very short term of the disturbance, the change in duration of OfTW cable installation activities is not considered to increase the assessed magnitude of the effect (small) assigned in the Original ES.

5.6.2.3 Noise

107. In respect of noise associated with OfTW cable installation activities, as described in Section 23.4.1.2 of the Original ES, the magnitude of the effect was considered to be negligible given the small impact ranges predicted. As above, the change in duration of OfTW cable installation activities is not considered to increase the assessed magnitude of the effect (negligible) assigned in the Original ES. In light of

the above, the assessment remains unchanged from that provided in the Original ES.

108. The proximity of the cable landfall to the Spey SAC was recognised in Section 23: OfTW Fish and Shellfish Ecology of the Original ES. The OfTW cable installation methods used in the near shore area are described in detail in Section 4: Amended Project Description. As suggested by ASFB in their response to the Original ES, consultation with relevant authorities will be on-going to discuss issues surrounding potential disturbance to migratory species of conservation importance and potentially identify suitable mitigation measures.

5.6.3 CONSIDERATION OF THE MOST LIKELY SCENARIO – WIND FARM

109. Section 4: Amended Project Description presents the most likely scenario for the Amended Project. The parameters for fish and shellfish ecology are shown in Table 5.6. The assessments presented Section 5.6.1 and Sections 11.4 and 23.4 the Original ES present the worst case parameters of the Rochdale Envelope in accordance with the requirements of the EIA Regulations. This Section presents a qualitative discussion of the most likely scenario and its potential effects on relevant fish species.

5.6.3.1 Construction and Decommissioning

Increased Suspended Sediment Concentrations and Sediment Re-deposition

110. As described in the Section 9: Wind Farm Physical Processes and Geomorphology, of the Original ES, installation of jackets on pin piles foundations will result in similar levels of increased SSCs and sediment re-deposition to those associated with seabed preparation for installation of gravity bases. It should be noted, in this context, that drilling to facilitate pin pile installation may only be required in a limited number of locations, subject to the characteristics of the substrate. In addition, the likely number of turbines to be installed is 140 as opposed to 277 (the maximum number of turbines assessed as the worst case scenario). This would result in a decrease in both the frequency and total duration of disturbance associated with SSCs and sediment re-deposition. Taking the above into account, the effects of increased SSCs and sediment re-deposition on fish receptors are expected to be less than those described in the Original ES. The conservative assumptions made for the purposes of modelling increased SSCs and sediment re-deposition made in Section 9: Wind Farm Physical Processes and Geomorphology of the Original ES should also be noted in this context.

Noise

111. The most likely scenario in terms of piling is based on the use of one piling vessel and an overall construction period of 3 years, with piling occurring for one year. The total installation time per jacket location (assuming 4 piles) is estimated at 30-38 hours for a typical scenario. This includes pre-site works, vessel positioning, pile preparation, etc. The duration of active piling is likely to be between 3 and 5 hours per pile depending on the characteristics of the substrate. The maximum blow force of hammer to be used for driving turbine and substation piles is 2,300 kJ. Note that this is the blow force used in the modelling of the worst case scenario used for the

purposes of the impact assessment above. Whilst a smaller blow force may be required, at this stage, the use of 2,300 kJ blow force cannot be ruled out.

112. The noise modelling outputs shown in Figure 5.2, Figure 5.3 and Figure 5.4 (where worst case Scenario 1 was illustrated) do therefore provide an indication of the likely expected impact ranges. It should be noted, however, that given the reduced likely number of turbines requiring installation (140 as opposed to 277), assuming active piling for individual piles takes between 3 and 5 hours and taking an overall construction period of 3 years, piling would only occur during approximately 6.4%-10.7% of the construction phase. This would reduce the frequency of noise related effects and potentially lessen the significance of the effects identified using the worst case parameters in Section 5.5.1.1 It should also be noted in this context that most likely scenario considers that the majority of the piling activity will be undertaken during the first year of Wind Farm construction. This would reduce the number of spawning events potentially affected by construction noise in the case of herring and cod to one instead of three or two. Similarly, in the case of salmonids, it would result in disturbance to one run of smolts exiting rivers rather than two or three. Similarly, returning salmon would be potentially affected during one year. This would also be the case for seat trout, whether migrating through and/or feeding in areas disturbed by construction noise.

5.6.3.2 Operation

Loss of Habitat

113. Compared to the worst case scenario, the most likely scenario would result in a substantial reduction in total area of seabed directly affected by the Wind Farm. In the Original ES, the worst case of habitat loss was based on the use of gravity base foundations of the largest diameter. As shown in the most likely scenario given in Table 5.6, it is likely that pin-piles on jackets will be used. In addition, the total number of turbines is likely to be 140 as opposed to 277.

114. A comparative indication of the footprint of worst case and most likely foundations is given in Table 5.17.

Table 5.17: Comparison of Zone of Influence for Worst Case and Most Likely Scenario Foundations

Zone of Influence per Turbine	**Worst Case (277 turbines)**		**Most Likely Case (140 turbines)**
	Gravity Bases	**Pin piles (2.4 m diameter) on jackets**	**Pin piles (1.8 m diameter) on jackets**
Maximum Footprint (areas of seabed in direct contact with structure)	3,318 m^2	14 m^2	11 m^2
Shadow (area of seabed over which structure is sited)	3,318 m^2	6,145 m^2	2,153 m^2
Maximum Permanent Zone of Influence	18,385 m^2	7,644 m^2	3,073 m^2

115. As shown in Table 5.17, the area of seabed affected by the introduction of pin piles on jackets compared to that affected as a result of the introduction of gravity bases is substantially smaller. It should also be noted that the total length of inter array cable required in the most likely case is 260 km as opposed to the 350 km (assessed as worst case) and it is likely that 230 km out of the 260 km of inter array cabling will be buried. As a result, the potential loss of habitat associated with cable protection (i.e. rock dumping/matressing) will also be reduced.

116. Taking account of the most likely scenario, the potential effects on fish receptors, particularly sandeels, are likely to be reduced.

Introduction of New Habitat

117. The most likely scenario will also result in a substantial decrease in the amount of hard substrate introduced (proportional to the loss of habitat described above). Given the uncertainties and complexity of the potential interactions between hard substrate, the benthic community and fish receptors, it is not possible to ascertain whether the effects will be reduced from those assessed in the worst case.

Electromagnetic Fields (EMFs)

118. The maximum length of inter-array cabling will most likely be 260 km as opposed to the 350 km used for assessment of worst case in the Section 11.4.2.3 of the Original ES. In addition, cable will be buried or protected where feasible and the minimum burial depth will be 1 m as opposed to 0.6 m used for assessment of the worst case scenario.

119. The smaller length of cabling, together with the increased minimum burial depth, will reduce the potential for sensitive species to interact with EMFs, and therefore likely reducing the potential effect identified taking account of the worst case parameters.

Noise

120. Installation of 140 turbines instead of 277 may lessen the potential effects associated with operational noise. This will, however, be dependent on the final location, layout and distance between turbines and subject to potential different sensitivities of particular fish receptors. It is reasonable to assume, however, that taking account of the most likely scenario, the effect of operational noise on fish receptors will, at worst, be as assessed for the worst case scenario in Section 5.6.1.2.

Changes to Fishing Activity

121. Installation of 140 turbines instead of 277 may lessen the potential effects associated with changes to fishing activity. This will however be dependent on the final location, layout and distance between turbines and subject to the uncertainties outlined in respect to changes to fishing activity in Section 5.6.1.2.

5.6.4 CONSIDERATION OF THE MOST LIKELY SCENARIO – OFTW

5.6.4.1 Increased Suspended Sediment Concentrations (SSCs) and Sediment Re-deposition

122. The effect of sediment disturbance on fish receptors associated with the installation of the OfTW is expected to be reduced, taking account of the most likely scenario.

In comparison to the potential effects for the worst case scenario assessment presented in Section 21: OfTW Physical Processes and Geomorphology, of the Original ES, the most likely scenario will lead to a reduction of 32% in the sediment volume released during installation works based on the assumptions set out in Section 9: Physical Processes and Geomorphology of this ES Addendum. As per the worst case assessment, increases in SSC will remain local and temporary in nature and may be of a (32%) smaller magnitude. The extent of deposition effects will likely remain unchanged but the thickness of any resulting sediment deposits would be reduced also by 32%.

123. The most likely scenario for the maximum length of cable which will require protection is 10.7 km instead of 45% of the total cable length originally assessed. This will lessen the potential degree of interaction between fish receptors and EMFs as the majority of the export cable will likely be buried. It should also be noted that the cable burial depth (assumed to be 0.6 m in the worst case scenario) is likely to be 1 m. This would further reduce and mitigate any potential effects associated with EMFs on sensitive species.

5.6.4.2 Noise

124. Regarding noise and vibration, the most likely scenario for the reduced OfTW cable installation time may well result in the reduction in the magnitude of the potential effects associated with noise and vibration. However, when considering the most likely scenario it is reasonable to assume that the effect of noise on fish receptors will not result in effects of greater significance than those assessed in the Original ES Section 23: OfTW Fish and Shellfish Ecology. Therefore the assessment of effects regarding noise remains unchanged from that detailed in the Original ES Section 23.4.1.2.

5.7 MITIGATION MEASURES AND RESIDUAL EFFECTS

125. There are a range of mitigation measures which may be implemented during the construction of the Wind Farm. BOWL is committed to ongoing consultation with MSS, SNH and the ASFB to discuss and further refine any proposed mitigation measures.

126. When piling commences a 'soft-start' procedure will be employed and the force of piling will gradually be increased to alert species in the vicinity to the commencement of the operations and thus reduce the potential for injury to these species. The soft-start is the gradual ramping up of piling power, incrementally over a set time period, until full operational power is achieved. In line with best practice guidelines, BOWL will implement a soft-start period of not less than 20 minutes. Until further geotechnical data is made available, no further information is available on the ramping up process and soft-start procedure, this will, however, be further defined in the construction management statement.

127. In addition to the measures outlined above, BOWL is committed to reducing effects on fish as a result of piling noise through the implementation of a range of measures during piling. These include:

- If concurrent piling operations are undertaken, vessels will operate at no more than 5 km from each other. The purpose of this will be to minimise the potential area of ensonification from that presented in the worst case, and the use of two vessels should also decrease the installation programme; and
- Upon receiving detailed geotechnical information, BOWL will develop a piling strategy with the aim of minimising effects on agreed species throughout the construction period. The current Rochdale Envelope currently allows for the use of hammer energy up to 2,300 kJ, although the most likely scenario is that the largest hammer energy will not be required across the entire Wind Farm. Where possible the piling programme will determine what hammer energies are most likely to be used at specific locations in advance of any piling commencing, which will allow the development of a piling programme that has measures embedded within it to reduce the effects on fish species when compared to the worst case scenario presented in the Original ES and ES Addendum. This may include measures such as the spatial phasing of piling across the Wind Farm to minimise effects on the more sensitive parts of the Moray Firth during certain times of the year. As the detailed geotechnical information is not yet available, the specific measures which will be used cannot be defined. However, BOWL will continue discussions with Marine Scotland and relevant consultees in order to devise a piling strategy with the aim of minimising certain impacts where possible.

128. Given the uncertainties in relation to the use that salmonids make of the Moray Firth Area, however, the definition of effective mitigation measures is limited at this stage. As previously mentioned, potential forms of mitigation could be considered in more detail requiring discussion with the relevant competent authorities.

129. Taking the above into account, the residual effects associated with the construction/decommissioning and operational phases of the Wind Farm are therefore as assessed in Section 5.6 for the Wind Farm and OfTW.

5.8 MONITORING

130. Based on recommendations made by MSS, BOWL is committed, in consultation with Marine Scotland, to undertake the appropriate additional surveys as a condition of consent. These may include;

- Sandeel survey; and
- Cod survey.

131. In order to reduce duplication of effort such as mobilisation and demobilisation of vessels, surveys will be combined where possible. BOWL in consultation with MSS and other stakeholders will ensure that survey methodology, rationale and approach is consistent and that surveys are undertaken at the appropriate time of year.

132. The objective of the surveys would be to substantiate baseline presence of the species listed above (sandeel and cod) so that results can be compared post construction to assess potential effects of the development and to validate assessments made in the ES.

133. In addition BOWL is currently engaging with MSS and other developers to define an adequate salmon and sea trout monitoring strategy.

134. It is worth noting that SSE Hydro Generation, which forms part of SSE, has long standing relationships with various Salmon Fishery Boards (some dating back several decades). As far back as the 1943 Act of Parliament that established the North of Scotland Hydro Electric Board, there was a requirement on the company to avoid, as far as possible, injury to fisheries and the stock of fish.

135. SSE Hydro Generation has various existing monitoring programmes in north eastern Scotland and there may be potential to input into some of the relevant existing monitoring programmes already established.

136. SSE's Hydro Generation holds fish count data at the following ten sites on rivers that flow into the Moray Firth:

- River Cassley: Duchally Diversion Weir
- River Shin: Shin Diversion Weir
- River Conon: Torr Achility Power Station
- River Conon: Luichart Dam
- River Conon: Meig Diversion Weir
- River Beauly: Aigas Dam
- River Beauly: Kilmorack Dam
- River Beauly: Beannachran Dam
- River Ness: Dundreggan Dam (River Moriston)
- River Ness: Invergarry Dam (River Garry)

137. Fish counts are collected and collated by SSE Hydro Generation by using the latest iteration of a type of resistivity counter. These have been video validated. Some sites are located relatively low down the catchments and regularly count thousands of ascending salmon and others are located further upstream and count many fewer fish in a season.

138. The count data is made available to all the relevant local District Salmon Fishery Boards (DSFBs) on a fortnightly basis throughout the counting (salmon) season and as final counts at the end of each season. The existing counters have an automatic digital camera attached and so images of all the counting events are stored and made available on CD to the DSFBs and local Fishery Trust biologists at the end of each season. This enables counts to be validated. Accurate categorisation of grilse from multi sea winter salmon can also be attempted and subsequent egg deposition estimates derived. The count data has also been supplied on a fortnightly basis to the Freshwater Fisheries Lab - part of MSS for the last 20 years.

139. SSE Hydro Generation has a long history of working in partnership with the various DSFBs and associated Fisheries Trusts in the Moray Firth District. It has been heavily involved in supporting the production of fishery, ecological, hydrological and fluvio geomorphological data to enable management decisions to be taken from a solid evidence base. This work has included projects such as:

- Smolt trapping using Rotary Screw Traps (RSTs) and permanent "wolf" type traps. On the River Spey SSE Hydro Generation has commissioned the Spey Foundation to quantify smolt production on a couple of upper Spey tributaries over a four year period so that the data can be used to determine whether there is any effect on production following a proposed flow change on both tributaries;
- On the River Conon there is 15 years data on smolt trapping and the use of Passive Integrated Transponder (PIT) tags which have aided the quantification of freshwater smolt survival, subsequent marine survival and confirmation of the accuracy of adult homing to tributary of origin. A lot of this work has been jointly organised and funded by the Cromarty Firth DSFB, Marine Science Scotland and SSE Hydro Generation:
- On the River Conon SSE Hydro Generation support the Cromarty Firth DSFB to operate a large wild salmon mitigation stocking exercise. Large numbers of ascending adult salmon are trapped and used to produce on average 3 million eggs for restocking purposes. This is a unique system which without this intervention would not produce the level of smolt escapement that it should;
- Quantification of smolt escapement from upper Shin catchment using passive integrated transponder (PIT) tagging technology - partnership project undertaken by SSE Hydro Generation, Kyle of Sutherland DSFB and SEPA;
- Quantification of sediment movements in lower river Shin working with Geomorphologists from SEPA - with the aim of producing sediment management plans;
- Electrofishing surveys for juvenile salmonids commissioned by SSE Hydro Generation of the DSFBs to quantify access issues upstream of dams and weirs;
- SSE Hydro Generation's continual support for the Scottish Fisheries Coordination Centre (SFCC) - development of targeted training for Fisheries Managers, and the successful implementation of databases for storing accurate fish and habitat data - now used by MSS, SNH and SEPA; and
- Working closely with SEPA to try and deliver effective alterations to water management regimes to maximise ecological benefit and meet Water Framework Directive (WFD) targets of improving ecological potential at a number of water bodies classified as not meeting European standards, but at the same time maintaining the production of renewable energy output.

140. SSE Hydro Generation has long standing relationships with relevant DSFBs, and BOWL will aim to maintain and strengthen these relationships throughout the lifetime of the Project.

141. BOWL acknowledge that the monitoring described above is freshwater based however, BOWL's approach to monitoring (whether freshwater or marine) will be to work with MSS and the salmon fishery boards in order to identify suitable monitoring options or 'buy in' to existing monitoring schemes. The monitoring rational, methodology and specific species being targeted will be agreed with the relevant statutory, fishery board bodies and other local fishing industries.

142. It is noted that at the stage of submitting this ES Addendum, no specific monitoring strategies for salmon and sea trout have been devised although MSS are taking the lead to develop such monitoring. The monitoring programme will be designed to ensure that any predicted impacts are monitored and quantified, with objectives previously agreed by MSS.

5.9 ASSESSMENT OF CUMULATIVE EFFECTS

5.9.1 INTRODUCTION

143. The Original ES was submitted to MS-LOT in April 2012. At this time it was the first offshore wind farm application in Scottish Territorial Water and the wider Moray Firth. As outlined in Section 3: EIA Process and Methodology, the information regarding cumulative projects, and specifically the neighbouring Moray Firth Round 3 Zone was assessed based on the information available at the time of assessment. This section updates the assessment of cumulative effects based on the amendments to the baseline and consultee responses presented in Table 5.1, plus further and updated information on the Moray Firth Round 3 Zone, as presented in MORL's ES, which was submitted to MS-LOT in August 2012.

5.9.2 CUMULATIVE BASELINE

144. In general terms, the cumulative baseline is considered to remain unchanged from that provided in the Original ES. In the particular case of sandeels further information on their potential distribution and abundance in the Wind Farm has been provided (see MORL, 2012) where the distribution of sandeel predators (particularly seabirds) has been integrated.

145. It should be noted that site specific data are currently available for the adjacent Moray Firth Round 3 Zone, where a sandeel specific survey was carried out in 2012. The outcome of this research is included in MORL's ES (Volume 10, Part 1, Biological Environment Technical Appendices, Annex 4.3 C, Sandeel Survey) (MORL, 2012). The following presents a summary of the results of the MORL survey.

146. This survey indicated a generally patchy distribution of sandeels within the Moray Firth Round 3 Zone, with 29 out of the 114 stations sampled recording presence of the species, Where recorded, densities of sandeels were generally low and did not exceed 40 individuals at a single station. The results indicated that the survey area does not support large sandeel populations. However, the limitations of the survey method, and the patchy distribution of sandeels are noted. It is also noted that there is extensive suitable habitat type for sandeels throughout the Moray Firth (MORL, 2012).

5.9.3 CUMULATIVE ASSESSMENT METHOD

147. The cumulative assessment methodology is in general terms as described in Section 11.8 of Original ES Chapter. It differs however in the number of developments included for assessment with this assessment being focused on the potential cumulative effect of three wind farm projects within the Moray Firth Round 3 Zone; Telford, Stevenson and MacColl, referred to as the Offshore Generating Station, and

the associated Offshore Transmission Infrastructure (OfTI). A description of the elements included for assessment in MORL's ES is given below.

148. The Offshore Generating Station comprises the following infrastructure associated with the three proposed wind farms:

- Turbines and associated substructures and foundations;
- Inter-array cabling; and
- Offshore met mast (within one site only but location to be confirmed).

149. The OfTI comprises the following elements:

- Up to six AC Offshore Substation Platforms;
- Two AC/DC Offshore Converter Substation Platforms;
- Inter-platform cabling; and
- Offshore export cables.

150. Information on the worst case scenarios used for assessment of the Moray Firth Round 3 Zone Offshore Generating Station and OfTI as given in MORL's ES (Volume 3- Offshore Generating Station Impact Assessment, Chapter 7.2: Fish and Shellfish Ecology and Volume 4 - Transmission Infrastructure Impact Assessment, Chapter 10.2 Fish and Shellfish Ecology) is provided in Table 5.18 and Table 5.19, respectively.

Table 5.18: Rochdale Envelope Scenario used for Assessment of Potential Effects of the Offshore Generating Station on Fish and Shellfish Ecology *(MORL ES, Volume 3- Offshore Generating Station Impact Assessment, Chapter 7.2: Fish and Shellfish Ecology)*

Potential Effect	Wind Farm Design Parameters
Construction and Decommissioning	
Increased in suspended sediment concentrations and sediment re-deposition	**Seabed preparation for gravity base foundations installation:** Maximum number of turbines installed: 339; Max. base diameter: 65 m; and Dredger affected width: 125 m. **Drilling to facilitate pin pile installation**: Max. number of turbines 339; Max. pile diameter: 2.5 m; and Max. number of piles per foundation: four. **Inter-array cable burial:** Trenching by energetic means (i.e. jetting and dredging) **Max. total inter-array cabling length:** 572 km**;** **Target trench depth:** 1 m**;** and **Trench affected width per trench:** 6 m**:** **Max. number of cables in a trench**: one.
Noise	**Installation of turbine foundations:**

Potential Effect	Wind Farm Design Parameters
	Max. number of turbines installed: 339; Max. pile diameter: 2.5 m; Max. number of piles per foundations: four; and Max. number of simultaneous piling operations: six. **Installation of one met mast:** Monopile: 4.5 m diameter.
Operation	
Loss of habitat	**Max. net reduction of seabed habitat of 3.76 km² based on the following factors, equating to 1.27 % of total area of the three proposed wind farm sites:** Placement of gravity base foundations of 65 m diameter = 3,317 m² per turbine; Scour protection material = 3,770 m² per foundation; Cable protection associated with up to 4 J tubes per turbine assuming protection required up to 100 m distance from turbine and at 10 m width = 4,000 m² per turbine; and 339 turbines (if lowest rated options installed).
Introduction of New Habitat	**Maximum footprint of 2.63 km² based on the following factors, equating to 0.89 % of the total area of the three proposed wind farm sites:** Scour protection material = 3,770 m² per foundation; 339 turbines; One met mast foundation; and Cable protection associated with up to 4 J tubes per turbine assuming protection required up to 100 m distance from turbine and at 10 m width = 4,000 m² per turbine.
Noise	Max no of turbines: 339
EMFs	**Inter array cables:** Type: AC; Max. voltage: 66kV; Max. total inter array cabling length: 572 km; and Target trench depth: 1 m
Changes to Fishing Activity	Max number of turbines: 339

Table 5.19: Rochdale Envelope Scenario used for Assessment of Potential Effects the OfTI on Fish and Shellfish Ecology *(MORL ES, Volume 4-Transmission Infrastructure Impact Assessment, Chapter 10.2 Fish and Shellfish Ecology)*

Potential Effect	Wind Farm Design Parameters
Construction and Decommissioning	
Increased in suspended sediment concentrations and sediment re-deposition	**Seabed preparation for gravity base foundations installation:** Max. Number of OSPs: eight (six AC and two DC); Max number of GBS per OSP: four; Max. base diameter: 65 m; and Dredger affected width: 190 m.

Potential Effect	Wind Farm Design Parameters
	Drilling to facilitate pin pile installation: Max. Number of OSPs: eight (six AC and two DC); and Pile diameter: 3 m. **Cable installation by energetic means (i.e. jetting):** Inter-platform cable installation: -Trench affected width per trench: 6 m; and -Max. cabling length: 90 km. Offshore Export Cables installation: -Max. number of cable trenches: two; -Trench affected width per trench: 6 m; and -Cable length from wind farm to shore: 105 km.
Noise	**Impact Piling for installation of OSPs:** Max. number of OSPs: eight (six AC and two DC) Max. pile diameter: 3m; and Max. Number of piles: Up to 6-legged jacket for AC OSPs, up to 8-legged jacket for DC OSPs. **Noise related to cable installation activities**: Suction dredging; Cable laying; Rock placing; and Vessel noise.
Operation	
EMFs	**Inter-platform cabling:** Type: 220 kV AC; Max. number of OSPs: eight (six AC and two DC); Max. number of cables in a trench: one; Max. cabling length: 90 km; and Target trench depth: 1 m. **Offshore Export Cables:** Type: 320 kV DC; Max. number of cable trenches: two; Max. number of cables: four (two bundles of two cables in each trench); Cable length from wind farm to shore: maximum 105 km ;and Target trench depth: 1m
Changes to Fishing Activity	Max. Number of OSPs: Eight (Six AC and two DC); Max. Inter-platform cable Length: 90 km; and Max. Offshore Export cables Length: 105 km.

151. The worst case scenarios for assessment of cumulative effects used in respect of the Wind Farm and OfTW are as previously presented in Table 5.4 and Table 5.5.

5.9.4 ASSESSMENT OF CUMULATIVE EFFECTS

152. In order to undertake the assessment of cumulative effects between the Amended Project (Wind Farm and OfTW) and the Moray Firth Round 3 Zone Offshore Generating Stations and OfTI, relevant outputs of the ES carried out by MORL have been integrated in the assessment. These are presented in MORL's ES Volume 5-

Whole Project and Cumulative Impact Assessment, Section 12.1.8 Fish and Shellfish Ecology Assessment. As MORL's "Whole Project Assessment" takes account of the cumulative effects of the Offshore Generating Station together the OfTI, this is has been considered to be the most suitable assessment of the Moray Firth Round 3 Zone Project to include for cumulative assessment purposes.

153. As described in Section 5.6 of this ES Addendum, for the purposes of the assessment of cumulative effects only fish receptors for which likely significant effects (above minor) were identified in the Original ES, whether on a site specific basis, or cumulatively with other projects, and for which concern in the responses to the Original ES (Table 5.1) has been raised have been included for detailed assessment. These are salmon, sea trout, cod, herring and sandeels (*Ammodytidae spp.)*. In the particular case of sandeels, this section covers the potential for likely significant effects to occur on this species in relation to the assessment of increased SSCs, sediment re-deposition, changes to fishing activity and loss of habitat.

154. Potential effects on other species, and in the case of sandeels potential effects not listed above, are considered to remain unchanged from those previously presented in Section 11.8.5 of the Original ES.

155. The assessment of cumulative effects is provided in Table 5.20 below. This includes the residual effects associated with the Wind Farm, OfTW and Moray Firth Round 3 Zone Whole Project together with a rationale as to how the significance of potential effects has been determined. For consistency purposes, as presented in MORL's ES "Whole Project Assessment" the nature and probability of the effect is not given, the assessment being focused on the significance of the effect (negligible, minor, moderate, major).

Table 5.20: Assessment of Cumulative Effects of the Wind Farm, OfTW and the Moray Firth Round 3 Zone Whole Project

Effect	Receptor	Beatrice Project		Moray Firth Round 3 Zone Whole Project	Cumulative Assessment	Rationale
		Wind Farm	OfTW			
Construction						
Increased SSCs and sediment re-deposition)	Salmon and Sea trout	Negligible	Negligible	Minor	Minor	Taking the minor effects associated with both the Amended Project and the Moray Firth Round 3 Zone Whole Project it is considered that any cumulative effect will also be of minor significance. The very short term, localised and small expected increases in SSCs and sediment re-deposition need to be recognised in this context.
	Cod	Minor	Negligible	Minor	Minor	
	Herring	Minor	Negligible	Minor	Minor	
	Sandeels	Minor	Minor	Minor	Minor	
Noise	Salmon and Sea trout	Minor	Negligible	Minor	Minor/Moderate	Taking the minor effects associated with both the Amended Project and the Moray Firth Round 3 Zone Whole Project a cumulative effect of minor significance should be expected. In light of the numerous uncertainties in relation to migratory routes and final piling schedules for both developments, however, the potential for a moderate effects to occur needs to be acknowledged.
	Cod	Moderate	Negligible	Minor	Moderate	Given the moderate and minor effects associated with the Amended Project and the Moray Firth Round 3 Zone Project cumulatively, the effect of construction noise on cod is considered to be of moderate significance. The same uncertainties in relation to the current use of the Moray Firth area for spawning previously described in Section 5.6.1.1 for the Wind Farm alone are also applicable to the cumulative assessment. This conclusion has been amended from moderate/major from the Original ES as a result of further information on the assessment of effects of the Moray Firth Round 3 Zone in the MORL ES.

Effect	Receptor	Beatrice Project		Moray Firth Round 3 Zone Whole Project	Cumulative Assessment	Rationale
		Wind Farm	OfTW			
	Herring	Moderate	Negligible	Minor	Moderate	Given the moderate and minor effects associated with the Amended Project and the Moray Firth Round 3 Zone Whole Project cumulatively, the effect of construction noise on herring is considered to be of moderate significance. The same uncertainties in relation to usage of discrete spawning grounds in areas disturbed by construction noise previously described in Section 5.6.1.1 for the Wind Farm alone, are also applicable to the cumulative assessment.
Operation						
Loss of Habitat	Salmon and Sea trout	Negligible	n/a	Negligible	Negligible	The cumulative effect of habitat loss is considered to be negligible on species such as salmon and sea trout and cod, which are not substrate specific. In the particular case of herring and sandeels (both species dependent on the presence of adequate substrates), it is considered that there is potential for a minor cumulative effect to occur. In the particular case of sandeels, taking MORL's sandeel survey results , it is considered that there is little potential for loss of habitat associated with the Moray Firth Round 3 Zone to significantly add to the loss of habitat assessed for the Wind Farm alone. This has been revised from the moderate effect on sandeels presented in the Original ES.
	Cod	Negligible	n/a	Negligible	Negligible	
	Herring	Negligible	n/a	Minor	Minor	
	Sandeels	Minor	n/a	Minor	Minor	
Introduction of New Habitat	Salmon and Sea trout	Minor	n/a	Minor	Minor	The results of post-construction monitoring undertaken in operational wind farms to date do not suggest that introduction of new habitat has resulted in substantial effects on fish populations. The cumulative introduction of new habitat associated with the Amended Project and Moray Firth Round 3 Zone project is therefore considered to result in a minor effect. In the particular case of salmon and sea trout, the lack of robust information in relation to data from
	Cod	Minor	n/a	Minor	Minor	
	Herring	Minor	n/a	Minor	Minor	

Effect	Receptor	Beatrice Project		Moray Firth Round 3 Zone Whole Project	Cumulative Assessment	Rationale
		Wind Farm	OfTW			
						operational wind farms on a species specific basis it is however noted.
EMFs	Salmon and Sea trout	Minor	Minor	Minor	Minor	The results of post-construction monitoring undertaken in operational wind farms to date do not suggest that EMFs have resulted in substantial effects on fish populations. Taking the minor effects identified both for the Amended Project and the Moray Firth Round 3 Zone Whole Projects cumulatively they are also considered to result in a minor effect. In the particular case of salmon and sea trout, the uncertainties of the assessment given the lack of information on their behaviour at sea and the magnetic field strengths that may trigger responses in salmonids are recognised. Given the expected magnetic fields produced by the cables which will be well below the Earth's magnetic field no cumulative effects above minor are however expected on salmon and sea trout.
	Cod	Negligible	Negligible	Minor	Minor	
	Herring	Negligible	Negligible	Minor	Minor	
Operational Noise	Salmon and Sea trout	Minor	n/a	Minor	Minor	The results of post-construction monitoring undertaken in operational wind farms to date do not suggest that introduction of new habitat has resulted in substantial effects on fish populations. Taking the minor effects identified both for the Amended Project and the Moray Firth Round 3 Zone Whole Projects, cumulatively they are also considered to result in a minor effect. In the particular case of salmon and sea trout, the lack of robust information in relation to data from operational wind farms on a species specific basis should however be noted, as previously mentioned for the Wind Farm alone in Section 5.6.1.1.
	Cod	Minor	n/a	Minor	Minor	
	Herring	Minor	n/a	Minor	Minor	

Effect	Receptor	Beatrice Project		Moray Firth Round 3 Zone Whole Project	Cumulative Assessment	Rationale
		Wind Farm	OfTW			
Changes to Fishing Activity	Salmon and Sea trout	Negligible	n/a	Below moderate	Below moderate	The potential for fishing effort to be displaced into other areas within the Moray Firth or further afield as a result of the introduction of wind farm infrastructure is recognised. Given the comparatively low degree of fishing sustained by the Amended Project in comparison to the Moray Firth Round 3 Zone Project, it is considered that the Amended Project will not add significantly to the potential effect associated with the Moray Firth Round 3 Zone Project itself. Therefore, cumulative effects associated with changes to fishing activity are considered to remain below moderate, and hence not a likely significant effect in terms of EIA Regulations.
	Cod	Negligible	n/a	Below moderate	Below moderate	
	Herring	Negligible	n/a	Below moderate	Below moderate	
	Sandeels	Negligible	n/a	Below moderate	Below moderate	

156. As indicated in Table 5.20 construction noise is the only potential effect which is considered to result in cumulative likely significant effects (above minor) on the fish species for which a detailed assessment has been included in this ES Addendum. Moderate cumulative effects in this respect have been identified for cod, herring, salmon and sea trout. These are therefore likely significant effects in terms of EIA regulations.

5.10 STATEMENT OF SIGNIFICANCE

5.10.1 WIND FARM

157. Construction noise associated with the construction phase of the Wind Farm will result in a likely significant effect on herring and cod in terms of EIA Regulations. No other likely significant effects in terms of EIA Regulations have been identified as a result of the construction/decommissioning and operational phases of the Wind Farm on fish receptors relevant to this ES Addendum.

158. Likely significant cumulative effects in terms of EIA Regulations have been identified between the Wind Farm, OfTW and the proposed Moray Firth Round 3 Zone associated with construction noise on cod, herring and salmon and sea trout.

159. Likely significant (moderate) cumulative effects on sandeels as a result of habitat loss were predicted in the Original ES, although based on the further information provided in this section on sandeel baseline, this has been revised to a minor cumulative effect, which is not a likely significant effect in terms of the EIA Regulations.

5.10.2 OFTW

160. No likely significant effects in terms of EIA Regulations have been identified as a result of the construction/decommissioning and operational phases of the OfTW. As previously assessed in Section 23: OfTW Fish and Shellfish Ecology, of the Original ES, effects above minor have not been identified.

5.11 HABITATS REGULATIONS ASSESSMENT (HRA)

161. Annex 3B presents a report to inform an appropriate assessment in respect of Natura 2000 designations for which fish and shellfish form part of the qualifying interest or conservation objectives of the designation.

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