6 MARINE MAMMALS

6.1 INTRODUCTION

1. This section of the ES Addendum presents information to address consultation responses and consider further cumulative information in relation to marine mammals. In addition, this section presents a discussion of the effects which may occur as a result of the most likely scenario. The assessment has been undertaken by RPS Energy with supporting technical support from University of Aberdeen and Sea Mammal Research Unit (SMRU).

2. Specifically, this section provides further information to inform the marine mammal assessment, including:

- Consideration of both temporal and spatial worst case scenarios for piling noise for the Wind Farm alone;
- Population viability modelling for bottlenose dolphin (BND) *Tursiops truncatus* and harbour seal *Phoca vitulina* to assess long-term effects and improve certainty from the Original ES;
- Desktop information on harbour porpoise *Phocoena phocoena* sensitivity to piling noise and recoverability following piling operations to reduce uncertainty with respect to conclusions made in the Original ES;
- Further noise modelling undertaken for minke whale *Balaenoptera acutorostrata* using a similar baleen whale species (i.e. humpback whale *Megaptera novaeangliae*) as a proxy;
- Comparison of effects of differing hammer energies on marine mammals and consideration of a 'most likely scenario' for piling to provide some context for the worst case scenario assessed in the Original ES;
- Details of the integrated approach to monitoring to support conservation and development in the Moray Firth;
- Assessment of cumulative effects based on a number of different piling scenarios and population modelling for BND and harbour seal; and
- Information to support European Protected Species (EPS) Licensing.

3. It should be noted that the changes to the jack-up barge footprints, the change to the OfTW Corridor and the increased installation time for the OfTW cable included in Section 4: Amended Project Description, do not affect the worst case scenario in relation to the assessment of effects on marine mammal ecology and have, therefore, been scoped out in this assessment (see Section 6.3 for rationale).

4. This section is supported by the following documents in Volume 4: Technical Annexes:

- Annex 6A: Bottlenose Dolphin and Harbour Seal Population Modelling for Beatrice Offshore Wind Farm;
- Annex 6B: Integrating Marine Mammal Research and Monitoring to Support Conservation and Development in the Moray Firth; and
- Annex 6C: Information to Support European Protected Species (EPS) Licensing.

5. This section of the ES Addendum presents an Addendum to Chapter 12: Wind Farm Marine Mammals of the Original ES. Where applicable, reference is made in this assessment to the Original ES. This ES Addendum does not apply to Section 24: OfTW Marine Mammals of the Original ES which has not been amended. This section of the ES Addendum is supported by the following documents from Volume 4: Technical Annexes of the Original ES:

- Annex 12A of the Original ES: Bottlenose dolphin estimates Across the Moray Firth; and
- Annex 12B of the Original ES: Harbour seal framework.

6. 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;
- Information to Support EPS Licensing;
- Statement of Significance;
- Habitats Regulations Assessment; and
- References.

6.2 CONSULTATION

7. 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 marine mammals is presented in Table 6.1. Reference is also provided as to where these issues are addressed within this ES Addendum, if applicable.

Table 6.1: Summary of Original ES Consultation Responses and Project Response

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
Whale and Dolphin Conservation Society (WDCS).	Generally we believe there is insufficient local baseline data on cetacean population trends and movements on which assumptions in the ES are made.	The baseline assessment presents the results from both site-specific surveys and long-term monitoring programmes in the Moray Firth. Information on distribution of BND in coastal waters of East Scotland continues to be collected by Marine Scotland led project with intense deployment of C-PODs along east coast. The baseline information available for the Moray Firth in relation to marine mammals is one of the most robust available in the UK and is considered sufficient to allow an assessment of likely significant effects. A BOWL/MORL marine mammal monitoring programme (MMMP), including the collection of pre-construction baseline data, is proposed. A similar monitoring program is being proposed by The Crown Estate Joint Industry Projects.	No further information presented in this ES Addendum Annex 6B: Integrating marine mammal research and monitoring to support conservation and development in the Moray Firth
	Implications of all related activities (especially pile driving) and compound and continuous effects of developments in the Moray Firth, off Aberdeen and off Tay on cetacean welfare and behaviour are uncertain. The ES has not considered the lack of understanding of long-term population impacts specifically temporary or permanent displacement of minke whale or the effects of fracturing of the small BND population group where developments are proposed throughout the BND range.	The impact assessment adopts a precautionary approach through all aspects (noise modelling, population modelling, Rochdale Envelope) so that where there is uncertainty in predictions, the effects presented represent a worst case scenario. As part of this ES Addendum, further population modelling (Vortex model) has been undertaken for BND to reduce uncertainty in the predictions of long-term effects and further information is also provided on minke whale in terms of estimates of the numbers potentially affected by the Wind Farm alone and cumulatively. A further literature review investigation into the displacement of marine mammals around wind farms during operation and construction has been undertaken as part of this Addendum.	Vortex modelling: Section 6.6.1.1. Minke whale assessment: Section 6.6.1.1. Harbour porpoise: Section 6.6.1.1.

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
	If developments proceed a robust adaptive long-term monitoring program should be in place to recognise and understand adverse impacts, including cumulative impacts of other offshore developments and cable laying at Spey Bay. This should include an examination of behavioural effects of sound exposure levels. Data from such a monitoring program should be available to government and stakeholders and development halted should significant impacts be identified.	A marine mammal monitoring programme (MMMP) is being devised as a collaboration between BOWL and MORL and will be discussed and agreed upon with the statutory authorities.	Section 6.8
	The Rochdale Envelope did not scope in sufficient details on construction techniques, vessels and methods to be able to appraise their impacts and provide practical solutions.	Further technical information is presented in this ES Addendum including a 'most likely scenario' and a worst case scenario.	Section 6.6.2
	We have serious concerns over the noise generated from installing monopoles and request that alternatives to pile driving be fully considered.	Pile driving is currently the most practical option and methods to reduce impacts and further our understanding of the impacts are being examined. All the foundation types within the Rochdale Envelope for the Amended Project are currently being considered and examined to identify which will be feasible, though it is not currently possible to draw conclusions at this stage.	No further information presented in this addendum
	We request that a field study is set up to consider the noise impacts at various ranges from the mast installation.	Noise monitoring will be undertaken during the installation of the MORL met mast to validate noise propagation model. Similar monitoring for BOWL is being considered.	No further information presented in this addendum

Consultee	**Summary of Consultation Response**	**Project Response**	**Consultation Response Addressed**
	We consider Minke whale to be a potentially affected species of high local and international importance and draw attention to CRRU surveys. Potential changes in the foraging behaviour of minke whales is considered to be a vital issue, particularly due to cumulative effects of developments in a number of key foraging habitats throughout Scottish waters. This is vital as there is no evidence that local minke whale can shift to other summer foraging grounds and thus may be impacted.	Further information on the potential effects on minke whale is presented in this ES Addendum. Both the BOWL and MORL impact assessments consider that a long-term effect on minke whale is unlikely. Monitoring of the potential effects on minke whale will be part of the overall proposed BOWL/MORL MMMP.	Minke whale assessment: Section 6.6.1.1 Section 6.8
	We note that harbour seal population numbers have declined. Monitoring and mitigation for harbour seals is recommended and should include monitoring of strandings, specifically for spiral injuries potentially caused by ducted propellers.	Ducted propellers are essential for safe working practices at sea, and used throughout the marine industry. BOWL will continue to review research on seal injuries based on studies currently being undertaken by Sea Mammal Research Unit (SMRU).	No further information presented in this addendum
	We do not consider the INSPIRE noise model to be adequate, as it is validated on a much smaller pile than those being considered for the project.	The *INSPIRE* noise model is an industry standard and all effort is taken to ensure it predictions are accurate.	No further information presented in this addendum
	We believe that the source level can be lower than stated and induce strandings, particularly of minke whale.	There is no scientific evidence linking low frequency source noise to strandings in baleen whales. Published data would be required to demonstrate an association.	Minke whale assessment: Section 6.6.1.1
	Re: SPEAR model and ranking of noise impacts. We have concerns about the ranking of noise sources when it may be the cumulative impact of a variety of sources that contributes to the greatest impacts.	The SPEAR model illustrated that piling noise is considered to cause the greatest impact on receptors. Noises from other sources within this impact zone would not contribute additively to the effect of piling noise.	No further information presented in this addendum

Consultee	**Summary of Consultation Response**	**Project Response**	**Consultation Response Addressed**
	The noise thresholds for behavioural effects, PTS and TTS are theoretical, and requires ground-truthing in order to be valid. As the assessment framework in this ES is thus based on unproven values we consider results to be speculative, and we have grave concerns about the application of the Thompson assessment framework. We present alternative though unpublished PTS for harbour seals. Suggest that there is no threshold avoidance in harbour seals. We do not agree an injury curve should be based on frequency weighed audiograms and suggest that the injury curve is flattened across frequencies. The failure of frequency weighed audiograms is particularly evident at low frequencies. PTS intensity values are considered to be too high. We suggest TTS should be used to consider long-term (as well as short-term) effects rather than PTS that is used, as repeated TTS may lead to PTS.	The noise thresholds used in this assessment are based on a peer-reviewed publication (Southall et al., 2007) and on an approach that is frequently used for offshore wind farm assessment in the British Isles (Nedwell et al., 2007). Both approaches were presented and approved by the statutory authorities for use in this assessment. The noise thresholds presented in these studies for behavioural effects, permanent threshold shift (PTS) and temporary threshold shift (TTS) are based on current literature and assessed and modelled by leading members in the field of marine mammal acoustics. The seal assessment framework (Thompson et al., 2011) was also approved in consultation with statutory bodies as the agreed assessment methodology for looking at long-term population level effects.	No further information presented in this addendum
	The effectiveness of soft start has not been tested, and should include a source shutdown to be considered to be a mitigation measure. There is no discussion in the Beatrice ES regarding mitigation options. No mitigation is proposed to deal with wide scale behavioral impacts.	The soft start procedure is an industry standard recommended by the Joint Nature Conservation Committee JNCC guidelines on minimising the risk of injury to marine mammals from piling noise (JNCC, 2010). Piling will not commence if a marine mammal is sighted within the 500 m mitigation zone. A range of mitigation measures have been proposed in the Original ES and BOWL and the wider offshore wind industry are investigating the feasibility of a number of mitigation measures to reduce the effects of construction noise on marine mammals.	Section 6.7 Original ES: Section 12.6

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
	We disagree that confidence in a behavioural disturbance to intermittent and constant exposure is low/very low.	These conclusions are based on a thorough literature review of potential effects and following the agreed assessment framework presented in the Original ES.	No further information presented in this addendum
	The inclusion of the southern Moray Firth as a new MPA Search Location should be a consideration in the ES.	This is noted in section 12.3.1.6 in the Original ES. SNH were consulted to determine the boundaries and designation details for this MPA but none were available during this assessment.	Original ES: Section 12.3.1.6
	We do not believe that by using the qualifier *"the levels of received noise in this area are unlikely to result in displacement of all individuals"* meets the conservation objectives of the SAC and a more stringent level of displacement is required.	This ES Addendum provides further information to supplement the Habitat Regulations Assessment (HRA) on BND. The statement was based on the work of Finneran et al. (2005) with respect to the dose-response of individuals to noise levels sufficient to elicit a TTS/fleeing or behavioural response.	Annex 3B Report to Inform an Appropriate Assessment
	The effects of displacement on harbour porpoises, minke whales and harbour seals during construction and operation are not currently known. A robust monitoring programme should be a requirement of consent to ground-truth these speculations.	A marine mammal monitoring programme is being devised in collaboration between BOWL and MORL and will be discussed and agreed upon with the statutory authorities.	Section 6.8
	We have concerns on the uncertainty of the impacts of developments on prey species (particularly for BND) and suggest a monitoring program as a requirement of consent.	The impacts on fish and shellfish resources are considered in this ES Addendum including the need for any monitoring.	Section 5: Fish and Shellfish Ecology of this ES Addendum
	We disagree with determined probably of effects determined in Table 12.15, specifically considering the effects of 2.5yr on a probable lifespan of harbour porpoise of 10yr as short-term.	Further information supporting the harbour porpoise assessment has been included in this ES Addendum, including supporting information regarding EPS.	Harbour porpoise: Section 6.6.1.1
	We do not believe that cumulative impacts are the same for harbour porpoises as individual development impacts, when the MORL development is proposed to take longer to construct.	Further information supporting the harbour porpoise assessment has been included in this ES Addendum, including supporting information regarding EPS.	Harbour porpoise: Section 6.6.1.1

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
	We question the approach and level of confidence in using seals as a proxy species for minke whales cumulative noise impact assessment.	This ES Addendum presents further noise maps including one for humpback whale (baleen whale) as a proxy for minke whale. There are no specific noise maps available for minke whale in the published literature.	Minke whale assessment: Section 6.6.1.1
	We have concerns about the considerable data gaps and resulting limitations and assumptions for harbor seal modeling.	The harbour seal framework was undertaken by experts in the field of marine mammal science and assumptions therefore based on their many years of experience. Further modelling work has been completed as part of this ES Addendum looking at how the population may change using different assumptions about probability of survival and the carrying capacity of the Moray Firth population.	Harbour seal assessment: Section 6.6.1.1
SNH/JNCC/MS-LOT 6 Sep 2012 (Meeting)	Presentation of impact assessments for the windfarm development scenario 'most likely' to be developed, as well as for the 'worst case(s)' is required. Only presenting the Beatrice ES 'worst case' for each receptor of concern presents difficulty for any consideration of cumulative impacts, and mitigation options.	The impact assessment is based on the worst case scenario for each receptor. A qualitative discussion of the 'most likely' scenario is provided in this addendum to give an indication as to effects arising from the most likely construction scenario.	Section 6.6.2
	Population modelling requirements for harbour seal and BND. These are the two species (and SAC interests) where we consider that modelling will be required to determine any long-term effects on agreed reference populations of concern. For harbour seals, SNH and JNCC have advised that the cumulative impacts of Beatrice and MORL Round 3 need to be assessed against the population of the Moray Firth seal management unit.	BND population modelling has been carried out for the Wind Farm alone and cumulatively and is presented in this ES Addendum. The reference population for BND is the most recent population estimate for the Moray Firth of 195 individuals (Cheney et al., 2012). The harbour seal framework used a reference population for the whole of the Moray Firth based on harbour seal tracking data and a habitat association model to predict the distribution and probability of occurrence across the Moray Firth.	BND assessment: Section 6.6.1.1 Harbour seal assessment: Section 6.6.1.1

Consultee	Summary of Consultation Response	Project Response	Consultation 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.	There are uncertainties within the assessment in the Original ES, particularly with regards to the long-term noise effects on BND, which have been highlighted within the assessment, together with the precautionary approach we have taken throughout. The BND model that has been developed helps to reduce this uncertainty. In particular, the cumulative effects of piling are the key issue for BND and the model provides a prediction of the long-term effects on the Moray Firth population from cumulative piling. A discussion of the 'most likely scenario' has been included in this addendum for the purposes putting the outputs of the 'worst case scenario' into context and aiding decision makers and consultees with their assessments.	BND Section 6.6.1.1 Section 6.6.2
	Licensing requirements for European Protected Species – this issue is not acknowledged or discussed in the Beatrice ES. Once we have clearer information on the 'most likely' development scenario for Beatrice, we may be able to give this issue further consideration. Collective EPS requirements with MORL also need to be considered.	This ES Addendum includes supporting information to demonstrate the basis for which an EPS licence application would be made, if required. With a clearer picture of the most likely scenario and the further population modelling works, there will be sufficient information for the EPS licence application, if required. An EPS Licence is anticipated to be required if the Amended Project consents are granted and piling is required to install foundations. Collective EPS licensing requirements will be discussed with MORL and the statutory authorities following submission of this ES Addendum.	Annex 6C: Supporting Information in Respect of European Protected Species Licensing
	'Total impacts' on each receptor need to be considered and, where relevant, acknowledged as 'worst case'. For example, for BND, the ES considers the impacts of piling noise by itself as 'worst case', but does not consider that the 'worst case' for BND might actually be the impact of piling noise in combination with the impact of disturbance due to construction vessels and / or in combination with the potential impacts from displacement of prey species.	Although not considered as a separate 'Interactions' section in the Original ES, these issues were considered in the text. For example Section 12.5.1.4 of the Original ES deals with loss of foraging area/reduction of prey species and states that "*predicted levels of avoidance [from noise disturbance] by marine mammals suggest that any reduction in prey availability may be offset through a reduction in predation in these areas.*" Although this was considered in the Original ES, for clarity a section on 'total impacts' has been included as part of this ES Addendum.	Section 6.6.1.3

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
	While the ES acknowledges the above HRA requirements, and BOWL has now submitted a draft HRA report, the assessment for Beatrice is still incomplete, with a lack of interpretation against the conservation objectives of the relevant SPAs and SACs. For a number of key receptors, consideration of the conservation objective relating to 'population of the species as a viable component of the designated site' will need to be supported by population modelling work.	Population modelling has now been undertaken and has been included in this Addendum. In addition, the population modelling has been included in the information to inform an Appropriate Assessment, which considers the potential effects against the conservation objectives of the SAC.	Annex 3B: Report to Inform an Appropriate Assessment
	For key receptors (including SPA and SAC interests) where there could be significant effects, we advise that mitigation options need to be discussed in the ES (and HRA report, where relevant). For operational impacts mitigation may be achieved through design – such as choice of turbine or windfarm layout. In respect of construction impacts the available mitigation includes construction programming.	A range of mitigation measures have been proposed in the Original ES and BOWL and the wider offshore wind industry are investigating the feasibility of a number of mitigation measures to reduce the effects of construction noise on marine mammals.	Section 6.7 Original ES: Section 12.6
	While 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.	The Original ES does consider the duration and timing of noise impacts both for the Wind Farm alone and cumulatively with other offshore developments. These are outlined in Table 12.3 of the Original ES, the table on construction phasing in the cumulative impacts section (Table 12.18 of the Original ES), and in Section 12.5 of the Original ES. Both the temporal and spatial worst cases were considered in the assessment. Further assessment is also provided in this ES Addendum.	Section 6.5
	For a range of key receptors, cumulative HRA is required and needs to be supported by population modelling in order to determine any long-term effects on populations of concern.	As discussed above BND population modelling has now been undertaken for cumulative impacts.	BND assessment: Section 6.6.1.1

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
	Whilst there was a presentation of the spatial effects of construction piling noise, the temporal effects were not clear. What was the likely amount of piling in a 12 hour period, and could this be explored?	The temporal effects were considered and that the worst case was that animals within the ensonified area would remain disturbed/displaced for the duration of the piling regime (2 to 3 years in the case of the Wind Farm alone). Although piling would not occur continuously, this is the assumed temporal extent of the effect. Further information on the actual piling durations is provided in this ES Addendum.	Section 6.6.2
	Were there periods where there is no piling noise e.g. when vessels are moving between locations, and has this been considered?	There would be periods where there is no piling noise, though to ensure a precautionary approach, it has been assumed that animals would not return to the area between piling events and that the effect occurs 24 hours a day. Although studies of the effects of pile driving at a single location show that animals are likely to return to a disturbed area within hours of cessation of the piling, there is a degree of uncertainty as to likelihood that animals will return to a disturbed area following repeated exposure to multiple piling events over the duration of the piling phase. However, recognising that there may be periods of several days where no piling occurs and where animals may return to the area, this ES Addendum provides a quantification of the proportion of the piling phase when no piling noise will occur, though the precautionary assumptions discussed above have still been used to assess effects on marine mammals.	See Table 6.2 for precautionary assumptions made and Section 6.6.2

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
	Why have a range of potential impacts not been considered for hammer sizes and piling scenarios.	Reduction of pile size has little relation to piling noise. Blow force is the key factor in the size of the ensonified area. Whilst a discussion could be included in this ES Addendum around construction practice and likely design scenarios, including context on potential working hours etc, a range of assessments would not be presented, as consent is being sought for the worst case. MS-LOT concurred that the worst case scenario is what must be considered by consultees and the regulator. A discussion of the 'most likely scenario' has been included in this ES Addendum for the purposes putting the outputs of the 'worst case scenario' into context and aiding decision makers and consultees with their assessments.	Section 6.6.2
	How soon will animals return the ensonified area?	A literature review suggests a range of potential time periods which have been discussed.	Harbour porpoise: Section 6.6.1.1
	Cumulative effects of overlapping construction timescales and how these interact were discussed, and the general consensus was that it would be useful to consider how these would interact.	The consultation between MORL and BOWL will continue through the consenting process, as the cumulative effects of construction would be key. Cumulative effects have been assessed in this ES Addendum and a MMMP is being devised as a collaboration between BOWL and MORL and will be discussed and agreed upon with the statutory authorities.	Section 6.7 Original ES: Section 12.6 Annex 6B: Integrating marine mammal research and monitoring to support conservation and development in the Moray Firth
	It was noted that BND population modelling has now been performed. Was a trend evident in the results?	BND population modelling had been undertaken for the Moray Firth Round 3 Zone scheme, and cumulatively, and results indicated that there would be no long-term effect on the integrity of the population. This will be included in the updated assessment that is included in this ES Addendum.	BND assessment: Section 6.6.1.1

Consultee	Summary of Consultation Response	Project Response	Consultation Response Addressed
	It was requested that current population trends are considered in any predictive population modelling.	The most up-to-date information on population trends for both BND and harbour seal was used in the modelling assessment.	BND assessment: Section 6.6.1.1 Harbour seal assessment: Section 6.6.1.1
	Mitigation of the short and medium-term effects should also be considered, as it is not only the long-term effects that have raised concerns.	A range of mitigation measures have been proposed in the Original ES and BOWL and the wider offshore wind industry are investigating the feasibility of a number of mitigation measures to reduce the effects of construction noise on marine mammals.	Section 6.7
	The difficulties in reducing the short and medium-term effects were outlined, and concerns were raised about what these mean.	The short to medium-term effects are largely cited in relation to the duration of the piling phase as recovery to baseline conditions is considered to be likely (based on information provided in our assessment) following cessation of the piling.	Section 6.6.1
	There were concerns that the assessment of porpoises was not being considered in sufficient detail, and potentially population units.	Further information has been provided in this ES Addendum to support the impact assessment in the Original ES. Population level effects are assessed against a reference population of 'North Sea' as a whole.	Harbour porpoise: Section 6.6.1.1
	It was suggested that a fuller understanding of the impacts is required prior to a mitigation/monitoring discussion. Moreover, cumulative monitoring of the different windfarm developments was preferred and more sensible, although any consents would need to ensure that each development scheme could progress individually.	Ongoing discussions with statutory authorities regarding mitigation and monitoring are a key part of this assessment process.	Section 6.7 Original ES: Section 12.6

6.3 *SCOPE OF ASSESSMENT*

8. As shown in Section 6.2, there are a number of consultation responses which have required further information or renewed assessment to be presented in this section. In addition, further cumulative information has become available in relation to marine mammals. In summary, the scope of this section includes the following:

- Consideration of both temporal and spatial worst case scenarios for piling noise for the Wind Farm alone in the assessment of effects on all marine mammal species. Although the Original ES considered both temporal and spatial effects, further information has been provided here to supplement the Original ES;
- Population viability modelling for BND and harbour seal to assess long-term effects and improve certainty from the Original ES. Population modelling for BND was not undertaken for the Original ES and the harbour seal framework was subsequently revised following consultation responses on the Original ES;
- Desktop information on harbour porpoise sensitivity to piling noise and recoverability following piling operations to improve certainty of the conclusions made in the Original ES;
- Noise modelling undertaken for minke whale using a similar baleen whale species (i.e. humpback whale) as a proxy since the Original ES did not present noise maps for this species;
- Comparison of effects of differing hammer energies on marine mammals and consideration of a lower blow force energy for piling to provide some context for the worst case scenario assessed in the Original ES;
- Details of the integrated approach to monitoring to support conservation and development in the Moray Firth. The Original ES did not present an outline monitoring programme;
- Assessment of cumulative effects based on a number of different piling scenarios. In the Original ES the worst case spatially was presented as eight concurrent piling events whereas this ES Addendum presents an assessment based on a stepped approach starting with two concurrent piling events at the Wind Farm and adding a further two piling events at each step. As before the cumulative assessment also considers a temporal worst case scenario, where less concurrent piling events occur, although piling occurs over a longer period; and
- Further assessment of both the spatial and temporal worst case cumulative scenarios, specifically long-term population modelling for harbour seal and BND.

9. The scope of this section has therefore been determined by considering the consultee comments received as well as further cumulative information. The amendments to the Project, as outlined in Section 4: Amended Project Description, do not affect the scope of this assessment, as these do not change the worst case scenario for marine mammal receptors. Although the increase size of the jack up vessels results in an increased short-term footprint on the seabed and associated habitat loss, this is not large enough to either directly or indirectly affect the assessment of effects on marine mammals presented in Section 12: Wind Farm

Marine Mammals of the Original ES. The amendment to the OfTW in relation to both installation time and amended route do not affect the effects associated with the installation of the OfTW, and therefore does not result in the effects of the OfTW being revised.

10. This section is generally supplemental to Section 12: Wind Farm Marine Mammals of the Original ES. Where this section updates and replaces conclusions made in the Original ES, this is made clear. This section must be read alongside Section 12: Wind Farm Marine Mammals of the Original ES.

11. This Addendum does not apply to Section 24: OfTW Marine Mammals of the Original ES which has not been amended.

6.4 BASELINE

6.4.1 STUDY AREA

12. The Wind Farm Study Area for the assessment of effects on marine mammals remains unchanged from that presented in Section 12.2.4 of the Original ES.

6.4.2 BASELINE CONDITIONS

13. The baseline conditions relating to the offshore Wind Farm Study Area remains unchanged from that presented in Section 12.3 of the Original ES.

6.5 ASSESSMENT METHODOLOGY

14. The approach to the assessment remains unchanged from that presented in Section 12.2.7 of the Original ES, however, further work has been undertaken to provide information on a most likely scenario as a comparison with the worst case scenario and provide greater certainty, thereby providing a more robust assessment.

15. The Original ES assessed the worst case scenario as the maximum effects likely to be experienced on receptors from a particular aspect or process of the Project. This section of this ES Addendum includes revisions to this worst case assessment and also consideration of a most likely scenario, which represents the most likely scenario within the parameters of the Rochdale Envelope in order to better understand the potential effects.

16. In considering the potential effects on marine mammal species in this assessment, the Original ES highlights a number of uncertainties regarding the accuracy of marine mammal distribution maps, the robustness of both the noise modelling and population modelling methods, and the approach to assessing effects on individuals and populations (Section 12.2.9 of the Original ES). In consideration of these uncertainties, at all stages of the assessment, a precautionary approach has been adopted (Table 6.2). Table 6.2 was not presented in the Original ES (although the assessments were made with reference to it), and is included in this section to provide a concise summary of the conservatisms within the approach to the assessment. The approach to assessing potential effects in this ES Addendum follows the same process described in Section 12.2.7.2 of the Original ES; following the most recent guidelines on marine ecological impact assessment (IEEM, 2010).

For each effect, an assessment of the magnitude of the effect and sensitivity of the receptor is described and the significance of the effect is predicted.

17. An effect refers to a change in the receptor in response to a change in the environment. The duration of effects is defined using the following terms:

- Short-term: effects lasting a few days i.e. an immediate response to an environmental change;
- Medium-term: effects lasting over the period of construction years; and
- Long-term: effects lasting beyond the construction phase and possibly over the lifetime of the Amended Project, which is currently not determined, although may be in the order of (up to 25 years).

18. Understanding the long-term effects is key to assessing any predicted changes which are measured against the Favourable Conservation Status (FCS) of the population. Consideration is given to whether protected populations are maintaining themselves in the long-term; this is a key aspect of assessing whether the integrity of a European site is adversely affected for the HRA (Annex 3B).

Table 6.2: Precautionary Assumptions Adopted in the Approach to Assessment for the Wind Farm

Assumption	Justification
Noise modelling assumes the largest hammer energy required for the stiffest soil type in the development area.	This represents the absolute maximum hammer energy that would be required during piling. Therefore, in areas where the substrate is softer, a lower hammer energy would be used. Experience of previous windfarms shows that the maximum hammer energy is rarely achieved (Theobald et al., 2010; Bailey et al., 2010). This leads to an overestimate of the extent of ensonification for the duration of the project. Additionally, where the maximum blow force is required, this would not be required for the complete duration of a piling event as the blow force would be progressively increased to the maximum.
Noise modelling locations have been chosen as those closest to the most sensitive areas and provide the greatest area of ensonification.	The numbers of individuals potentially affected by piling is estimated as a worst case based on the location closest to the most sensitive areas (i.e. the SACs for BND and harbour seal). In addition, in considering two concurrent vessels the two locations most likely to result in the worst case effect (closest to the SAC and extending in the greatest area from the north to the south coast) were considered. For two piling locations situated closer together, the area of ensonification would be considerably decreased and the effects would be lesser for locations further away from the SACs.
Noise levels received in a given grid cell[1] based on the maximum levels received in that cell.	The perceived noise levels for each species in a given grid cell was based on the maximum noise level that touched any part of the grid cell rather than the noise level that accounted for the greatest proportion of that grid cell. This overestimates the number of animals experiencing higher levels of noise.

[1] Within the noise response models, the Study Area is divided into cells of equal area to test the predicted noise levels against the gridded species density estimates. This allows an estimate of the number of animals experiencing a given noise level to be estimated.

Assumption	Justification
Amount of noise exposure overestimated.	The noise model overestimates the noise exposure an animal receives since it does not account for any time that marine mammals spend at the surface, the reduced sound levels near the surface, nor the temporal hearing recovery between piling sequences. In addition, the model assumes that animals are continuously exposed to pressure levels in mid-water, where they are highest, whereas pressure levels reduce substantially near the surface.
Use of the 186 dB Sound Equivalent Level (SEL) criteria to model PTS in pinnipeds	The 186 dB SEL criteria, proposed by Southall et al. (2007) was based on limited scientific evidence and scientists at the University of Aberdeen working together with BOWL and MORL subsequently suggested a revision to this criteria, proposing that 198 dB SEL is more appropriate. Although 198 dB SEL was previously used as the PTS threshold for the harbour seal model in the Original ES, following further consultation, this has now been revised and the more conservative threshold of 186 dB SEL is used and presented here in this ES Addendum, since it was felt that the threshold could lie between these two values.
Animals displaced throughout entire piling sequence.	The assessment assumes that any animal displaced does not return to the affected area until all piling at BOWL has ceased. This is highly conservative as previous studies of wind farms show that some of those animals displaced may return within a matter of hours to a disturbed area. The return rate and proportion of animals that return depends upon the noise levels experienced during disturbance (Brandt et al., 2011).
Upper fit curve assumed for the dose response.	For the proportion of animals displaced, the modelling looked at the best fit curve and the upper and lower boundaries of this curve. In order to adopt the precautionary approach, the upper fit was taken as the dose response model which overestimated the proportion of animals likely to response to the higher end of the perceived noise levels experienced.
SAFESIMM model predicts a higher number of animals would experience noise levels sufficient to cause PTS onset.	The SAFESIMM model provides a more precautionary estimate of the number of animals predicted to experience PTS compared with the INSPIRE noise model. The SAFESIMM model simulates the three dimensional movements of animals moving through a sound field as 'directed random walks' (as opposed to a single fleeing direction away from the source used in the INSPIRE model) and uses this to predict the speed at which they will leave the affected area. As with the INSPIRE model, the SAFESIMM model assumes that animals continue to experience sound pressure even at the surface, and the proportion of animals leaving the area is based on the dose-response relationship.
Population models assume that displacement can lead to reproductive failure in seals and BND.	The population model assumes that all animals that are displaced during piling will suffer fitness consequences and as a result fail to breed in that year or produce calves that die. This is conservative for two reasons: 1) as described above, animals are unlikely to be displaced for the entire construction phase; and 2) animals displaced may not suffer fitness consequences if there is suitable foraging ground elsewhere and therefore may still breed and produce calves that survive.

Assumption	Justification
PTS onset leads to a 25% increase in risk of mortality.	The criteria proposed by Southall et al. (2007) has been adopted in this assessment using the noise levels at which a reduction in hearing acuity may start to occur. There is no evidence to suggest marine mammals exposed to such levels would suffer mortality, however, based on expert judgement and consultation with stakeholders, it was agreed that the 25% risk would provide a highly conservative assumption.

6.5.1 WORST CASE SCENARIO

19. The worst case scenario remains unchanged from that described in Section 12.2.7.1 of the Original ES in relation to effects on marine mammals and is presented in Table 6.3. Further information to support the assessment of effects of the worst case scenario with regards to piling noise is presented in this ES Addendum.

Table 6.3: Worst Case Scenario for Marine Mammals for the Wind Farm

Potential Effect	Worst Case Scenario Assessed
Construction / Decommissioning	
Physical injury, displacement and behavioural impacts resulting from pile driving.	Short-term typically up to five hours of actual pile driving for each pile; maximum blow force of 2,300 kJ for a maximum of 277, 3.6 MW turbines, with each foundation requiring four pin piles, each with a maximum of 2.4 m diameter. Total of 16,000 hammer strikes per foundation with soft start procedures built in to the modelling. 3x 5 m meteorological mast monopile and 3 x 3 m pin pile Offshore Substation Platforms (OSPs) also modelled in noise assessment. Up to two piling vessels operating concurrently at two locations at the western and south western most corners of the the Wind Farm site to represent the closest locations to the SACs (see Figure 12.7 of the Original ES). Using a single vessel, piling is assumed to occur over a 3 year construction phase; using two vessels, piling is assumed to occur over a 2 year construction phase. These estimates include weather downtime and transfer to and from ports. Noise from inter-array cable lay trenching - range of vessels using tools such rock cutter plough through to water jetting and standard ploughs.
Physical injury/mortality from vessels with ducted propellers and ship strike.	Use of up to two piling vessels with ducted propellers over a 24 hour period for approximately 8.4 months. A range of construction vessels is considered with some exceeding 100 m in length, and others with speeds of >25 kts.

Potential Effect	Worst Case Scenario Assessed
Suspended solids impairing foraging efficiency.	Dredging overspill (silts and clays) at 30 kg/s during gravity foundation base seabed preparation, 90 m pit diameter, 5 m pit depth, 3.6 MW layout. Drill arisings (sands, silts and clays) at 26 kg/s during installation of 277 pin-piled jacket foundations (four pin piles, 3.0 m diameter, 60 m burial, 3.6 MW layout) plus burial of up to 325 km inter-array cable length. Elevation in suspended solids concentration (SSC) and bed load during installation of inter-array cable based on trenching by energetic means (e.g. jetting) as predicted by coastal processes studies (single trench with cross-section of disturbance 3 m deep by 2.5 m wide, 100 % of material resuspended); release of any associated pollutants into the water column.
Indirect effects due to loss of foraging area/ reduction of prey species	Reduction of prey species within Wind Farm Site over a period of up to four years based on gravity base foundations.
Operation	
Noise disturbance from turbine operation.	Noise from 277, 3.6 MW turbines
Noise disturbance from maintenance vessels.	Maximum of 1,760 number of maintenance vessels movements per annum over the operational lifespan of Amended Project with vessels of typically 18-20 m in length.
Collision risk from maintenance vessels.	Maximum of 1,760 number of maintenance vessels movements per annum over the operational lifespan of the Amended Project with vessels of typically 18-20 m in length.
Behavioural impacts arising from EMF.	Magnetic field strength of 1.7 μT immediately adjacent to cable and 0.61 μT up to 2.5m from cable for a typical 3 core 33 kV array cable. Maximum length of cable (350 km) will be used and buried to a depth of 0.6 m or protected by means of rock placement or concrete mattressing.
Changes in prey resources and tidal regimes due to presence of turbine structures.	277, 3.6 MW gravity bases, three meteorological masts, two Alternating Current (AC) OSP, one Direct Current (DC) converter and up to 0.48 km² of cable protection will lead to a total habitat loss/gain of 3.8 km² (Section 11: Wind Farm Fish and Shellfish Ecology of the Original ES) and the same scenario will lead to the greatest effect on coastal processes
Cumulative	
Cumulative impact.	The Wind Farm site and OfTW Corridor have been assessed as a single project against cumulative impacts from other projects/activities in the study area and wider region.

Potential Effect	Worst Case Scenario Assessed
Cumulative impact.	Moray Firth Round 3 Zone worst case scenario of up to six simultaneous pin pile jacket foundations with a maximum pile diameter of 3 m and optimum blow force of 1,800 kJ. A stepped cumulative assessment has been undertaken starting with two piling vessels at the Wind Farm and adding a further two piling vessels at the Moray Firth Round 3 Zone until the maximum of eight simultaneous piling vessels is reached. This is presented in the cumulative impact assessment in Section 6.9.

6.5.2 MOST LIKELY SCENARIO

20. The most likely scenario involves a reduction in the number of turbines installed from 277 to 140 turbines. The scenario assessed is the same as that described in Table 6.3 with two exceptions. First, the overall duration of the piling phase would reduce from three years to one year for a single installation vessel and from two years to nine months for two installation vessels. Second, there would be a reduction in the total number of vessels used during construction and installation.

6.6 ASSESSMENT OF POTENTIAL EFFECTS

6.6.1 ASSESSMENT OF THE WORST CASE SCENARIO

6.6.1.1 Physical Injury, Displacement and Disturbance from Noise Emissions during Pile Driving

21. Piling is assumed to occur over 2 to 3 years of the construction phase as a precautionary assumption, since animals may potentially be displaced over the entire duration of the phase. However, the actual time required for piling is considerably less, and therefore, it should be noted that during non-piling periods, some animals are likely to return to the area. The piling schedule for the worst case scenario is as follows:

- For each piling vessel:
  - 20 hours piling per foundation;
  - 231 days (0.6 years) piling in total for 277 foundations;
  - Periods of non-piling will include 10 hours to set up for each turbine, 0.5 hours between each pin pile, and 6 hours to move between turbines; and
  - Piling downtime (e.g. for weather etc) is estimated as 20% of total time i.e. 46 days.

22. For a single vessel, over a 3 year piling phase, piling accounts for 231 days, or 21% of the phase. For two vessels, over a two year piling phase, piling is not assumed to occur as simultaneous events and therefore the piling will occur over twice as many days (462) in that time, accounting for 63% of the piling phase. For the single piling vessel in particular, the assumption of piling over the entire 3 year construction phase is highly precautionary, since the actual duration of the piling accounts for only 21% of this phase. For the purposes of noise modelling however, piling is assumed to occur over the entire period of the piling phase (i.e. 3 years for 1 vessel and 2 years for 2 vessels).

Bottlenose Dolphin (BND)

Summary of Assessment in the Original ES

23. The assessment concluded that noise arising from piling operations is unlikely to cause death or physical injury to animals. Noise modelling showed that acoustic injury in the form of PTS, based on a fleeing animal, is predicted to occur out to a maximum of 500 m (Section 12.5.1.1 of the Original ES) and therefore falls within the Project design mitigation zone. Following the JNCC (2010) guidelines, this will involve the use of dedicated marine mammal observers (MMOs) and passive acoustic monitoring (PAM) operatives with the aim of detecting animals within a 500 m mitigation zone prior to commencement of the piling (see Section 12.6 of the Original ES). As described in Table 6.2 the prediction of effects of PTS on BND was based on a precautionary approach using the SAFESIMM model (Section 12.2.7.9 of the Original ES).

24. The key effect identified was therefore the potential disturbance of animals out to a distance of 43.4 km from the source (Table 12.13 in the Original ES). The potential effect was assessed by overlaying the noise contours on the probability of occurrence of BND map. A more accurate prediction of received noise levels was achieved by looking at the change over the area of potential impact in 5 dB_{ht} increments.

25. In the Original ES it was not considered scientifically robust to provide a quantification of absolute numbers of BND potentially displaced by the piling noise since this relied on density estimates, which were difficult to estimate from the available data (Appendix 2 of Annex 12A: Bottlenose dolphin densities across the Moray Firth of the Original ES). For example, the long-term studies were focussed on near-shore waters particularly in the inner Moray Firth, and the southern coastline, and there is uncertainty over potential use of offshore waters (Wilson et al., 1997; Hastie et al., 2004; Culloch & Robinson, 2008; Cheney et al., 2012). Density estimates could therefore only be extrapolated from information on the probability of occurrence of BND, which itself was predicted using decision-tree analysis based on information on visual sightings of BND, scaled using C-POD data which detected all 'dolphin' species . In particular, the density estimates did not reflect the fact that BNDs are more regularly encountered in groups as opposed to singularly. As a result, modelled density estimates across the Moray Firth were likely to overestimate numbers in offshore areas whilst recent work has provided robust empirical evidence that BNDs rarely occur in offshore parts of the Moray Firth (Appendix 2 of Annex 12A: Bottlenose dolphin densities across the Moray Firth of the Original ES).

26. Consequently, the baseline maps used in the Original ES show probability of occurrence of BND rather than density. The assessment of effects therefore focussed on the likelihood that BND from the Moray Firth population would occur within the zone of behavioural disturbance (out to a maximum threshold of 75 dB_{ht}). In addition, ecological information on the Moray Firth population, such as key feeding areas and movements into and out of the Moray Firth, was sought to aid in the assessment.

27. Subject to these uncertainties, and based on the precautionary approach adopted (Table 6.2), the assessment concluded that during the piling phase of the Wind Farm there would be a negative effect of small to medium magnitude, which would be a likely significant effect in terms of the EIA Regulations, and the confidence in this prediction was assessed as probable. Long-term effects were considered to be unlikely, but if any do occur, these would be of small to medium magnitude, which would be a likely significant effect in terms of the EIA Regulations (see section 12.5.1.1 of the Original ES).

Population Modelling and Re-evaluation of Effects

28. To further inform the assessment of the long-term effects on BND, BOWL together with MORL subsequently commissioned population modelling to be undertaken by the University of Aberdeen. Two different scenarios were assessed based on the worst case spatially (greatest area of ensonification) and the worst case temporally (longest duration of piling). These scenarios are presented in Table 6.4.

Table 6.4: Different Construction Scenarios Modelled for the BND VORTEX Model *(Dates of commencement of construction are estimated since an accurate start date is not yet confirmed)*

Construction Scenario	Description
BOWL 1	One piling vessels at location A Construction starts in 2014 for 3 years
BOWL 2	Two piling vessels at location A & B Construction starts in 2014 for 2 years

29. Although there were a number of caveats highlighted with respect to the estimates of BND densities across the Moray Firth, these densities were necessary to feed into the population modelling and were also the best estimates available at the time of modelling. However, it is important to note that predictions of the number of animals affected is a precautionary approach since the density estimates for offshore areas (which fall within the noise impact zones) are considered to be overestimates. For this reason, the assessment presents a range of estimates, based on lower, best and upper fit models as described below.

30. The number of animals predicted to experience PTS is based on the SAFESIMM approach, which is precautionary in its assessment of the speed at which animals leave the affected area (see Table 6.2). Annex 6A (see Section 3.3.2, Annex III) presents the approach adopted in the SAFESIMM model. The relationship between the noise level and proportional displacement followed the dose-response relationship described by Finneran et al., (2005). In summary, for this approach, sound field data generated by the INSPIRE noise model is overlaid on the predictions of BND densities across the Moray Firth, and the number of animals predicted to experience PTS is modelled based on the proportional response as given in the dose-response curve (Plate 12.2 of the Original ES) (Figure 6.1). For all construction scenarios, the SAFESIMM model predicted that no animals would be affected by PTS (Table 2 in Annex 6A) and therefore in the long-term there would be no effect on the population.

31. Behavioural displacement was also adapted from the dose-response relationship for PTS and TTS proposed by Finneran et al. (2005) using empirical data extrapolated from a study of harbour porpoise response to piling noise by Brandt et al. (2011) (Plate 12.3 and Section 12.2.7.8 of the Original ES) (see also later in this ES Addendum for further information on this study). Using harbour porpoise as a proxy for BND to model behavioural response was considered conservative as harbour porpoise as a species are likely to be more noise sensitive than BND. For example, for non-pulsed sound, harbour porpoise exhibit a moderate behavioural response (based on the Southall et al., 2007, severity scoring criteria) such as changes in swim speed, locomotion, dive profile, and acoustic behaviour, at received levels of 80 to 180 dB re 1 µPa. In contrast, mid-frequency cetaceans, such as BND, are less sensitive, showing moderate behavioural responses to non-pulsed sound from 120 to 180 dB re 1 µPa (Southall et al., 2007).

32. Following the dose-response approach, the number of animals displaced behaviourally was then estimated using the outputs of the INSPIRE model, which predicted the gradual decrease in noise levels in 5 dB_{ht} increments out to a threshold of 75 dB_{ht}, overlaid on the BND density map (Figure 6.2). The model also looked at the effect of varying the dose-response curves (upper, best and lower fit) for the prediction of the proportion of the population excluded from the area. The outputs of the different construction scenarios, for the upper, best and lower fit dose-response, are presented in Table 6.5 (see also Table 2 of Annex 6A). For single piling at the Wind Farm, the prediction was that 19 animals may be behaviourally displaced based on the best-fit, accounting for 9.6% of the population. For concurrent piling, the predicted displacement is of 20 animals (10.3% of the population), based on the best-fit.

Table 6.5: Estimated Numbers (and % of the population) of BND Predicted to be Behaviourally Displaced from Different Construction Scenarios

Scenario	**Upper**		**Best**		**Lower**	
	N	%	n	%	n	%
BOWL 1	32	16.3	19	9.6	1	0.4
BOWL 2	33	17.0	20	10.3	1	0.5

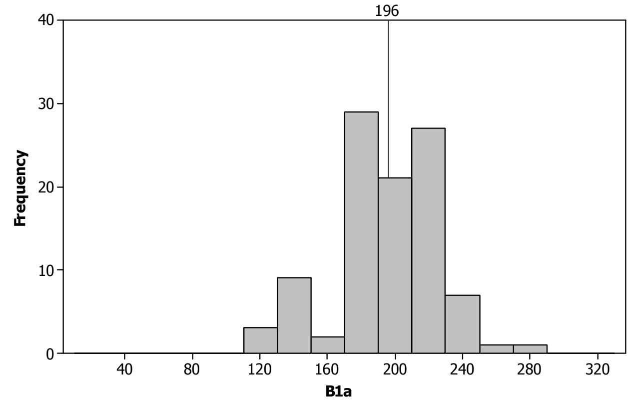
33. The BND population VORTEX model uses a population viability analysis (PVA) model described in Thompson et al. (2000) to predict the distribution of population size after 25 years following exposure of the population to different construction scenarios presented in Table 6.4 (see Annex 6A). The model was run for a 25 year period to reflect the potential operational lifespan of the Wind Farm, however, this should not be interpreted as 25 years being considered to be the potential duration of the effect. The model was based on the best available demographic and life history parameters and assumed a stable or increasing population as the baseline in line with the latest Site Condition Monitoring Report for the Moray Firth SAC (Cheney et al., 2012).

34. It was assumed that displacement would result in a reduction in reproduction (implemented by 'harvesting' calves) that was proportional to the proportion of the population that were displaced in any one year. The VORTEX model was then run to simulate the population dynamics over 25 years in order to determine the long-term effects of a reduction in reproduction on the population compared with a predicted baseline population after 25 years. This was carried out for each of the construction scenarios presented in Table 6.4. The output of the model is a frequency distribution showing the predicted population from each of the 100 model runs. To maintain the current baseline level, the plot will therefore show the highest frequency centred around 196 individuals on the x axis.

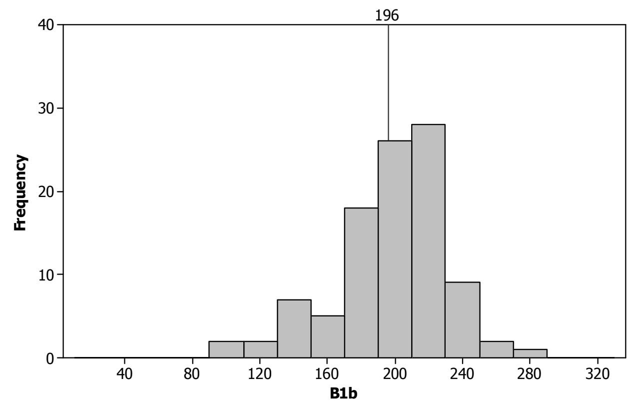
35. The calculation of the reproductive status of the population was based upon there being an average of four female and four male calves produced each year from a stable population of 196 individuals. The VORTEX model included a precautionary approach with respect to always rounding up the estimates of calves taken, and always harvesting more female calves if there were an odd number of calves.

36. For both construction scenarios, and for the upper, best and lower fit dose-response curves, the model showed that after 25 years, the baseline level (based on a stable or increasing population of 196 individuals) would be reached suggesting that there would be no long-term effect on the BND population (Plate 6.1 and Plate 6.2). Based on the potential ecological effects on the BND population in the Moray Firth, and evidence from studies of operational wind farms in the North Sea, full recovery (to baseline levels) is likely to occur over the medium-term (<3 years) with animals returning to the disturbed area immediately following cessation of the piling.

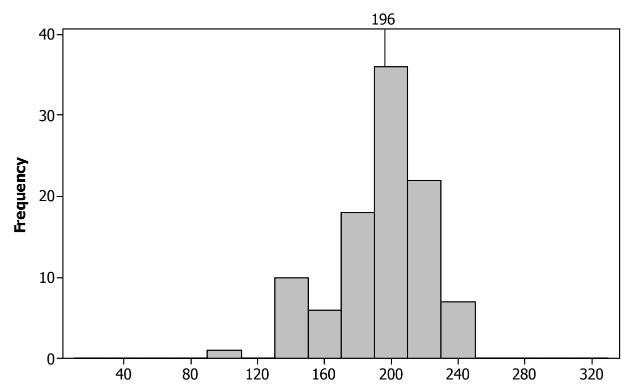
a) Lower



b)Best



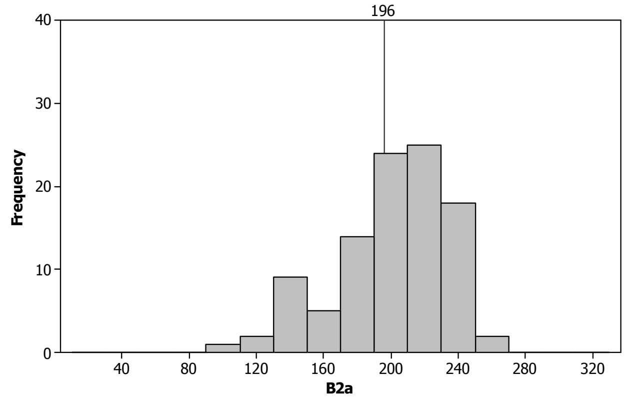
c)Upper



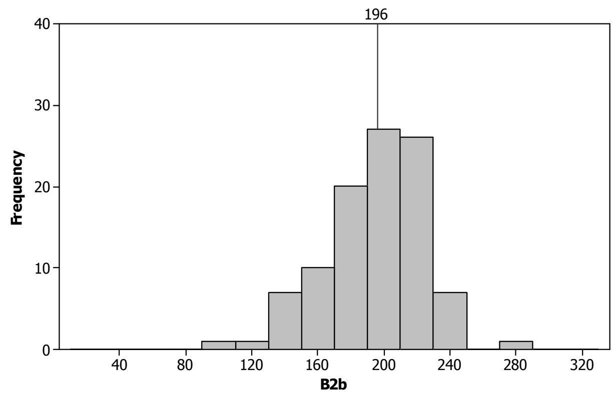
Number of individuals predicted after 25 years

Plate 6.1: Results of the BND Population Modelling for Construction Scenario BOWL 1*(showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve).*

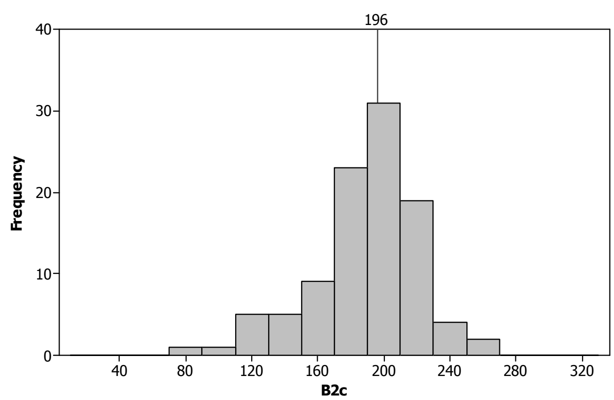
a)Lower



b)Best



c)Upper



Number of individuals predicted after 25 years

Plate 6.2 Results of the BND Population Modelling for Construction Scenario BOWL 2 *(showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve).*

Conclusions on Effects of the Wind Farm on Bottlenose Dolphins

37. The Original ES predicted that a small to medium magnitude effect of minor to moderate significance in the short-term and small to medium magnitude effect of moderate significance in the long-term, i.e. both significant under the EIA Regulations (Section 12.5.1.1 of the Original ES). This revised assessment has been considered in light of the results from the new BND population model. The assessment considers that there will be a small to medium magnitude negative effect of behavioural displacement of between 1 to 33 individuals during the piling phase, which would result in a minor to moderate effect on BNDs, a high value receptor, which would be a likely significant effect under the EIA Regulations. This could lead to a reduction in reproductive output of the population over a period of two to three years (depending on whether single or concurrent piling is carried out) but in the long-term the population is predicted to recover to the baseline levels of a stable, or increasing population. Therefore, over the long-term, there are predicted to be negligible magnitude effects which are not likely significant effects under the EIA Regulations. The new modelling work undertaken reduces the uncertainties and therefore it is possible to conclude no likely significant long-term effect. The predictions made in this ES Addendum are considered to be probable. As stated previously, based on the potential ecological effects on the BND population in the Moray Firth, and evidence from studies of operational wind farms in the North Sea, full recovery (to baseline levels) is likely to occur over the medium-term (<3 years) with animals returning to the disturbed area immediately following cessation of the piling.

Harbour Porpoise

Summary of Assessment in the Original ES

38. The assessment concluded that there would be a temporary negative effect of behavioural displacement on harbour porpoise during the piling phase. For the spatial worst case scenario of concurrent piling (Figure 6.3), the number of individuals potentially displaced was estimated as 4,350. Based on recent SCANS estimates of the North Sea population of porpoises of 249,643 individuals (Hammond, 2006) the proportion of the population potentially displaced was predicted as 1.7%.

39. Harbour porpoise is an abundant, wide-ranging species, which spends much of the time in offshore waters, and is distributed throughout the waters of the British Isles. The assessment in Section 12.5.1.1 of the Original ES considered that temporary displacement during the two or three year construction phase is unlikely to have any biological significance on the population and the magnitude of effects was considered to be small. Due to the sensitivity and international conservation status of harbour porpoise, the significance was assessed as minor, and not a likely significant effect in terms of the EIA Regulations. Long-term effects were considered unlikely to occur and therefore would not be a likely significant effect. The confidence in the assessment was considered to be probable. Further information on the sensitivity of harbour porpoise to noise from pile-driving in given below to support these conclusions.

Supporting Evidence for the Assessment Based on a Recent Literature Review

40. The potential for both short to medium-term responses to pile driving and long-term population effects were investigated based on previous studies of offshore wind farms, during construction and immediately post-construction.

41. In terms of short to medium-term effects, several studies have reported changes in acoustic detection rate or porpoise density during installation of offshore wind farms using pile-driving, which implies an avoidance response in free-ranging animals (e.g. Carstensen et al., 2006; Tougaard et al., 2009). Behavioural response in porpoises was seen to extend a considerable distance from the piling activity, for example, at Horns Rev offshore wind farm in Denmark the zone of responsiveness was shown to extend up to 21 km from the source (Tougaard et al., 2009). Although the effects extended a large distance at Horns Rev, the duration of was limited to a short period of pile-driving activity during the construction phase, with populations recovering within 24 hrs of cessation of the piling (Tougaard et al., 2009).

42. Similarly, a study of the short-term response of harbour porpoise (and other cetaceans) to installation of the two Beatrice Demonstrator Turbines showed that during installation of the first turbine, harbour porpoise occurred regularly around the study area and continued to use this area during the piling period (Thompson et al., 2010). However, a disturbance response was considered likely since the number of hours in which they were detected were lower during piling compared to before and after. Notably, the median hours per day that harbour porpoise were detected increased in the period immediately following piling activity (within a week) for both turbine installations, suggesting that porpoise will return to a disturbed area fairly quickly after possible displacement.

43. Most recently, Brandt et al. (2011) used a gradient sampling design to look at behavioural displacement in harbour porpoise at increasing distances from a single piling activity using a 900 kJ hammer energy at Horns Rev II offshore wind farm. The study found that recovery time decreased with increasing distance from the piling activity. At distances of 2.5 to 4.8 km, the abundance (measured as porpoise positive minutes) returned to baseline levels after 17 to 24 hours following cessation of piling; at distances of 10.1 to 17.8 km the abundance returned to baseline after 9 to 10 hours; and at 21.2 km there was a negligible decrease in abundance, and actually, after 70 hours the abundance exceeded baseline levels by 31%.

44. Another important finding in this study was that pile driving did not lead to 100% avoidance throughout the study area (Brandt et al., 2011). At closer distances (2.5 to 4.8 km) there was 100% avoidance, however, this proportion decreased significantly moving away from the pile driving activity, such that at distances of 10.1 to 17.8 km, avoidance occurred in 32 to 49% of the population. At 21.2 km, the abundance reduced by just 2%. Although the parameters in the Brandt et al. (2011) study differ from those considered for the Wind Farm, the proportional response demonstrated at Horns Rev is nonetheless an important finding, as it suggests that the dose-response curve adopted in the modelling study for the Wind Farm is the most appropriate approach.

45. Southall et al. (2007) also acknowledge that there is a graduated relationship between behavioural response and noise level. Changes in behaviour and the ranges at which these occur, are likely to vary considerably between individual animals and for the same animal in different circumstances. Influencing factors will include the animal's sex, age and physiological state (e.g. health, pregnancy); motivation (e.g. hunger, breeding); behaviour prior to exposure (e.g. prey pursuit, social interaction, resting); the relative importance of local habitat resources (e.g. prey availability); and previous experience with the sound (the degree to which the animal has habituated to these or similar sounds).

46. The proportional response and potential rapid recovery of harbour porpoise suggests that following cessation of piling, the population may return to baseline levels. Indeed, considering all the precautionary assumptions adopted in the noise modelling study (Table 6.2) it is likely that many animals will tolerate increased noise levels in the zone of behavioural avoidance. For example, one of the assumptions is that harbour porpoise will travel in the mid-water column where sound pressure levels are greatest. However, in reality animals would not be subjected to these high sound pressure levels at all times since they are likely to move up and down through the water column, and surface to breathe, where the sound pressure would drop to zero. Westgate et al. (1995) showed that 30-60% of a harbour porpoise population is most likely to move in the upper two metres of water column and the sound pressure here is considerably lower than in the mid-water column. Similarly, Teilman et al. (2007) obtained dive data from 14 harbour porpoises, and demonstrated that tagged individuals spent 68% of their time in depths of less than five metres.

47. There is also evidence from the Dutch offshore wind farm, Egmond aan Zee, that harbour porpoise may return to the wind farm area immediately (within 24 hours) following pile-driving during the construction phase, with numbers over a period of one year measured as greater than baseline levels (Scheidat et al., 2011). The reason for this was unclear, but it was hypothesised that the increase may have been due to increased food availability within the operating wind farm due to the 'reef' effect of the foundations, and/or the absence of vessels in an otherwise heavily trafficked part of the North Sea.

48. In contrast to the studies listed above that show potential for rapid recovery following wind farm construction one monitoring study of harbour porpoise at the Nysted offshore wind farm in the western Baltic between 2001 and 2012 showed that recovery of harbour porpoise to baseline population levels following the construction phase was slow (Teilman and Carstensen, 2011). However, this is not directly comparable to studies of harbour porpoise at other offshore wind farms, such as Horns Rev I (80 mono piles), Horns Rev II (91 mono piles) and Egmond an Zee (36 mono piles), since the foundations at Nysted (72 turbines) were gravity bases and therefore whilst the noise levels may have been much lower compared to piling, the duration of installation of the foundations was much longer at Nysted (Teilman and Carstensen, 2011). In addition, the densities of porpoise were eight times lower at Nysted prior to construction compared with the densities around Horns Reef and therefore, even though comparatively fewer animals were affected

at any one time, over the duration of the construction phase, a higher proportion of the population was affected at Nysted leading to a likely significant effect in terms of a proportional decrease in porpoise activity.

49. In general, the population consequence of behavioural disturbance for harbour porpoise is difficult to determine due to a paucity of long-term studies. The work currently being undertaken by SMRU and the University of Aberdeen on the PCoD will address some of the uncertainties associated with predicting long-term effects of disturbance on marine mammal populations in the future (Lusseau et al., unpublished). The study, due to be published in 2013, aims to elicit expert opinion to produce a strategic framework that will allow a more robust approach to assessing the risks to marine mammals from renewable energy developments, and therefore reduce the uncertainty often associated with such assessment.

Conclusions on Effects of the Wind Farm on Harbour Porpoise

50. The Original ES predicted short to medium-term effects of negligible to small magnitude and of minor significance and predicted no long-term effects, i.e. no likely significant effects in terms of the EIA Regulations (12.5.1.1 of the Original ES) (this was assessed as being probable). In summary, it is considered that the conclusions of the Original ES assessment are supported based on the further evidence provided here, with no change to the predictions made.

Minke Whale

Summary of Assessment in the Original ES

51. The minke whale is the smallest of the mysticetes, or baleen whales, and is widely distributed along the Atlantic coastline of Britain and Ireland as well as in the northern and central North Sea (Reid et al., 2003). Their distribution varies annually, but tends to be linked to the distribution of prey species (Robinson and Tetley, 2005 and 2007). Most sightings within continental shelf waters occur between May and September, with numbers peaking between July and September, depending on the region (Evans et al., 2003). Site-specific data collected during boat-based surveys in the Moray Firth showed that minke whales occurred predominantly between April and October. Along the southern Moray coast there are peaks in sightings in June, July and August, when minke whales are associated with feeding on their preferred prey item, sandeels, in areas of upwelling along this southern coastline (Robinson and Tetley, 2005). Recent advice from JNCC regarding an appropriate reference population is to consider the east and west coast of the British Isles as one population (*H. Niner, JNCC, pers. comm* 10.12.12). Based on the recent SCANS estimates for these blocks, the reference population is estimated as 18,958 individuals for the whole east and west coast of the British Isles (Hammond et al., in press). Modelled surface density estimates based on SCANS-II (in 2005) for minke whale show that the key area for minke is offshore in the central North Sea, with smaller areas of higher density around the coast of southern Ireland, the southwest coast of England and the northeast coast of Scotland (Plate 6.3) (Hammond, 2006). In SCANS block J, which encompasses the Moray Firth and Shetland Isles, the most recent modelled density estimate for minke whale is 0.022 animals km^2 (Hammond et al., in press).

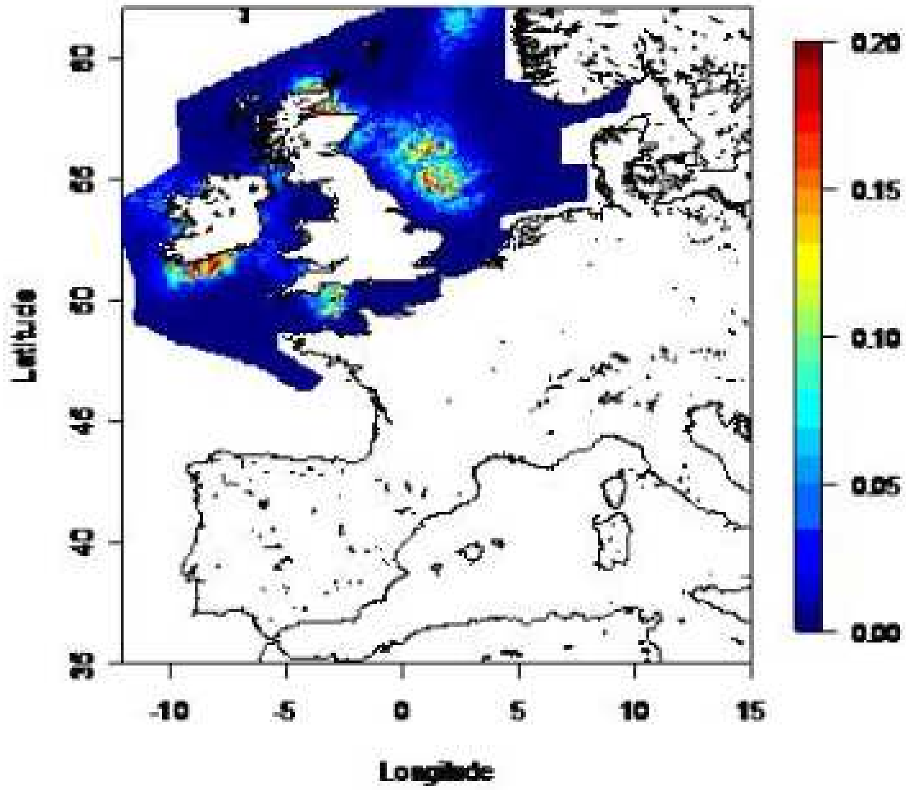


Plate 6.3 Modelled surface density estimates (animals km^{-2}) for minke whale around the coast of the British Isles (source: Hammond, 2006).

52. The assessment considered that there would be behavioural displacement during the piling phase, but only a small proportion of their potential range would be affected. The magnitude of effects was considered to be small and based on the sensitivity and international conservation status of minke whale, this could lead to an effect of minor significance, which is not a likely significant effect in terms of the EIA Regulations. Long-term effects were considered unlikely to occur, and are therefore not likely significant effects. The confidence in the predictions was assessed as being probable.

Revised Assessment Based on Further Noise Modelling

53. Following further noise modelling using humpback whale (a baleen whale) as a proxy for minke whale, this assessment has been re-evaluated in this ES Addendum. In the absence of robust predicted density estimates for minke whale across the Moray Firth (since the sample size was too small to undertake density modelling), the SCANS II estimate for the average density in Block J (0.022 animals km^2) was used to estimate the numbers potentially affected (Hammond et al. in press).

54. Mysticetes hear at very low frequencies of <10 Hz and have a wide auditory range of between 7 Hz up to 22 kHz (see Table 12.6 in Original ES). Whilst baleen whales do not use echolocation to communicate, they can produce low frequency, loud sound that can travel greater distances through the water compared with the higher

frequency sound, made by echolocating species. It is thought that sounds produced by baleen whales may aid in navigation and long distance migration. In addition, vocalisations in baleen whales have been linked to intrasexual selection, where individual male whales use loud, low frequency calls to maintain their separation distance to other males thereby establishing their dominance. In the same way, vocalisations may also demonstrate fitness to females when trying to attract a mate, and therefore sound is important for intersexual selection.

55. As mentioned previously, the thresholds used in the noise modelling assessment for minke whale are derived from studies of another baleen whale – humpback whale – in the absence of empirical data for minke whale. Based on the published work of Southall et al. (2007), the criteria for permanent auditory injury, expressed as the onset of PTS, is 198 dB re 1 µPa^2.s. This is extrapolated from studies that measured the onset of temporary auditory injury, or TTS, as 183 dB re 1 µPa^2.s, given that PTS cannot be ethically or legally induced in animals to determine the threshold. Noise thresholds for behavioural effects were modelled using Subacoustech's dB_{ht} metric, which employs a frequency weighting for minke whale based on the hearing ability of the species. The thresholds proposed in this case are: i) 90dB_{ht} where the prediction is that there would be strong avoidance by virtually all individuals with the potential for TTS over a prolonged period; and ii) 75dB_{ht} where the prediction is that there may be significant avoidance by up to 50% of individuals although habituation will limit the response. The dB_{ht} metric also gives a threshold of 110 dB_{ht} as the noise level that could cause the onset of TTS. This is suggested as the tolerance limit of sound with the potential for TTS to be caused from a single event.

56. The modelling shows that noise levels of 198 re 1 µPa^2.s, which could elicit the onset of PTS, would be relatively localised around the piling locations, with effects predicted out to a distance of 1.65 km (Figure 6.4). Due to the coarse scale resolution of the SCANS data, it would be inaccurate to estimate the number of animals affected by PTS, but auditory damage can be mitigated by soft-start piling procedures and pre-piling monitoring as described in Section 6.7. As animals move away from the source they continue to be exposed to levels sufficient to elicit TTS. Thus, repeated exposure at levels of 110 dB_{ht} or greater may also induce PTS. However, based on the dB_{ht} approach, the potential for temporary auditory damage would also be localised around the piling location (Figure 6.5). Far field effects would be manifest as behavioural displacement of minke whales, and the extent of such effects occur over a large area since the outermost threshold for behavioural effects (75 dB_{ht}) reaches both the north and south coast of the Moray Firth. Based on the SCANS density estimates, the total number of minke whale likely to experience noise levels sufficient to cause strong avoidance by all individuals (90 dB_{ht}) for a single piling vessel is 106 (0.58% of the reference population). This estimate increases slightly for the worst case spatial scenario of two concurrent piling vessels, with 113 individuals displaced (0.61%), although the period of displacement would be reduced from 3 years to 2 years (Table 6.4). Significant avoidance by up to 50% of animals exposed to noise levels of 75 dB_{ht} would affect 319 individuals (1.71% of the population) for single piling over a 3 year construction

phase, or 329 individuals (1.77% of the population) for concurrent piling over a 2 year construction phase. These estimates are precautionary since they are based on the total count of individuals within each noise threshold, rather than a dose-response relationship which would predict a more graduated response with fewer individuals affected. In addition, as highlighted, piling would not occur as a continuous event over the entire construction phase.

57. Empirical evidence for the effect of underwater noise on minke whale comes from studies of other baleen whales. Overt avoidance behaviour of bowhead whales was recorded over distances of six to eight kilometres in response to noise levels of 150 – 180 dB re. 1µPa, with some avoidance behaviour observed out to at least 20 km (Koski and Johnson, 1987). Migrating bowheads avoided an area out to 10 km from drilling activity in the Alaskan Beaufort Sea with animals further afield (>20 km) also diverting their course (Hall et al. 1994). Grey whales also showed whale avoidance behaviour to drilling noise and alteration in their call characteristics was also noted, suggesting adaptations to reduce masking (Dahlheim, 1987). A reduction in the abundance of grey whales in a lagoon in Mexico was attributed to playbacks of drilling noise over a duration of 120 hours (Jones et al. 1994). In this study, numbers were reduced up to a month following the drilling noise, but returned to normal the following winter.

58. McCauley et al. (1998) observed humpback whale during seismic surveys, and experimentally exposed individuals to air gun noise, off the west coast of Australia. Whilst no disruption of whale migration routes was observed, avoidance behaviour was exhibited out to a range of five to eight kilometres from the source with 100% avoidance out to a range of three to four kilometres. Typical received noise levels at five kilometres were measured as 162 dB re.1 µPa2. Avoidance in minke whale was also noted during seismic surveys in UK waters, but spatially was more localised compared to small odontocetes (Stone, 2003; Stone and Tasker, 2006).

Conclusions on Effects of the Wind Farm on Minke Whales

59. The Original ES concluded that a short to medium-term effect of small to negligible magnitude and minor to negligible significance would occur and no long-term effects, i.e. no likely significant effects in terms of EIA Regulations. Based on the noise modelling results presented here and the potential sensitivity of minke whale, inferred from studies of other baleen whales, the assessment has been subsequently revised. Short to medium-term effects are predicted over the duration of the piling phase, which would result in displacement of individuals over a large proportion of the Moray Firth during this period. Since minke whales are widely distributed throughout the North Sea and around the British Isles, and are not tied to specific feeding ground, it is likely that individuals will move to alternative habitat during the period of disturbance. In addition, for the worst case scenario of concurrent piling, only a small proportion of the population (1.77%) would be affected during this time, and effects would only occur during the summer months when minke whales are present in the area. Subject to the uncertainties regarding the population consequences of disturbance, and with regard to the precautionary approach adopted in this assessment there is considered to be a short to medium-

term effect of small to medium magnitude and minor to moderate significance (i.e. a likely significant effect in terms of the EIA Regulations) which is probable, although no long-term likely significant effect is predicted, since the population is predicted to recover to baseline levels following cessation of the piling. Therefore there would be no long-term likely significant effect in terms of the EIA Regulations.

Harbour Seal

Summary of the Assessment in the Original ES

60. Harbour seals are present throughout the Moray Firth and individuals that regularly use the waters around the Wind Farm Site have strong links to the Dornoch Firth and Morrich More SAC, designated for harbour seals, in the inner Moray Firth. Based on the modelled at-sea densities for this species, the impact assessment concluded that there would be short to medium-term (during piling) effects on the population from both PTS and behavioural displacement (Figures 6.6 and 6.7). An estimated four individuals may experience PTS based on the fleeing animal model. For behavioural effects, it was estimated that up to 1,126 individuals, accounting for 65% of the population, may be displaced during piling.

61. Based on the importance of the Study Area for harbour seals from the SAC as a key foraging area, and the number of individuals potentially affected, the magnitude of effects was considered to be large. Due to the sensitivity of harbour seals, and international conservation status, the effect would be of major significance and therefore a likely significant effect in terms of the EIA Regulations.

62. As a result, BOWL (and MORL) commissioned further population modelling by the University of Aberdeen to look at whether these effects could lead to a long-term effect on the population. The harbour seal framework subsequently formed the basis for the assessment, giving greater confidence to the predictions of the assessment (Thompson et al. 2011). The outcome of this modelling showed that, whilst the population size was temporarily reduced during the piling phase, there was no long-term effect on population viability (see Plate 12.12 in the Original ES).

63. In development of the harbour seal population model, a number of precautionary assumptions were made based on the experience of scientific experts in the field. However, one of the issues raised in response to the Original ES (see Table 6.1), was the robustness of the model predictions based on variations in the model parameters. Specifically, the question arises as to what the effect on the long-term population of harbour seal would be if the assumptions regarding i) the survival rate resulting from PTS, and ii) the carrying capacity of the Moray Firth harbour seal population were to change. These questions were addressed through further modelling work within the harbour seal framework, and the outcome is described below.

Re-modelling of the Long-Term Population Effects on Harbour Seal

64. Further modelling was carried out following the methods described in the harbour seal framework developed specifically to model construction impacts from the Wind Farm and the Moray Firth Round 3 Zone (Annex III of Annex 6A). In

addition to exploring the effects of changing the animals probability of survival resulting from PTS, and the carrying capacity of the population, the model also looked at the effect of varying the dose response curves (upper, best and lower fit) for the prediction of the proportion of animals excluded from the area.

65. As described for BNDs, noise modelling was undertaken to determine the number of animals potentially affected by PTS and behavioural displacement using the dose-response relationship to estimate proportional effects. The two scenarios considered are the same as those modelled for BND, with a single piling vessel operating over three years or two piling vessels operating concurrently over two years (Table 6.4). The original harbour seal framework presented in Annex 12B of the Original ES applied a PTS threshold of 198 dB SEL for harbour seal since it was considered that the threshold of 186 dB SEL proposed by Southall et al. (2007) was overly conservative, and based on limited scientific evidence. However, following consultation with the statutory authorities it was agreed that, since the threshold may lie between these two received noise levels, a precautionary approach should be adopted and therefore the threshold for PTS for pinnipeds in water was taken forward for population modelling as 186 dB SEL (Annex II of Annex 6A; see also Table 6.2).

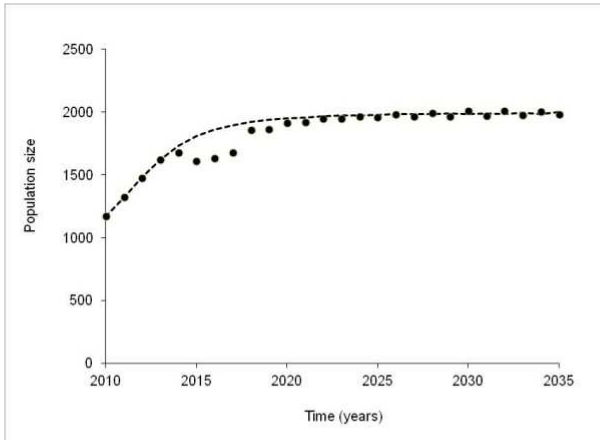
66. Figure 2 in Annex 6A presents the graphs showing the population size over time (modelled over 25 years) for both the single piling scenario at the Wind Farm and the concurrent piling scenario (Table 6.4). The effect of decreasing mortality rate arising from PTS is a smaller predicted reduction in the population size in the short to medium-term. Thus, as the mortality rate is increased from 10 to 30%, so the amount by which the population decreases over the short-medium-term (a three to four year period out of the modelled 25 years) is seen to slightly increase (Plate 6.4; see also Annex 6A). However, over 25 years the population returns to the predicted baseline levels. Similarly, neither varying the carrying capacity (K) of the harbour seal population from K=2000 to K=1000, nor varying the dose-response has any apparent effect on the long-term viability of the population, although as before there are some slight differences over the three to four year period where the population is predicted to decrease before returning to the predicted baseline levels (Plate 6.5 and Plate 6.6).

Conclusions on Effects of the Wind Farm on Harbour Seals

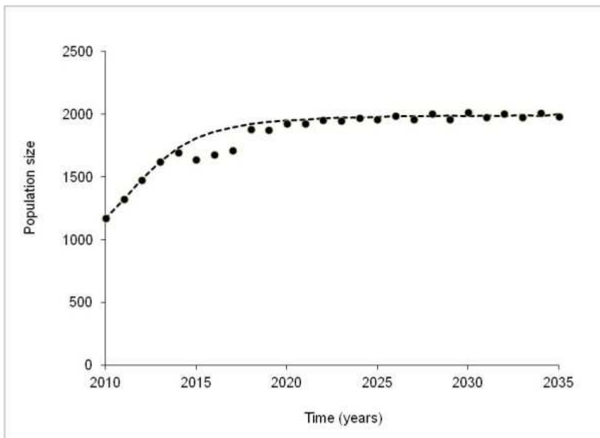
67. The Original ES concluded that in the short to medium-term, a large magnitude effect of major significance (i.e. a likely significant effect in terms of the EIA Regulations) and no long-term effect (i.e. not a likely significant effect in terms of the EIA Regulations; Paragraph 190 of the Original ES) could occur. In summary, the results of this further modelling do not change the impact assessment in the Original ES. There are considered to be short-term effects of large magnitude on harbour seals, which are of major significance. However, recovery to baseline levels is predicted to occur over a four to five year period and therefore in the long-term the population will recover. Consequently, the magnitude of effect is negligible and not a likely significant effect in terms of the EIA Regulations. The

results of the further modelling have, however, increased the confidence in the assessment, particularly with regard to the absence of long-term effects.

a)30%



b)20%



c)10%

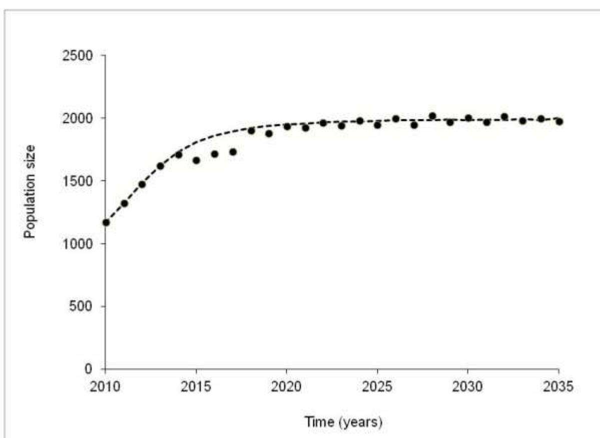
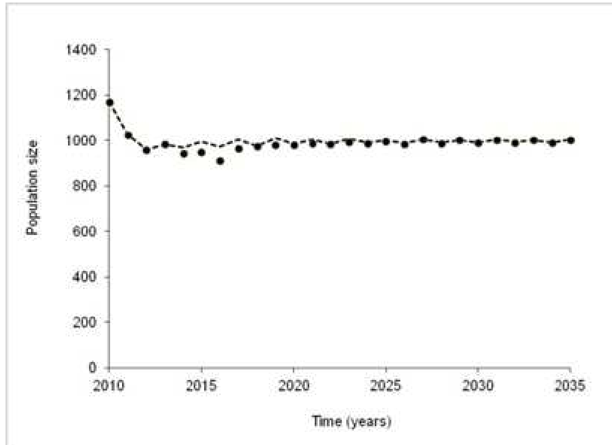


Plate 6.4: Variation in the Long-Term effect on the Population of Harbour Seals from Single Piling at BOWL A *(based on mortality rates of a) 30%, b) 20% and c) 10% and based on K=2000. Figures showing the concurrent piling scenario are very similar and are presented in Annex 6A)**.***

a)K=1000



b)K=2000

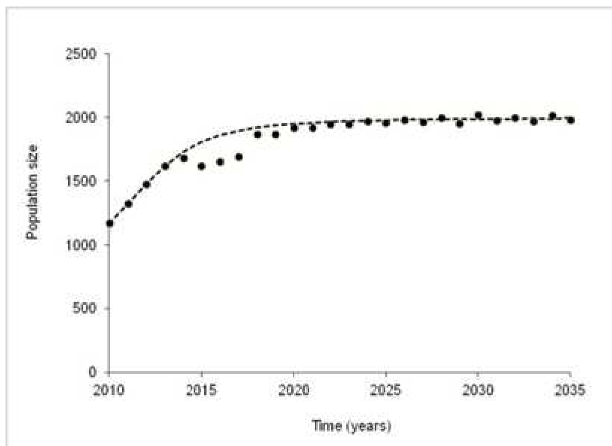
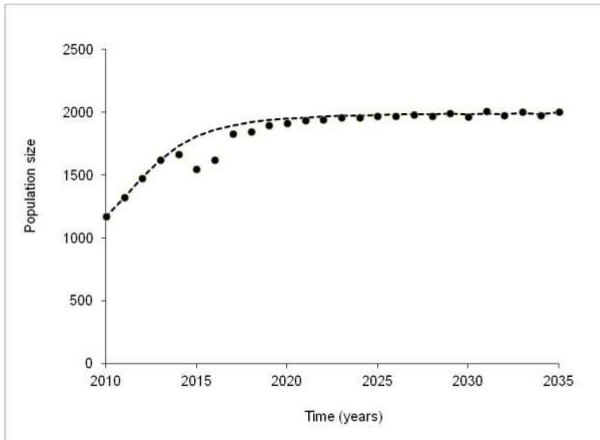
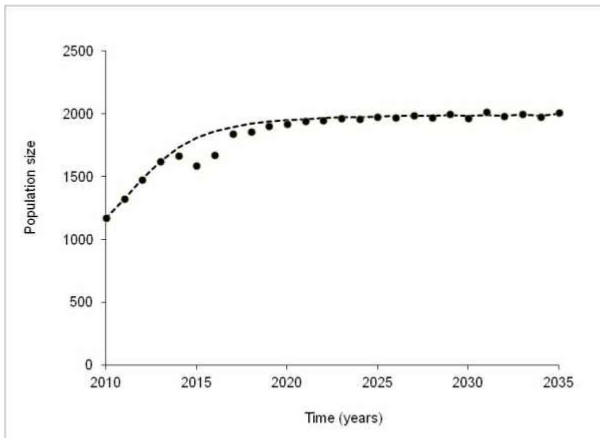


Plate 6.5: Comparison of the Effects of Varying the Carrying Capacity (K) on the Long-Term Viability of the Harbour Seal Population from Single Piling *(based on a) K=1000 and b) K=2000) (figures presented are based on the best-fit dose-response curve. Figures showing the concurrent piling scenario are very similar and are presented in Annex 6A).*

a)Upper



b)Best



c)Lower

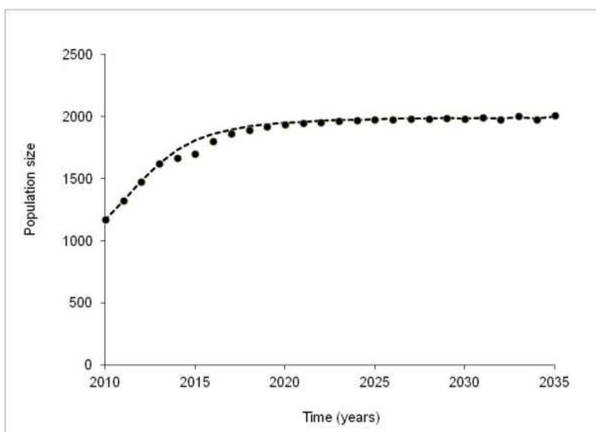


Plate 6.6: Comparison of the Effects of Varying the Dose-Response Curve on the Long-Term Viability of the Harbour Seal Population from Single Piling *(based on a) upper, b) best, and c) lower fit curves) (figures presented are based on a carrying capacity of K=2000. Figures showing the concurrent piling scenario are very similar and are presented in Annex 6A)**.***

6.6.1.2 Comparison of Effects at Different Hammer Energies

68. In response to issues raised by the consultees, this section provides a comparison of the changes in impact area based on two different modelled hammer energies: 2,300 kJ (the 'worst case scenario') and 1,800 kJ. It should be noted that this is for illustrative purposes and consequently the assessment only focuses on the worst case scenario as defined in the Rochdale Envelope since consent is being sought for use of the 2,300 kJ hammer energy.

69. The Rochdale Envelope for the worst case scenario considers, as precautionary approach, that the maximum hammer energy will be applied at each location throughout the Wind Farm Site. However, studies of offshore wind farms have demonstrated that this maximum hammer energy is rarely achieved (Theobald et al., 2010; Bailey et al., 2010) and therefore it is likely that the areas of ensonification modelled are an overestimate of the magnitude of effects. In particular, the hammer energy ramps up over time from a 'soft-start' energy level, and therefore the maximum energy required at a particular site is only employed for a fraction of the time.

70. In order to demonstrate the influence of reduced piling hammer energies on marine mammals in the vicinity of the Wind Farm site, the areas and numbers of animals affected by piling at the Wind Farm site for the two different hammer energies have been calculated for BND (Figure 6.8 and 6.9) and harbour seal (Figure 6.10 and 6.11). These are presented in Table 6.6, though it should be noted that the numbers of animals affected are absolute numbers for comparison purposes only and are not calculated based on the dose-response relationship. It should also be noted that for the purposes of this comparison, modelling for one piling location only (location A) has been considered.

71. The reduced hammer energy of 1,800 kJ is predicted to reduce the areas within the 90 dB_{ht} and 75 dB_{ht} noise contours by approximately 15% and 9.5%, respectively. This would result in a 3.7% and 11.3% reduction of the numbers of BND affected within the 90 dB_{ht} and 75 dB_{ht} noise contours, respectively, and a 12.5% and 6.5% reduction in the harbour seal numbers affected within the 90 dB_{ht} and 75 dB_{ht} noise contours, respectively.

Table 6.6: Areas and Maximum Number of BND and Harbour Seal Predicted to be within the Behavioural Impact Ranges of 90dB$_{ht}$ (strong avoidance) and 75 dB$_{ht}$ (significant avoidance) from Piling Location A for Two Hammer Energies. *(Note: For BND, the numbers of animals affected presented are absolute numbers for comparison purposes only (these are not calculated on the dose response relationship))*.

Hammer Energy (kJ)	dB$_{ht}$	BND		Harbour seal	
		Area (km^2)	Number (Max)	Area (km^2)	Number (Max)
2300	90	689	0.27	1,055	297.316
	75	4,192	15.72	6,330	1107.471
1800	90	587	0.26	887	259.996
	75	3,786	13.94	5,729	1,035.63

72. The result of decreasing hammer energy is an overall decrease in the spatial magnitude of effect during the piling phase. However, the reduction in hammer energy does not lead to a large enough decrease in the area of ensonification, and consequently the relative number of animals affected, for the conclusion of the impact assessment to change, particularly with regard to the sensitivity of marine mammal receptors.

6.6.1.3 Interactions of Effects

73. The assessment of effects arising from all potential effects on marine mammals considered in the Original ES that have the potential to interact is presented in Table 6.7. The limitation of this assessment is that each impact is considered in terms of the worst case scenario, and these may be different for the different impacts. For example, increased sedimentation considers installation of gravity bases as the worst case scenario, whilst noise from piling considers installation of pin piles as the worst case. Therefore, by combining these effects the assessment may over-estimate the effects arising from a worst case scenario for some effects.

74. The potential for effects to combine during construction, operation or decommissioning to create an effect of greater magnitude than the effect of each individual effect is considered to be unlikely (Table 6.7). This is primarily due to the relatively small magnitude and significance of the effects during the operational and decommissioning phases (compared to the effect of underwater piling noise during the construction phase) and the short recovery rates predicted following the construction phase effects, including piling operations. Therefore, there is no change in the magnitude of effects or the significance of effects from those presented for each of the effects alone.

75. The assessment of effects arising from all potential effect on marine mammals (as presented in Table 6.7) considers all marine mammal species combined, rather than considering each species individually. This is due to the similarity of effects on marine mammal species for most of the effects throughout the lifetime of the project (the exception being impacts related to underwater construction noise).

Table 6.7: Summary of the Potential Total (Inter-Related) Effects on Marine Mammals

Phase	Construction Phase		Operational Phase		Decommissioning Phase		Level 1 Effects (temporal inter-related effects across lifetime of project)	Level 2 Effects (multiple effects acting on the same receptor)
	Sources	Significance of Individual Effect	Sources	Significance of Individual Effect	Sources	Significance of Individual Effect		
Underwater noise causing physical injury/ disturbance	Installation of foundation structures (piling)	Minor to moderate[2] Minor[3] Moderate[4] Major[5]	Operational Noise	Not a likely significant effect	Removal of project structures	Minor	Subsea noise will be produced at all stages of the Amended Project, from piling and vessel noise during construction, to operation and maintenance vessel noise and activity in the operational phase. However, although marine mammals will be exposed to noise across the project phases, in the case of construction and decommissioning, the events generating the noise will be temporally discrete (in the case of piling). Whilst there may be behavioural responses to piling noise for certain species of marine mammals, resulting in potential avoidance of the site, longer-term exclusion from the site (i.e. during the operational phase) due to adverse subsea noise levels is not predicted. Therefore, no likely significant inter-related effects	Scope exists for Level 2 inter-related effects on all marine mammal species identified as occurring within and around the Study Area. The majority of effects listed in this table will all potentially affect marine mammals at the same time. The greatest scope for interaction of different effects on marine mammals will be in the construction phase, when subsea noise from piling/drilling and vessel activity, coupled with increased suspended sediment concentrations, habitat disturbance, potential loss of prey items and vessel strikes, will all potentially interact to increase the significance of the individual impacts on marine mammals.

[2] Bottlenose dolphin
[3] Harbour porpoise and grey seal
[4] Minke whale
[5] Harbour seal (negligible long-term effect)

Phase	**Construction Phase**		**Operational Phase**		**Decommissioning Phase**		**Level 1 Effects (temporal inter-related effects across lifetime of project)**	**Level 2 Effects (multiple effects acting on the same receptor)**
	Sources	**Significance of Individual Effect**	**Sources**	**Significance of Individual Effect**	**Sources**	**Significance of Individual Effect**		
							across different project stages are predicted over and above the effects listed here for the individual project stages.	
	Vessel activity	Minor	Vessel activity	Minor	Vessel activity	Minor		
EMF	N/A	N/A	Export and inter array cables	Minor	N/A	N/A	This effect will only arise in the operational phase therefore there will be no Level 1 effects.	However, in reality, the displacement of marine mammal species from the main site during piling events will actually reduce the exposure to the other impacts, namely increased suspended sediment concentrations and increased vessel strike risk.
Vessel strikes (collision) with marine mammals	Vessel activity	Minor	Vessel activity	Minor	Vessel activity	Minor	The potential for vessel strikes will arise at all stages of the Amended Project, resulting in a potential Level 1 effect. However, it is not predicted that the significance of any potential vessel strikes will increase due to the interaction of this impact across all Project stages, rather be maintained at the same level throughout the project (with resultant minor adverse significance prediction).	A situation may also arise where any potential loss of prey items is offset by the fact that as marine mammals are displaced from areas around piling, the fish that form part of their diet may also be displaced, thus remaining available for marine mammal feeding.
Loss of prey resources for marine	Installation of foundation	Negligible	Presence of foundations / scour	Negligible	Removal of project structures	Negligible	The potential loss of prey items for marine mammals as a result of the Amended Project will arise at all	Therefore, it is predicted that the interaction of these impacts may act, to some extent, to counter certain

Phase	Construction Phase		Operational Phase		Decommissioning Phase		Level 1 Effects (temporal inter-related effects across lifetime of project)	Level 2 Effects (multiple effects acting on the same receptor)
	Sources	Significance of Individual Effect	Sources	Significance of Individual Effect	Sources	Significance of Individual Effect		
mammals	structures		protection/ cable protection				stages of the Project via displacement of prey in the construction phase (as a result of piling activities) through to loss of potential benthic habitats due to foundations in the operational phase. However, the significance of this inter-related effect is not predicted to increase over and above the negligible predictions made for the individual Project phases as there will not be an on-going, additive loss of prey, rather an initial loss, followed by recovery of areas, leading to no large-scale and long-term loss of prey items.	potential effects occurring and as such, any inter-related effect will not be of any greater significance than those already assessed individually in the original marine mammal ES chapter.
Reduction in foraging ability due to increased suspended sediment concentrations	Installation of foundation structures	Negligible	N/A	N/A	Removal of project structures	Negligible	There is no potential for level 1 effects due to no potential for temporal overlap.	

6.6.2 CONSIDERATION OF THE MOST LIKELY SCENARIO

76. Section 4: Amended Project Description presents the most likely scenario for the Project. The assessments presented in Section 6.6.1 and in the Original ES (Section 12.5) 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 marine mammals.

77. The most likely scenario involves a reduction in the number of turbines installed from 277 to 140 turbines. This would have an effect on some of the impacts identified for marine mammals, since there would be the following changes:

- A reduction in the piling duration, although the piling installation programme for each turbine would remain the same as for the worst case scenario; and
- A reduction in the number of vessels used over the construction and operation phases.

78. Comparison of the worst case and most likely scenarios, suggests that the effects on marine mammals may differ, primarily in terms of temporal effects (Table 6.8). Installation of fewer turbines would shorten the piling phase from three years to one year for a single installation vessel, and from two years to in the order of nine months for two vessels working concurrently. Disturbance over fewer breeding cycles is less likely to affect marine mammal populations in the medium-term and therefore reduce the magnitude of effects (temporally) during piling. Spatially, the effects would not alter from the worst to the most likely scenario as the same maximum hammer energy of 2,300 kJ is proposed for both scenarios. Therefore, although the duration of effect would be decreased for the most likely scenario, there is still considered to be a likely significant effect on BND, harbour seals and minke whale in the short/medium-term. It is however, likely that a reduction in the piling phase will increase the certainty that there would be no likely significant long-term population-level effects on these species.

79. There are no detailed figures available to allow quantification of the reduction in vessel movement from the worst case to the most likely scenario. However, whilst the number of vessels on site during construction may be similar during both scenarios, the duration of the disturbance would be lower for the most likely scenario as the construction phase would be shortened. During operation there would be a reduction in the number of vessel movements reflecting the smaller number of turbines that require maintenance for the most likely scenario.

80. Similarly, the duration of OfTW cable installation and cable protection works would be less for the most likely scenario and consequently the duration of disturbance would be decreased from an overall total of 690 days to 479.

Table 6.8: Comparison of the Worst Case and Most Likely Scenarios for the Wind Farm and OfTW and Their Relevance for Marine Mammal Receptors

Worst Case	Most Likely	Relevance for Marine Mammals
Piling installation programme (based on the time from when the first pile is driven through to the time when the last pile is driven)		
Single piling: 3 years Concurrent piling: 2 years	Single piling: 1 year Concurrent piling: in the order of 9 months	Reduction in the duration of displacement, which would reduce the possibility of population level effects as fewer breeding cycles are likely to be affected.
Reduction in the total number of vessels movements during construction and operation		
Construction: Maximum number of vessels on site at any one time is 46 over 2-3 years. Operation: 1,760 maintenance vessels per annum.	Construction: Maximum number of vessels on site at any one time is approximately 20 (although 8 is considered to be more typical) over 9 months to 1 year. Operation: no information available but less than that predicted for the worst case since the number of turbines is less.	Reduction in the potential for disturbance from vessel noise and reduction in collision risk to marine mammals.

81. In summary, the most likely scenario would reduce the duration of short to medium-term effects on marine mammals, particularly with respect to noise impacts from piling, disturbance and collision risk from vessel movements during construction and operation, and disturbance and collision risk during cable laying activities. Although this discussion does not consider that the effects would be reduced to such an extent that their significance would be reduced (due to the importance of marine mammals in the Study Area), it is likely that the effects may be of smaller magnitude. Since the duration of effects would be reduced the time until recovery would also be shorter for the most likely scenario.

6.7 MITIGATION MEASURES AND RESIDUAL EFFECTS

6.7.1 MITIGATION MEASURES

82. The mitigation proposed for reducing the effects of piling noise on marine mammals have been updated from those included in the Original ES. The suite of mitigation proposed is discussed in this section.

83. In summary this involves the following measures, following the JNCC (2010) guidelines on reducing the risk of injury to marine mammals during piling:

- During all piling operations trained Marine Mammal Observers (MMOs) will use visual and where required, acoustic detection, to ensure that marine mammals are not within the direct injury zone (termed the "mitigation zone" -

as agreed with relevant Statutory Advisors). The use of MMOs will subsequently reduce the potential for injurious effects for any marine mammal species present in the mitigation zone;

- Passive Acoustic Monitoring (PAM) will be particularly important for periods of poor visibility or night time conditions. PAM buoys will surround the piling location and detections will be sent back to the PAM operator on a dedicated vessel. The use of PAMs will subsequently reduce the potential for injurious effects for any marine mammal species present in the mitigation zone;
- Acoustic Deterrent Devices (ADDs) are a particularly useful tool for mitigating effects upon seals as a result of the difficulties associated with identifying and observing these species, particularly at night and during periods of poor visibility; and
- When piling commences, a 'soft-start' procedure will be employed and the force of piling will gradually be increased to alert marine mammals in the vicinity to the commencement of the operations and thus reduce the potential for injury on all marine mammal species. BOWL will take account of the most up to date soft-start guidance at the time.

84. In addition to the measures outlined above, BOWL is committed to reducing effects on marine mammals 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 reduce 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 reducing 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 marine mammals 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 reduce 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 mitigating certain impacts where possible.

6.7.2 RESIDUAL EFFECTS

85. The soft-start procedure described above has been incorporated as part of the Development Design Mitigation outlined in Section 12.4 of the Original ES.

Therefore the assessment of piling noise has been undertaken with this mitigation measure in mind. Adherence to the latest or best practice guidelines (JNCC at the time of writing) will, however, reduce the possibility of auditory injury to animals within the mitigation zone. However, since the main effect is behavioural displacement, the residual effects are the same as those described above in the assessment.

6.8 MONITORING

86. For this Project, both alone and cumulatively with the Moray Firth Round 3 Zone, a robust monitoring programme will be key to underpinning understanding of the predicted behavioural effects arising from the piling operations. BOWL is working together with MORL to devise a marine mammal monitoring programme (MMMP) that tests the predictions of the assessment of potential effects (Annex 6B presents a proposed MMMP). The programme aims to focus on the collecting data that will test key assumptions of the environmental assessment, thereby reducing uncertainty and conservatism in future assessments. To this end, the MMMP will make an important contribution to the offshore wind industry, allowing greater scientific understanding of the potential adverse or beneficial effects of offshore wind farm on marine mammals. The MMMP has been devised as a series of research initiatives, either as discrete research programmes or as part of broader, wide-scale national or even international, research, monitoring and surveillance programmes.

87. There is a wealth of existing baseline information and research expertise in relation to marine mammals in the Moray Firth. This is both historic, given the importance of the surrounding area for marine mammals, and more recent, as a result of work undertaken on the Amended Project and adjacent Moray Firth Round 3 Zone. The MMMP therefore presents a unique opportunity in UK waters to better understand the interactions between marine mammals and offshore renewable energy developments.

88. The MMMP outlines a number of questions for each of the key marine mammal species and subsequently proposes a scope of monitoring to answer these questions (Table 2 in Annex 6B). The draft MMMP was presented to Marine Scotland, Marine Scotland Policy, Marine Scotland Science, The Crown Estate and the Highland and Islands Enterprise at a meeting on 11th March 2013 and on-going consultations are taking place to refine the details of the programme.

89. The MMMP proposes a programme of monitoring that considers the short, medium and long-term effects that have been predicted in the impact assessments for BOWL and MORL. Short-term effects focus on the immediate response to piling and look at displacement of individuals or changes in the distribution of populations during the pile driving activity and duration of those changes (i.e. how long until a return to the baseline levels). These questions will be addressed through programmes such as photo-ID studies. Current DECC funded SEA studies on the response of harbour seals to piling noise may also be useful in understanding short-term effects. It should be noted that the incorporation of these studies into the MMMP will

depend largely on whether the required equipment is available in time (Ian Davis, MSS, *pers. comm.*).

90. Medium-term effects focus on questions such as how the fitness or reproductive success of individuals may be affected or whether there is evidence of tolerance to noise levels generated from piling. Photo-ID studies of harbour seals will be used to provide information on the abundance, survival and reproduction at breeding sites pre-, during and post- construction, whilst the photo-ID work described above for BND together with surveys using PAM devices, such as C-PODs, deployed prior to and during the construction period will be used to understand changes over the medium-term.

91. Long-term effects are more difficult to address and therefore integration with wider-scale existing programmes will be key. Long-term trends in the abundance of seals in the Moray Firth to look at changes in the population over time will be determined using data from the core national monitoring programme, currently run by SMRU. Data from the Scottish Marine Animals Stranding Scheme, which nationally monitors marine mammal strandings, will also feed into the long-term monitoring programme.

92. Long-term effects will also be addressed through focused studies in the BOWL/MORL MMMP. Photo-ID studies for BND (in May-September) will continue on an annual basis pre-, during and post construction and, together with the C-POD network, will provide an assessment of the long-term changes in the population using the Moray Firth SAC in response to different phases of the BOWL/MORL offshore wind farm projects.

93. Finally, to understand whether short-term effects of disturbance during construction will have long-term population consequences it is important to gain an understanding of other factors that may influence population dynamics. Therefore, the programme will include acoustic surveys to monitor the existing noise levels in the Moray Firth and collation of data from other studies (either from other parts of the BOWL/MORL monitoring programme or using data already available) that can provide information on key prey populations, physical processes, by-catch etc. Further information on the PCoD will be sought from the SMRU Ltd and University of Aberdeen study which is due for publication this year.

6.9 ASSESSMENT OF CUMULATIVE EFFECTS

6.9.1 INTRODUCTION

94. 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 provides further information on the assessment of cumulative effects based following consideration of consultee responses presented in Table 6.1 (including a request to carry out population modelling), plus further

and updated information on the Moray Firth Round 3 Zone, as presented in the Moray Firth Round 3 Zone's ES which was submitted to MS-LOT in August 2012.

6.9.2 CUMULATIVE BASELINE

95. The baseline conditions relating to the Study Area remain unchanged from those presented in Section 12.3 of the Original ES.

6.9.3 CUMULATIVE ASSESSMENT METHODOLOGY

96. The assessment methodology generally remains unchanged from that presented in Section 12.9 of the Original ES, with the exception of the further population modelling for harbour seal and BND, which has been developed to inform the assessment of long-term effects. In order to further inform the cumulative assessment made in the Original ES, this ES Addendum provides further detail on the spatial extents of marine mammal impact areas, assuming different piling scenarios at the Amended Project and the Moray Firth Round 3 Zone (including the cumulative worst case scenario assessed in the Original ES).

97. As the Moray Firth Round 3 Zone comprises three individual sites, each with up to two piling events per site, consideration is given to how increasing the number of piling events across the two developments increases from the Amended Project alone, to the maximum number of eight concurrent piling vessels, which represents the spatial worst case cumulative scenario.

98. This 'stepped' assessment is in the form of a semi-quantitative comparison of the areas impacted for each scenario and the relative number of marine mammals predicted to occur within these impact areas. This considers the effects of the Wind Farm and the Moray Firth Round 3 Zone giving consideration to the breakdown of the Moray Firth Round 3 Zone into stages, as outlined in the Moray Firth Round 3 Zone ES. As such the following assessment works through the following scenarios (including Cumulative Scenario 3, the spatial worst case scenario included in the Original ES and this ES Addendum):

- Cumulative scenario 1: Wind Farm plus Moray Firth Round 3 Zone MacColl Wind Farm (1+2);
- Cumulative scenario 2: Wind Farm plus Moray Firth Round 3 Zone MacColl (1+2) plus Stevenson Wind Farms (4+6); and
- Cumulative scenario 3: Wind Farm plus Moray Firth Round 3 Zone MacColl (1+2) plus Stevenson (4+6) and Telford Wind Farms (3a and 5a), i.e. the worst case scenario for spatial extent.

99. In addition to the stepped assessment above, and in line with the worst case scenarios for construction of the Moray Firth Round 3 Zone, the cumulative assessment also assesses the both the worst case spatially (maximum number of concurrent piling vessels) and the worst case temporally (longest duration of piling activity) cumulative piling scenarios of the Wind Farm with the Moray Firth Round 3 Zone. In summary the following cumulative scenarios were considered:

- Two piling vessels at the Wind Farm over two years (2014 & 2015) followed immediately by MORL 1+5 for three years (2016 – 2018) (5 years in total);

- Eight concurrent piling vessels over two years representing the worst case spatially; and
- Single piling vessel at the Wind Farm followed by a single vessel at Moray Firth Offshore Round 3 Zone for seven years representing the worst case temporally.

100. The updated cumulative assessment involved modelling of the long-term viability of the BND and harbour seal populations to re-evaluate the potential for long-term population-level effects. This used the same methods described for the Wind Farm alone, as described in Section 6.6.1.1 for BND for harbour seal. The results of the further modelling work are presented in this section, but are distinct from the stepped cumulative scenario described above as the scenarios considered in the population modelling are those described in the Original ES and presented in the Moray Firth Round 3 Zone ES. Table 1 in Annex 6A describes the scenarios assessed in the population modelling.

101. These two different approaches to the cumulative assessment are presented in the following two sub-sections: 6.9.4 Stepped cumulative assessment; and 6.9.5 Assessment of spatial and temporal worst cases for cumulative noise effects.

6.9.4 STEPPED CUMULATIVE ASSESSMENT: COMPARISON OF CUMULATIVE NOISE EFFECT AREAS

102. The cumulative scenarios (along with the two piling scenarios for the Wind Farm) are presented visually in Figures 6.12(i) and (ii) for BND, Figures 6.13(i) and (ii) for harbour porpoise, Figures 6.14(i) and (ii) for harbour seal, Figures 6.15(i) and (ii) for grey seal and Figures 6.16(i) and (ii) for minke whale[6]. The total area affected by noise levels sufficient to elicit PTS are illustrated on each figure. As the number of piling locations increase, so the risk of PTS increases. However, the potential for PTS can be significantly reduced through following JNCC (2010) guidelines on minimising the risk of injury to marine mammals, whereby monitoring is undertaken within a 500 m mitigation zone prior to commencing piling. Further details on mitigation are provided in Section 6.7 of this ES Addendum.

103. It should be noted that the PTS contours on the figures are based on a multiple-pulse exposure calculation, which considers the increasing blow energies over the entire duration of piling. Since it takes into account a number of different noise sources in different locations the model assumes the ‘fleeing animal’ is at the geometric centre of all the piling locations and flees from this position in a straight line in 180 transects (i.e. every 2 degrees). Some of these transects will be directly towards the location of piling, and in these directions the greatest exposures will occur. By assuming the animal is in the geometric centre, a precautionary approach is adopted since this will represent the maximum distance over which animals will have to move to avoid PTS. Animals at any location, other than the geometric centre, will have a shorter route to move away from the noise levels and therefore the predicted effect will be smaller.

[6] Note: the underlying density maps have been coarsely digitised into grid cells of approximately 3.5 x 5.0 km using the modelled density estimates of the SCANS II data (shown in Plate 6.3) and therefore were not sufficiently accurate to use in the calculation for assessment of effects.

104. The stepped cumulative assessment focuses on a comparison of behavioural effect zone, as this is considered to be the key issue for marine mammals over the piling phase and cannot be mitigated through the best practice procedures employed for PTS. The areas within the 75 dB_{ht} and 90 dB_{ht} noise contours and the numbers of animals predicted to be affected within these contours are presented in Table 6.9 for each of the three cumulative scenarios and the two piling scenarios for the Wind Farm.

105. It should be noted that the presented numbers of animals affected are absolute numbers using the most up-to-date density plots available for each species. These are those used in the Original ES for all species, with the exception of BND where predicted densities of BND across the Moray Firth were used, in contrast to the Original ES which presented the probability of occurrence of BND. Since the numbers presented were calculated using absolute numbers (i.e. these are not based on the dose response relationship), these are considered to be semi-quantitative and are therefore only used for comparison purposes.

106. The assessment shows that for both the 75 and 90 dB_{ht} noise contours, the greatest proportional change in the area of ensonification and the estimates of numbers affected occurs moving from Scenario 1 to Scenario 2 (Plate 6.7 to Plate 6.11).

6.9.4.1 Bottlenose Dolphin

107. For BND, the numbers of animals affected within the 90 dB_{ht} contour are similar for each of the scenarios (i.e. <4 individuals for all scenarios), with the exception of the scenario of single piling at the Wind Farm, where the number of animals affected is lower (0.36 individuals) (Table 6.9). The large proportional increase in numbers affected from single piling at Wind Farm alone compared to concurrent piling at Wind Farm and the cumulative scenarios occurs because the noise contours extend further towards the areas that have a higher frequency of occurrence of BND (Plate 6.8). For the 75 dB_{ht} contour, there is a marginal increase in the numbers affected by concurrent piling at the Wind Farm compared to single piling at the Wind Farm, but a considerable increase with the addition of Scenario 1 and Scenario 2 (Plate 6.11; Figure 6-12(ii) . There is no increase following the inclusion of the final two piling locations at the Moray Firth Round 3 Zone (i.e. Scenario 3).

108. Although the magnitude of effect on BND, i.e. the area of ensonification, is predicted to increase through the different cumulative scenarios assessed, particularly scenarios where noise contours extend towards the coastline, the significance of the effect would not be expected to change from that described in Section 6.6.1.1 (i.e. likely significant effect according to the EIA Regulations). Further details of the population modelling undertaken to inform the cumulative assessment (particularly with regard to long-term population effects) are provided in Section 6.9.5.

6.9.4.2 Harbour Porpoise

109. For harbour porpoise, the number of animals within the 90 dB_{ht} contour increases by approximately 30% compared with single piling at the Wind Farm with the introduction of two piling locations at the Moray Firth Round 3 Zone (i.e. Scenario

1, Figure 6.13(ii); Plate 6.9), and by approximately 61% compared with single piling at the Wind Farm with the introduction of a further 2 piling locations at the Moray Firth Round 3 Zone site (i.e. Scenario 2, Figure 6.13(ii); Plate 6.9). Similarly, within the 75 dB_{ht} contour, the largest increase in the number of harbour porpoise within these contours occurs between Scenario 1 and 2, with the introduction of the third and fourth piling locations at the Moray Firth Round 3 Zone site, with all other scenarios resulting in small increases (i.e. ~1%) in the numbers of animals affected (Plate 6.11). These large increases in number of animals affected between Scenario 1 and 2 can be explained by the large increase in area of ensonification between these two scenarios, particularly for the 75 dB_{ht} contour (Plate 6.7 and Plate 6.10).

110. The Original ES predicted a cumulative effect of negligible to small magnitude and minor significance on North Sea harbour porpoise with no long-term effects (i.e. not likely significant effects according to the EIA Regulations), due to the wide distribution of this population and availability of alternative habitats in the wider North Sea (Section 12.9.4.1 of the Original ES). Further information on the sensitivity of this species to piling noise and recoverability following piling operations support the conclusions made in the Original ES with respect to effects from the Wind Farm alone (which also predicted effects of negligible to minor significance; see Section 6.6.1.1). Since the stepped approach described in this addendum considers intermediate piling scenarios between the Amended Project alone and the worst case scenario assessed in the Original ES, the conclusion made in the Original ES has not been revised.

6.9.4.3 Harbour Seal

111. The numbers of harbour seal affected within the 90 dB_{ht} noise contour increases by approximately 20% with the addition of the second piling location at the Wind Farm (see Figure 6.14(ii)) and by approximately 30% with the introduction of the third and fourth piling locations at the Moray Firth Round 3 Zone (i.e. Scenario 2, see The greatest difference again is moving from Scenario 2 to Scenario 3 where two Wind Farm and four Moray Firth Round 3 Zone locations are piled concurrently for the latter. Scenario 3 represents a proportional increase of 73% compared with single piling at the Wind Farm (Plate 6.9). The number of animals predicted to occur within the 75 dB_{ht} contour shows a more gradual increase across each of the scenarios, with the numbers of animals affected increasing by approximately 14% between the single piling at the Wind Farm scenario (Figure 6-14(i)) and Scenario 3 (Figure 6-14(ii) (Plate 6.11).

112. Although the magnitude of effect on harbour seal, i.e. the area of ensonification, is predicted to increase through the different cumulative scenarios assessed, the significance of the effect would not be expected to change from that described in Section 6.6.1.1, i.e. an effect of major significance which is a likely significant effect according to the EIA Regulations. Further details of the population modelling undertaken to inform the cumulative assessment (particularly with regard to long-term population effects) are provided in Section 6.9.5.

6.9.4.4 Grey Seal

113. For grey seal, the number of animals within the 90 dB_{ht} noise contours increases steadily with the introduction of further piling locations for each of the scenarios, with the largest increase (by 44%) occurring with the introduction of the third and fourth piling locations at the Moray Firth Round 3 Zone (i.e. Scenario 2, see Figure 6-15(ii); Plate 6.9). Within the 75 dB_{ht} contour, the increases in the numbers of animals affected are more varied, with large increases recorded with the introduction of the second piling location at the the Wind Farm site (see Figure 6-15(ii)) and the introduction of the third and fourth piling locations at the Moray Firth Round 3 Zone site (i.e. Scenario 2, Plate 6.11).

114. The Original ES concluded a cumulative effect of small magnitude and minor significance on grey seals with no long-term effects (i.e. not likely significant effects according to the EIA Regulations), due to their wide foraging area and lack of site fidelity (Section 12.9.4.1 of the Original ES). The Original ES also predicted that piling for the Wind Farm alone would result in effects of minor significance (Section 12.5.1.1 of the Original ES). Since the stepped approach described in this addendum considers intermediate piling scenarios between the Wind Farm alone and the worst case scenario assessed in the Original ES, the conclusion made in the Original ES has not been revised.

6.9.4.5 Minke Whale

115. Finally, for minke whale, the numbers of animals within the behavioural impact contours were directly related to the area within these contours. This is because the abundance within Moray Firth was based on the mean abundances presented in the SCANS data (i.e. 0.022 individuals per km^2). As such, the number of animals within each contour increases with the addition of each piling location, with the largest increase predicted with the introduction of the third and fourth piling locations at the Moray Firth Round 3 Zone (i.e. Scenario 2, see Figure 6-16(ii)) for both the 90 dB_{ht} and 75 dB_{ht} noise contours (Plate 6.9 and Plate 6.11).

116. The Original ES predicted cumulative effects of small magnitude and minor significance with no long-term effects (i.e. not likely significant effects according to the EIA Regulations; see Section 12.9.4.1 of the Original ES). As detailed in this addendum (Section 6.6.1.1), the conclusion made in the Original ES has been revised for the Wind Farm alone, based on updated noise modelling undertaken for minke whale, with a short to medium-term effect of medium magnitude and moderate significance predicted (i.e. a likely significant effect according to the EIA Regulations). The cumulative assessment has therefore also been revised from the Original ES and it can be concluded that a medium magnitude effect of moderate significance will occur in the short to medium-term, with these effects considered to be probable. This is a likely significant effect according to the EIA Regulations, though as with the Original ES, no likely significant long-term effects on minke whale populations are expected.

Table 6.9: Maximum Areas of Behavioural Impact Ranges and Maximum Number of Marine Mammals Predicted to be within these Ranges from a Range of Cumulative Scenarios Associated with the Wind Farm and Moray Firth Round 3 Zone. *(Note: the numbers of animals affected presented are absolute numbers for comparison purposes only (these are not calculated on the dose response relationship)).*

Scenario	**dB_{ht}**	**BND**		**Harbour Porpoise**		**Harbour Seal**		**Grey Seal**		**Minke Whale**	
		Area (km^2)	**Number (Max)**	**Area (km^2)**	**Number (Max)**	**Area (km^2)**	**Number (Max)**	**Area (km^2)**	**Number (Max)**	**Area (km^2)**	**Number (Max)**
BOWL 1 Piling Location	**90**	689	0.36	1,555	1,205	1,052	297	1,052	192	4,821	106
	75	4,175	15.74	7,692	4,586	6,284	1,106	6,284	1,325	14,513	319
BOWL 2 Piling Locations	**90**	885	3.29	1,767	1,309	1,307	357	1,307	225	5,155	113
	75	4,424	15.85	7,999	4,638	6,658	1,155	6,658	1,634	14,964	329
Cumulative Scenario 1	**90**	1,157	3.70	2,101	1,575	1,617	387	1,617	275	5,621	124
	75	4,885	19.18	8,189	4,657	7,104	1,204	7,104	1,662	15,105	332
Cumulative Scenario 2	**90**	1,722	3.93	2,919	1,942	2,322	515	2,322	396	7,286	160
	75	6,345	23.04	10,224	5,422	9,139	1,258	9,139	1,958	19,329	425
Cumulative Scenario 3	**90**	2,000	3.93	3,214	2,067	2,604	561	2,604	449	7,666	169
	75	6,730	23.04	10,634	5,433	9,546	1,259	9,546	1,993	19,748	434

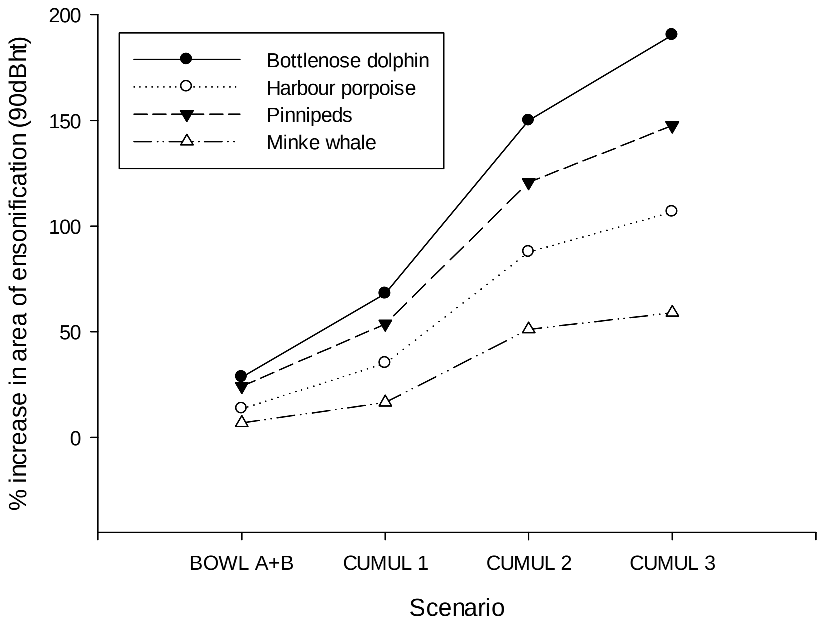


Plate 6.7: Proportional Increase in the Areas of Ensonification for Each Species Across Each of the Stepped Cumulative Scenarios *(Areas are based on modelling for the 90 dB_{ht} noise contour. The line linking each point has been drawn to show the pattern across the scenarios and holds no statistical significance).*

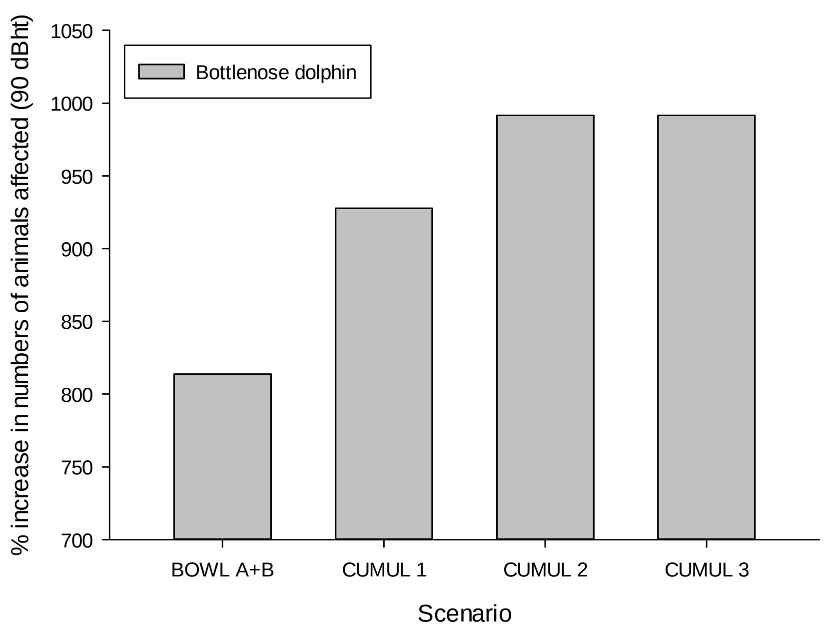


Plate 6.8 Proportional Increase in the Estimated Number of Animals Affected for BND Across Each of the Stepped Cumulative Scenarios *(Numbers are based on counts within the 90 dB_{ht} noise contour)***.**

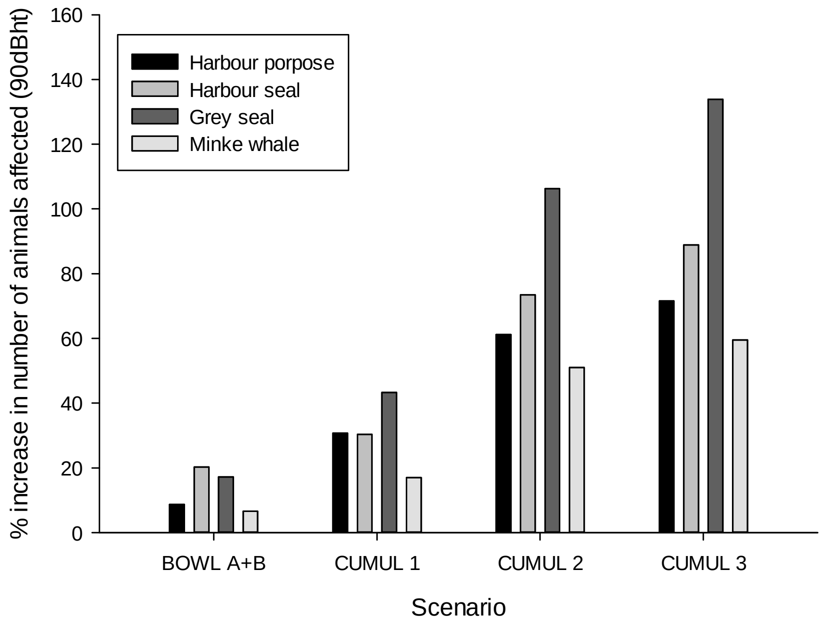


Plate 6.9 Proportional Increase in the Estimated Number of Animals Affected for Each Species Across Each of the Stepped Cumulative Scenarios** (Numbers are based on counts within the 90 dB_{ht} noise contour)**.

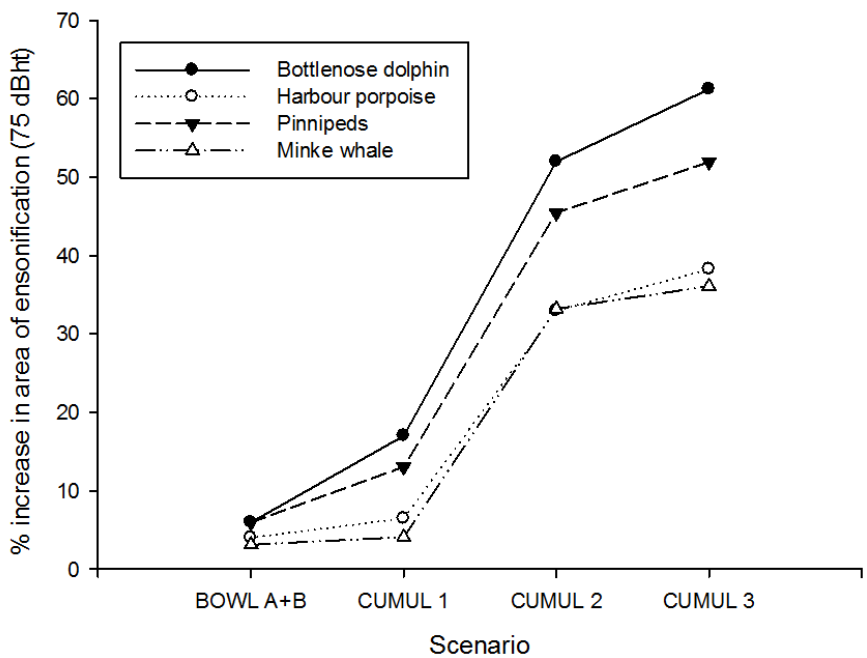


Plate 6.10 Proportional Increase in the Areas of Ensonification for Each Species Across Each of the Stepped Cumulative Scenarios** (Areas are based on modelling for the 75 dB_{ht} noise contour. The line linking each point has been drawn to show the pattern across the scenarios and holds no statistical significance)**.

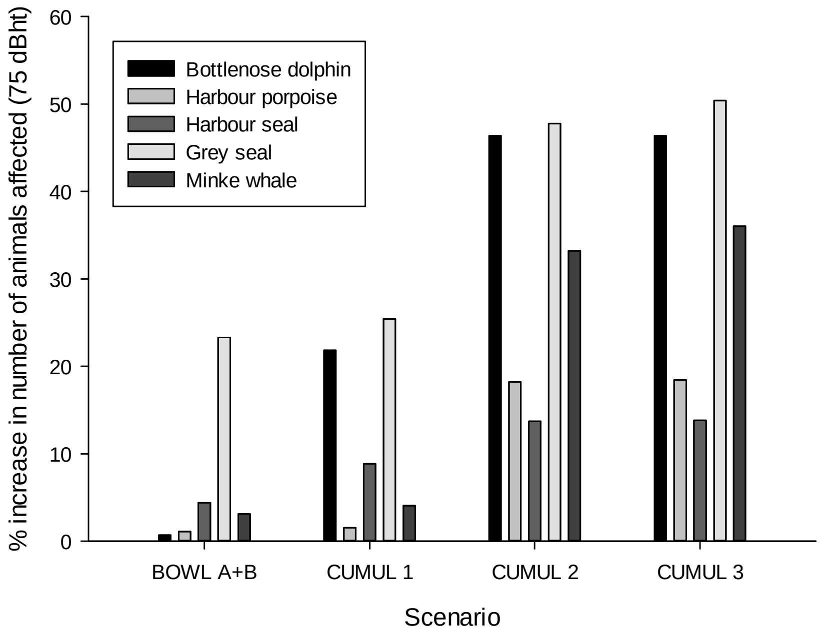


Plate 6.11 Proportional Increase in the Estimated Number of Animals Affected for Each Species Across Each of the Stepped Cumulative Scenarios** (Numbers are based on counts within the 75 dB_{ht} noise contour).**

6.9.5 ASSESSMENT OF SPATIAL AND TEMPORAL WORST CASES FOR CUMULATIVE PILING NOISE EFFECTS (INCLUDING POPULATION MODELLING)

6.9.5.1 Bottlenose Dolphin

117. The assessment of cumulative noise effects on the long-term viability of the BND population followed the same methods described for the Wind Farm alone (Section 6.6.1.1). The cumulative scenarios assessed were the same as those presented for the Moray Firth Round 3 Zone assessment and are presented in Table 6.10. These scenarios[7] were chosen to represent a range of spatial and temporal scenarios, from the worst case spatially, where all eight locations are piled concurrently (cumulative C) to the worst case temporally, where only single piling was carried out for both the Wind Farm and Moray Firth Round 3 Zone (cumulative B). The final scenario (cumulative A) lies between the two extremes and considers two concurrent piling vessels at the Wind Farm followed immediately by two concurrent piling vessels at Moray Firth Round 3 Zone. Therefore, the population model provides flexibility in the assessment of the worst case scenario.

118. These scenarios are not to be confused with the stepped cumulative assessment above, which has the aim only of presenting a comparative assessment of the proportional increase in potential effects (in terms of area of ensonification and number of animals displaced) as more piling locations are gradually added to the

[7] Note: Cumulative scenarios are labelled here as A, B and C so as not to be confused with the stepped scenarios assessed above (labelled 1, 2 and 3).

cumulative scenario. The stepped scenario has therefore not been considered in terms of the population modelling assessment.

Table 6.10: Construction Scenarios Modelled for the Cumulative Assessment.

Construction scenario	Description
Cumulative A Intermediate scenario	BOWL A+B for two years (2014 & 2015) followed immediately by MORL 1+5 for three years (2016 – 2018) 5 years in total
Cumulative B Temporal Worst Case	BOWL A for three years (2014 – 2016) concurrently for the final year with MORL 1 for five years (2016 – 2020) 7 Years in total
Cumulative C Spatial Worst Case	BOWL A+B for two years concurrently with MORL (1, 2, 3, 4, 5 & 6) for two years (2016 – 2017) 2 Years in total

119. The number of BND estimated to experience PTS and behavioural displacement during these different scenarios was estimated using SAFESIMM model, which applied the dose-response curve within the modelled noise thresholds as described previously (Section 6.6.1.1). As for the Wind Farm alone, the cumulative assessment showed that for all scenarios considered, no animals were predicted to experience PTS (see Table 2 in Annex 6A).

120. The estimates of the number of BND displaced from three cumulative construction scenarios (cumulative A, B and C) are presented in Table 6.11 and were derived from the different combinations of locations modelled in the population modelling work (Tables 1 and 2 in Appendix 6A). The worst case spatially for long-term effects, with concurrent piling at two Wind Farm locations followed by six Moray Firth Round 3 Zone locations, would lead to the greatest number of individuals displaced, albeit for the shortest duration (four years). Based on the best fit dose-response curve, there is predicted to be 20 to 21 individuals (best fit) displaced in each of the four construction years, accounting for 10.3 – 11.0% of the Moray Firth BND population (cumulative scenario C in Table 6.11).

121. The worst case temporally, with single piling at the Wind Farm and Moray Firth Round 3 Zone over a seven year period in total (with 1 year of overlap in piling at the Wind Farm and Moray Firth Round 3 Zone), is predicted to displace between 17 to 21 individuals per year (best fit), accounting for 8.9 to 10.7% of the Moray Firth BND population (cumulative scenario B in Table 6.11).

122. Between these two extremes, cumulative scenario B with two piling vessels working concurrently at the Wind Farm followed by two piling vessels working concurrently at Moray Firth round 3 Zone, is predicted to displace between 19 to 20 individuals (9.7 to 10.3% of the population) each year (best fit) over the five year construction period (Table 6.11).

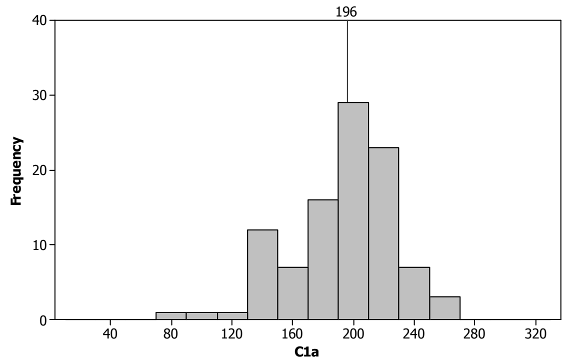
Table 6.11: Estimated Numbers (and % of the Moray Firth Population) of BND Predicted to be Displaced by Each of the Different Cumulative Scenarios Showing with Numbers Presented for Each Year of Construction. *(The range of values presented are for the predictions based on the lower, best and upper fit dose-response curves. The numbers were derived from the combinations of locations modelled at the Wind Farm and Moray Firth Round 3 Zone as presented in Table 2, Annex 6A.)*

		Year 1			**Year 2**			**Year 3**			**Year 4**			**Year 5**			**Year 6**			**Year 7**		
		Lower	**Best**	**Upper**	**Lower**	**Best**	**Upper**	**Lower**	**Best**	**Upper**	**Lower**	**Best**	**Upper**	**Lower**	**Best**	**Upper**	**Lower**	**Best**	**Upper**	**Lower**	**Best**	**Upper**
Cumulative A	**N**	1	20	33	1	20	33	1	19	33	1	19	33	1	19	33	-	-	-	-	-	-
	%	0.5	10.3	17.0	0.5	10.3	17.0	0.3	9.7	16.8	0.3	9.7	16.8	0.3	9.7	16.8	-	-	-	-	-	-
Cumulative B	**N**	1	19	32	1	19	32	1	21	35	0	17	31	0	17	31	0	17	31	0	17	31
	%	0.4	9.6	16.3	0.4	9.6	16.3	0.4	10.7	17.8	0.2	8.9	15.7	0.2	8.9	15.7	0.2	8.9	15.7	0.2	8.9	15.7
Cumulative C	**N**	7	67	82	7	67	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	%	3.6	34.2	41.8	3.6	34.2	41.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

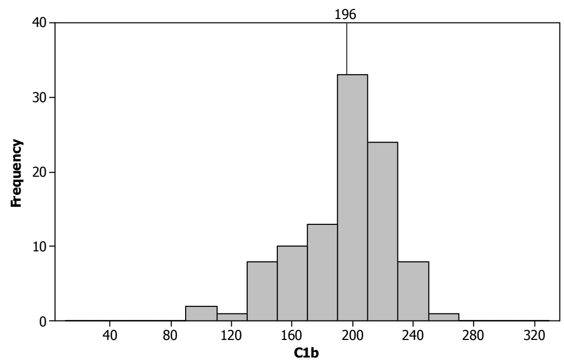
123. Subsequently, population modelling was undertaken to determine the potential long-term, population-level effects of displacement of individuals for each of the three scenarios presented above (Annex 6A). As described previously, the BND VORTEX model uses a PVA model to predict the distribution of population size after 25 years following exposure of the population to each of the construction scenarios in Table 6.10. The baseline population is taken from the most recent estimates of the Moray Firth SAC BND population of 196 individuals in a stable or increasing population (Cheney et al., 2012).

124. The results of the population modelling for BND show that for each cumulative scenario, and for the upper, best and lower fit dose-response curves, after 25 years the baseline level of 196 individuals is the most frequently predicted population level, suggesting that there would be no long-term effect on the BND population (Plate 6.12, Plate 6.13, and Plate 6.14). As described previously (Section 6.6.1.1), although the model is run over a 25 year period, this does not reflect the time to recovery. Recovery of the population would start to occur immediately following cessation of the piling, and based on the potential ecological effects on the BND population, and evidence from operational wind farms, full recovery to baseline conditions is likely to occur over the medium-term (<3 years).

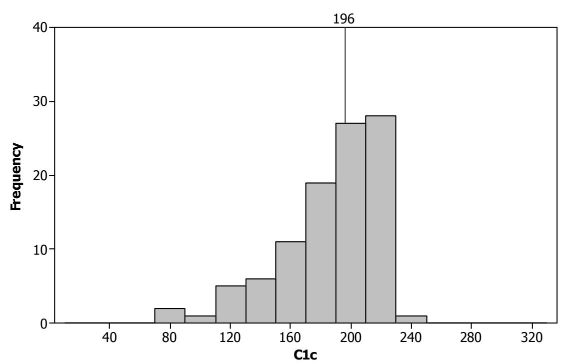
a) lower



b) best



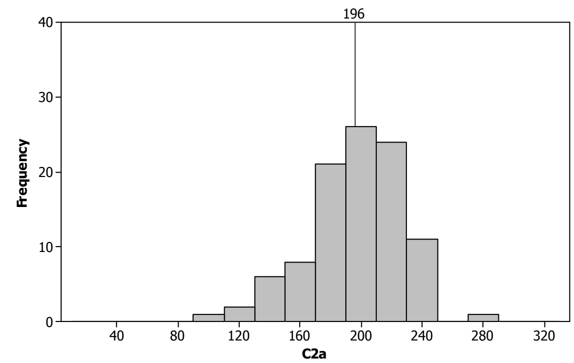
c) upper



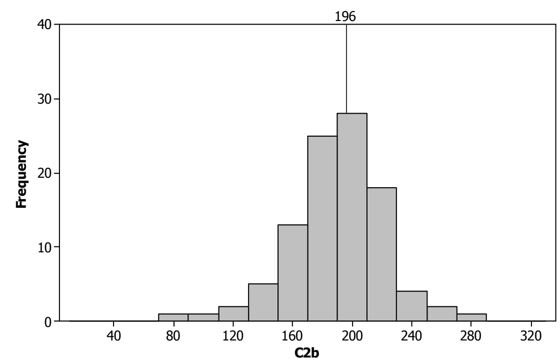
Number of individuals predicted after 25 years

Plate 6.12 Results of the BND Population Modelling for Cumulative scenario A *(BOWL A+B for two years followed immediately by MORL 1+5 for three years showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve)****.***

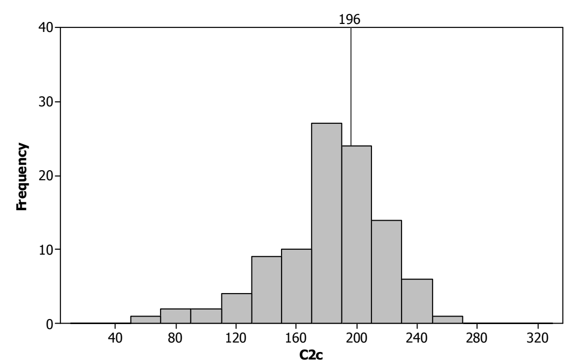
a) lower



b) best



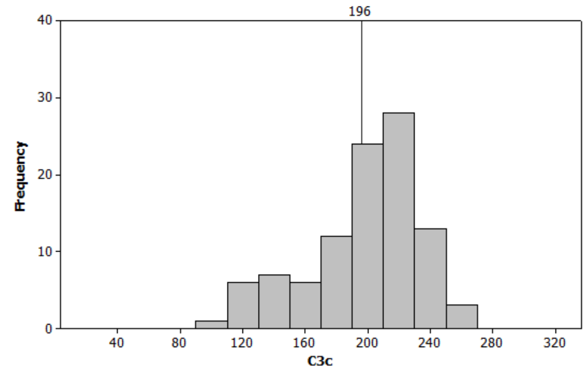
c) upper



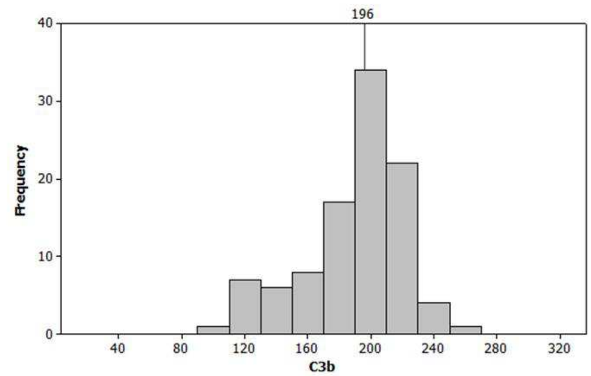
Number of individuals predicted after 25 years

Plate 6.13 Results of the BND Population Modelling for Cumulative Scenario B *(BOWL A for three years and MORL 1 for five years with a one year overlap showing the output for the model using the a) lower, b) best and c) upper-fit for the dose response curve)***.**

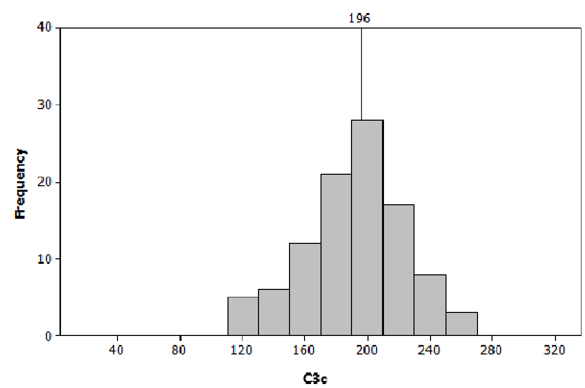
a) lower



b) best



c) upper



Number of individuals predicted after 25 years

Plate 6.14 Results of the BND Population Modelling for Cumulative Scenario C *(BOWL A+B for two years followed by MORL 1-6 for two years showing the output for the model using the a) lower, b best and c) upper-fit for the dose response curve).*

Conclusions on Cumulative Effects on Bottlenose Dolphins

126. This revised cumulative assessment in respect of long-term effects is therefore considered in the light of the results of the BND population modelling. For the worst case temporal scenario, there is predicted to be a small to medium magnitude of displacement of between 17 to 21 BNDs per year over a seven year duration (with an absolute maximum of 35 individuals displaced in any one year based on

the upper fit dose-response curve). For the worst case spatial scenario (scenario C), there is predicted to be an average displacement of 67 individuals per year over a two year duration with an absolute maximum of 82 individuals displaced in any one year (based on the upper fit dose-response curve).

127. The Original ES concluded a cumulative effect of medium magnitude and moderate significance in the short to medium-term (i.e. a likely significant effect according to the EIA Regulations) on BND as a result of piling at the Wind Farm and Moray Firth Round 3 Zone. Long-term cumulative effects on BND were predicted to be of moderate significance (Section 12.9.4.1 of the Original ES). Taking into account both the number of animals (and proportion of the population) displaced and the duration of displacement, for both the spatial and temporal worst case scenarios, the conclusion in the Original ES has not been updated for the short to medium-term (i.e. moderate significance and therefore a likely significant effect according to the EIA Regulations). However, in the long-term, under both scenarios, the population is predicted to recover to baseline levels and based on studies of other wind farms in the North Sea (e.g Tougaard et al., 2009, Thompson et al., 2010, Brandt et al., 2011) recovery is predicted to start following cessation of the piling activity and return to baseline conditions in the short to medium term (<3 years). Therefore the conclusion in the Original ES has been amended with a negligible magnitude for long-term effects, which is of negligible significance and is not a likely significant effect under the EIA Regulations.

6.9.5.2 Harbour Seal

128. The assessment of cumulative noise effects on the long-term viability of the harbour seal population followed the same methods described for the Wind Farm alone (Section 6.6.1.1). As described for the Wind Farm alone, further modelling was carried out to explore the effects of changing the carrying capacity of the population and the effect of varying the dose response curves (upper, best and lower fit) for the prediction of the proportion of animals excluded from the area. The effect of varying the mortality rate of individuals exposed to PTS was not explored for the cumulative scenarios since the modelling for the two Wind Farm scenarios showed only minimal differences in the population over time (Plate 6.4).

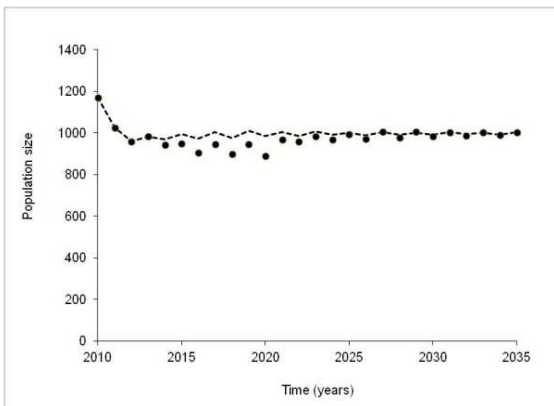
129. A more conservative threshold for the noise levels predicted to cause PTS was adopted in the revised Harbour Seal Framework compared with the approach used for the Original ES in order to adopt a more precautionary approach (see Section 6.6.1.1).

130. The cumulative scenarios considered were based on the worst case temporally (cumulative B), the worst case spatially (cumulative C) and a scenario in between these two extremes (cumulative A), and are the same as those given for BND (Table 6.10). The results of this modelling are similar to those predicted for the Wind Farm alone: varying the carrying capacity and dose-response curve has no effect on the long-term viability of the harbour seal population (Plate 6.15 to Plate 6.18).

Conclusions on Cumulative Effects on Harbour Seals

131. The Original ES concluded that a large magnitude cumulative effect of major significance (i.e. a likely significant effect according to the EIA Regulations) in the short to medium-term on harbour seal as a result of piling at the Wind Farm and Moray Firth Round 3 Zone sites. Long-term effects were predicted to be of negligible magnitude and of minor to negligible significance (i.e. not a likely significant effect according to the EIA Regulations). The results of this further modelling do not materially change the cumulative impact assessment in the Original ES. There are considered to be short to medium-term effects of large magnitude on harbour seals for both the worst case spatially and the worst case temporally, which are of major significance. However, in the long-term the population is predicted to recover over a period of five years or less (as predicted by the population model) and therefore the magnitude of effect is negligible and not a likely significant effect.

a)K=1000



b)K=2000

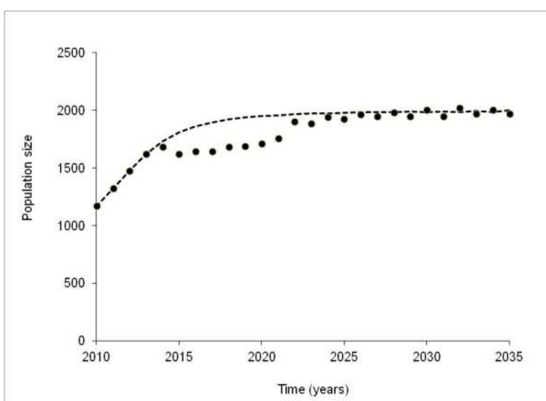
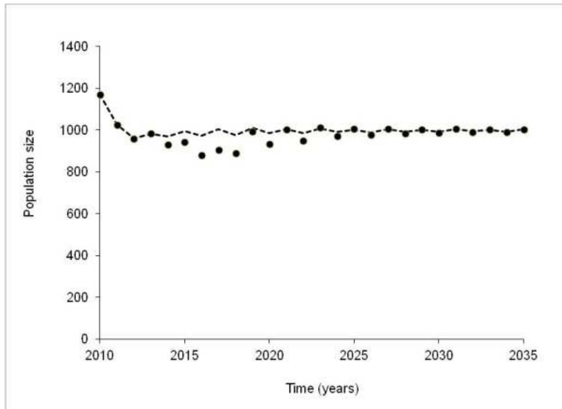


Plate 6.15 Comparison of the Effects of Varying the Carrying Capacity (K) on the Long-Term Viability of the Harbour Seal Population from Cumulative Scenario B (Worst-Case Temporally) Based on a) K=1000 and b) K=2000. *(Figures presented here are based on the best-fit dose-response curve. Figures for the lower and upper fit dose-response curve are presented in Annex 6A)****.***

a)K=1000



b)K=2000

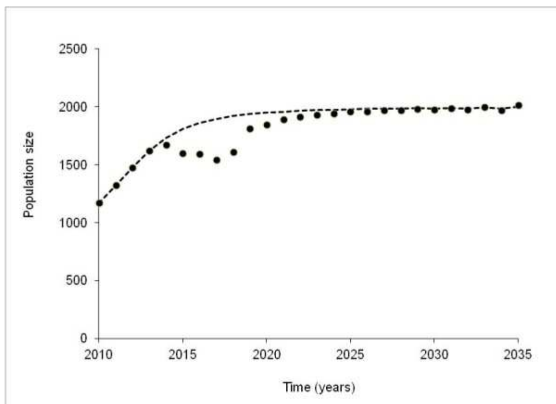
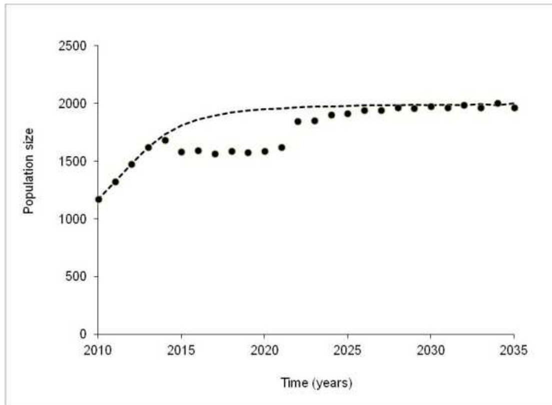
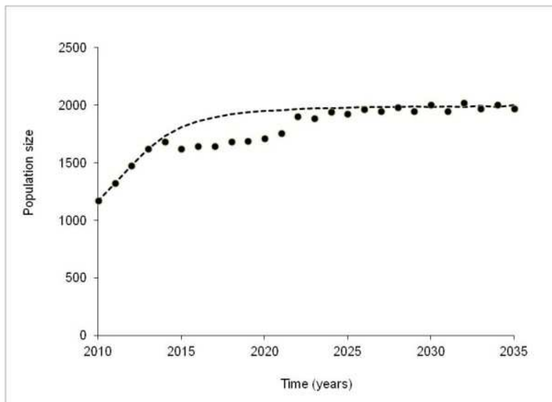


Plate 6.16 Comparison of the Effects of Varying the Carrying Capacity (K) on the Long-Term Viability of the Harbour Seal Population from Cumulative scenario C (Worst-Case Spatially) Based on a) K=1000 and b) K=2000. *(Figures presented here are based on the best-fit dose-response curve. Figures for the lower and upper fit dose-response curve are presented in Annex 6A)****.***

a)Upper



b)Best



c)Lower

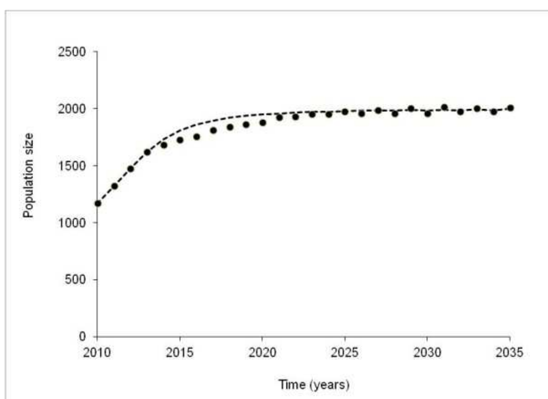
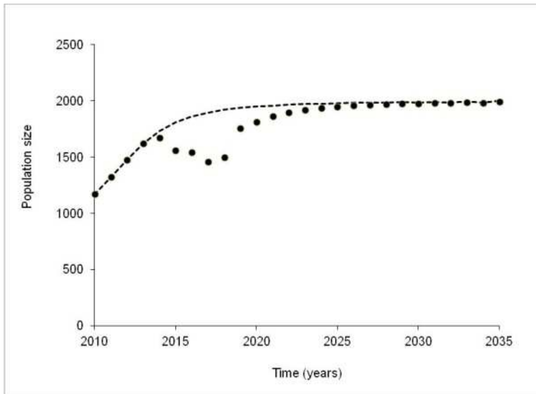
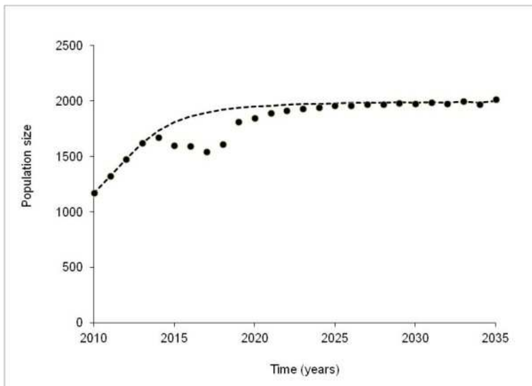


Plate 6.17 Comparison of the Effects of Varying the Dose-Response Curve on the Long-Term Viability of the Harbour Seal Population from Cumulative Scenario B (Worst Case Temporally) Based on a) upper, b) best, and c) lower fit curves. *(Figures presented here are based on a carrying capacity of K=2000)***.**

a)Upper



b)Best



c)Lower

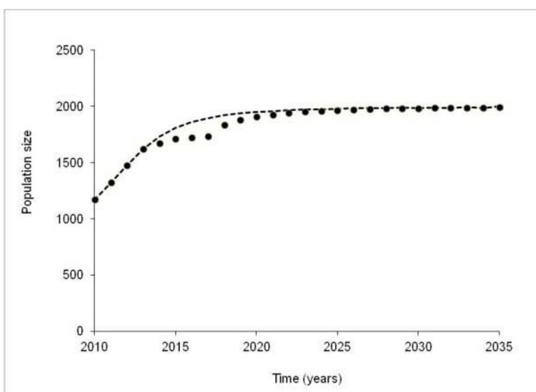


Plate 6.18 Comparison of the Effects of Varying the Dose-Response Curve on the Long-Term Viability of the Harbour Seal Population from Cumulative Scenario C (Worst Case Spatially) Based on a) upper, b) best, and c) lower fit curves. *(Figures presented here are based on a carrying capacity of K=2000. Figures for a carrying capacity of K=1000 are presented in Annex 6A)*.

6.9.6 SUMMARY OF CUMULATIVE EFFECTS

132. The information presented here shows that the cumulative effects of piling activity will occur in the medium-term, over the duration of the piling phase, with possible displacement of marine mammals from the disturbed area. The extent and duration of effects will depend on which pile driving scenario is adopted with the worst case spatially leading to greater numbers of individuals displaced over a short duration (maximum two years) and the worst case temporally leading to fewer individuals displaced over a longer period (up to seven years). Likely significant effects in the medium-term were predicted for BND, harbour seal and minke whale, whilst the effects on harbour porpoise and grey seal were considered to be not likely significant effects. The assessment also considered at how these medium-term effects may affect the population in the long-term. A thorough literature review of published studies on the potential effects of noise from pile-driving on marine mammals was undertaken and for the two SAC citation species – BND and harbour seal – population modelling was undertaken. The conclusion of this assessment was that, for all species, there are no long-term likely significant effects predicted.

6.10 INFORMATION TO SUPPORT EUROPEAN PROTECTED SPECIES LICENSING

133. Information to support EPS Licensing has been prepared and is presented in Annex 6C. A finalised application will not be submitted until the Project consents have been granted and it has been determined that the licensable construction operations are the required option among the potential alternatives. Furthermore, it is anticipated that many of the details contained in the EPS supporting information (including the specific details of the project design, the nature of the impact and numbers of animals affected, and, potentially, mitigation measures to be employed) will need to be revisited once construction parameters have been finalised and amendments made where necessary.

134. The marine mammal assessment (as presented in Section 12: Wind Farm Marine Mammals of the Original ES) concluded that effects on marine mammals were of minor or negligible significance in most cases (i.e. trivial disturbance; JNCC, 2010), with the exception of underwater noise during the construction phase, where piling is required to install turbine foundations. Consequently an EPS licence is only required for foundation installation using piling operations. An EPS licence is also only required for the cetacean species most likely to be affected (in terms of their Favourable Conservation Status; see Annex 6C) by piling noise, i.e. the three most abundant cetacean species in the Moray Firth, BND, harbour porpoise and minke whale.

6.11 STATEMENT OF SIGNIFICANCE

135. Short and medium-term likely significant effects are predicted as a result of the piling noise for the Wind Farm alone for harbour seal and BND, which reiterates the findings of the Original ES. Short and medium-term likely significant effects are also predicted for minke whale as a result of piling noise for the Wind Farm alone, which replaces the findings of the Original ES. No short and medium-term likely

significant effects are predicted for all other marine mammal species as a result of the Wind Farm alone, which is in line with the Original ES.

136. No long-term likely significant effects are predicted for any marine mammal species as a result of the Wind Farm alone. This replaces the conclusions of the Original ES, where long-term likely significant effects were predicted for BND. The further population modelling for this species has demonstrated that there is no likely significant effect as a result of the Wind Farm alone.

137. The likely significant effects for the Project cumulatively with the Moray Firth Round 3 Zone are the same as for the Wind Farm alone i.e. short and medium-term likely significant effects on harbour seal, BND and minke whale, but no long-term likely significant effects on any marine mammal species in the Moray Firth.

138. The findings are supported by evidence from studies of other operational wind farms in the North Sea which show that marine mammals are predicted to recover quickly from disturbance events, such as piling. It was concluded that for all species there would be no likely significant long-term effect on marine mammals in the Study Area.

6.12 HABITATS REGULATIONS ASSESSMENT

139. Annex 3B presents a Report to Inform an Appropriate Assessment in respect of Natura 2000 designations for which marine mammals form part of the qualifying interest or conservation objectives of the designation.

6.13 REFERENCES

140. References remain unchanged from those presented in Section 12.12 and 24.9 of the Original ES, with the exception of the following sources:

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