East Anglia Offshore Wind

VATTENFALL

SCOTTISHPOWER RENEWABLES

East Anglia THREE

Chapter 12

Marine Mammal Ecology

Environmental Statement

Volume 1

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Author – Royal HaskoningDHV
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12 MARINE MAMMAL ECOLOGY

12.1 Introduction

1. This chapter of the Environmental Statement (ES) describes the existing environment with regard to marine mammals which includes pinnipeds (seals) and cetaceans (whales, dolphin and porpoise) and assesses the potential impacts of the proposed East Anglia THREE project during the construction, operation and maintenance, and decommissioning phases. Where appropriate, mitigation measures and residual impacts are presented.

2. This assessment also considers information from, and refers to, the following chapters within this ES:

- Chapter 3 Policy and Legislative Context;
- Chapter 5 Description of the Development;
- Chapter 6 Environmental Impact Assessment Methodology;
- Chapter 9 Underwater Noise and Electromagnetic Fields;
- Chapter 11 Fish and Shellfish Ecology; and
- Chapter 15 Shipping and Navigation.

12.2 Consultation

3. To inform the ES, East Anglia THREE Limited (EATL) has undertaken a pre-application consultation process, including the following key stages:

- Scoping Report submitted to the Planning Inspectorate (November 2012);
- Scoping Opinion received from the Planning Inspectorate (December 2012);
- Evidence Plan process (ongoing, *Appendix 12.1*);
- Section 42 consultation on the Preliminary Environmental Information Report (PEIR) (May 2014); and
- Section 42 consultation Phase III.

4. EATL has followed the non-statutory Evidence Plan Process, which has included an expert topic group for Marine Mammals. The Evidence Plan Process has been used to consult with Natural England, and agree the approach taken forward in many aspects of the impact assessment for marine mammals (more details of the Evidence

Plan process are provided in Chapter 6 Environmental Impact Assessment (EIA) Methodology).

5. Relevant consultation responses are presented in *Table 12.1*.

Table 12.1 Consultation responses

Consultee	Date /Document	Comment	Response / where addressed in the ES
Secretary of State	December 2012 Scoping Opinion East Anglia THREE and FOUR	The data and information gained from the chapter on Underwater Noise and Electromagnetic Fields should be cross referenced to inform the assessment on marine mammals.	Section 12.6.1
		The assessment should also consider the displacement and potential barrier effects as a result of noise emitted during the construction period, and the effect on marine mammals as a result of the potential displacement/disturbance of their food sources.	Section 12.6.1
		The assessment should consider impacts to marine mammals on a cumulative scale; particularly as the proposed development may be part of further developments within the East Anglia Zone.	Section 12.7
		The ES should set out in full the potential risk to European Protected Species (EPS) and confirm if any EPS licences will be required for example, for harbour porpoise *Phocoena phocoena* and grey seals.	Section 12.6.1, 12.6.2 and 12.6.3 assesses impacts to harbour porpoise as an EPS. Harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus* are not EPS.
		The SoS considers that there is potential for the presence of EPS within the study area for the proposed development. Where a potential risk to an EPS is identified and before making a decision to grant development consent the CA must, amongst other things, address the derogation tests in Regulation 53 of the Habitats Regulations. Therefore the Applicant may wish to provide information which will assist the decision maker to meet this duty. Where required the Applicant should,	Section 12.5.3 confirms that harbour porpoise are the only commonly occurring EPS in the area. EATL has committed to the development of a marine mammal mitigation protocol (MMMP) post consent in consultation with Natural England (section 12.6.1) to mitigate an injury offence to harbour porpoise from pile driving noise. A draft MMMP will be submitted with the ES. The MMMP will also mitigate injury in other EPS (low frequency and mid-frequency cetaceans).

Consultee	Date /Document	Comment	Response / where addressed in the ES
		in consultation with Natural England and the Marine Management Organisation (MMO), agree appropriate requirements to secure necessary mitigation.	EATL will complete an EPS licence application post consent if appropriate, once there is more certainty within the project design envelope on construction methods, and therefore any updated assessment or mitigation requirements. The approach to developing a MMMP and EPS licence application post consent has been agreed with Natural England (*Table 12.1*, and *Appendix 12.1)*
JNCC and Natural England	December 2012 Scoping Response East Anglia THREE and FOUR	Key concerns: Potential effects on marine mammals from noise during construction – both at a project-level and cumulatively.	These impacts are assessed in section 12.6.1.
		Advice: Confidence of data that will arise through the on-going surveys. We refer the developer to various streams of work that may be helpful when assessing impacts, and consequently informing the requirements of the EPS licensing process, on marine mammals, including the relevant Offshore Renewables Joint Industry Projects (ORJIP) currently undergoing definition, Population Consequences of Disturbance (PCoD) and the Joint Cetacean Protocol (JCP).	At the time of submission of the ES, the JCP data are not yet available. Interim PCoD model has been developed and it is understood that strategic assessment will be undertaken, although the outcome of this is not yet available. The other relevant ORJIP initiative (on the use of acoustic deterrent devices ADDs) is referred to in section 12.6.1. EATL will continue to remain up to date on developments in these areas. EATL is also contributing the Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS) project which is also considered as a relevant work stream.
		The effects of displacement and potential barrier effects as a result of noise emitted during the construction period should be considered.	Section 12.6.1

Consultee	Date /Document	Comment	Response / where addressed in the ES
		We feel that it is more important and more relevant to consider impacts to marine mammals on a cumulative scale, particularly for these projects that are following on from previous development in the zone.	Section 12.7
Suffolk County Council	December 2012 Scoping Response East Anglia THREE and FOUR	Regarding the offshore works, the County Council identified concerns for EA ONE of collisions between marine mammals and high speed watercraft accessing the windfarm sites. We would, therefore, like to see the cumulative impacts of the increasing number of sites and subsequent trips by maintenance teams.	Section 12.6.2 assessed additional maintenance vessel traffic on top of the existing baseline levels (also see Chapter 5 Description of the Development and Chapter 15 Shipping and Navigation).
		The marine mammal mitigation plan also needs to identify best practice to minimise impacts, for example from piling works, on cetaceans.	EATL has submitted a draft MMMP as part of the Development Consent Orders (DCO) application that will be updated post consent in consultation with Natural England (section 12.6.1) to mitigate an injury offence to harbour porpoise from pile driving noise.
Natural England	October 2013 Marine Mammals Expert Topic Group (ETG) Meeting 1	Agreement on the following areas: • Sufficient data have been collected to inform the baseline; • Scope of impacts to be assessed; • Reference populations to be used; • Seal densities used will be SMRU at-sea densities; • A quantitative assessment for pile driving noise in harbour porpoise, grey and harbour seal; a qualitative approach will be used for all other impacts; • Sensitivity and magnitude definitions proposed	See *Appendix 12.1* for details.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		are appropriate.	
Natural England	November 2013 Marine Mammals ETG Meeting 2	Agreement on the following areas: • Methods and duration of baseline surveys; • Species considered in the assessment (harbour seal, grey seal and harbour porpoise); • Methodologies for noise assessment; • Methods for CIA; • Methods for HRA Screening.	See *Appendix 12.1* for details.
Natural England	April 2014 Marine Mammals ETG Meeting 3	Agreement on the following areas: • Appropriate site specific densities for the assessment; • EPS licence will not be applied for until post consent; • Approach to quantifying impacts from pile driving noise; • Approach to developing MMMP post consent; • Approach to and results of CIA screening.	See *Appendix 12.1* for details.
Whale and Dolphin Conservation (WDC)	July 2014 Meeting	EATL met with WDC to discuss marine mammals and the development.	None required.
Natural England	July 2014 Section 42 Consultation Response	Main point:	
		Natural England stresses that EPS licences will be required and acknowledges the cumulative/more strategic issues in relation to marine mammals and highlights the need for	EATL acknowledges that an EPS licence may be required (see section 12.6.1.1). It was confirmed by Natural England in April 2014 that there was no expectation of a

Consultee	Date /Document	Comment	Response / where addressed in the ES
		the applicant to be prepared to work with other developers, alongside Regulators and SNCBs, in order to reduce cumulative effects as required.	draft EPS licence to be provided with the Application EATL confirm their ongoing support of strategic initiatives and will continue to work with other developers, Regulators and Statutory Nature Conservation Bodies (SNCBs) see section 12.7
		Comments:	
		NE Point 19 We recommend that information relating to cause of corkscrew deaths for marine mammals especially harbour seals, and best practice to mitigate for this, is kept under review and measures taken to be aligned with best practice if necessary. Natural England advises the acknowledgement and the inclusion of the following condition within the ES and within the DML's (respectively) in order to acknowledge the possibility of corkscrew injuries to marine mammals. This will recognise the possibility of such an event occurring and ensure that the appropriate guidance is followed at that time: "A marine mammal mitigation protocol, the intention of which is to prevent injury, primarily auditory injury to marine mammals within the vicinity of piling, and appropriate monitoring surveys are to be agreed in writing with the MMO and relevant SNCBs."	EATL is committed to following ongoing research and changes to mitigation requirements in relation to this issue see section 12.6.1.6 The possibility of corkscrew injuries is acknowledged by inclusion in the assessment (section 12.6.1.6, section 12.6.2.6 and section 12.6.3.4. However, the advice, at the time of writing, from the SNCBs (i.e. Scottish Natural Heritage, Natural England, Natural Resources Wales, Joint Nature Conservation Committee) in February 2015 is that, based on the latest information it is considered very likely that the use of vessels with ducted propellers may not pose any increased risk to seals over and above normal shipping activities. EATL has submitted a draft MMMP as part of the DCO application that will be updated post consent in consultation with Natural England (section 12.6.1) to mitigate an injury offence to harbour porpoise from pile driving noise.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		NE Point 94 Condition included for DBCB within DML's 1&2 condition 9(1)(e) and DML3&4 condition 8(1)(e) that could be adopted : "Appropriate surveys (i.e. such as those included within the Disturbance Effects on Harbour Porpoise of the North Sea (DEPONS) project or agreed alternative monitoring) of existing marine mammal activity inside the area(s) within the Order limits in which it is proposed to carry out construction works or any wider area(s) as appropriate which is required to test predictions in the environmental statement concerning key marine mammal interests of relevance to the authorised scheme." It may be appropriate to amend ',alternative monitoring..' with '…or agreed East Anglia zone/site specific monitoring…'?	DML Part 2, 17 (1) (d) Appropriate surveys of existing marine mammal activity inside the area(s) within the Order limits in which it is proposed to carry out construction works and any wider area(s) where appropriate which is required to test predictions in the environmental statement concerning key marine mammal interests of relevance to the authorised scheme.
		NE Point 95 Natural England notes that the planned development of renewable energy in UK waters could involve multiple piling events occurring concurrently and sequentially across a species' range, over several years. This has the potential to have a detrimental impact on the favourable conservation status of populations of cetacean species occurring in UK waters. Continued strategic discussion is required between UK Regulators and SNCBs to consider the wider issues of an EPS licensing framework across UK waters as a whole.	EATL confirms their ongoing support of strategic initiatives and will continue to work with other developers, Regulators and SNCBs see section 12.7.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		NE Point 96 Given the potential impacts on marine mammals described, it is clear that mitigation will play a key role in any wind farm developments in the North Sea, in particular in the context of this development, reduce cumulative effects arising from disturbance. It will therefore be beneficial if all developers make a concerted attempt to reduce the acoustic output from pile driving (e.g. sleeving), to investigate alternative installation methods (e.g. suction bucket) and to plan activities within the scope of what is proposed to reduce the potential that they contribute to negative effects on populations.	The use of the Rochdale approach to assessment means that the worst case foundation parameters are considered for marine mammals in this chapter (i.e. piled foundations). Alternative foundations are still being considered at this site, and Chapter 5 Description of Development provides details of the alternate foundations. ScottishPower Renewables and Vattenfall are both members of the Offshore Wind Accelerator (OWA) programme that is Carbon Trust's flagship collaborative RD&D initiative looking at cost reduction such as alternative foundation solutions (http://www.carbontrust.com/our-clients/o/offshore-wind-accelerator).
		NE Point 97 Natural England welcomes the Applicant‘s commitment to implementing the JNCC‘s piling guidelines as mitigation and will review the development of an effective marine mammal mitigation plan (MMMP) near construction time. Natural England also recommend that the applicant keeps a watching brief on the work carried out under ORJIP on Acoustic Mitigation Devices and any further developments of best practice in relation to mitigation options.	A draft MMMP is included with this application.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		NE Point 99 Construction programming may need to be considered across all projects and the applicant should be prepared to work with other developers, alongside Regulators and SNCBs, in order to reduce cumulative effects as required.	EATL confirms their ongoing support of strategic initiatives and will continue to work with other developers, Regulators and SNCBs see section 12.7.
		NE Point 100 An EPS license will be required to cover the risk of disturbance to all cetacean species identified as likely to be in the area….the consideration of less noisy alternatives to piling, the total area of impact, the duration of impact and the number of animals likely to be affected would need to be clearly presented.	The use of the Rochdale approach to assessment means that the worst case foundation parameters are considered for marine mammals (i.e. piled foundations) in this chapter. Alternative foundations are still being considered at this site as detailed in Chapter 5 Description of Development. The EPS Licence application, if appropriate, would be completed post consent.
		NE Point 105 We agree that, based on the assessment of auditory injury (PTS), the establishment of a mitigation zone out to at least 500m (following current JNCC 2010a guidelines) would prevent exposure of individuals to noise thresholds which could lead to instantaneous onset of PTS. This should form part of the MMMP which should be a condition for development to proceed.	EATL has included a draft of the MMMP with this application see section 12.3.2. The MMMP will be secured by article 32 (a) (s) within the draft DCO.

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		NE Point 106 We agree that the maximum distance of a mitigation zone (likely to be 1km or less) can be confirmed during development of a MMMP once piling parameters have been confirmed. We also confirm that an injury offence to EPS species is unlikely to be committed but note that disturbance offence may require an EPS licence.	Both points are acknowledged by EATL.
Suffolk Wildlife Trust	July 2014 Email comments in response to PEIR.	Point 1.1.3 It is recognised that underwater noise from pile driving is likely to constitute the greatest risk to marine mammals and that the largest spatial footprint of underwater noise would come from pile driving associated with monopole foundations. We would therefore question why monopole foundations are still included within the Rochdale envelope, when they were removed from the East Anglia ONE project, ostensibly for this reason. We would urge East Anglia THREE Ltd to use foundation types which are less noisy to install and to further explain the inclusion of monopoles as a foundation type.	Whilst the East Anglia ONE project noted the benefit to other marine receptors, including marine mammals, mitigation was not the primary objective. At the time of application the decision was primarily technical as monopile foundation types were considered technically limited to the lower end of the range of turbine sizes and water depths and therefore not ideally suited for the site conditions. The use of the Rochdale approach to assessment means that the worst case foundation parameters are considered for marine mammals (i.e. piled foundations). Alternative foundations are still being considered at this site as detailed in Chapter 5 Description of Development. Section 12.6.1.1 assesses both the spatial (monopiles) and temporal (jackets) worst case. With regard to displacement effects, the assessment shows that the use of driven monopiles would result in the displacement of a greater number of individuals for a much shorter amount of time than the use of jackets.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		Point 1.1.4 We would expect East Anglia THREE Ltd to invest in and follow the development of such quieter foundation types. Not only will this ensure that these are made commercially available sooner but also that the best available technology can be employed at the time of construction.	Alternative foundations are still being considered at this site, and Chapter 5 Description of Development provides details of the alternate foundation solutions.
		Point 1.1.5 Similarly, we would expect East Anglia THREE Ltd to invest in and follow the development of mitigation techniques, to support their intended embedded mitigation to prevent PTS/auditory injury to marine mammals. This embedded mitigation, of creating an exclusion zone around any piling operation, is relied upon to remove the potential for PTS. However, we have concerns that the current mitigation guidance from JNCC is not necessarily fit for purpose for the installation of the larger turbines proposed for Round 3 development. Specifically we have concerns as to the efficacy of Marine Mammal Observers and Passive Acoustic Monitoring for detecting marine mammals and the impact of the noise from the soft start procedure. The current ORJIP project looking at the potential use of Acoustic Deterrent Devices as alternative mitigation is attempting to address these issues and we would urge East Anglia THREE Ltd to follow this project's	EATL has included a draft of the MMMP with this application see section 12.3.2. The MMMP will be secured by article 32 (a) (s) within the draft DCO.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		outputs. We would also expect that East Anglia THREE Ltd would commit to using the best available mitigation techniques available at the time of construction.	
		Point 1.1.6 We note the low confidence in the data underpinning the assessment for potential 'corkscrew' injuries to marine mammals, specifically pinnipeds. As such, we would expect East Anglia THREE Ltd to follow the progression of the investigation into this issue, to update the assessment if further data becomes available and to follow best practice guidance for mitigation of this impact.	EATL is committed to following ongoing research and changes to mitigation requirements in relation to this issue see section 12.6.1.6.
		Point 1.1.7 We would also expect that East Anglia THREE Ltd would include mitigation of 'corkscrew' injuries within the proposed Marine Mammal Mitigation Protocol (MMMP). We believe that the MMMP should be comprehensive and include mitigation of all potential impacts on marine mammals, not just those arising from pile driving.	SNCBs advice in February 2015, based on the latest information, considered it very likely that the use of vessels with ducted propellers may not pose any increased risk to seals over and above normal shipping activities and therefore mitigation measures and monitoring may not be necessary (see Section 12.6.1.6).
		Point 1.1.8 We have strong concerns as to the impacts assessed in the Cumulative Impact Assessment, specifically in relation to underwater noise impacts on harbour porpoise, impacts on prey species for harbour porpoise and harbour seal and collision risk with ducted propellers for all three species assessed, all of which have moderate or major adverse significant impacts predicted. We do not accept	EATL confirms their ongoing support of strategic initiatives and will continue to work with other developers, Regulators and SNCBs in order to understand and reduce cumulative impacts where possible. EATL and both parent companies are strong supporters of industry project established to understand the consequences of displacement on harbour porpoise based on empirical data. Both parties are financially supporting

Consultee	Date /Document	Comment	Response / where addressed in the ES
		that the small contribution from the East Anglia THREE development is justification for not proposing further mitigation for these impacts and believe that East Anglia THREE Ltd should do further work to either minimise the impact or propose further mitigation.	DEPONS (www.depons.au.dk) and AK Schallschutz (an industry project that aims to understand efficacy of noise mitigation systems deployed on multiple offshore windfarms in German waters). See Section 12.7.4.
		Due to the levels of impacts predicted, coupled with the uncertainty surrounding these potential impacts, we believe that comprehensive monitoring of marine mammals should be required both pre and post construction. Noting the requirements within the Deemed Marine Licences for East Anglia ONE, we would expect comparable conditions for the East Anglia THREE development.	EATL have submitted an In-Principle Monitoring Plan with the DCO application detailing an agreed approach to monitoring.

Consultee	Date /Document	Comment	Response / where addressed in the ES
The Danish Nature Agency	July 2014 Email comments in response to PEIR.	The Danish Nature Agency does not have any objections to the proposed project "Offshore Wind Farm in North Sea East Anglia Zone".	Acknowledged.
Rijkswaterstaat Zee en Delta	July 2014 Email comments in response to PEIR.	Harbour porpoise Regardless of the density in distribution, negative effects of the construction of wind farms on harbour porpoises should be avoided or mitigated. We kindly ask you to reconsider the threshold levels used, since avoidance effects may be underestimated.	The noise thresholds used in our impact assessment for harbour porpoise (and all other species of marine mammal) have been agreed through comprehensive consultation with Natural England and the Marine Management Organisation (MMO) and have been used for other recent UK windfarm EIAs such as Dogger Bank and Hornsea.
		Monitoring of sound levels and impacts Regardless of the density in distribution, negative effects of the construction of wind farms on harbour porpoises should be mitigated. It is currently not clear what foundation method will be used in the East Anglia THREE wind farm. The levels of the produced underwater sound for the different methods vary substantially. We recommend monitoring the produced sound levels and limiting them to keep these under a level where significant negative effects on the harbour porpoise will not occur due to building activities.	The approach to mitigation of impacts on harbour porpoise (and other species of cetacean) is in-line with UK guidelines from the Joint Nature Conservation Committee (JNCC) in the development of a Marine Mammal Mitigation Plan (MMMP). The potential worst-case for noise impacts has been modelled for marine mammals (see section 12.6.1.1; Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*). It is a condition of the draft DML, Part 2, 17 a. to undertake noise monitoring of the installation of the first four piled foundations of each piled foundation type to be installed
		Cumulative Impact Assessment: Dutch wind farms Cumulative impacts are assessed in the light of a reference population. For several species, among which harbour porpoise, the reference population is based on an	EATL have concluded a robust screening exercise of publically available information in-line with UK guidance and in consultation with Natural England unfortunately information was not received in time for the

Consultee	Date /Document	Comment	Response / where addressed in the ES
		international, trans-boundary distribution. Therefore all projects impacting an internationally distributed population should be included in a cumulative impact assessment. Although Dutch offshore wind farms are listed, it is stated that there are no environmental statements available (Chapter 12 Marine Mammal Ecology, Page 108). However, for all permitted Dutch off shore wind farms environmental impact assessments/ appropriate assessments are available.	consideration of Dutch wind farms in the CIA.
		Ecological effects in international perspective Delta Considering the potential harmful effects of wind farm construction activities for sea mammals, we have concerns with regard to underwater noise. Therefore we would like you to consider the possibility to apply the now available techniques to reduce this noise during building activities, and to apply regulations for a maximum noise-power level in order to protect marine mammals.	Should pile driving be the chosen installation method for foundation installation, the methods used for mitigation will include a soft start procedure, which will allow for a slow ramp up in hammer energy, and the establishment of exclusion zones around the noise source. EATL has included a draft of the MMMP with the DCO application. The exact methods to be employed to establish the mitigation zone would be agreed approximately six months prior to the start of construction, and will follow best practice methods at the time. Currently, no mitigation measures have been proposed in relation to disturbance effects, and this approach has also been agreed in consultation with Natural England and the MMO.

Consultee	Date /Document	Comment	Response / where addressed in the ES
		The mentioned issue emphasizes the necessity of international coordination related to building activities in the North Sea, in order to create a common understanding on ecological effects of wind farms and management options for protection of the marine environment. As the Dutch government, we hope to intensify contacts with the UK governmental bodies, and in parallel we aim to discuss this issue within OSPAR. At the same time we hope that wind farm developers will keep improving applied methodologies, taking into account a broader international perspective when predicting environmental effects of wind farm construction activities in the North Sea.	EATL confirms their ongoing support of strategic initiatives and will continue to work with other developers, Regulators and SNCBs see section 12.7.
Natural England	23rd July 2015 / Phase III response via email	We would recommend any changes to piling timings or increase in the duration of piling activities during construction from to the Two Phased approach is particularly considered in the cumulative impact assessment (CIA).	The worst –case scenario has been included in the CIA, based on the spatial worst-case scenario, which is the same for a Single Phased or Two Phased approach and duration based on the Two Phased approach.
Natural England	7th August 2015, draft ES response via email	Table 12.6, the date for the report in the wording for the entry for the '*Harbour seal telemetry data*' requires updating, but had not been flagged	Text in Table 12.6 and reference has been updated.

Consultee	Date /Document	Comment	Response / where addressed in the ES
Natural England	7th August 2015, draft ES response via email	Parts of the underwater noise assessment are difficult to follow without having the Underwater Noise and Electromagnetic Fields chapter and the associated appendix to hand. Inserting figures from the underwater noise assessment into the Marine Mammal chapter would help illustrate many of the noise related points and aid readability, particularly for the spatial assessments.	Plates 9.4 and 9.8 from Appendix 9.1 have been included (*Diagrams 12.6* and *12.7*) to illustrate SEL contours correspond to possible avoidance of area and potential area of fleeing response for harbour porpoise and potential area of fleeing response for pinnipeds.
Natural England	7th August 2015, draft ES response via email	It would be useful to include the number of individuals as a percentage of the reference population in Table 12.18.	The numbers of individuals as a percentage of the reference population have been included in Table 12.18.
Natural England	7th August 2015, draft ES response via email	Natural England recommends considering re-structuring the document to avoid levels of numbering such as 12.6.1.1.2.4.1.1. This would aid readability.	It is acknowledged that there is a high level of numbering of sub-section headings, but this was necessary in order to separate each impact and criteria, and be consistent with the format of other chapters.
Natural England	July 2015 Marine Mammals Expert Topic Group (ETG) Meeting 5	Agreement on the following areas: • List of sites in updated screening for HRA; • Reference populations to be used in the HRA; • Impacts to be assessed in the HRA; and • CIA Methodology.	See *Appendix 12.1* for details

12.3 Scope

12.3.1 Study area

6. Due to the mobile and transitory nature of marine mammals, it is necessary to examine species occurrence not only within the East Anglia THREE site and 4km buffer area, but also over the wider North Sea region. For each species of marine mammal this wider area has been defined based on current knowledge and understanding of the biology of each species, and taking account of feedback received during consultation. The proposed reference population for each receptor considered in the impact is defined in section 12.5.

7. The status and activity of cetaceans known to occur within or adjacent to the East Anglia THREE site is considered in the context of regional population dynamics at the scale of the southern North Sea, or North Sea depending on the data available for each species and the extent of the agreed reference population.

12.3.2 Worst case

8. This section establishes the worst case scenario for each category of impact as a basis for the subsequent impact assessment. For this assessment this involves both a consideration of the relative timing of construction scenarios, as well as the particular design parameters of each project that define the project design envelope for this assessment (*Table 12.2*). Where relevant, the proposed Single Phase and Two Phased approaches to construction have been assessed separately.

9. Full details of the range of development options being considered by EATL are provided within Chapter 5 Description of Development. Only those design parameters with the potential to influence the level of impact on marine mammals are identified in *Table 12.2*.

10. The realistic worst case scenarios identified here are also applied to the Cumulative Impact Assessment (CIA). When the worst case scenarios for the project in isolation do not result in the worst case for cumulative impacts, this is addressed within the cumulative section of this chapter (see section 12.7).

Table 12.2 Worst case parameters for marine mammal receptors (separated for single phased and two phased approach, where relevant)

Impact	Parameter	Maximum worst case Single Phase Approach	Maximum worst case Two Phased Approach	Rationale
Construction				
Underwater noise from pile driving	Number of wind turbines	172 (7MW devices) 100 (12 MW devices)		Although the 12MW devices will result in a smaller number of foundations, the area of potential noise propagation around pile driving will be greater using the maximum hammer energy. Therefore, the maximum number of wind turbines is presented for both the 7MW and 12MW arrays and the monopile and jacket foundations. This approach is repeated throughout the table providing alternate temporal and spatial worst case information for the assessment.
	Number of offshore platforms	5 x electrical 2 x met masts 1 x accommodation	6 x electrical 2 x met masts 1 x accommodation	Up to 2 HVDC converter stations and 4 HVAC collector stations. Under a Single Phase approach a maximum of 3 HVAC collector stations would be required.
	Proportion of foundations that are piled	100%		
	Number of piles per foundation	4 (jackets)		
	Number of piled foundations Wind turbines	172 x 4 = 688 (jackets) 172 (7MW monopiles) 100 (12MW monopiles)		
	Number of piled foundations	8 x 4 = 32 (jackets)	9 x 4 = 36 (jackets)	

Impact	Parameter	Maximum worst case Single Phase Approach	Maximum worst case Two Phased Approach	Rationale
	Offshore Platforms			
	Total number of piled foundations	720 (jackets) 172 (7MW monopiles) or 100 (12MW monopiles)	724 (jackets) 172 (7MW monopiles) or 100 (12MW monopiles)	
	Hammer energy	1,800kJ (jackets) 3,500kJ (monopile).		1,800kJ will be the maximum hammer energy used for piling the jackets, but 2,000kJ was modelled for the noise impact assessment as a proxy.
	Pile diameter	3.5m (jackets) 12m (monopile)		Pin pile diameters will vary depending on the specific design but are expected to be up to 3.5m in diameter in the case of a square footprint foundation (724 piles) and up to 4m for three legged (triangular) jackets 543 piles). Therefore, 3.5 m diameter is worst case.
	Piling time – single pile	20 min soft start plus 86 minutes (jacket), or 184 minutes (7MW, 10m diameter monopile), or 227 minutes (12MW 12m diameter monopile).		
	Total piling time (including soft start)	1,272 hours (jackets), 585 hours (7MW monopiles)	1,279 hours (jackets), 585 hours (7MW monopiles)	

Impact	Parameter	Maximum worst case Single Phase Approach	 Two Phased Approach	Rationale
		412 hours (12MW monopiles)	412 (12MW monopiles)	
	Duration of pile driving within construction period	15 months (8 months using two vessels)	16 months (two phases of 8 months each, separated by approx. 10 months)	
	Average waiting time between pile driving (single piling vessel)	7MW monopiles – 38 hours 42 minutes (assuming 0.57 foundations per vessel per day) 12MW monopiles- 37 hours 59 minutes (assuming 0.57 foundations per vessel per day) Jackets - 8 hours 46 minutes (assuming 0.57 foundations per vessel per day)		
	Number of concurrent piling events	2	N/A	In a Two Phased approach, there will be no need for two piling vessels working simultaneously
	Maximum spacing between piling vessels	Not constrained (site boundaries)		
	Spatial worst case parameters	Monopile: 2 concurrent piling events, 12m diameter piles, 3,500kJ hammer.		Maximum area of impact at one time and maximum anticipated pile energy. The area of impact will be considered based on the location where the greatest ranges of impact are predicted

Impact	Parameter	Maximum worst case: Single Phase Approach	Maximum worst case: Two Phased Approach	Rationale
	Temporal worst case parameters	720 Jackets: No concurrent piling, 8 offshore platforms, 1,800kJ hammer.	724 Jackets: No concurrent piling, 9 offshore platforms, 1,800kJ hammer.	Greatest duration of pile driving. 1,800kJ will be the maximum hammer energy used for piling the jackets, but 2,000kJ was modelled for the noise impact assessment as a proxy.
Underwater noise from vessels (indicative vessel types)	Maximum number of vessels on site at any one time during construction	55		See Chapter 5 Description of Development for details on vessel profiles. Not all the vessels listed would be onsite at the same time, it would be a combination of different vessels depending on what work is being done and when.
	Vessel types – foundation installation	1 x dredging vessel 2 x jack up vessel 2 x heavy lift vessel 6 x support vessel 3 x tugs and barges		
	Vessel types – turbine installation	2 x jack-up vessel 2 x DP heavy lift vessel 2 x accommodation/support vessel 4 x service vessels 6 x support vessels		
	Vessel types - electrical substation	1 x installation vessel 1 x tug/accommodation barge		

Impact	Parameter	Maximum worst case: Single Phase Approach	Maximum worst case: Two Phased Approach	Rationale
	installation	1 x supply vessel 5 x support vessels		
	Vessel types - cable installation	2 x inter-array cable laying vessel 1 x accommodation /support vessel 1 x export cable laying vessel 3 x export cable support vessel 2 x pre-trenching/backfilling vessel 2 x cable jetting and survey vessel		
	Regular operation option 1	8 x workboat		
	Regular operation option 2	2 x accommodation and supply vessel 1 x workboat		
	Indicative number of movements	5,685	7,636	
Vessel interaction	Average number of vessels and types	Details of vessel numbers and types provided above. Assumption that all vessels could have thruster systems and/or ducted propellers.		
Underwater noise from seabed preparation, rock	Inter-array cable installation method	Ploughing / jetting / pre-trenching or cutting		

Impact	Parameter	Maximum worst case: Single Phase Approach	Maximum worst case: Two Phased Approach	Rationale
dumping and cable installation	Inter-array cable length	550km		
	Inter-array cable protection	Rock dumping		
	Duration of inter-array cable installation	14 months	2 x 14 months (7 months using two vessels) separated by 4 months (or 11 months)	
	Platforms link	195km	240km	
	Duration of platforms link installation	11 months	2 x 5 months (separated by 8 months)	
	Interconnection cable length	380km		Maximum interconnection cable between East Anglia THREE site and East Anglia ONE site.
	Duration of interconnection cable installation	13 months	2 x 13 months (separated by 5 months)	
	Total export cable length	664km		
	Duration of export cable installation	22 months	2 x 11 months (separated by 7	

Impact	Parameter	Maximum worst case: Single Phase Approach	Maximum worst case: Two Phased Approach	Rationale
			months)	
	Export cable installation method	Ploughing / jetting / trenching		
	Total duration of cable installation works	41 months	39 months	
Impacts upon prey species	As identified in Chapter 11 Fish and Shellfish Ecology	Output of assessment in Chapter 11 Fish and Shellfish Ecology		
Operation and maintenance				
Underwater noise from vessels	Number of windfarm support vessel trips to site	4,000 two-way trips (average per annum)		
Underwater noise from turbines	Number of wind turbines	172 (7MW devices) 100 (12MW devices)		
	Wind turbine size	12MW		
Underwater noise from any maintenance activities, such as any additional	Parameters for any cable lengths or areas requiring any additional rock dumping or cable re-burial are unknown, but would be less than during construction.			

Impact	Parameter	Maximum worst case: Single Phase Approach	Maximum worst case: Two Phased Approach	Rationale
rock dumping and cable re-burial				
Impacts upon prey species	As identified in Chapter 11 Fish and Shellfish Ecology	Output of assessment in Chapter 11 Fish and Shellfish Ecology		
Vessel interaction	As per underwater noise from vessels			Vessel interaction includes potential collision risk and possible injuries from ducted propellers. The parameters, e.g. number of vessel and trips, are the same used in the vessel noise assessment. Worst-case scenario is that all vessels have to be taken into account as a potential collision risk.
Physical barrier effects	Minimum spacing between wind turbines	675 x 900m		
	Layout pattern	Rows with an offset packing arrangement		
Decommissioning				
Underwater noise from vessels, seabed preparation, foundation and cable removal	Assumed to be as construction (with no pile driving). Explosives will not be used, assumed piles cut off below seabed level and all structures above seabed level removed.			
Impacts upon prey species	As identified in Chapter 11 Fish and Shellfish	Output of assessment in Chapter 11 Fish and Shellfish Ecology		

Impact	Parameter	Maximum worst case Single Phase Approach	Maximum worst case Two Phased Approach	Rationale
	Ecology			
Vessel interaction	Assumed to be as construction.			

11. Embedded mitigation will be included and referred to where necessary. If the impact does not require mitigation (or none is possible) the impact will remain the same. If however, further mitigation is required there is an assessment of the post-mitigation residual impact.

12. Embedded mitigation relevant to marine mammals:

- At the time of the lease agreement with The Crown Estate, the East Anglia THREE site was selected to ensure there is no overlap between marine mammal designated sites at the East Anglia THREE site or offshore cable corridor.
- The development of the project design has resulted in an increase in wind turbine size reducing the overall number of wind turbines. This would reduce noise impacts during construction and indirect impacts on prey species as a result of less pile driving and less vessel movements.
- EATL will commit to the use of soft start and exclusion zones to prevent auditory injury to European Protected Species (EPS) during pile driving activities.
- EATL have provided a draft marine mammal mitigation plan (MMMP) with this application. The MMMP would be developed in the pre-construction period and will be based upon best available information and methodologies at that time in consultation with the relevant authorities.
- EATL will continue to review the development of alternative foundation installation (through industry and academic studies) and more efficient mitigation options for marine mammals.

12.4 Assessment methodology

12.4.1 Guidance

13. The assessment of potential impacts upon marine mammals has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIP). Those relevant to marine mammals are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) 2011a); and
- NPS for Renewable Energy Infrastructure (EN-3) (DECC 2011b).

14. The specific assessment requirements for marine mammals, as detailed in the NPS, are summarised in *Table 12.3*, together with an indication of the section numbers of the ES chapter where each is addressed.

Table 12.3 NPS assessment requirements

NPS requirement	NPS reference	ES reference
"Where necessary, assessment of the effects on marine mammals should include details of: • Likely feeding areas; • Known birthing areas / haul out sites; • Nursery grounds; • Known migration or commuting routes; • Duration of the potentially disturbing activity including cumulative / in-combination effects with other plans or projects; • Baseline noise levels; • Predicted noise levels in relation to mortality, Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS); • Soft-start noise levels according to proposed hammer and pile design; and • Operational noise."	Paragraphs 2.6.90-2.6.99 of the NPS EN-3 (July 2011)	Section 12.5 provides a description of the existing environment. Section 12.6.1 details the assessment of impacts during construction, including pile driving. Section 12.6.2 assessed operational noise.
"The applicant should discuss any proposed piling activities with the relevant body. Where assessment shows that noise from offshore piling may reach noise levels likely to lead to an offence [as described above], the applicant should look at possible alternatives or appropriate mitigation before applying for a licence."	Paragraph 2.6.93 of the NPS EN-3 (July 2011)	Section 12.6.1 details the assessment of impacts during construction, including pile driving, and mitigation measures. EATL has consulted with Natural England on this issue (*Table 12.1*).

15. With regard to the Planning Inspectorate decision making, NPS paragraphs 2.6.94 to 2.6.99 set out the issues and mitigation that may be considered. This refers to preferred methods of construction and suitable noise mitigation, the conservation status of marine EPS, and the need to take into account the views of the relevant statutory advisers, and notes that fixed structures are unlikely to pose a significant collision risk to marine mammals. With regard to mitigation, the potential for monitoring before and after piling is noted, a preference for 24 hour working to

reduce the overall construction program and attendant effects is set out and the need for soft start procedures for piling is also noted.

16. The Marine Policy Statement (MPS, HM Government 2011) provides the high-level approach to marine planning and general principles for decision making that contribute to achieving this vision. It also sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high level objective of '*Living within environmental limits*' covers the points relevant to benthic ecology; this requires that:

- Biodiversity is protected, conserved and where appropriate recovered and loss has been halted.
- Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems.
- Our oceans support viable populations of representative, rare, vulnerable, and valued species.

17. With regard to the East Inshore and East Offshore Marine Plans (HM Government 2014) Objective 6 *"To have a healthy, resilient and adaptable marine ecosystem in the East Marine Plan areas"* and Objective 7 *"To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas"* are of relevance to this Chapter as these cover policies and commitments on the wider ecosystem, set out in the MPS including those covering the Marine Strategy Framework Directive (see Chapter 3 Policy and Legislative Context).

18. Cetaceans and pinnipeds are protected under a wide range of national and international legislation as outlined in *Table 12.4*.

Table 12.4 National and international legislation in relation to marine mammals

Legislation	Protection	Details
The Conservation of Habitats and Species Regulations 2010	All cetaceans, grey and harbour seal	In England and Wales, The Conservation of Habitats and Species Regulations 2007 (as amended) consolidate all the various amendments made to the Conservation (Natural Habitats, andc.) Regulations 1994, implementing the requirements of the Habitats Directive into UK law. All cetacean species are listed under Schedule 2 (EPS) and all seals are listed under Schedule 4 (animals which may not be captured or killed in certain ways). Provisions of The Habitats Regulations are described further below. It should be noted that the 2010 Habitats Regulations only apply within the territorial seas.
Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended)	All cetaceans, grey and harbour seal	The Offshore Marine Conservation Regulations 2007 (as amended) apply the Habitats Directive to marine areas within UK jurisdiction, beyond 12 nautical miles, and provide further clarity on the interpretation of "disturbance" in relation to species protected under the Habitats Directive. Thus enabling energy developers to better qualify and, where possible, quantify, the impacts on marine mammals and determine whether the potential disturbance is permissible as part of a consented development. Provisions of The Offshore Marine Regulations are described further below.
Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)	Odontocetes	Formulated in 1992, this agreement has been signed by eight European countries bordering the Baltic and North Seas (including the English Channel) and includes the United Kingdom (UK). Under the Agreement, provision is made for the protection of specific areas, monitoring, research, information exchange, pollution control and increasing public awareness of small cetaceans.
The Berne Convention 1979	All cetaceans, grey seal and harbour seal	The Convention conveys special protection to those species that are vulnerable or endangered. Appendix II (strictly protected fauna): 19 species of cetacean. Appendix III (protected fauna): all remaining cetaceans, grey and harbour seal. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981 (with any aspects not implemented via that route brought in by the Habitats Directive).
The Bonn Convention 1979	All cetaceans	Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction. One of the measures identified is the adoption of legally binding agreements, including ASCOBANS.

Legislation	Protection	Details
The Wildlife and Countryside Act 1981 (as amended)	All cetaceans	Schedule five: all cetaceans are fully protected within UK territorial waters. This protects them from killing or injury, sale, destruction of a particular habitat (which they use for protection or shelter) and disturbance. Schedule six: Short-beaked common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus* and harbour porpoise; prevents these species being used as a decoy to attract other animals. This schedule also prohibits the use of vehicles to take or drive them, prevents nets, traps or electrical devices from being set in such a way that would injure them and prevents the use of nets or sounds to trap or snare them.
The Countryside and Rights of Way Act 2000	All cetaceans	It is an offence to deliberately or recklessly damage, or disturb any cetacean in English and Welsh protected waters under this Act.
Oslo and Paris Convention for the Protection of the Marine Environment (OSPAR)	Bowhead whale *Balaena mysticetus*, northern right whale *Eubalaena glacialis*, blue whale *Balaenoptera musculus*, and harbour porpoise	OSPAR has established a list of threatened and/or declining species in the North east Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the European Commission (EC) Habitats and Birds directives and measures under the Berne Convention and the Bonn Convention.
Conservation of Seals Act 1970	Grey and harbour seal	Provides closed seasons, during which it is an offence to take or kill any seal, except under licence or in certain particular circumstances (grey seal: 1 September to 31 December; harbour seal: 1 June to 31 August). Following the halving of the harbour seal population as a result of the Phocine Distemper Virus (PDV) in 1988, an Order was issued under the Act which provided year round protection of both grey and harbour seal on the east coast of England. The Order was last renewed in 1999.
UK Biodiversity Action Plan (BAP)	Harbour porpoise	Harbour porpoise are a feature of the Norfolk, Suffolk and Essex Local Biodiversity Action Plans (LBAPs). These LBAPs are plans which seek to ensure that nationally and locally important species and habitats are conserved and enhanced in a given area through focused local action.

19. The principal guidance documents used to inform the assessment of potential impacts on marine mammals are as follows:

- Guidance on the Assessment of Effects on the Environment and Cultural Heritage from Marine Renewable Developments. Produced by: the Marine Management Organisation (MMO), the Joint Nature Conservation Committee (JNCC), Natural England, the Countryside Council for Wales (CCW) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) (MMO 2010);
- The Protection of Marine EPS From Injury and Disturbance: Draft Guidance for the Marine Area in England and Wales and the UK Offshore Marine Area (JNCC et al. 2010a);
- Guidelines for Ecological Impact Assessment in Britain and Ireland, Marine and Coastal (Institute for Ecology and Environmental Management (IEEM) 2010);
- Environmental Impact Assessment for offshore renewable energy projects – guide (BSI 2015);
- Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments Final Report (SMRU Ltd on behalf of The Crown Estate 2010);
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Cefas 2012); and
- Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (JNCC et al. 2010b).

12.4.1.1 The Habitats Directive

20. A vital piece of wildlife legislation in relation to marine renewable energy and marine mammals is the European Union (EU) Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ('the Habitats Directive').

21. All cetaceans are protected as EPS under Annex IV of the Habitats Directive because they are classified as being endangered, vulnerable or rare. Both grey seal and harbour seal are protected under Annex II of the Habitats Directive. Grey seal and harbour seal are also listed on Annex V of the Habitats Directive, which requires their exploitation or removal from the wild to be subject to management measures. Both these measures are provided for within national legislation, as for cetaceans.

22. Harbour porpoise and bottlenose dolphin are also listed under Annex II of the Habitats Directive, which requires Member States of the EU to designate areas essential to their life and reproduction as Special Areas of Conservation (SAC).

23. Under Article 12 of the Habitats Directive, Member States are required to take the requisite measures to establish a system of stricter protection for species in their natural range prohibiting:

- All forms of deliberate capture or killing of specimens of these species in the wild;
- Deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration; and
- Deterioration or destruction of breeding sites or resting places.

12.4.1.2 Habitats Regulations and Offshore Marine Regulations guidance

24. Under the Habitats Regulations 2010 ('HR' as amended) and Offshore Marine Regulations 2009 ('OMR' as amended), a person is guilty of an offence if a person:

- Deliberately captures, injures or kills any wild animal of an EPS; and
- Deliberately disturbs wild animals of any such species.

25. The nature of 'disturbance' is further detailed, with an offence arising if the disturbance of any such species is likely:

- To impair their ability to survive, to breed or reproduce, or to rear or nurture their young; and
- In the case of animals of a hibernating or migratory species, to hibernate or migrate;
- To affect significantly the local distribution or abundance of the species to which they belong;
- To deliberately take or destroy the eggs of such an animal; and
- To damage or destroy, or do anything to cause the deterioration of, a breeding site or resting place of such an animal.

26. Following the amendments made to the HR and OMR in 2010, the UK legislation now more clearly transposes the requirement contained in the Habitats Directive to prohibit deliberate disturbance, and better reflect the circumstances in which

disturbance may be particularly damaging to the animals concerned (as envisaged by Article 12). In addition, the HR and OMR provide for the offence of deliberate injuries.

12.4.1.3 Favourable Conservation Status (FCS)

27. In order to assess whether a disturbance could be considered 'non-trivial' in relation to the objectives of the Habitats Directive, consideration should be given to the definition of the FCS of a species given in Article 1(i) of the Habitats Directive. There are three parameters that determine when the Conservation Status of a species can be taken as favourable:

- Population(s) of the species is maintained on a long-term basis;
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- The habitat on which the species depends (for feeding, breeding, rearing etc.) is maintained in sufficient size to maintain the population(s) over a period of years/decades.

28. Member states report back to the EU every six years on the Conservation Status of marine EPS. *Table 12.5* shows that in the UK, four out of 11 cetacean species have been assessed as having an 'unknown' Conservation Status (based on the 2007-2012 reporting; JNCC 2013). This is a result of a lack of recent population[1] estimates that encompassed their natural range in UK and adjacent waters and / or having no evidence to determine long-term trends in population abundance.

29. Another 17 species were considered to be uncommon, rare or very rare in occurrence, so it was not possible to ascertain their Conservation Status. The seven species outlined in *Table 12.5* as having a 'favourable' Conservation Status, are underpinned by an assessment of moderate to low reliability. It can be interpreted that:

- A greater understanding of the species/population(s), or the factors affecting it, is required before a confident concluding judgment can be made by experts; and

[1] 'Population' is defined in the EC guidance on the strict protection of animal species as a group of individuals of the same species living in a geographic area at the same time that are (potentially) interbreeding (i.e. sharing a common gene pool).

- The current estimate of population and/or trend are based on recent, but incomplete or limited survey data, or based predominately on expert opinion.

30. *Table 12.5* presents the Conservation Status of commonly occurring cetacean species within UK waters. The abundance estimates are generated from the Small Cetaceans in the European Atlantic and North Sea surveys (SCANS and SCANS-II) and Cetacean Offshore Distribution and Abundance (CODA) surveys as reported in the 3rd UK Habitats Directive reporting 2013 (JNCC 2013).

Table 12.5 Common cetacean species in Annex IV of the Habitats Directive occurring in UK and adjacent waters, FCS assessment and UK favourable reference population (JNCC 2013) CV =coefficient of variation, the percentage variation of mean value

Species	FCS assessment	UK Favourable Reference Population	Minimum - Maximum	Year of assessment
Harbour porpoise *Phocoena phocoena*	Favourable	177,567 (CV 0.15)	132,553 – 237,868	2005
Minke whale *Balaenoptera acutorostrata*	Favourable	15,822 (CV 0.45)	6,819 – 36,711	2005-2007
Fin whale *Balaenoptera physalus*	Favourable	741 (CV 0.19)	512-1,072	2007
Common dolphin *Delphinus delphis*	Favourable	14,576 (CV 0.24)	9,166-23,178	2005-2007
Long-finned pilot whale *Globicephala melas*	Unknown	Unknown[2]	20,091 – 76, 158	2007
Risso's dolphin *Grampus griseus*	Unknown	Unknown[3]	175 - 4,440	2010
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Favourable	62,532 (CV 0.32)	34,535 – 113,229	2005-2007
Killer whale *Orcinus orca*	Unknown	69 [4]	50 - 100	2005 - 2012
White-beaked dolphin *Lagenorhynchus albirostris*	Favourable	9,876 (CV 0.32)	5,307 – 18,379	2005
Sperm whale *Physeter macrocephalus*	Unknown	Unknown	340 – 1,334	2007
Bottlenose dolphin *Tursiops truncatus*	Favourable	12, 758 (CV 0.26)	7,728 – 21,062	2005 - 2007

[2] In the absence of a robust estimate of abundance for UK waters and lack of information on population structure in the wider Northeast Atlantic, the FRV is currently reported as unknown. Over entire CODA region the population estimate is 25,101 (CV=0.33; JNCC 2013).

[3] Given a lack of a robust UK population estimate and knowledge of stock structure, the Favourable Reference population is unknown (JNCC 2013).

[4] No CV provided.

12.4.1.4 EPS guidance

31. The JNCC, Natural England and CCW (JNCC et al. 2010a) have produced draft guidance concerning the Regulations on the deliberate disturbance of marine EPS (cetaceans, turtles and Atlantic sturgeon *Acipenser oxyrinchus*), which provides an interpretation of the regulations in greater detail, including pile driving operations (JNCC et al. 2010b), seismic surveys (JNCC et al. 2010c) and explosives (JNCC et al. 2010d).

32. The draft guidance details all activities at sea that could potentially cause a deliberate injury or disturbance offence and summarises information and sensitivities of species to which the regulations apply. The guidance refers to the Habitats Directive Article 12 Guidance (EC 2007) stating that, in their view, significant disturbance must have some ecological impact.

33. The draft guidance provides the following interpretations of deliberate injury and disturbance offences under Regulation 39(1) of the Habitats Regulations and Offshore Marine Regulations, as detailed in the paragraphs below:

> "*Deliberate actions are to be understood as actions by a person who knows, in light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action;*
>
> *Certain activities that produce loud sounds in areas where EPS could be present have the potential to result in an injury offence, unless appropriate mitigation measures are implemented to prevent the exposure of animals to sound levels capable of causing injury*."

34. The term "disturbance" is not defined in Article 1 or Article 12 of the Habitats Directive or in the Habitats Regulations or Offshore Marine Regulations. Although not legally binding, The Habitats Directive Article 12 Guidance (EC 2007) states that:

> *"In order to assess a disturbance, consideration must be given to its effect on the conservation status of the species at population level and biogeographic level in a Member State. For instance, any disturbing activity that affects the survival chances, the breeding success or the reproductive ability of a protected species or leads to a reduction in the occupied area should be regarded as a "disturbance" in terms of Article 12."*

35. Following amendments, the HR and the OMR better define the level of disturbance which constitutes an offence. Regulation 39(1)(b)(1A) makes it clear that any

disturbance which is likely to have any of the negative effects which are potentially significant contributors, with regard to impact on the conservation status of EPS, will amount to disturbance under regulation 39(1)(b).

36. The draft guidance (JNCC et al. 2010a) also highlights that sporadic "trivial disturbance" should not be considered as a disturbance offence under Article 12.

37. For the purposes of marine users, the draft guidance states that a disturbance which can cause offence should be interpreted as:

> *"Disturbance which is significant in that it is likely to be detrimental to the animals of an EPS or significantly affect their local abundance or distribution."*

38. The draft guidelines also state that a disturbance offence is more likely where an activity causes persistent noise in an area for long periods of time, and a disturbance offence is more likely to occur when there is a risk of:

- Animals incurring sustained or chronic disruption of behaviour scoring five or more in the Southall et al. (2007) behavioural response severity scale; or
- Animals being displaced from the area, with redistribution significantly different from natural variation.

39. In order to assess whether a disturbance could be considered non-trivial in relation to the objectives of the Directive, JNCC et al. (2010a) suggest that consideration should be given to the definition of the FCS of a species given in Article 1(i) of the Habitats Directive. There are three parameters that determine when the conservation status of a species can be taken as favourable:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable element of its natural habitats.
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future.
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

40. Therefore, any action that could increase the risk of a long-term decline of the population, increase the risk of a reduction of the range of the species, and/or increase the risk of a reduction of the size of the habitat of the species can be regarded as a disturbance under the Regulations. For a disturbance to be considered

non-trivial, the disturbance to marine EPS would need to be likely to at least increase the risk of a certain negative impact on the species at FCS.

41. JNCC et al. (2010a) do not provide guidance as to what would constitute a 'significant group' or proportion of the population, but provide some discussion on how to assess whether the numbers potentially affected could be of concern for a population's FCS.

42. JNCC et al. (2010a) state that:

> "*In any population with a positive rate of growth, or a population remaining stable at what is assumed to be the environmental carrying capacity, a certain number of animals can potentially be removed as a consequence of anthropogenic activities (e.g. through killing, injury or permanent loss of reproductive ability), in addition to natural mortality, without causing the population to decrease in numbers, or preventing recovery, if the population is depleted. Beyond a certain threshold however, there could be a detrimental effect on the population*".

43. Further discussion on the use of thresholds for significance and the permanent or temporary nature of any disturbance is considered by defining the magnitude of potential effect in this assessment (section 12.6.1). Consideration of any potential essential habitat or geographical structuring of EPS is provided in the Existing Environment section (section 12.5.3) of this chapter.

44. In order to assess the number of individuals from a species that could be removed from the regional population through injury or disturbance without compromising the FCS in its natural range, the ES considers:

- The numbers affected in relation to the best and most recent estimate of population size; and
- The threshold for potential impact on the FCS, which will depend on:
- The species' / populations' life-history;
- The species' FCS assessment in UK waters; and
- Other pressures encountered by the population (cumulative effects).

45. One of the key parameters for consideration within this assessment is the population size. The EPS Guidance advises that the best available abundance estimates could be used as a baseline population size, taking account of any evidence of regional

population structuring (JNCC et al. 2010a). In the case of the proposed East Anglia THREE project, *Table 12.5* suggests that the European population estimates derived from the SCANS II and CODA surveys offer the best reference population for all commonly occurring cetacean species in the UK. In the case of harbour porpoise, the SCANS II data also offers the opportunity for assessing potential impacts of the proposed East Anglia THREE project in the context of the North Sea population. Updated analysis of the SCANS II data by Hammond et al. (2013) has provided population estimates that have been used in this assessment along with the Inter-Agency Marine Mammal Working Group (IAMMWG) management units (IAMMWG 2015), rather than those used in the FCS assessment (*Table 12.5*).

46. Consideration should be given to the fact that the estimates of population size for EPS are based on data collected in 2005, and numbers of individuals impacted is based on absolute abundance and density estimates from survey data collected between 2011 and 2013 and the population size of each species of cetacean may have changed over this time. However, at the time of completing this assessment the 2005 SCANS II data were agreed by EATL and Natural England to be the most appropriate data set (*Table 12.1*).

47. An EPS licence is required if the risk of injury or disturbance to cetacean species is assessed as likely under regulations 41(1) (a) and (b) in The Conservation of Habitats and Species Regulations and 39(1) (a) and (b) in The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (amended in 2009 and 2010).

48. Given the potential implications of the EPS Guidance, this EIA has focused on cetaceans which have been recorded as either common, regular or uncommon, seasonal visitors to the East Anglia THREE site plus 4km buffer. It follows that if an EPS licence is required, the risk assessment would also focus on these species.

49. As part of the risk assessment for potential injury and disturbance offences, an assessment has been undertaken to determine the likelihood of any injury and / or disturbance offences likely to occur from construction, operation and decommissioning activities relating to the proposed East Anglia THREE project.

50. Additionally, it is noted that many activities at sea will not require a licence, since their potential for injury and / or disturbance is intrinsically low (below the threshold where an offence is possible) or can be effectively mitigated.

51. If a licence is required, an application must be submitted, the assessment of which comprises three tests, namely:

- Whether the activity fits one of the purposes specified in Regulation 53(2)(e);

- Whether there are no satisfactory alternatives to the activity proposed (that would not incur the risk of offence); and
- That the licensing of the activity will not result in a negative impact on the species'/ population's FCS.

52. Under the revised definitions of 'deliberate disturbance' in the HR and OMR, chronic exposure and / or displacement of animals could be regarded as a disturbance offence. If these risks cannot be avoided, then EATL is likely to be required to apply for a marine wildlife licence from the MMO in order to be exempt from the offence.

53. An EPS licence, if granted, will be valid for a limited time period, therefore an application would be submitted after the Development Consent Order (DCO) application is made prior to the onset of construction, and in consultation with the relevant Statutory Nature Conservation Bodies.

54. The EPS licence application will be submitted post consent, and at least three to six months prior to the start of construction, such that the most up to date information can be used in the assessment of the potential impacts on the FCS of the species concerned. At this time the project design envelope will have been further refined through detailed design and procurement activities and hence further detail will be available on the construction techniques selected for the construction of the windfarm than are available at the time of writing this ES, as well as full consideration of the mitigation measures that will be in place following the development of the Environmental Management Plan (EMP) including a MMMP. A draft MMMP is provided with the DCO application.

55. This approach has been agreed with Natural England (*Table 12.1*).

12.4.2 Data sources

56. The generic data sources outlined in *Table 12.6* have been used to inform the description of the existing environment and the study area in relation to marine mammals. In addition the following reports relating to the development of the East Anglia Zone have been used:

- East Anglia Offshore Wind Limited. 2012b. East Anglia ONE Environmental Statement. Chapter 11 Marine Mammals; and
- East Anglia Offshore Wind Limited. 2012c. Zonal Environmental Appraisal (ZEA) Report.

57. In addition to generic data sources, Zone and project specific surveys have been completed in the region that have also been used to inform the existing environment section of this chapter.

58. These surveys include:

- The Crown Estate Enabling Actions high-definition video aerial surveys of Zone 5. November 2009 – March 2010, completed by HiDef Aerial Surveying Ltd;
- EAOW boat based surveys of the East Anglia ONE site, May 2010 – April 2011, completed by The Institute of Estuarine and Coastal Studies (IECS);
- EAOW aerial digital surveys of the East Anglia ONE site (plus 4km buffer), April 2010 – October 2011, completed by APEM Ltd;
- EAOW aerial digital surveys of the East Anglia Zone, April 2010 – October 2011, completed by APEM Ltd; and
- EAOW aerial digital surveys of the East Anglia THREE site (plus 4km buffer), September 2011 – August 2013, completed by APEM Ltd (*Appendix 12.2*).

59. The data collected during the EATL aerial digital surveys have been analysed to generate estimates of density over the East Anglia THREE site plus 4km buffer (*Appendix 12.2*). The densities across the East Anglia THREE site plus buffer have been used in the impact assessment. Densities over the East Anglia THREE site plus buffer area were higher than the original site only densities, and it was agreed in consultation that the densities over the East Anglia THREE site plus buffer would be used in the assessment due to the higher values adding precaution. Impacts from pile driving noise will range beyond the East Anglia THREE site boundary; therefore the densities over the wider area are more appropriate to be used in the impact assessment.

Table 12.6 Broad-scale data sources to inform the marine mammal site characterisation at East Anglia THREE

Title	Nature of the data	Spatial coverage	Data holder	Publication
Atlas of Cetacean Distribution in North west European Waters "Joint Cetacean Database"	Provides an account of the distribution of all 28 cetacean species that are known to have occurred in the waters off north west Europe in the last 25 years, Data sources: SCANS data, European Seabirds at Sea and the Sea Watch Foundation.	North west European waters, including North Sea, Irish Sea and English Channel.	JNCC	Reid et al. 2003
Small Cetacean Abundance in the North Sea and Adjacent Waters (SCANS)	Shipboard (890,000km^2) and aerial line (150,000km^2) transect surveys conducted to provide accurate and precise estimates of abundance as a basis for conservation strategy in European waters.	North Sea, English Channel, Celtic Sea, western Baltic Sea, waters around north east Scotland and the west coast of Norway/Sweden.	The Sea Mammal Research Unit (SMRU)	Surveys conducted in summer 1994. Report by Hammond et al. 2002.
Small Cetacean Abundance in the Atlantic and North Sea (SCANS II)	SCANS-II provides the most precise broad-scale estimates of cetacean abundance in UK waters, covering over 1,350,000km^2 and over 35,000km of survey track line (boat and aerial surveys combined).	SCANS extended west and south into Irish, French and Spanish waters.	SMRU	Surveys carried out in 2005, report published 2008 and reissued with new analysis 2013 (Hammond et al. 2013).
Inter-Agency Marine Mammal Working Group (IAMMWG) Management Units (MU) for marine mammals in UK waters	The Inter-Agency Marine Mammal Working Group (IAMMWG) comprises representatives of the UK Statutory Nature Conservation Bodies (SNCBs). The report provides agreed Management Units (MUs) for the seven most common cetacean species and the two seal species in UK waters, including details of each MU, boundaries and estimated abundance figures.	UK wide	JNCC	IAMMWG 2013, IAMMWG 2015
The Coastal Directive Project – JNCC Coasts and Seas of the United Kingdom	The Coastal Directories Project, coordinated by the JNCC, was developed to produce a wide-ranging baseline of environmental information for each part of the UK coastal and near shore marine zone. Each section provides a summary of the regions environment, including protected sites, wildlife habitats and species, human uses, archaeology etc.	Region 6 Eastern England: Flamborough Head to Great Yarmouth and Region 7 Southeast England Lowestoft to Dungeness.	JNCC	Barne et al. 1998
Distributions of	Data on the distributions and abundances of cetaceans,	Majority of English and Welsh	WWT (Consulting)	WWT 2009

Title	Nature of the data	Spatial coverage	Data holder	Publication
Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008. WWT	seals, turtles, sharks and ocean sunfish *Mola mola* were collected opportunistically during aerial surveys for waterbirds conducted by Wildfowl and Wetlands Trust Consulting. The report details the distributions of all records of these species collected in areas of waterbird surveys around the UK coast between 2001 and August 2008 using distance-sampling methodology developed in Denmark by National Environment Research Institute (NERI).	coastline, some areas of Scotland and Northern Ireland	Ltd	
Seal telemetry data	Pinniped tagging programmes are included as part of regular population monitoring programmes (e.g. Special Committee on Seals (SCOS 2014). The telemetry data allow usage of coastal and marine areas to be examined.	UK wide	SMRU	Sharples et al. 2008 Russel and McConnell 2014
SCOS	Scientific advice to government on matters related to the management of seal populations, the SCOS formulates this advice.	UK wide	SMRU	SCOS 2014, 2013, 2012, 2010
Strategic Environmental Assessment (SEA) 3	Information on the abundance and distribution of marine mammals within the SEA 3 Block. In particular, important seal breeding colonies in the Humber Estuary, The Wash and the Farne Islands.	Southern North Sea, from Dover to Berwick-Upon-Tweed	DECC	DECC 2002
Offshore Energy SEA (Appendix A3a.7)	Baseline description of distribution and abundance of marine mammals in UK waters.	UK wide	DECC	DECC 2009
Offshore Energy SEA (Various Technical Reports)	Boat based marine mammal surveys of the Dogger Bank Zone and North Sea between February 2008 and March 2009. Telemetry of grey seals in the North Sea (conducted by SMRU).	North Sea	DECC	DECC 2009
North Atlantic Marine Mammal Commission (NAMMCO) Scientific Publications (various titles)	NAMMCO Publications on population and biological data.	Harbour seals in the North Atlantic and Baltic, grey seals in the North Atlantic and Baltic, harbour porpoises in the North Atlantic.	Various	

Title	Nature of the data	Spatial coverage	Data holder	Publication
Marine Scotland seal density estimates	Broad scale mapping of seal density estimates at 5x5km resolution	UK	Marine Scotland	Jones et al.2013
International Whaling Commission (IWC) Population Estimates	The Scientific Committee is undertaking a major compilation and review of abundance estimates that was expected to be completed by mid-2013.	Global	IWC	
Joint Cetacean Protocol	Information on the distribution, abundance and population trends of cetacean species occurring in the area.	UK waters and wider Northeast Atlantic.	JNCC	Final reporting not yet available.

12.4.3 Impact assessment methodology

60. The impact assessment follows the standard methodology as presented in Chapter 6 EIA Methodology and the description of the proposed East Anglia THREE project given in Chapter 5 Description of the Development.

61. Each impact was identified during scoping and consultation (*Table 12.1*), and through previous experience in offshore windfarm impact assessment. The impacts have been assessed through a consideration of receptor sensitivity and magnitude of effect, in order to derive an overall level of impact (see Chapter 6 EIA Methodology for further details).

62. In the case of marine mammals a large number of species fall within legislative policy outlined in section 12.4.1, and are therefore internationally important. As such, all species of marine mammal are considered to be of high value. Value is not used within the impact matrix as value and sensitivity are not necessarily linked within a particular impact; a receptor could be of high value (e.g. EPS) but have a low or negligible physical / ecological sensitivity to an effect. It is important in impact assessments not to over inflate the potential significance of an impact at the population level simply because a feature is 'valued'.

63. The approach to the impact assessment has been consulted on and agreed with Natural England in the Marine Mammals Expert Topic Group as part of the Evidence Plan process (*Table 12.1,* and *Appendix 12.1)*.

12.4.3.1 Sensitivity

64. Definitions of the different sensitivity levels for the receptor are presented in *Table 12.7*.

Table 12.7 Definition of sensitivity

Sensitivity	Definition
High	Individual receptor has very limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	Individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	Individual receptor has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact.
Negligible	Individual receptor is generally tolerant to and can accommodate or recover from the anticipated impact.

65. The sensitivity level of marine mammals to each type of impact is justified within the impact assessment.

66. The sensitivity of marine mammals to impacts from pile driving noise is currently the impact of most concern across the offshore wind sector. The sensitivity to potential impacts of lethality, physical injury, auditory injury or hearing impairment, as well as behavioural disturbance or auditory masking have been considered for each species, using available evidence including published data sources.

12.4.3.2 Magnitude

67. The significance of the potential impacts of the proposed East Anglia THREE project is also based on the intensity or degree of disturbance to the baseline conditions and is categorised into four levels of magnitude: high; medium; low; or negligible, as defined in *Table 12.8*.

68. The thresholds defining each level of magnitude of effect for each impact have been determined using expert judgement, current scientific understanding of marine mammal population biology and JNCC et al. (2010a) draft guidance on disturbance to EPS species. The magnitude of each effect is calculated or described in a quantitative or qualitative way within the assessment.

69. The JNCC et al. (2010a) draft guidance provides some discussion on how many animals may be removed from a population without causing detrimental effects to the population at FCS. As such this guidance has been considered in defining the thresholds for magnitude of effects. All species considered in this assessment (both cetaceans and pinnipeds) are high value so using the JNCC et al. (2010a) draft guidance is deemed appropriate in assigning the thresholds for magnitude of effect presented in *Table 12.8*.

70. The number of animals that can be ‘removed’ through injury or disturbance will vary between species, but is largely dependent on the growth rate of the population; populations with low growth rates can sustain the removal of a smaller proportion of the population. For most species of cetacean there is a large amount of uncertainty as to the growth rate of the population, but JNCC et al. (2010a) consider that it is generally accepted that for cetaceans the population growth rates will be lower than 10% per year. The Guidance states that:

“*An IWC/ASCOBANS workshop in 2000 recommended that 4% a year should be used as a conservative estimate of the maximum potential growth rate for harbour porpoise. This value is generally accepted as the default for cetaceans and in the* *absence of better information is considered a reasonable measure that could be used*".

71. The JNCC et al. (2010a) draft guidance provides limited consideration of temporary effects, with guidance reflecting consideration of permanent displacement. *Table 12.8* considers the potential that different proportions of the population being impacted leads to different magnitudes of effects depending on whether the effect is permanent or temporary.

72. In this assessment temporary effects are considered to be of medium magnitude at greater than 5% of the reference population being affected within a year. JNCC et al. (2010a) draft guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the 'default' rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth could be halted. In assigning 5% to a temporary impact in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

73. In this assessment, permanent effects to greater than 1% of the reference population being affected within a year are considered to be high magnitude. The assignment of this level is informed by the JNCC et al. (2010a) draft guidance (suggesting 4% as the 'default maximum growth rate for cetaceans) but also reflects the large amount of uncertainty in the potential individual and population level consequences of permanent effects. It also considers what may be the potential rate of increase in a population with regard to existing pressures (such as by-catch of harbour porpoise). For example, population modelling of harbour porpoise in the North Sea (Winship 2009) suggests relatively low rates of potential increase in this population. Even in the absence of by-catch, growth rates were estimated to be approximately 0% (95% probability interval of -6% to +5%) for a density-independent model, and around 2% (95% probability interval of 0 to 7%) for a density dependent model.

Table 12.8 Definitions of terms relating to the magnitude of anticipated effect on marine mammals

Magnitude	Definition
High	Permanent irreversible change to exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >1% of the reference population are anticipated to be exposed to the effect per year. OR Temporary effect (limited to stage of development (i.e. construction, operation or decommissioning)) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >10% of the reference population are anticipated to be exposed to the effect per year.
Medium	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that >0.01% or <=1% of the reference population anticipated to be exposed to effect per year. OR Temporary effect (limited to stage of development (i.e. construction, operation or decommissioning)) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >5% or <=10% of the reference population anticipated to be exposed to effect per year.
Low	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that >0.001 and <=0.01% of the reference population anticipated to be exposed to effect per year. OR Intermittent and temporary effect (limited to stage of development (i.e. construction, operation or decommissioning)) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >1% or <=5% of the reference population anticipated to be exposed to effect per year.
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that <=0.001% of the reference population anticipated to be exposed to effect per year. OR Intermittent and temporary effect (limited to stage of development (i.e. construction, operation or decommissioning)) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that <=1% of the reference population anticipated to be exposed to effect per year.

12.4.3.3 Overall impact

74. The level of overall impact, and its significance, is determined by a combination of the magnitude of effect as defined in *Table 12.8* and the sensitivity of the receptor to the impact being assessed (*Table 12.7*). The probability of the impact occurring is also considered in the assessment process. If doubt exists concerning the likelihood of occurrence or the prediction of an impact, the precautionary approach is taken to assign a higher level of probability to adverse effects.

75. Following from the identification of a potential impact, the impact matrix (*Table 12.9*) is used to define the level of impact. Impacts defined as major or moderate are considered significant for the purpose of EIA.

Table 12.9 Impact significance matrix

Sensitivity	Magnitude				
	High	Medium	Low	Negligible	No change
High	Major	Major	Moderate	Minor	No impact
Medium	Major	Moderate	Minor	Negligible	No impact
Low	Moderate	Minor	Minor	Negligible	No impact
Negligible	Minor	Negligible	Negligible	Negligible	No impact

76. As with the definitions of magnitude and sensitivity, the matrix used for a topic is clearly defined by the assessor within the context of that assessment. The impact significance categories are defined as shown in *Table 12.10*.

77. Note that for the purposes of the EIA, major and moderate impacts are deemed to be significant. In addition, whilst minor impacts are not significant in their own right, it is important to distinguish these from other non-significant impacts as they may contribute to significant impacts cumulatively or through interactions.

Table 12.10 Impact significance definitions

Impact Significance	Definition
Major	Very large or large change in receptor, either adverse or beneficial, which are important at a population (national or international) level because they contribute to achieving national or regional objectives, or, expected to result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate or large change in receptor, which may to be important considerations at national or regional population level. Potential to result in exceedance of statutory objectives and / or breaches of legislation.
Minor	Small change in receptor, which may be raised as local issues but are unlikely to be important at a regional population level.
Negligible	No discernible change in receptor.
No impact	No impact, therefore no change in receptor.

12.4.3.4 Confidence in assessment

78. As presented in Chapter 6 Environmental Impact Assessment Methodology, an overview of the confidence of the data and information underpinning the assessment will be presented. Confidence will be High, Medium or Low depending on the type of data (quantitative, qualitative or lacking) as well as the source of information (e.g. peer reviewed publications, grey literature) and its applicability to the assessment.

12.4.4 Cumulative impact assessment

79. The CIA will identify areas where the predicted impacts of the construction, operation, maintenance and decommissioning of the project could interact with impacts from different industry sectors within the same regional and impact sensitive receptors.

80. Guidance on cumulative impact assessments, where relevant, included:

- The Planning Inspectorate (2012) Advice Note 9 – Using the ‘Rochdale Envelope’;
- MMO (2014) A Strategic Framework for Scoping Cumulative Effects. A report produced for the Marine Management Organisation;
- Natural England (2013) Development of a Generic Framework for Informing Cumulative Impact Assessment (CIA) Related to Marine Protected Areas Through Evaluation of Best Practice; and

- RenewableUK (2013). Cumulative Impact Assessment Guidelines Guiding Principles For Cumulative Impacts Assessment In Offshore Wind Farms.

81. The Planning Inspectorate (2012) Advice Note 9 states that:

> "*In assessing cumulative impacts, other major developments should be identified through consultation with the local planning authorities and other relevant authorities on the basis of those that are*:
>
> *Under construction;*
>
> *Permitted application(s) but not yet implemented;*
>
> *Submitted application (s) but not yet determined;*
>
> *Projects on the Planning Inspectorate's Programme of Projects;*
>
> *Identified in the relevant Development Plan (and emerging Development Plans – with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited; and*
>
> *Identified other plans and programmes (as appropriate) which set the framework for future development consent/approvals, where such development is reasonably likely to come forward".*

82. These stages of project development have been adopted as 'tiers' of project development status within the cumulative impact assessment. These tiers are based on guidance issued by JNCC and Natural England in September 2013, as follows:

- Tier 1: built and operational projects;
- Tier 2: projects under construction plus tier 1 projects;
- Tier 3: projects that have been consented (but construction has not yet commenced) plus tiers 1 and 2;
- Tier 4: projects that have an application submitted to the appropriate regulatory body that have not yet been determined, plus tiers 1-3;
- Tier 5: projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects), plus tiers 1-4; and

- Tier 6: projects that have been identified in relevant strategic plans or programmes plus tiers 1-5.

83. The types of plans and projects to be taken into consideration are:

- Other offshore windfarms;
- Other renewables developments;
- Aggregate extraction and dredging;
- Licenced disposal sites;
- Shipping and navigation;
- Planned construction sub-sea cables and pipelines; and
- Oil and gas installations.

84. The CIA was a two part process in which an initial list of potential projects was identified with the potential to interact with the proposed East Anglia THREE project based on the mechanism of interaction and spatial extent of the reference population for each marine mammal receptor. Following a tiered approach the list of projects will then be refined based on the level of information available for this list of projects to enable further assessment.

85. The plans and projects screened in to the CIA are:

(1) Located in the marine mammal management unit (MU) population reference area (defined for individual species in the assessment sections).

(2) Offshore windfarm and other renewable developments if there is the potential that the construction period could overlap with the proposed East Anglia THREE project, as discussed and agreed with NE (*Appendix 12.1*) this has been based on a seven year window from the date of consent during which the projects could be constructed (a highly precautionary approach).

(3) Offshore windfarm and other renewable developments if the construction period could overlap with the proposed East Anglia THREE project, based on best available information on when the developments are likely to be constructed (more realistic approach and indicative scenario).

86. See section 12.7 for further details on the approach to the two assessments.

87. The CIA will consider projects, plans and activities which have sufficient information available in order to undertake the assessment. Insufficient information will preclude a meaningful quantitative assessment, and it is not appropriate to make assumptions about the detail of future projects in such circumstances.

88. The tiered approach adopted is analogous to that outlined by JNCC and Natural England for ornithology interests. The definition of the tiers and impacts considered within the CIA was agreed with Natural England at ETG meetings, and is provided in *Appendix 12.1*. For marine mammals, the tier of projects considered in the CIA is outlined in Table *12.11*.

Table 12.11: Tiers in relation to project category which have been screened into the CIA

Project category	UK	Other
Other offshore windfarms	Tier 1,2,3,4	Tier 1,2,3
Other renewable developments (tidal and wave)	Tier 1,2,3,4	Tier 1,2,3
Aggregate extraction and dredging	Tier 1,2,3	Screened out
Oil and Gas installations (including surveying)	Tier 1,2,3	Screened out
Navigation and shipping	Tier 1,2,3	Screened out
Planned construction of sub-sea cables and pipelines	Tier 1,2,3	Screened out
Licenced disposal sites	Tier 1,2,3	Screened out

12.4.5 Transboundary impact assessment

89. The potential for transboundary impacts will be addressed by considering the reference populations and potential linkages to non-UK sites as identified through telemetry studies.

90. The assessment of the effect on the integrity of the transboundary European sites as a result of impacts on the designated grey seal and harbour porpoise populations has been undertaken and presented in the HRA Report which has been informed by the assessment of impacts on the North Sea populations of harbour seal, grey seal and harbour porpoise presented in this chapter.

12.5 Existing environment

91. In UK waters, two groups of marine mammals commonly occur: cetaceans (whales, dolphins and porpoises) and pinnipeds (seals). Of these two groups, 11 species of cetacean may be seen regularly throughout the year including: minke whale, fin whale , sperm whale, killer whale, humpback whale *Megaptera novaeangliae*, harbour porpoise, bottlenose dolphin, common dolphin, Risso’s dolphin, Atlantic

white-sided dolphin and white-beaked dolphin. Two seal species are common and resident in UK waters: grey seal and harbour (or common) seal.

92. Cetacean populations occurring in UK waters are generally wide-ranging; their distribution and abundance vary considerably over time and space, influenced by both natural and anthropogenic factors (Reid et al. 2003). There may be some areas of regular high density for some species, but how important these areas are in comparison to others in their natural range, is still generally unknown (Reid et al. 2003). Given that these species are not constrained to UK waters and are known to travel considerable distances, the assessment is made over a wider context to incorporate potential population impacts throughout their range.

93. The cetacean data used to inform the existing environment incorporates the most recent assessments of UK marine mammal populations occurring within UK waters, as identified through the Habitats Directive 3rd UK reporting round (JNCC 2013), whose range encompasses the East Anglia THREE site and offshore cable corridor as well as the results of site specific surveys.

94. The Inter Agency Marine Mammal Working Group (IAMMWG) Management Units (MUs) for marine mammals in UK waters have been used as appropriate reference populations for cetacean species (IAMMWG 2015). This has been agreed in consultation with Natural England (*Table 12.1*).

95. When considering the foraging and haul-out patterns of harbour and grey seal, the potential impacts of the proposed East Anglia THREE project have been assessed in relation to a small number of breeding colonies scattered along the east coast of the UK (and the relevant UK MUs) and the west coast of mainland Europe, due to the limits of the MUs being UK territorial waters (12nm). This has been agreed in consultation with Natural England (*Table 12.1*).

12.5.1 Study area

96. The study area for marine mammal interest, with regard to the proposed East Anglia THREE project, is relatively wide, covering a large portion of the North Sea for all species. For some species, the area of interest is even wider, extending to the North Atlantic.

97. The species diversity and abundance of marine mammals within the southern North Sea is relatively low and reduces progressively southwards (Sea Watch Foundation 2008). The most common and regularly occurring cetaceans are those species associated with relatively shallow continental seas, such as harbour porpoise and white-beaked dolphin. The species reports from the 3rd UK Habitats Directive

reporting round (JNCC 2013) are used as an indicator for species whose range stretches throughout the proposed East Anglia THREE project.

98. The data presented by Reid et al. (2003), SCANS I (Hammond et al. 2002), SCANS II (Hammond et al. 2013) and JNCC (2013) confirm that seven marine mammal species occur regularly over large parts of the southern North Sea. These are grey seal, harbour seal, harbour porpoise, bottlenose dolphin, white-beaked dolphin, killer whale and minke whale.

99. Other species, including Atlantic white-sided dolphin, sperm whale and long-finned pilot whale are occasional visitors to the southern North Sea. The conservation status and best available population estimates for cetacean species are presented in *Table 12.5*.

100. Species considered as only occasional visitors, defined by Reid et al. (2003) are not considered further in the description of the existing environment. Grey seal, harbour seal, harbour porpoise, white-beaked dolphin, minke whale, bottlenose dolphin, killer whale and common dolphin are discussed in more detail below.

12.5.2 Pinnipeds

12.5.2.1 Grey seal

12.5.2.1.1 Population size

101. The geographical range of the grey seal is restricted to the Northern hemisphere. In the north east Atlantic, distribution is centred on breeding colonies in the UK (predominantly Scotland), Iceland, Norway, Ireland, and the Baltic.

102. Grey seal breed annually when females come ashore to give birth on land or ice during which time the females fast. Within Europe there are two apparent reproductively isolated populations: the Baltic population which use sea ice to pup and a population that breeds outside the Baltic and pup on land.

103. In the UK, the breeding season is between September and December. In the Wadden Sea, November to January and, in the Baltic, February to March. Conception occurs at the end of lactation, three to four weeks after giving birth.

104. Grey seal spend a greater proportion of their time ashore during the annual moult (four months after conception) when delayed implantation of the fertilised egg occurs (Hall 2002). Densities at sea during the breeding season and moult are likely to be lower than at other times of the year (DECC 2009).

105. The European population estimate of grey seal is based on estimates of pup production. Excluding the UK, the European pup production estimate is 10,030 based on a range of survey estimates between 1994 and 2012 (SCOS 2014).

106. The UK holds approximately 38% of the world's grey seal breeding population. The UK total grey seal population size in 2013 was estimated at 111,600 individuals (SCOS 2014). The overall population size is estimated through a population modelling approach to extrapolate survey derived pup production estimates. In the UK, the major grey seal breeding colonies in Scotland are monitored using aerial surveys by SMRU to estimate pup production. Pup production estimates from English colonies are derived from ground count data and have unknown confidence intervals (IAMMWG 2013).

107. The main breeding site of interest for grey seal is on the east coast of England at Donna Nook in Lincolnshire, 150km from the East Anglia THREE site, which is used by a colony approximately 3,474 individuals, based on August aerial surveys in 2013 (SCOS 2014). Smaller colonies are present closer to the East Anglia THREE site on the Norfolk coast at Blakeney Point NNR (approximately 112km) with a colony of approximately 63 individuals and 219 individuals in The Wash during the August 2013 aerial survey. Grey seals may also haul out at other suitable isolated beaches closer to the East Anglia THREE site, with 219 seals at Scroby Sands the closest reported haul out, approximately 71km from the site (SCOS 2014).

108. There has been an apparent re-distribution of foraging grey seals in the UK, with summer surveys indicating a large reduction in the numbers of grey seals recorded in the Outer Hebrides and a large scale increase in numbers of grey seals hauling out in the central and southern North Sea during the summer. The summer counts in eastern England have increased at an average rate of 20.8% p.a. since 2000 (*Diagram 12.1*). Over the same time period the pup production at colonies south of the Farne Islands have increased at an average rate of 12% p.a. This dramatic increase in summer counts most likely indicates a seasonal movement of seals into the southern North Sea, presumably from breeding populations further north in the North Sea (SCOS 2014).

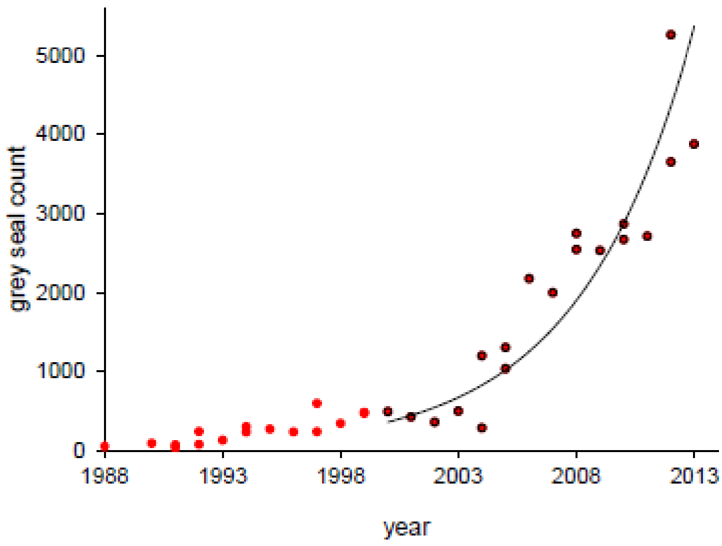

Diagram 12.1 Counts of grey seals in the southern North Sea (Lincolnshire to Kent) during August (SCOS 2014).

109. The total number of pups born at colonies in 2012 in the UK was estimated to be approximately 62,700 of which of which 10,200 (16.3%) were estimated to be from North Sea colonies (including Isle of May, Fast Castle, Farne Islands, Donna Nook, Blakeney Point and Horsey/Winterton; SCOS 2014).

110. The southernmost colonies within the North Sea experienced a 30% increase in pup production between 2010 and 2011 (*Diagram 12.2*), equating to 15% increase per annum for the last 10 years (SCOS 2012). This rate of increase indicates that seals from outside the local area are recruiting into the breeding population in the southern North Sea (SCOS 2012). Numbers of pups born at these east coast of England colonies continue to increase rapidly. Colonies in the southern North Sea increased by 10.5% between 2010 and 2012. Pup production at Donna Nook and East Anglia increased by 14.4% (SCOS 2014).

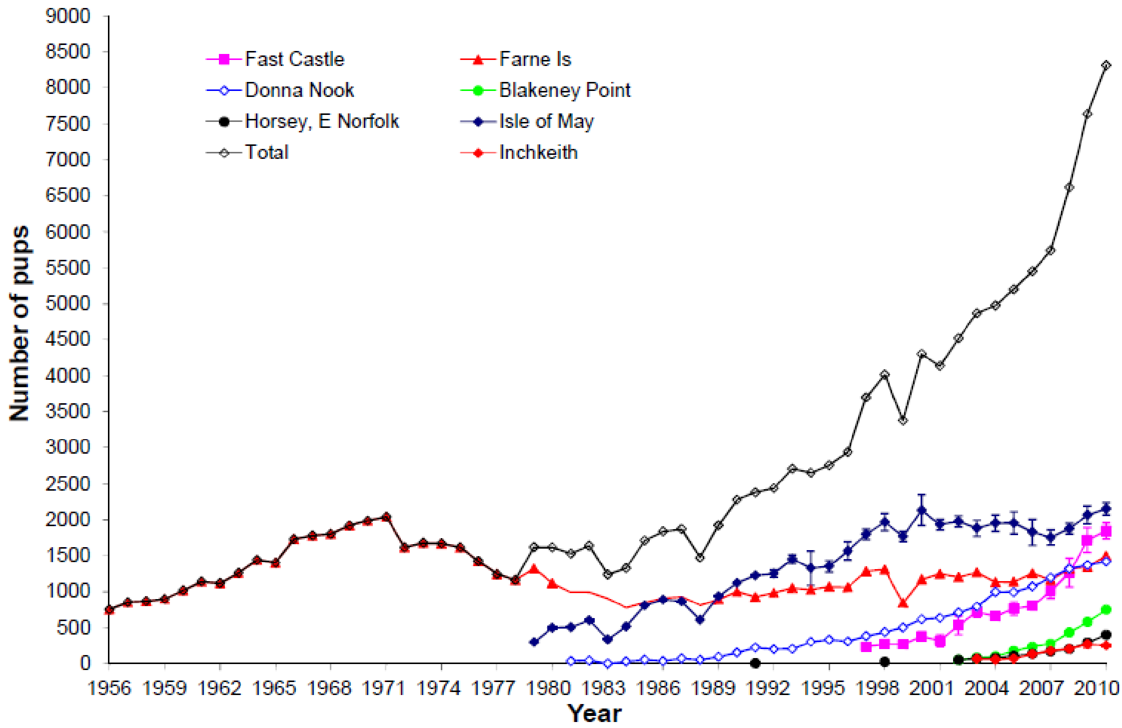

Diagram 12.2 Grey seal pup production at North Sea colonies in the UK (SCOS 2012).

111. The north Dutch coastline is an important foraging zone and migration route for grey seal (Brasseur et al. 2010). Annual surveys are conducted in the Wadden Sea, during the moult and breeding season by the Trilateral Seal Expert Group (TSEG). The most recent TSEG counts for adult grey seals (during the spring moult) in 2014, indicated numbers increased to 4,276 animals in total in the Wadden Sea area, over 50% more than in 2013. This is not thought to be a result of population growth and compared to 2012, total numbers in 2014 only increased by slightly more than 6%. It is more likely that in 2013 the moult count was unusually low as fewer animals were hauling out in the Wadden Sea area than usual (TSEG 2014a).

112. Pup surveys are conducted mid-winter and, as a result, year to year variation is expected. Based on the most recent breeding survey, there was an observed rise in pup production at some sites, and a decrease at others. The total number of pups in the Wadden Sea area grew by almost 11% in compared to 2013 (TSEG 2014a).

113. A recent study on the grey seal development in the Dutch part of the Wadden Sea shows that the growth of the breeding population is fuelled by the annual immigration of grey seals from the UK (Brasseur et al. 2014).

114. Grey seals have not been seen to breed in the Danish Waddenzee and as a result are only counted during the summer during surveys for harbour seal.

12.5.2.1.2 Diet

115. The grey seal is an opportunistic predator of fish and invertebrates. In the North Sea, principal prey items are sandeel (Ammodytidae spp.), whitefish (cod *Gadus morhua*, haddock *Melanogrammus aelgefinus*, whiting *Merlangius merlangus* and ling *Molva molva*) and flatfish (plaice *Pleuronectes platessa*, sole *Solea solea*, flounder *Platichthys flesus*, dab *Limanda limanda*) (Hammond and Grellier 2006).

116. Diet composition for grey seals has been assessed at a UK wide scale in 1985, 2002 and in 2010/11 study. The major prey species were sandeels and large gadoids (Gadidae spp.); however, some marked differences were seen in 2010/11 compared to 2002 (and 1985). In 2010/11, the proportion of gadoids in the diet increased in Orkney and Shetland but decreased in the Inner and Outer Hebrides and the central North Sea. Conversely, in 2010/11, the proportion of sandeel in the diet decreased in Orkney and Shetland but increased in the Outer Hebrides and central North Sea (SCOS 2014).

12.5.2.1.3 At sea distribution

117. A DECC funded survey undertaken by Wildfowl & Wetlands Trust (WWT) (2009) recorded the distribution and abundances of cetaceans, seals, turtles, sharks and Ocean Sunfish between 2001 and 2008 around the UK coastline. Records of seal species were sparse around the coast of East Anglia but there were frequent, low density observations offshore from the north Norfolk coast and The Wash (WWT 2009).

118. Detailed information on at sea distribution of grey seal is available from telemetry studies. Movements vary from short range trips between local haul out sites to extended foraging trips and journeys between distant haul out and breeding sites.

119. Grey seal are known to forage up to 145km from their haul out sites (Thompson et al. 1996) and over wide estimated ranges of 1,088 to 6,400km^2 (Dietz et al. 2003). Telemetry studies of grey seal in the UK have identified a highly heterogeneous spatial distribution with a small number of offshore ‘hot spots’ continually utilised (Matthiopolous et al. 2004; Jones et al. 2013).

120. Marine Scotland commissioned SMRU to map at sea seal density estimates based on telemetry data around the UK, collected between 1991 and 2011 for grey seal and 1991 to 2012 for harbour seal (Jones et al. 2013). Mean at sea density estimates with upper and lower 25% Confidence Intervals (CI) are provided at a resolution of

5km by 5km. *Diagram 12.3* shows the estimated at sea usage of grey seal around the UK. Grey seal usage of the southern North Sea in the vicinity of the East Anglia THREE site is comparatively low to other locations around the UK.

121. Within the East Anglia THREE site the mean at sea density estimate for 5km by 5km cells is 0.28 grey seal (or 0.011 per km^2). The density estimates across the East Anglia THREE site range from 0 (minimum lower 25% CI) to 0.014 per km^2 (maximum upper 25% CI, *Figure 1* and *Figure 2* in *Appendix 12.1*).). The maximum mean at sea density estimate for area within the East Anglia THREE site will be taken forward in the assessment. Additionally there is low usage of the offshore cable corridor by grey seals.

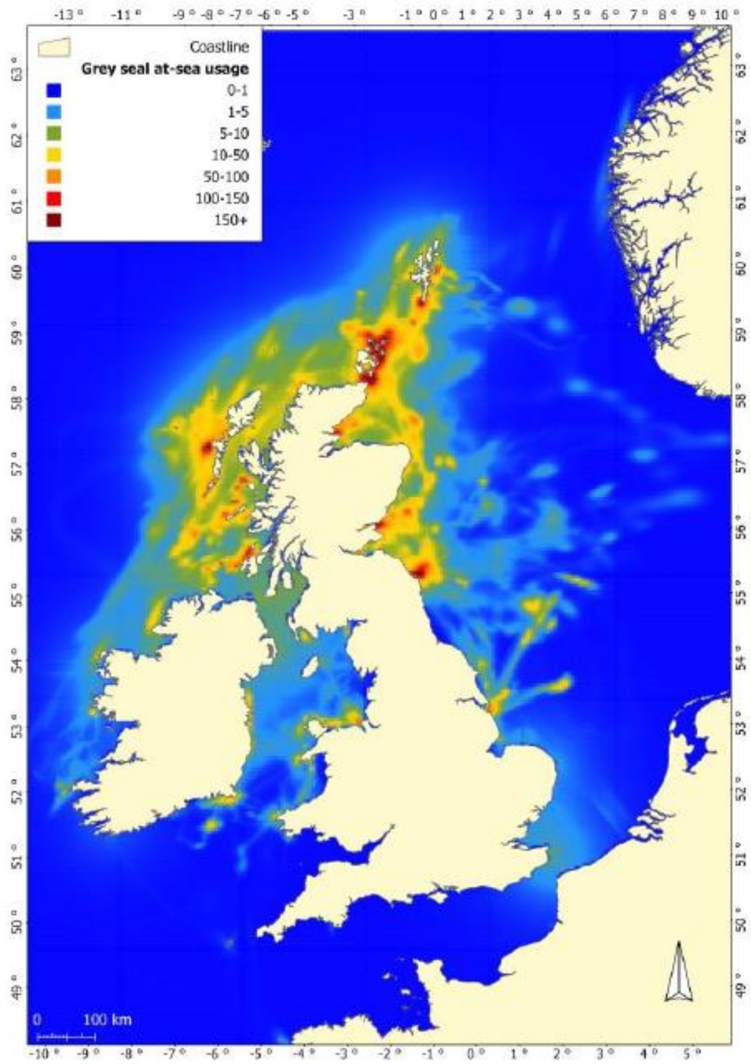

Diagram 12.3 Estimated at sea usage of grey seal around the UK (Jones et al. 2013).

122. SMRU hold a database of telemetry data of tagged grey seal pups and adults from important breeding locations in UK, including the Farne Islands, Donna Nook, Abertay Sands and the Isle of May from 1988 to 2008. EATL has commissioned SMRU Marine Ltd to investigate the connectivity between tagged grey seal and the East Anglia THREE site plus a 20km buffer area (hereafter referred to as East Anglia THREE seal study area; *Appendix 12.3)*.

123. *Appendix 12.3* presents the tracks of all grey seal pups and adults contained within the SMRU database. None of the 92 tagged grey seals aged one year or over entered the East Anglia THREE seal study area. It appears that grey seals do not utilise the East Anglia THREE seal study area.

124. A large number of grey seal have also been tagged at haul out sites at Dutch colonies (e.g. Brasseur et al. 2010). EATL has commissioned IMARES to explore connectivity between tagged grey seal and the East Anglia THREE seal study area (*Appendix 12.4*).

125. From the Dutch telemetry studies a total of 77 grey seal were tagged at haul out sites in the Netherlands between 2005 and 2013. Of these seals, six were found to travel within 20 km of the East Anglia THREE site. Of these six seals, three entered the offshore cable corridor and two were within the East Anglia THREE site (*Appendix 12.4*). It is likely all seals spent less than 2% of their 'time-at-sea' within the East Anglia THREE site (*Appendix 12.4)*.

12.5.2.1.4 Site specific surveys

126. Aerial surveys conducted for the East Anglia Zone (Zonal Environmental Appraisal Report) from November 2009 – April 2011, did not record any observations of seals (East Anglia Offshore Wind 2012c).

127. During aerial surveys at the East Anglia ONE site (East Anglia Offshore Wind Ltd, 2012b) no observations of grey seal were made. During boat based surveys, no grey seal were recorded, suggesting that there is low usage of the East Anglia ONE site (East Anglia Offshore Wind 2012b).

128. Aerial surveys conducted for East Anglia THREE commenced in September 2011 and were completed in August 2013. Details of the surveys are provided in *Appendix 12.2*. The survey area consisted of the East Anglia THREE site and a 4km buffer around it.

129. Observations of seals were not classified to a particular species. The results of the aerial surveys support the tagging data and suggest that there is low usage of the East Anglia THREE site and the East Anglia THREE site plus buffer (*Appendix 12.2*).

130. Over the 24 month survey period a total of two submerged seals were recorded in the East Anglia THREE site in July 2012. Harbour and grey seals could not be identified to species level and were grouped as phocids. The density estimate for East Anglia THREE site in July 2012 was 0.070 individuals per km^2 and mean density of 0.0029 individuals per km^2. The density estimate for the East Anglia THREE site plus buffer in July 2012 was 0.030 individuals per km^2, with a mean density of 0.0013 individuals per km^2 (*Appendix 12.2*).

131. The SMRU mean at sea density estimates for grey seal (0.014 individuals per km^2; Jones et al. 2013) are higher than these aerial survey estimates, and will be taken forward for the impact assessment. This approach has been agreed in consultation with Natural England (*Table 12.1*).

12.5.2.1.5 Summary of the importance of the site for grey seal

132. Given the site specific and contextual data described above it is concluded that the East Anglia THREE site and offshore cable corridor are of limited importance for grey seal.

12.5.2.1.6 Reference population for assessment

133. Based on the evidence from telemetry studies (*Appendix 12.3* and *Appendix 12.4*), the reference population extent will incorporate the South-east England, North-east England and East Coast IAMMWG MUs and, given the movement of seals between UK and Dutch colonies, the Waddenzee population.

134. The most recent estimate of the Dutch Waddenzee population is 4,276 seals (TSEG 2014a). The South-east England MU has an estimated population size of 10,350; the North-east England MU has an estimated population size of 7,800; and the East Coast Scotland MU has an estimated population size of 6,800 (IAMMWG 2013).

135. This total reference population is therefore 29,226 grey seal. This has been agreed with Natural England in consultation (*Table 12.1*).

12.5.2.2 Harbour seal

12.5.2.2.1 Population size

136. Harbour seal have a circumpolar distribution and are widespread throughout the Northern Hemisphere. The harbour seal is the smaller of the two UK seal species occurring along all coasts of the UK. Approximately 30% of European harbour seals are found in the UK; this proportion has declined from approximately 40% in 2002 (SCOS 2014).

137. In the UK, pupping occurs in the summer (June and July) and peak moulting occurs in August. Densities of harbour seal at sea are therefore likely to be lower during this period than at other times of the year (DECC 2009).

138. In the UK harbour seal are surveyed during their annual moult on a three to five year cycle by SMRU. Using the most recent survey data (2007-2013) the UK minimum population size is estimated at 26,290 individuals, and approximately 17.6% of these individuals were surveyed at English haul outs (SCOS 2014).

139. Not all individuals in the population are counted during surveys because a portion will be at sea at any one time. SMRU use flipper mounted transmitters to track haul out behaviour during moulting and can convert counts to total population size (Lonergan et al. 2012). When accounting for animals hauled out during the survey period, the total estimated size of the UK harbour seal population in 2013 was approximately 36,500 with an approximate 95% confidence interval of 29,900 – 49,700 (SCOS 2014).

140. The combined counts for the south-east of England in 2013 were 4,504 harbour seals, which were very similar to the previous equivalent count of 4,568 (SCOS 2014). One aerial survey of harbour seals was carried out by SMRU in Lincolnshire and Norfolk during moult season in August 2013. The 2013 count for this area from Donna Nook to Scroby Sands (4,022) was 4% lower than the 2012 count (4,189) (SCOS 2014). The number of harbour seals in The Wash was 3,174 and 304 at Blakeney Point during the August 2013 survey (SCOS 2014). The Wash and North Norfolk Coast SAC population was estimated at 3,781 harbour seals, based on the 2012 survey (SCOS 2013).

141. Harbour seal are also routinely surveyed in the Wadden Sea, where populations are showing a rapid and strong growth (Reijnders et al. 2010). As part of the Trilateral Seal Expert Group (TSEG) coordinated aerial surveys are conducted in Denmark, Germany and the Netherlands. A total of 26,576 harbour seals were counted in 2013 which composed 3,368 in Denmark, 9,174 in Schleswig-Holstein, 6,968 in Lower Saxony and Hamburg, and 7,066 in the Netherlands Wadden Sea (TSEG 2014b). The estimate for the total Wadden Sea harbour seal population, including seals being in the water during the survey, in 2014 was 39,100 (TSEG 2014b).

12.5.2.2.1 Diet

142. The results of diet studies carried out in 2010/11 indicate a wide range of prey types are consumed by harbour seals namely: sandeels, gadoids, flatfish, scorpion fish *Myoxocephalus scorpius*, sandy benthic fish, pelagic fish and cephalopods. Diet

composition varied seasonally and regionally and prey diversity and diet quality also showed some regional and seasonal variation (SCOS 2014).

12.5.2.2.2 At sea distribution

143. In a DECC funded survey undertaken by WWT (2009) records of seal species were shown to be sparse around the coast of East Anglia but there were frequent, low density observations offshore from the north Norfolk coast and The Wash (WWT 2009). Only one harbour seal was positively identified to species level off the coast of Great Yarmouth.

144. At sea distributions for grey and harbour seal have been produced by the SMRU (Jones et al. 2013) which utilise telemetry data from 1991-2012 and count data from 1988-2012. Mean density estimates with upper and lower 25% CIs are provided at a resolution of 5km by 5km (*Diagram 12.4*). There is low usage of the offshore cable corridor by harbour seals, and the area of the southern North Sea in the vicinity of the East Anglia THREE site.

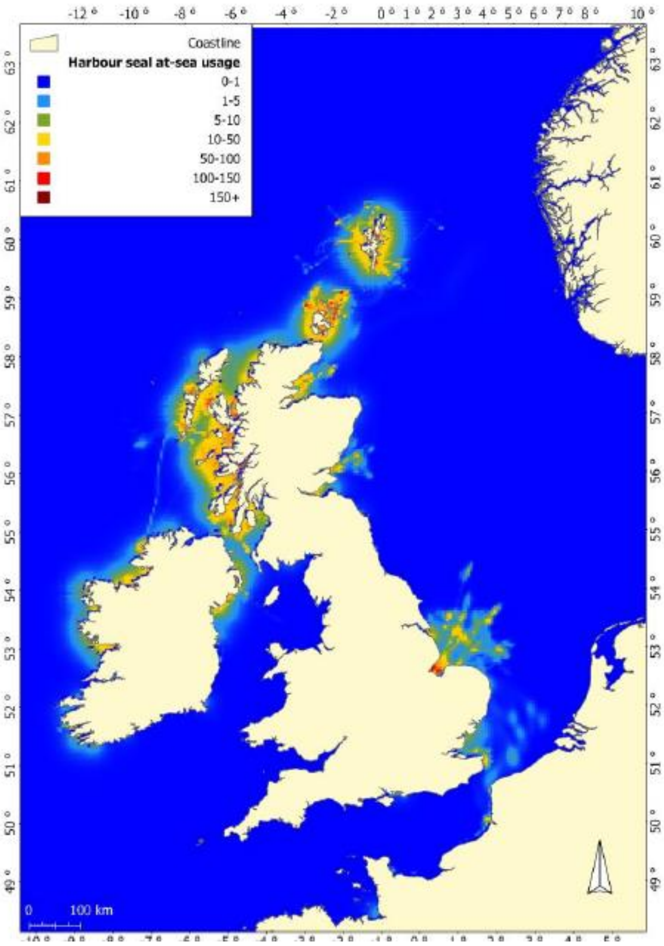

Diagram 12.4 Estimated at sea usage of harbour seal around the UK (Jones et al. 2013).

145. Within the East Anglia THREE site the mean density estimate for 5km by 5km cells is 0.000659 individuals per 25km^2 (or 0.000026 per km^2). The density estimates range from 0 (minimum lower 25% CI) to 0.0003 per km^2 (maximum upper 25% CI, see *ETG meeting 2 document in Appendix 12.1*). The maximum mean densities within the East Anglia THREE site will be taken forward in the assessment.

146. Harbour seal are highly mobile and, although they are known to travel considerable distances to feeding grounds, they are generally resident in one area and do not seasonally migrate. Tracking studies have shown that harbour seal travel 50-100km offshore and can travel 200km between haul-out sites (Lowry et al. 2001; Sharples et al. 2012).

147. Between 2001 and 2006 tagging of harbour seal was undertaken by the SMRU at a number of haul out sites around the UK, including The Wash and the Outer Thames in England (Sharples et al. 2012). The tagging allowed the transits made by individual seals to be mapped, showing the extent of their ranges offshore and the locations of foraging areas. Animals were found to repeatedly return to specific foraging areas. The majority of seals tagged at haul outs in the Outer Thames made short foraging trips within 40km of their haul out sites with some connectivity apparent between the Wash and the Outer Thames (Sharples et al. 2012).

148. SMRU hold a database of telemetry data of harbour seal juveniles and adults from tagging locations including the Wash and the Thames Estuary from 2003 to 2012 (including data from the Zoological Society of London seal tagging study). These telemetry data can be used to inform levels of connectivity between tagged harbour seal and the East Anglia THREE site plus a 20km buffer area (herein referred to as East Anglia THREE seal study area; *Appendix 12.3*).

149. None of the 43 tagged harbour seals aged one or above entered the East Anglia THREE seal study area (*Appendix 12.3*). These data support the conclusion that harbour seal do not regularly utilise the East Anglia THREE seal study area, as shown by the at sea densities (Jones et al. 2013).

150. A large number of harbour seal have also been tagged at haul out sites at Dutch colonies (e.g. Brasseur et al. 2010). EATL has commissioned IMARES to explore connectivity between tagged harbour seal and the East Anglia THREE site (*Appendix 12.4)*.

151. A total of 273 harbour seal were tagged at sites in the Netherlands between 1997 and 2013. Of these seals, 10 were found to travel within 20km of the East Anglia

THREE site. Of these 10 seals, six entered the offshore cable corridor and two were within the East Anglia THREE site. It is likely all but one harbour seal spent less than 2% of their 'time-at-sea' within the area, with an exception being a harbour seal tagged in 2007 which spent at least 2% and up to 17% of its 'time-at-sea' within the offshore cable corridor (*Appendix 12.4*).

152. The Dutch tagging data illustrate the long ranging movements harbour seal and levels of connectivity between Dutch haul out sites and those on the east coast of England.

12.5.2.2.3 Site specific surveys

153. As described for grey seal previously, aerial surveys conducted for the East Anglia Zone, did not record any observations of seals (East Anglia Offshore Wind 2012c) neither did aerial surveys at the East Anglia ONE site. However, during boat based surveys, three harbour seal were recorded, suggesting that there is low usage of the East Anglia ONE site (East Anglia Offshore Wind 2012b).

154. As described for grey seal, observations made during aerial surveys conducted for the proposed East Anglia THREE project did not record seal to species level (*Appendix 12.2*). Over the 24 month survey period a total of two submerged seals were recorded in the East Anglia THREE site in July 2012. The density estimate for the East Anglia THREE site in July 2012 was 0.070 individuals per km^2 and mean density of 0.0029 individuals per km^2. The density estimate for the East Anglia THREE site plus buffer in July 2012 was 0.030 individuals per km^2, with a mean density of 0.0013 individuals per km^2 (*Appendix 12.2*).

155. The SMRU at sea densities of harbour seal (0.0003 individuals per km^2) are lower than the densities estimated for seal species from the APEM surveys. However, the species specific estimates made using telemetry data are likely to provide a more robust estimate to be taken forward in the assessment. This approach has been agreed in consultation with Natural England (*Table 12.1*).

12.5.2.2.4 Summary of importance of the site for harbour seal

156. Given the site specific and contextual data described above it is considered that the East Anglia THREE site and offshore cable corridor are of limited importance for harbour seal.

12.5.2.2.5 Reference population for assessment

157. Based on the evidence from telemetry studies (UK and Dutch), the reference population will include the South-east England MU (with a population estimate of

3,567 based on the 2011 survey; IAMMWG, 2013) and the Waddenzee region (with a population of approximately 39,100 seals, TSEG 2014b).

158. The total reference population of 42,667 harbour seal has been agreed with Natural England in consultation (*Table 12.1*). However, given the large difference between the UK and Waddenzee contribution to this total, impacts will also be placed in context against the UK South-east England MU.

12.5.2.3 Current stressors

159. During 1988, a major epizootic outbreak of phocine distemper virus (PDV) occurred causing the deaths of approximately 17,000 harbour seal in European waters. The epizootic spread from the Kattegat over several months infecting seals in the Baltic, Waddensea, North Sea and Irish Sea. The worst affected area in the UK was the east coast of England (mainly The Wash) where the harbour seal population declined by 52% (SCOS 2014). There was a subsequent PDV outbreak in 2002, resulting in a decline of 22% in The Wash harbour seal population, but had limited impact elsewhere in Britain. Counts in The Wash and eastern England did not appear to recover from the PDV outbreak until 2009, but have increased dramatically over the past few years (SCOS 2014). In contrast, adjacent European colonies in the Wadden Sea have experienced continuous rapid growth since 2002, but this may now be slowing (SCOS 2014). Populations in the Wadden Sea are showing a rapid and strong growth since the two epizootic outbreaks in 1988 and 2002 (Reijnders et al. 2010).

160. There are currently major declines in Scottish harbour seal populations with the ultimate cause of the declines largely unexplained, and the subject of ongoing research (SMRU 2012). Harbour seal counts were stable or increasing until around 2000 when declines were seen in Shetland (which declined by 30% between 2000 and the most recent count in 2009), Orkney (down 78% between 2000 and 2013) and the Firth of Tay (down 93% between 2000 and 2013). However, other regions have been largely continually stable (west coast of Highland region and the Outer Hebrides). Counts along the English east coast were very similar to those reported in 2012 (SCOS 2014).

161. A number of damaged seal carcasses have been washed up on beaches around Scotland and the North Norfolk English coast (Thompson et al. 2010b). The majority of seal carcasses were identified as harbour seal, but also included some juvenile grey seal. All the seals had a characteristic wound consisting of a single smooth edged cut starting at the head and spiralling around the body. Based on the post mortems, it was concluded that mortality was caused by a single traumatic event involving a strong rotational shearing force (Bexton et al. 2012). Initial tests

indicated the wounds were consistent with interactions between seals and ducted propellers (Onoufriou and Thompson 2014).

162. Recent observations, however, have indicated that such injuries can be caused by grey seal predation on weaned grey seal pups and young harbour seals (Thompson et al. 2015). The injuries documented were consistent with those seen in spiral death cases and the animals targeted for predation fitted the observed age structure of known spiral death carcasses found. Although there is currently no direct evidence of grey seals predating adult harbour seals, it is reasonable to consider that this is possible.

163. Based on the latest information, the SNCBs advice in February 2015, is that "it is considered very likely that the use of vessels with ducted propellers may not pose any increased risk to seals over and above normal shipping activities and therefore mitigation measures and monitoring may not be necessary in this regard, although all possible care should be taken in the vicinity of major seal breeding and haul-out sites to avoid collisions."

164. However the results of trials and the observed predation by seals suggest that there are still a number of uncertainties as to the frequency of occurrence, and mechanisms for this type of injury. The use of vessels with ducted propellers will be a consideration for potential collision risk to harbour (and grey) seal species as per normal shipping activity if used during the installation and maintenance of the proposed East Anglia THREE project.

12.5.3 Cetaceans

12.5.3.1 Harbour porpoise

12.5.3.1.1 Population size

165. Harbour porpoise is the most commonly sighted cetacean in the North Sea (ASCOBANS 2012) and is the cetacean most likely to be the most frequently observed in the East Anglia THREE site and offshore cable corridor.

166. Guidance, developed by IAMMWG has identified three management units appropriate within the UK Exclusive Economic Zone (EEZ); the North Sea, West Scotland and Celtic and Irish Seas (IAMMWG 2013, 2015, *Appendix 12.1*). The IAMMWG MUs are transboundary as they incorporate a number of European EEZs.

167. The abundance of harbour porpoise in these MUs (*Table 12.12)* is based upon the SCANS II and CODA surveys (Hammond et al. 2013, Macleod et al. 2009 as presented in IAMMWG 2013, 2015).

Table 12.12 UK harbour porpoise management unit abundance

Management Unit	Abundance of animals	CV	95% CI	Source
North Sea (NS)	227,298	0.13	176,360 – 292,948	Hammond et al. 2013
West Scotland (WS)	21,462	0.42	9,740 – 47,289	Hammond et al. 2013; Macleod et al. 2009
Celtic and Irish Sea (CIS)	104,695	0.32	56,774 – 193,065	Hammond et al. 2013; Macleod et al. 2009

168. The SCANS and SCANS II surveys were a major international collaborative survey program carried out to provide baseline data on cetacean abundance in the North Sea, Baltic and Celtic Seas. Surveys were undertaken in the summer of 1994 and 2005 and the extent of the 2005 survey was greater than in 1994. Estimated abundance in 2005 in the equivalent area surveyed in 1994 was 323,968 (CV=0.22; 95% CI=256 300 - 549 700, Hammond et al. 2013), compared to 341,366 (CV=0·14; 95% CI=260 000 - 449 000) in 1994 (SCANS II 2008). Therefore, there was no reported change in the overall estimated abundance in the North Sea.

169. In 2005 the Southern North Sea population was estimated to be 140,229; the Northern North Sea 33,598; the Central North Sea 58,623; and a European wide population of 375,358 (95% CI 256,304 - 549,713).

170. Despite no overall change in population size between the two surveys, large scale changes in the distribution of porpoise were observed between 1994 and 2005, with the main concentration shifting from North eastern UK and Denmark to the southern North Sea (*Diagram 12.5)*. Such large scale changes in the distribution of harbour porpoise are likely the result of changes to the availability of principal prey within the North Sea (SCANS II 2008).

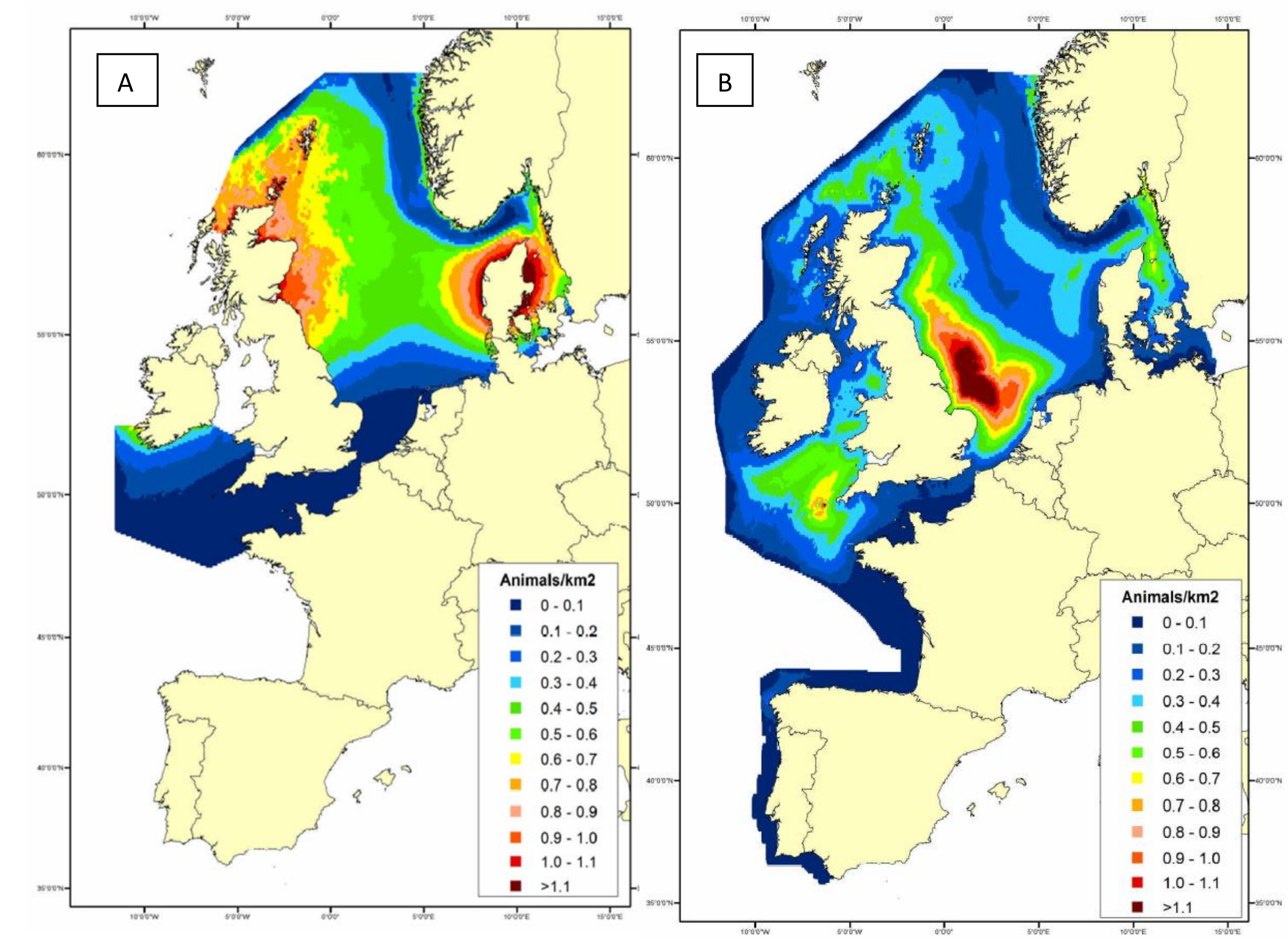

Diagram 12.5 Harbour porpoise estimated density surface (animals per km^2) in (a) 1994 and (b) 2005 (Hammond et al. 2013)

171. The SCANS II density surfaces suggest that the East Anglia THREE site has a density of between 0.4-0.8 harbour porpoise per km^2. The mean density for the SCANS II survey block B, which encompasses the East Anglia THREE site is 0.331 (CV 0.38) individuals per km^2 (Hammond et al. 2013).

172. The annual harbour porpoise distribution around the UK from the Atlas of Cetacean Distribution in North west European Waters (Reid et al. 2003) reports harbour porpoise as being widely distributed across the north and central North Sea, with important concentrations off the west coast of Scotland in the southern Irish Sea, and off south-western Ireland (Reid et al. 2003). It was generally believed that the shallow, more silt laden, waters of the southern North Sea have fewer sightings, and authors have suggested that numbers of harbour porpoise in the southern North Sea and English Channel declined during the twentieth century (Reid et al. 2003). However, as highlighted by SCANS I and SCANS II, there is potential for changes in

distribution to occur, the most likely cause being changes in availability and distribution of their prey species.

173. The JNCC Cetacean Atlas (Reid et al. 2003) recorded sightings of harbour porpoise throughout the East Anglia Zone. The highest sightings rates in the south eastern North Sea occur in January to April; although overall sightings are low in this region (Reid et al. 2003*)*.

174. Data on distribution and abundance of marine mammals in parts of the North Sea have also been collected opportunistically during aerial surveys for waterbirds conducted by WWT Consulting from 2001-2008 (WWT 2009). The survey method was comparable to that used for the collection of previous cetacean data including the SCANS project (Hammond et al. 2002). Between 2001 and 2008 a total of 4,588 sightings, comprising 5,439 individual animals, were made of harbour porpoise (WWT 2009). The results show a similar distribution in occurrence to those presented in Reid et al. (2003), with higher relative densities close to shore around the west coast and off the Lincolnshire and Yorkshire coasts, but with much higher relative densities recorded off the coast between Norfolk and Kent. Results are also similar to those recorded in the SCANS II project, in which much larger numbers of harbour porpoise were recorded in the southern North Sea areas than the more northerly survey areas.

175. Eight draft SACs (dSAC) for harbour porpoise in UK waters are being considered by the UK and devolved governments, with consultation expected in late 2015. The exact location and size of the proposed Southern North Sea dSAC for harbour porpoise has still to be established. This site has been screened into the information for an HRA assessment with the agreement of Natural England. It is the understanding of EATL that there is no requirement for additional assessment, until such time as a public consultation on the dSACs is launched.

12.5.3.1.2 Diet

176. Harbour porpoise in the North Sea feed mainly on demersal fish, notably small gadoids, clupeids and sandeels (Santos and Pierce 2003). It is believed that the balance of their diet has changed over the past 40 years from herring *Clupea harengus* to whiting dominated, reflecting the change in composition of available food resources (Reid et al. 2003).

12.5.3.1.3 Site specific surveys

177. The Crown Estate Enabling Actions high-definition video aerial surveys of the East Anglia Zone had the highest sighting rates during the winter (November 2009 to February 2010). Overall, the highest concentrations of marine mammals were

towards the south, west and north-east of the East Anglia Zone (East Anglia Offshore Wind 2012c). Of these sightings 38% were positively identified as harbour porpoise and 53% as 'small cetacean' (which could be harbour porpoise or patterned dolphin). It is likely many of those identified 'small cetaceans' were harbour porpoise (East Anglia Offshore Wind Limited 2012c).

178. During the 24 months of aerial surveys covering the East Anglia ONE site (November 2009 – October 2011) 181 cetaceans in total were recorded, 130 of which (72%) were positively identified as harbour porpoise, and a further 2.5% identified as either a porpoise or a dolphin (East Anglia Offshore Wind 2012b).

179. Aerial surveys conducted for the East Anglia THREE site plus buffer commenced in September 2011 and were completed in August 2013 (*Appendix 12.2*). The survey area consisted of the East Anglia THREE site and a 4km buffer around it. The East Anglia THREE aerial surveys show harbour porpoise occur across the East Anglia THREE site plus buffer during both survey years (*Appendix 12.2*).

180. High resolution aerial stills capture marine mammals both above and just below the surface. However, there will still be an unknown proportion of the population submerged at depths which are not captured. In order to calculate estimates of abundance and density from the surveys which are as close to absolute values as possible two approaches were taken in the analyses of the aerial survey data; using surface only sightings corrected for availability, and using all sightings (with no correction factor) as detailed in *Appendix 12.2*. Correction factors applied were based on availability data provided in the latest Joint Cetacean Protocol Phase II report (Paxton et al. 2011). Estimates of abundance and density were also calculated over the East Anglia THREE site and the East Anglia THREE site plus buffer independently.

181. *Appendix 12.2* provides all of the estimates of abundance and density, however, in the interest of taking a precautionary approach to the assessment, only the approach to analysis which provides the highest estimates of harbour porpoise density are summarised below. These estimates will be taken forward in the impact assessment, as agreed with Natural England during consultation (*Table 12.1*).

182. The highest mean estimates of density were generated from the East Anglia THREE site plus buffer using surface counts corrected for availability. Mean densities of animals within the East Anglia THREE site plus buffer across the full 24 month survey period were 0.179 individuals per km^2. The mean density of harbour porpoise for the East Anglia THREE site for the 24 month survey period was 0.135 individuals per km^2.

183. For a large number of above and below sightings during the surveys (43% within the East Anglia THREE site, and 41% within the East Anglia THREE site plus buffer) it was not possible to identify the marine mammals to species level when analysing aerial images (*Appendix 12.2*).

184. Survey data suggest that harbour porpoise are the most commonly occurring species of marine mammal, therefore all sightings classified as 'Unidentified dolphin / porpoise' have been assumed to be harbour porpoise, and used to generate a maximum density for harbour porpoise (*Appendix 12.2*).

185. The East Anglia THREE aerial surveys show sightings of unidentified dolphin and unidentified porpoise occur across the East Anglia THREE site plus buffer during both survey years (*Appendix 12.2*).

186. Within the East Anglia THREE site plus buffer the greatest estimate of mean density using the combined harbour porpoise and unidentified individuals was generated using surface counts corrected for availability. Mean densities of animals within the East Anglia THREE site plus buffer across the full 24 month survey period were 0.294 individuals per km^2. Mean densities of animals within the East Anglia THREE site across the full 24 month survey period were 0.226 individuals per km^2.

187. Under the assumption that any unidentified dolphin or porpoise were all harbour porpoise, this grouping is considered to represent a more precautionary abundance estimate (i.e. worst case scenario) for harbour porpoise. The density of individuals within the East Anglia THREE site plus buffer for the combined species group is also more comparable to the 2005 SCANS II survey (density estimate of 0.331 (CV 0.38) for survey block B), than the harbour porpoise only density estimate.

188. In agreement with Natural England, the higher and more precautionary site specific estimate from these combined sightings, based on corrected surface counts for the East Anglia THREE site plus buffer will be used in the impact assessment (0.294 individuals per km^2).

12.5.3.1.4 Reference population for assessment

189. The reference population used in the assessment is the North Sea Management Unit (NS MU (IAMMWG 2015)) with an estimated abundance of 227,298 (CV 0.13, 95% CI 176,360 – 292,948) based on the Hammond et al. (2013) analysis of the SCANS II data. This reference population has been agreed with Natural England in consultation (*Table 12.1*).

190. Given the transboundary nature of the IAMMWG management units, the NS MU comprises ICES area IV, VIId and Division IIIa (Skagerrak and north Kattegat). This could be a conservative approach as guidance from Marine Scotland (Northridge 2012) suggests that considering large stock areas for harbour porpoise is appropriate; with open borders existing between the North Sea and the Kattegat, the North Sea and Norwegian Sea and between western Channel and Celtic Shelf/Irish Sea.

12.5.3.1.5 Current stressors

191. Since 2000, the most common sources of mortality of stranded harbour porpoise are by-catch, attack from bottlenose dolphins, starvation and infectious disease (JNCC 2013).

192. Harbour porpoise in the southern North Sea are effectively apex predators as key species that prey on them in other geographies, such as killer whales, are absent. Some studies have shown that bottlenose dolphins will attack and kill harbour porpoise but do not actively prey on them for food (Ross and Wilson 1996; Deaville and Jepson 2011).

193. Harbour porpoise are under threat from anthropogenic pressures, in particular incidental fisheries by-catch. The principal area of concern for by-catch is the south-western waters of the western English Channel and Celtic Sea; and in the UK there is on-going research on mitigation measures. However, it is likely that, based on assessment including estimated levels of by-catch, the harbour porpoise population in the North Sea has relatively low rates of potential increase (Winship 2009).

194. In addition, harbour porpoise around the UK and throughout their range can be subject to range of threats and pressures, including collisions with vessels; disturbance either by the physical presence of vessels and / or noise disturbance (sources of anthropogenic noise include vessels, military activity, seismic surveys, pile driving, dredging and fisheries anti-predation devices); prey depletion or changes to prey composition; habitat loss or degradation; chemical pollution; marine litter, climate change; and cumulative and in-combination impacts (Clark et al. 2010; JNCC 2013).

12.5.3.2 White-beaked dolphin

12.5.3.2.1 Population structure

195. White-beaked dolphin are widespread across the northern European continental shelf. This species is cited as the most abundant cetacean after harbour porpoise in the North Sea (Jansen et al. 2010), and the waters off the coast of Scotland and north east England are one of the four global areas of peak abundance.

196. The species occurs mainly in waters of 50-100m in depth (Reid et al. 2003) and sightings are common throughout the year, with peaks between June and October (Reid et al. 2003). White-beaked dolphin breed mainly between May and August, although some breeding occurs in September and October (Anderwald and Evans 2010). The gestation period is approximately 11 months (Culik 2010).

197. Scientific evidence supports the assumption that white-beaked dolphin from around the British Isles and North Sea represent one population, with movement between Scottish waters and the Danish North Sea and Skagerrak (Banhuera-Hinestroza et al. 2009). A single MU is appropriate for this species comprising all UK waters and extending to the seaward boundary used by the European Commission for Habitats Directive reporting (area known as Marine Atlantic, termed MATL) (IAMMWG 2015). However, it is worth noting that this species usually occurs on the continental shelf (Reid et al. 2003). The abundance of white-beaked dolphin in the Celtic and Greater North Seas (CGNS) MU is 15,895 animals (CV=0.29; 95% CI=9,107-27,743; IAMMWG 2015), which is derived from the SCANS-II abundance estimate for continental shelf waters (Hammond et al. 2013).

198. The SCANS II survey provides a wider European population estimate of 16,536 (95% CI 9,245 – 29,586, Hammond et al. 2013). The wider population estimate from SCANS II does not include a genetically distinct North Norwegian population (Northridge et al. 1997).

12.5.3.2.2 Diet

199. White-beaked dolphin are typically found in relatively small groups of less than 10 individuals. They have a varied diet including mackerel, herring, cod, whiting, haddock, sandeels, gobies, flatfish and octopus (Reid et al. 2003).

200. The diet of white-beaked dolphin within the North Sea is dominated by gadoids, notably whiting and cod (Jansen et al. 2010). Stomach contents' analysis, from dolphins stranded mainly on the Scottish east coast, identified haddock and whiting as the predominant fish species being taken (Canning et al. 2008). In Scottish waters they also consume cephalopods (Santos et al. 1994).

12.5.3.2.3 At sea distribution

201. The numbers of white-beaked dolphin encountered in the southern North Sea are relatively low, with no density estimated for the SCANS II survey block B (Hammond et al. 2013). Within the East Anglia THREE site, the JNCC Cetacean Atlas indicates that there are few white-beaked dolphin sightings within the East Anglia Zone (Reid et al. 2003).

12.5.3.2.4 Site specific surveys

202. Surveys undertaken in the East Anglia Zone from November 2009 until April 2011 (East Anglia Offshore Wind Limited 2012c) recorded very low numbers of patterned dolphins, which are most likely to relate to white-beaked dolphin.

203. During 24 months of aerial surveys conducted for the East Anglia THREE site plus buffer, four white-beaked dolphin were recorded in the East Anglia THREE site (for the dolphins which could be identified to species level) in January 2012 (*Appendix 12.2*). These sightings lead to very low estimates of average abundance and density across the site, and given the sporadic nature of the sightings it is not appropriate to assume an average density over the entire survey period. The site specific surveys support other studies in concluding that this species is only occasionally sighted in this region of the North Sea.

204. Therefore, in agreement with Natural England, white-beaked dolphin will not be taken forward in the impact assessment (see ETG meeting 2 minutes in *Appendix 12.1*).

12.5.3.3 Minke whale

12.5.3.3.1 Population structure

205. Minke whale is widely distributed along the Atlantic seaboard of Britain and Ireland and throughout the North Sea. The JNCC Cetacean Atlas (Reid et al. 2003) indicates that minke whale occur regularly in the North Sea to the north of Humberside, but are comparatively scarce in the southern North Sea. Animals are present throughout the year, but most sightings are between May and September (Reid et al. 2003).

206. The only published population estimate for minke whale in UK waters is from the North Sea, English Channel and Celtic Sea undertaken for SCANS and SCANS II. The line transect survey conducted in July 1994 estimated 8,445 (95% CI 5,000-13,500) (Hammond et al. 2002). The SCANS II survey gave an overall estimate of 18,958 (CV 0.347); 10,786 (CV 0.29) for the North Sea; and 13,734 (CV 0.41; 95%CI 9,800 – 36,700) within an area comparable to the 1994 survey (Hammond et al. 2013). Although these estimates were not significantly different, there were noticeable changes in distribution between the two surveys (analogous to those observed in harbour porpoise) which again is most likely to be linked to changes in prey availability.

207. SCANS II estimated the average minke whale density across survey block B to be 0.01 (CV 0.98) individuals per km^2. The high CV value indicates there is a large amount of uncertainty around this estimate, this is a function of the very low sightings rates;

only two groups were sighted in block B. Figure 4 in Hammond et al. (2013) confirms that these two sightings were in the vicinity of the Channel Islands, and not in close proximity to the East Anglia Zone.

208. Genetic evidence suggests a limited spatial separation of populations within the North Atlantic (Anderwald and Evans 2010). The International Whaling Commission (IWC) treats this as a single stock (Central and North eastern North Atlantic), with a population estimate (in 1996 - 2001) of 174,000 (Northridge 2012). The IAMMWG considers a single population is appropriate for minke whale in European waters, at this time. The abundance of minke whale in the Celtic and Greater North Sea (CGNS) MU is 23,528 (CV 0.27, 95% CI 13,989 – 38,572, IAMMWG 2015).

209. The species is most commonly seen singly or, less commonly, in loose groups of up to three. In late summer, off the coast of northern and north west Britain, loose feeding aggregations of up to 15 animals may form (Anderwald and Evans 2010). In the northern hemisphere, mating is from October to March. Gestation is about 10 months, with calving occurring primarily between December and January (Seawatch Foundation 2008).

12.5.3.3.2 Diet

210. Minke whale feed upon a variety of fish species, including herring, sandeel, cod, haddock and saithe, as well as on invertebrates (Anderwald and Evans 2010). Feeding during the summer months is often observed in areas of upwelling or strong currents around headlands and small islands.

12.5.3.3.3 Site specific surveys

211. Aerial surveys undertaken for the ZEA did not record any minke whale (East Anglia Offshore Wind 2012c). In addition, no minke whale, or large cetaceans (which had the potential to be minke whale) were recorded in the East Anglia THREE site plus buffer during the 24 months of aerial surveys (*Appendix 12.2*).

212. As a result, of the lack of sightings during the site specific surveys, and the lack of sightings in this area of the North Sea during the SCANS II survey this species will not be considered in the impact assessment. This approach has been taken in agreement with Natural England (*Table 12.1*).

12.5.4 Other cetacean species

12.5.4.1 Bottlenose dolphin

12.5.4.1.1 Population structure

213. The bottlenose dolphin has a worldwide distribution in temperate and tropical seas, both in nearshore and offshore waters, including the northwest Atlantic seaboard of Europe (Reid et al. 2003). In terms of occurrence, the closest high density area to the East Anglia Zone is centred on the Moray Firth SAC, north east Scotland. This group of bottlenose dolphin are predominantly coastal residents (Thompson et al. 2010a). The current population estimate for the east coast of Scotland is 195 (95% highest posterior density interval 162-253; Cheney et al. 2012). Evidence suggests that the population is either stable or increasing (Cheney et al. 2012).

12.5.4.1.2 At sea distribution

214. In UK waters, bottlenose dolphins are essentially coastal in distribution, but they have also been recorded further offshore, particularly to the south west of Britain and Ireland. The Cetacean Offshore Distribution and Abundance (CODA) survey reported bottlenose dolphin sightings within the north western offshore component of the UK EEZ (CODA 2009).

215. During the SCANS II surveys, two bottlenose dolphin groups were sighted within survey block B which encompasses the East Anglia Zone; resulting in an estimated density of 0.0032 (CV 0.74) individuals per km^2.

216. IAMMWG currently recognise seven MUs for bottlenose dolphin in UK waters. The East Anglia THREE site is located in the Greater North Sea (GNS) MU, which is represented by ICES Area IV, excluding coastal east Scotland; and ICES area IIIa. The estimated population size of the GNS MU is zero (IAMMWG 2015).

12.5.4.1.3 Site specific surveys

217. No bottlenose dolphin were positively sighted during the aerial surveys of the East Anglia THREE site plus buffer.

218. Due to the very low occurrence of sightings during the site specific surveys, and based on the assessment of the population size by the IAMMWG this species will not be considered further in the assessment. This approach has been taken in agreement with Natural England (*Table 12.1*).

12.5.4.2 Killer whale

12.5.4.2.1 Population structure

219. Killer whales occur in deep waters beyond the edge of the continental shelf as well as in coastal waters (Weir et al. 2001; Reid et al. 2003). In UK waters, sightings are regular off the Northern Isles, Hebrides and (west) mainland Scotland (Bolt et al. 2009), sighting are less common to the west and south of Ireland and rare in the central and southern North Sea, Irish Sea, and English Channel (JNCC 2013).

220. Killer whales in UK waters are part of a wider population with known movements of individuals between UK, Iceland and Norway (Foote et al. 2011). Estimated population size in UK waters for killer whale is between 50 and 100 individuals based on photo-identification studies carried out from 1992-2008 (JNCC 2013). The favourable reference population for this species in UK waters is unknown (JNCC 2013).

12.5.4.2.2 Site specific surveys

221. No large cetaceans with the potential to be killer whale were sighted during the aerial surveys of the East Anglia THREE site plus buffer. Therefore, in agreement with Natural England, this species will not be considered further in the assessment (*Table 12.1*).

12.5.4.3 Other cetacean species

222. The other cetacean species that may occur occasionally within the East Anglia Zone include common dolphin, Atlantic white-sided dolphin and Risso's dolphin (Reid et al. 2003).

223. The common dolphin is the most numerous offshore cetacean species in the north east Atlantic, most often sighted off the western coast of the UK, in the Celtic Sea, and western approaches to the Channel, it is only occasionally sighted in the North Sea during the summer months (Reid et al. 2003).

224. No confirmed sightings of common dolphin were made in the southern North Sea during the SCANS II surveys (*Figure 5* in Hammond et al. 2013).

225. One individual was recorded across the 24 month site specific survey period, in December 2011 within the East Anglia THREE site plus buffer (*Appendix 12.2*).

226. Due to the very low occurrence of sightings during the site specific surveys, this species will not be considered further in the assessment. This approach has been taken in agreement with Natural England (*Table 12.1*).

227. During the East Anglia Zone specific aerial and boat based surveys there were also sightings of cetaceans which could not be classified to species. In the harbour porpoise section, we have assumed that all 'unidentified dolphin/porpoise' could be harbour porpoise.

228. In the East Anglia THREE site plus buffer surveys a number of observations have been classified to: 'unidentified dolphin not porpoise' (characteristics of a dolphin but unable to identify to species level) and 'unidentified patterned dolphin' (a patterned dolphin such as white-beaked, white-sided, common or striped dolphin but not identifiable to species level; *Appendix 12.2*).

229. In the East Anglia THREE site plus buffer seven unidentified dolphins were recorded, and only one unidentified patterned dolphin was recorded in the East Anglia THREE site plus buffer.

230. It is possible that these sightings are of species that we have excluded from the assessment due to low occurrence of species sightings. However, even if these sightings were confirmed to a species level the occurrence of those species would still be very low, and not warrant their inclusion in the assessment.

12.5.5 Summary of species and reference populations considered in the assessment

231. *Table 12.13*, below, provides a summary of the species being taken forward for the impact assessment, and the reference populations for each species.

232. During the impact assessment, the magnitude of impacts will be put in context against these reference populations (see *Table 12.8* for definitions of magnitude).

Table 12.13 Summary of species, reference populations and densities used in the impact assessment

Species	Reference population				Density estimate	
	Extent	Year of estimate	Size (95% CI)	Data source	No. individuals per km^2	Data source
Harbour porpoise	North Sea MU	2005	**227,298** (176,360 – 292,948)	IAMMWG (2015)	0.179 (harbour porpoise only), and 0.294 (harbour porpoise combined with in unidentified dolphin/porpoise)	Site specific surveys (*Appendix 12.2*)
Grey seal	South-east England, North east England and East coast MU and the Waddenzee	2007, 2008, 2010 and 2011 (UK) , 2013-2014 (mainland Europe)	10,350 + 7,800 + 6,800 + 4,276 = **29,226**	IAMMWG (2013) and TSEG (2014a)	Maximum mean density within the East Anglia THREE site 0.014	SMRU at-sea usage Jones et al. (2013)
Harbour seal	South-east England MU and Waddenzee	2011 (UK), 2014 (mainland Europe)	3,567 + 39,100 = **42,667**	IAMMWG (2013) and TSEG (2014b)	Maximum mean density within the East Anglia THREE site 0.0003	SMRU at-sea usage Jones et al. (2013)
	South-east England MU	2011 (UK)	**3,567**	IAMMWG (2013)		

12.6 Potential impacts

233. The impacts and the assessment methodologies during the construction, operation and decommissioning of the proposed East Anglia THREE project have been agreed in consultation with Natural England (*Table 12.1*). These are outlined for each of the relevant sections below (12.6.1, 12.6.2 and 12.6.3). In addition, it was agreed that potential impacts on marine mammals from release of contaminants and remobilisation or re-suspension of contaminated sediments were scoped out of the assessment subject to full justification within the ES. With regard to both spills or release of existing contaminants Chapter 8 Marine Water and Sediment Quality considers that the significance of both of these impacts is negligible (see sections 8.6.1.4 and 8.6.1.5). Given the highly mobile nature of marine mammals and the negligible impacts of changes in water quality it is considered that there would be **no impact** upon marine mammals from these sources and therefore there is no further consideration of them in construction, operation and decommissioning impacts discussed below.

12.6.1 Potential Impacts during construction

234. The construction scenarios which this assessment has been based on are presented within Chapter 5 Description of the Development. The realistic worst case scenario on which the assessment is based on for marine mammal receptors is outlined in *Table 12.2*.

235. Depending on the receptor, the construction of the windfarm (wind turbines, inter-array cables and collector and converter stations) may have very different impacts in terms of type and magnitude than those of the offshore cable corridor. The impacts of the entire project are assessed as a whole, although where relevant the impacts have been assessed separately for Single Phase and Two Phased approaches. For impacts that span both the windfarm and the offshore cable corridor and for Single Phase or Two Phased approach; magnitude may be discussed separately (under the same impact), however the greater of two magnitudes is used to define the significance of that impact for the project overall.

236. The impacts and the assessment methodologies during the construction of the proposed project have been agreed in consultation with Natural England (*Table 12.1*). The impacts assessed are:

- Underwater noise from pile driving, vessels, seabed preparation, rock dumping and cable installation;
- Impacts upon prey species; and

- Vessel interactions.

12.6.1.1 Impact 1: Underwater noise - Pile driving

237. The greatest noise impact during the installation of foundations will result from pile driving. The National Physical Laboratory (NPL) have completed underwater noise propagation modelling based on a range of hammer energies (including the worst case as outlined in *Table 12.2*) across the East Anglia THREE site. Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1* provide details of the noise propagation modelling methods, as well as acoustic concepts and the metric used in the assessment. The details are summarised below.

238. Noise propagation modelling has been competed at 20 locations within the East Anglia THREE site with the aim of estimating the potential impact ranges. The locations were selected to encompass a range of sound propagation conditions resulting from variation in bathymetry, including locations near up-sloping and down-sloping profiles, in addition to covering the geometrical extent of the East Anglia THREE site.

239. For the monopile foundations a 3,500kJ hammer is assessed as the maximum energy, and this is considered to have worst case impact on marine mammals from a single pile driving event (*Table 12.2*). When considering concurrent piling the ‘footprint’ approach is used to assess the maximum area over which likely and possible avoidance can occur in harbour porpoise. The noise footprint can be considered as containing the possible impact ranges for a given threshold which might occur, irrespective of the timing, specific location or number of piling vessels operating within the project boundary (Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*). Therefore, the footprint area may be greater than the combined area for two concurrent piling vessels, but is considered to approximate to the worst case scenario in this assessment.

240. Monopile foundations will result in the worst case *spatial impact* (i.e. will use the maximum hammer energy) based on the noise modelling undertaken (Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*).

241. With regard to the worst case *temporal impact*, the maximum duration of piling noise during construction of the offshore windfarm will result from the use of jackets (with four piles each), and only a single piling vessel operating at any one time.

242. For jacket foundations 1,800kJ is the maximum hammer energy that will be used, with a maximum of four piles per jacket. However, noise propagation modelling has not been completed for this hammer size, so the 2,000kJ hammer is used as a proxy.

243. As the greatest temporal impact results from construction by a single piling vessel, the area of impact will be considered based on the location where the greatest ranges of impact are predicted.

244. Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1* provide details on the ambient noise levels expected in the East Anglia THREE site. The ambient noise level is also highly likely to depend on the distance to shipping lanes, fishing areas, dredging areas or other areas where potential noise sources are operating. In the North Sea, the contribution of shipping noise to ambient levels has been shown to be significant (Ainslie et al. 2009). Natural environmental contributors to the ambient noise level in and around the East Anglia THREE site and the East Anglia Zone in general, will likely be from the wind (sea-state) with contributions from rain noise and biological noise. The primary anthropogenic contributors to the ambient noise level in the North Sea include shipping (e.g. fishing, cargo, cruise ship, ferries, and aggregate extraction) and oil and gas related activities. However, the ambient noise environment around the East Anglia THREE site would likely be dominated by local shipping (see section12.6.1.2 for current shipping levels) and sea-state.

245. The metrics used in the noise assessment are consistent with the Marine Strategy Framework Directive and include peak-to-peak pressure level and Sound Exposure Level (SEL). Sound Pressure Level (SPL) is used to describe the level of a continuous type noise such as shipping or operational wind turbine noise.

246. NPL provide a review of the potential effects of noise on marine mammals (Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*). The potential impacts of underwater noise on marine mammals can be summarised as lethal, physical injury, auditory injury, behavioural disturbance and masking, a brief description of each is provided below.

247. Very close to the source, the high peak pressure sound levels have the potential to cause death, or severe injury leading to death. High exposure levels from underwater sound sources can also cause hearing impairment; taking the form of a temporary loss in hearing sensitivity (Temporary Threshold Shift or TTS), or a permanent loss of hearing sensitivity (Permanent Threshold Shift or PTS). The potential for injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal, but is also influenced by the duration of exposure. Marine mammals may exhibit varying intensities of behavioural response at lower noise levels. The response can vary due to exposure level, the hearing sensitivity of the individual, context, previous exposure history or habitation, motivation and ambient noise levels (e.g. Southall et al. 2007).

248. The United States Marine Mammal Criteria Group of the National Marine Fisheries Service (NMFS) have proposed the 'M-weighting' model (Southall et al. 2007), as part of the Marine Mammal Noise Exposure Criteria. The marine mammal noise exposure criteria were developed through consensus of an expert committee and peer-reviewed. The criteria have found acceptance internationally and are now being recommended in the UK for use in environmental impact assessments, although these are currently being revised by National Oceanic and Atmospheric Administration (NOAA).

249. In Southall et al. (2007), the injury criteria consider both SEL and SPL, where the SPL is considered for a peak level, and is not subjected to a weighted response. In terms of behavioural criteria, two general approaches are considered, both of which are described by Southall et al. (2007); the single pulse behavioural disturbance criteria and behavioural response severity scaling for multiple pulses. In this assessment the single pulse behavioural disturbance criterion is considered for the purpose of estimating ranges where a strong aversive response might occur (assumed to represent strong (near 100%) avoidance as it is based on the onset of TTS). However, using these criteria does not account for the potential disturbance associated with the duration of the noise producing activity. The behavioural response severity scaling for multiple pulses (Southall et al. 2007) is used as an indicator of ranges where behavioural changes and some level of reduction in animal abundance may be expected (possible avoidance) over the duration of the noise impact. The scaling was developed to delineate those behaviours that are relatively minor and / or brief (scores 0-3); those with higher potential to affect foraging, reproduction, or survival (scores 4-6); and those considered likely to affect these vital rates (scores 7-9). A severity score of 5 indicates a change in swimming behaviour but not avoidance, and 6 indicates minor to moderate avoidance. However, no data are reported in Southall et al. (2007) for high-frequency cetaceans (this category includes the harbour porpoise).

250. Recent work by Lucke et al. (2009) suggested slightly different TTS and behavioural criteria than those proposed by Southall et al. (2007) for high-frequency cetaceans (harbour porpoise), which has also been used in this assessment. Lucke et al. (2009) reported TTS-onset at 194dB re 1 µPa peak pressure level and 164dB re 1 μPa^2s SEL from a seismic airgun pulse, and aversive behavioural reactions observed at received level of 168dB re 1 µPa peak pressure level (reported at 174dBpk-pk re 1 µPa) or

145dB re 1 µPa^{2}s SEL. In this assessment, 145dB re 1 µPa^{2}s SEL is used as a proxy for the severity scoring of 5-6[5].

251. Cumulative SEL injury for high-frequency cetaceans still uses the Southall et al. (2007) criteria, as Lucke et al. (2009) is based on single strike TTS.

252. For pinnipeds, several of the studies reviewed by Southall et al. (2007) indicate that fleeing and indeed any avoidance only occurs at noise levels which are considered sufficient to cause the onset of TTS. Therefore, no assessment of possible avoidance is made for harbour or grey seal.

253. The criteria used in this assessment are summarised in *Table 12.14*, and have been agreed in consultation with Natural England (*Table 12.1*).

254. A soft start for the first 20 minutes of pile driving has been included as embedded mitigation (following JNCC 2010a guidelines, as outlined in Chapter 5 Description of the Development). This has been taken into account in the noise propagation modelling – see *Appendix 9.1*)

255. The establishment of a mitigation zone, out to the maximum range of exposure that can lead to instantaneous PTS onset in harbour porpoise, through the development of a MMMP, is also included as embedded mitigation. This has been taken into account when assessing the potential risk of PTS.

256. EPS other than harbour porpoise are not considered in the impact assessment due to the lack of occurrence at the site. Following consultation with Natural England (*Table 12.1*, July 2014) it is acknowledged that an EPS licence may be required for species other than harbour porpoise, should additional information become available post consent.

257. In the interest of ensuring that an injury offence should not be caused to any EPS which could be an occasional visitor to the East Anglia Zone, results of the assessment of PTS onset ranges for low and mid frequency cetaceans (using the

[5] = Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source, moderate shift in group distribution, change in inter-animal distance and/or group size (aggregation or separation), prolonged cessation or modification of vocal behaviour (duration > duration of source operation), 6 = Minor or moderate individual and/or group avoidance of sound source, brief or minor separation of females and dependent offspring, aggressive behaviour related to noise exposure (e.g., tail/flipper slapping, fluke display, jaw clapping/gnashing teeth, abrupt directed movement, bubble clouds), extended cessation or modification of vocal behaviour, Visible startle response and brief cessation of reproductive behaviour).

Southall et al. 2007 criteria, see *Appendix 9.1*) will also be summarised and discussed.

Table 12.14 Summary of criteria used in the assessment

Species or species group	Impact	Criteria	
		Peak Pressure Level (dB re 1 μPa)	SEL (dB re 1 $\mu Pa^2 \cdot s$)
Harbour porpoise	Instantaneous injury (PTS onset)	200	179 (single strike)
	Fleeing response (TTS onset)	194	164
	Possible avoidance of area by exposed individuals	168	145
Pinnipeds (in water)	Instantaneous injury (PTS onset)	218	186 (M_{pw} weighted)
	Fleeing response (TTS onset)	212	171 (M_{pw} weighted)

12.6.1.1.1 Sensitivity

12.6.1.1.1.1 Lethal and physical injury effects

258. There is a lack of data which has prevented the establishment of explicit exposure criteria and a mechanism for this type of effect in marine mammals. However, in this assessment all species of marine mammal are considered to have high sensitivity to noise above thresholds that can cause instantaneous physical injury or death. Marine mammals are considered to have limited capacity to avoid such effects, and unable to recover from the effects.

12.6.1.1.1.2 Auditory injury (PTS onset)

259. All species of cetacean rely on sonar for navigation, finding prey and communication; they are therefore highly sensitive to permanent hearing damage (Southall et al. 2007). However, when considering the impact that any auditory injury has on an individual the frequency range over which the auditory injury occurs must be considered. PTS or TTS would normally only be expected in the critical hearing bands in and around the critical band of the fatiguing sound (e.g. Kastelein et al. 2012). Auditory injury resulting from sound sources like piling (where most of the energy occurs at lower frequencies) is unlikely to negatively affect the ability of high-frequency cetaceans to communicate or echo-locate. As such, sensitivity to PTS from pile driving noise is assessed as high for harbour porpoise.

260. Pinnipeds use sound both in air and water for social and reproductive interactions (Southall et al. 2007) but not for finding prey. Therefore, Thompson et al. (2012) suggest damage to hearing in pinnipeds may not be as important as it could be in

cetaceans. Pinnipeds also have the ability to hold their heads out of the water during exposure to loud noise, and potentially avoid PTS. As such, sensitivity to PTS in harbour and grey seal is considered to be medium, with the individual showing some tolerance to avoid, adapt to or accommodate or recover from the anticipated impact.

12.6.1.1.1.3 TTS onset

261. Harbour porpoise are assessed as having medium sensitivity to TTS onset, and grey and harbour seal low sensitivity. The sensitivity of each receptor to TTS onset is considered the same as flee response / likely avoidance (see Section 12.6.1.1.1.4.1).

12.6.1.1.1.4 Behavioural response

12.6.1.1.1.4.1 Flee response/likely avoidance

262. Southall et al. (2007) discuss a range of likely behavioural reactions that may occur as a result of exposure to noise. These include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement / diving behaviour, temporary or permanent habitat abandonment, and in severe cases panic, flight stampede or stranding, sometimes resulting in injury or death.

263. In the underwater noise assessment (Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*) the single pulse behavioural disturbance criterion is considered for the purpose of estimating ranges where a strong aversive response might occur (100% avoidance) as it is based on the onset of TTS. This type of response may be considered likely to affect vital rates based on the potential for a severe or sustained avoidance of an area.

264. The underwater noise modelling is very precautionary and this is outlined in the following paragraphs.

265. For example it does not account for any time that marine mammals may spend at the surface, or the reduced SEL near the surface where the animal would not be exposed to such levels and also does not account for any temporal hearing recovery. As such, the exposure predicted in the model is likely to be an overestimate of the exposure that a receptor might be subjected to.

266. Underwater noise modelling assumes that marine mammals 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. A study by Teilmann et al. (2007) on

diving behaviour of harbour porpoise in Danish waters suggests that animals spent 55% of their time in the upper 2m of the water column from April to August and over the whole year they spent 68% of their time in less than 5m depth. Teilmann et al. (2007) suggested that as temperature drops in October and November, the average dive frequency increases reflecting increased foraging activity as energy requirements increase to compensate for the decrease in temperature. The study also highlighted difference in diving behaviour between mothers and calves, with females spending more time diving than the calf which, given its lower breath-holding capacity, undertakes more frequent but shorter dives (Teilmann et al. 2007).

267. The swimming patterns of harbour porpoise undertaking direct travel are typically characterised by short submergence periods, compared to feeding animals (Watson and Gaskin 1983). These short duration dives with horizontal travel suggest that travelling animals, such as harbour porpoise moving away from pile driving noise, would swim in the upper part of the water column. It would be anticipated, that during a fleeing response, from a loud underwater noise, such as piling, that their swimming behaviour may change with a reduction in deep dives. This behavioural response would allow the animal to move to a greater distance from the adverse noise source in a shorter period of time and result in exposure to lower noise propagation close to the sea surface, compared to mid-water at a comparable distance (Nabe-Nielsen Pers. Comm).

268. The underwater noise modelling assumes an average swim speed of 1.5m/s (based on harbour porpoise mother calf pairs; Otani et al. 2000) as a fleeing speed, however, marine mammals may swim faster than this (e.g. harbour porpoise have been recorded swimming at speeds of up to 4.3m/s; Otani et al. 2000). The cumulative SEL dose does not take account of this and therefore is likely to overestimate the received noise levels.

269. Noise impact assessments assume that all animals within the species noise contour may be affected to the same degree for the maximum worst-case scenario. For example, that all animals exposed to noise levels that induce behavioural avoidance will be displaced or all animals exposed to noise levels that are predicted as inducing PTS or TTS will suffer permanent or temporary auditory injury respectively. However, a study looking at the proportion of trials at different SELs that result in TTS in exposed bottlenose dolphins suggests that to induce TTS in 50% of animals it would be necessary to extrapolate well beyond the range of measured SEL levels (Finneran et al. 2005). This suggests that for a given species, the potential effects follow a dose-response curve such that the probability of inducing TTS will decrease moving further away from the SEL threshold required to induce TTS. Further work

by Thompson et al. (2013) has adopted this dose-response curve to produce a theoretical dose-response for PTS in harbour seal by scaling up Finneran et al. (2005) dose response curve for changes in levels of TTS at different SEL, where the probability of seals experiencing PTS increases from an SEL of 186 up to 240 dB re 1 $\mu Pa^2 s^{-1}$; the point at which all animals are predicted to have PTS. Similarly, behavioural response was modelled as a dose-response based on studies of harbour porpoise at Horns Rev II (Brandt et al. 2011) which showed that as the distance from the source increases so the proportion of animals disturbed decreases.

270. The study by Brandt et al. (2011) of harbour porpoise at Horns Rev II suggests that pile driving may not necessarily lead to 100% avoidance, as is assumed for the worst-case scenario in modelling. The study found that at closer distances (2.5 to 4.8km) there was 100% avoidance, however, this proportion decreased significantly moving away from the pile driving activity, such that at distances of 10.1 to 17.8km, avoidance occurred in 32- 49% of the population. At 21.2km, the abundance reduced by just 2%. Although the parameters in this study differ from those considered for East Anglia THREE, it does suggest that an assumption of behavioural displacement of all individuals is precautionary, and that in reality not all individuals would move out of the area.

271. It should also be noted that the noise modelling assessment also has a number of precautionary assumptions to provide a realistic worst-case scenario. For example, the piling sequence is likely to be an overestimate of the hammer energy increase and average number of strikes per minute (based on worst-case seabed conditions); and the model assumes that maximum hammer energy is used although experience of previous wind farms shows that this is rarely achieved. The maximum hammer energy would only be required for a proportion of the piling duration and not at all the locations for East Anglia THREE. The duration for the installation of a monopile has also been taken as a worst-case scenario, with a total piling duration of 230 minutes (See *Appendix 9.1*), however the time required will also be dependent upon site conditions.

272. The duration of any flee response can vary, and the time between individuals being displaced and returning to an area should be considered against the waiting time between piling events. It is possible that a behavioural disturbance from a single pile driving event would be sufficient to exclude harbour porpoise from the area around the noise source for several days (Thomsen et al. 2006; Brandt et al. 2009; 2011; Thompson et al. 2010a). However, studies at the Borkum West II project in Germany that deployed a large bubble curtain during monopile installation reported on average (median) a significant expulsion effect was detectable until 9 to 12 hours

after pile driving activity. Detection rates were lowest until four hours after pile driving and increased gradually afterwards (Diederichs et al. 2014)

273. The duration of the exclusion could last up to three days following a single piling event if the animal is close to the source. Data presented by Brandt et al. (2009, 2011) indicated that harbour porpoise would completely leave the area (indicated by the duration of waiting time between porpoise detections after first piling) for a median time of 16.6 hours and a maximum of 74.2 hours within 0.5-6km of the noise source. Waiting times did not return to 'normal' until 22.7 hours after piling. At distances of greater than approximately 9km from the noise source the there was a much shorter duration of effect; with waiting times retuning to 'normal' between 1 and 2.6 hours after piling ceased. However, at 18-25km there was still a marked effect. Porpoise activity (measured by the number of minutes per hour in which porpoise were detected expressed as porpoise positive minutes) was significantly lower within approximately 3km of the noise source for 40 hours after piling.

274. The duration of any potential displacement effect will differ depending on the distance of the individual from the piling activity and the noise level the animal is exposed to. Furthermore, for those individuals distant from the activity and which therefore did not respond and were not affected, they will continue with their normal behaviour that may involve approaching the windfarm area.

275. Harbour porpoise have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein et al. 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein et al. 1997). Thermoregulation, especially in cold water, has high energy costs in marine mammals. Kastelein et al. (1997) estimate that a harbour porpoise may have a life expectancy of as little as three days in waters of 20°C under starvation conditions. Should harbour porpoise be excluded from an area of key prey resource it will likely seek an alternative food resource that could have an effect on the individual's fitness.

276. The effects on an individual's fitness are partly caused by the exclusion of animals from high-quality foraging areas and partly by the net energy losses associated with fleeing from disturbances (Nabe-Nielsen et al. 2014). Therefore impacts in lower quality habitat are likely to have a lower potential impact on an animal's fitness.

277. Harbour porpoise are assessed as having a medium sensitivity to likely avoidance.

278. Harbour seal and grey seal exhibit alternate periods of foraging and resting at haul out sites (during which limited or no feeding occurs). Prolonged fasting also occurs in these species during annual breeding and moult, when there are marked seasonal changes in body condition (Rosen and Renouf 1997; Bäcklin et al. 2011). Although adult seals may be relatively robust to short term (weeks rather than days compared to harbour porpoise) changes in prey availability, young and small individuals have a more sensitive energy balance. This is exhibited through effects of mass dependant survival (Harding et al. 2005). Although a fleeing response in harbour or grey seal may lead to a severe or sustained avoidance of an area, these species can be considered less sensitive to such an impact than harbour porpoise. Harbour and grey seal are assessed as having low sensitivity to likely avoidance.

12.6.1.1.1.4.2 Possible avoidance

279. This impact is not assessed in harbour or grey seal. As stated previously, only likely avoidance is considered in these species.

280. The behavioural response severity scaling for multiple pulses is used as an indicator of ranges where behavioural changes and some level of reduction in animal abundance may be expected (possible avoidance) in cetaceans. While no data are reported in Southall et al. (2007) for high-frequency cetaceans (this category includes the harbour porpoise), in this assessment possible avoidance thresholds are considered to approximate to the severity scoring of 5-6 (Southall et al. 2007). This type of behavioural response has the ability to affect foraging, reproduction or survival, should an individual respond, but not all individuals that are exposed to this level or noise will respond. Sensitivity of harbour porpoise to this type of impact is considered low.

281. *Table 12.15* summarises the sensitivity to each potential noise impact for pile driving for each of the marine mammal species considered in this assessment.

Table 12.15 Summary of marine mammal sensitivity to noise impacts from pile driving

Species	Lethal effect or physical injury	Auditory injury (PTS)	Onset of TTS	Behavioural disturbance (likely avoidance)	Behavioural disturbance (possible avoidance)
Harbour porpoise	High	High	Medium	Medium	Low
Grey seal	High	Medium	Low	Low	Low
Harbour seal	High	Medium	Low	Low	Low

12.6.1.1.2 Magnitude

12.6.1.1.2.1 Lethal effects

282. The predicted noise levels in close proximity to the pile are comparable to those estimated for the onset of auditory injury and mortality and would only be expected at noise levels substantially above those necessary to cause auditory injury. The pile driving installation is thus unlikely to result in radiated noise levels sufficient to cause instantaneous mortality in marine mammals beyond a few metres from the pile.

283. As a result of the establishment of mitigation zones through the MMMP, there should be no marine mammals within a few metres of the pile. Therefore, the potential magnitude of effect is no change.

12.6.1.1.2.2 Auditory injury (PTS onset)

284. *Table 12.16* summarises the PTS onset ranges for each species and species group for a range of hammer energies. The 1,400kJ hammer was the lowest modelled hammer energy. Although this is greater than the hammer energy at the start of the soft start the impact ranges for PTS onset are shown to be less than 500m at the higher energy. Therefore, the establishment of a mitigation zone out to at least 500m (following current JNCC 2010a guidelines) would prevent exposure of individuals to noise thresholds which could lead to instantaneous onset of PTS.

285. Using the 3,500kJ hammer energy, the maximum range of instantaneous PTS onset is less than 1km for harbour porpoise (and less than 500m in all other species). The establishment of a mitigation zone out to the maximum range of PTS onset in harbour porpoise (currently assessed as up to 1km using the 3,500kJ hammer) though the development of a MMMP, is included as embedded mitigation, and has been agreed during consultation (*Table 12.1*). *Table 12.16* confirms that mitigation out to this range will also prevent an injury offence to other EPS which may be rare or occasional visitors to the East Anglia Zone. The exact range of the mitigation zone will be confirmed during development of the MMMP post consent, once pile driving parameters have been refined within the project design envelope. The range may be less than 1km as currently assessed.

Table 12.16 Summary of PTS onset distances (around mid-water column) estimated for pile driving during construction at the East Anglia THREE site for different hammer energies.

Species or species group	Impact criteria SEL (dB re 1 µPa^2·s)	Maximum hammer energy kJ 1,400	2,000	3,500
Harbour porpoise	179	<500m	<500m	<1km
Pinnipeds (in water)	186	<500m	<500m	<500m
Low-frequency cetaceans	198	<500m	<500m	<500m
Mid-frequency cetaceans	198	<500m	<500m	<500m

286. As a result of the establishment of mitigation zones through the MMMP, there should be no marine mammals exposed to noise levels that could lead to the instantaneous onset of PTS. Therefore, the magnitude of effect is no change.

287. The potential for prolonged exposure to noise levels in a SEL dose were considered in the noise assessment (Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*). The assessment calculates the received noise dose that an individual animal could be exposed to during a piling sequence (based on the use of a 3,500kJ strike energy as the full hammer energy. A 20 minute soft-start period was assumed to start at 20% of the full hammer energy and was gradually stepped up to full hammer strike energy at a constant strike rate, with a total piling duration of 230 minutes - see Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1* for more information). It is assumed that individuals flee the noise source at the initiation of the soft start.

288. The assessment suggests starting ranges, which indicate the distance that an individual needs to be from the noise source at the onset of the piling sequence to prevent a cumulative noise exposure which could lead to PTS. However, this type of assessment is based on a number of assumptions, and does not take account of different exposure levels an animal will receive at different depths in the water column, or periods where exposure will be reduced in seals when their heads are out of the water. Therefore, this type of assessment is completed for information, and is not used to quantify potential impacts in any receptor.

289. The example assessment suggests that during the modelled piling sequence high frequency and mid frequency cetaceans will not be exposed to noise levels that could cause PTS, as at a start range of less than 500m the cumulative SEL dose does not reach the PTS thresholds. In the case of low frequency cetaceans, the starting range is greater than 500m, but less than 1km. In these species, which may be occasional visitors to the East Anglia THREE site, the potential for a cumulative dose SEL should be mitigated by the establishment of a mitigation zone by the MMMP out

to the maximum range of instantaneous PTS in harbour porpoise (up to 1km see *Table 12.16*).

290. Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1* suggest that starting ranges in pinnipeds are much greater than in cetaceans (approximately 16km). Therefore, there is the potential for exposure to noise levels that could cause PTS for harbour and grey seal.

291. It is not possible to quantify the number of individual seals of either species that could develop PTS following exposure due to the large amount of uncertainty in the use of this metric. However, given the extremely low densities of harbour and grey seal in the East Anglia THREE site, the magnitude of effect is assessed as low in both species, and in relation to the South-east England MU for harbour seal.

12.6.1.1.2.3 TTS onset

292. For pinnipeds and harbour porpoise, a fleeing response is assumed to occur at the same noise levels as TTS onset, and the potential impact described as 'likely avoidance of area' (see Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*) is assessed in section 12.6.1.1.2.4 below.

293. For EPS other than harbour porpoise, the fleeing response is also described at TTS onset thresholds, and is predicted to occur at ranges of less than 500m in both low and mid frequency cetaceans for the maximum hammer energy (see Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*). Therefore, as a result of the establishment of mitigation zones through the MMMP, no EPS should be exposed to noise levels that could lead to an injury offence.

12.6.1.1.2.4 Behavioural response

294. As outlined previously, the response of individuals to a noise stimulus will vary. However, for the purpose of this assessment, it is assumed that at the 'likely avoidance' range 100% of the individuals exposed to the noise stimulus will respond (flee response). At the 'possible avoidance' range, a smaller proportion of the individuals exposed to the noise stimulus are expected to show an avoidance response.

295. The numbers of individuals exposed to disturbance at these ranges, based on spatial and temporal worst cases are quantified below. The worst case overall magnitude of effect is considered in the assessment. Behavioural impacts and TTS are temporary, and will be limited to occurring in this stage of the development, although the duration of the temporary effect will vary.

12.6.1.1.2.4.1 Likely avoidance/TTS

296. In harbour porpoise and pinnipeds the range at which likely avoidance occurs is defined as the fleeing response or TTS onset range (*Table 12.17*). *Diagram 12.6* illustrates the potential range over which there could be a likely avoidance /TTS onset (164 dB re 1 µPa^2·s) for harbour porpoise and *Diagram 12.7* illustrates the potential range over which there could be a likely avoidance /TTS onset pinnipeds, respectively.

Table 12.17 Summary of fleeing response / TTS onset distances (around mid-water column) estimated for pile driving during construction at the East Anglia THREE site for different hammer energies

Species or species group	Impact criteria SEL (dB re 1 µPa^2·s)	Maximum hammer energy kJ		
		1,400kJ	2,000	3,500
Harbour porpoise	164	~3-5km	~4-6km	~5-8km
Pinnipeds (in water)	171	<1.5km	<1.5km	<2.5km

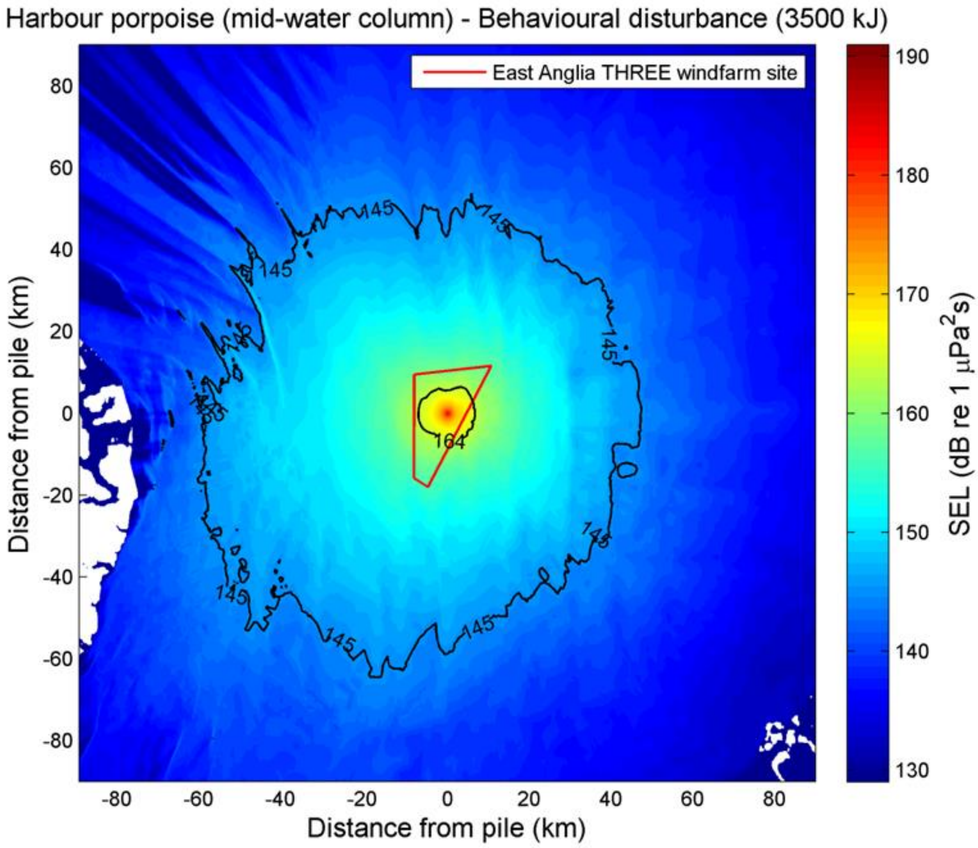

Diagram 12.6 Single pile propagation model output (see *Appendix 9.1*) for a 3,500 kJ hammer strike energy at the East Anglia THREE site (example location based on Location ID17), where the 145 and 164 dB re 1µPa^{2}s SEL contours correspond to possible avoidance of area and area of fleeing response/TTS onset, respectively, for harbour porpoise. White indicates a depth of < 0 m for tidal height modelled (HAT)

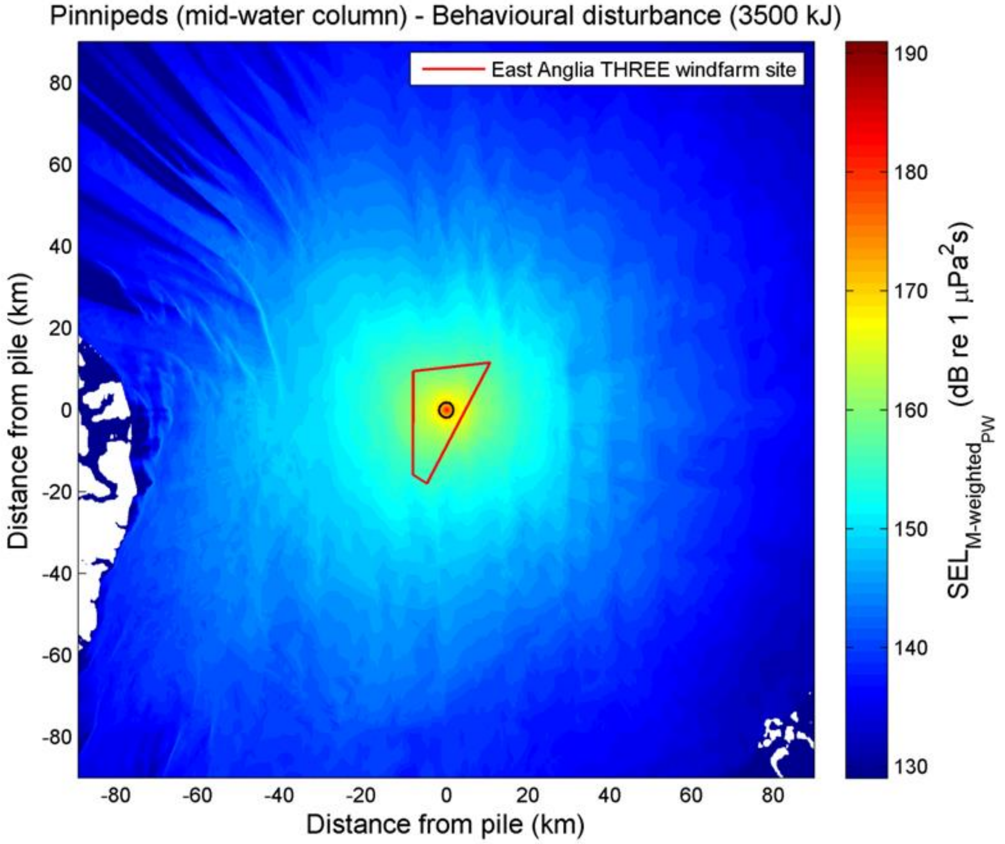

Diagram 12.7 Single pile propagation model output (see *Appendix 9.1*) for a pinniped indicating possible fleeing response (based on instantaneous TTS) for a 3,500 kJ hammer strike energy at the East Anglia THREE site (example location based on Location ID17). White indicates a depth of < 0 m for tidal height modelled (HAT)

Spatial worst case

297. The spatial worst case assesses the maximum area over which displacement could occur at any one time based on two concurrent monopile foundations being installed.

298. The maximum predicted fleeing response range for pinnipeds during construction at the East Anglia THREE site is less than 2.5km from the pile for the maximum hammer energy (*Diagram 12.7*). At such short ranges, the area of this disturbance can be assumed to approximate to a circle (with an approximate area of 19.6km^2).

299. In order to calculate the number of individual seals that could be exposed to this impact the maximum mean at-sea seal density within the East Anglia THREE site (section 12.5.2) has been multiplied by the area of effect. In the case of grey seal, this equates to 0.274 individuals (based on a maximum mean at sea density of 0.014 individuals per km^2). In the case of harbour seal, this equates to 0.006 individuals (based on a maximum mean at sea density of 0.0003 individuals per km^2).

300. During the construction of the East Anglia THREE site there could be two pile driving vessels operating concurrently across the site (e.g. worst-case of 39.2km^2 i.e. two 19.6km^2 areas). As such, the maximum number of individuals that could be affected would be doubled at most (as the range at which likely avoidance could occur would not overlap). Therefore a maximum of 0.55 grey seal and 0.012 harbour seal, which is less than 1% of the reference population for each species (and less than 1% of the South-east England MU in the case of harbour seal) would be affected. The location of the displacement area will not be constant throughout the construction period, but will move around the site as construction progresses.

301. This worst case spatial impact of disturbance (concurrently installing two 12MW monopiles using the 3,500kJ hammer) would be limited to the duration of any concurrent driving of monopiles. Concurrent pile driving could occur for 206 hours (*Table 12.2*) during a maximum eight month period of the 41 month (section 5 *Table 5.34*) construction period for a Single Phase approach. Concurrent piling is not currently anticipated for the Two Phased approach.

302. In the two vessel scenario, assuming the average waiting time of 38 hours between each piling event per vessel (*Table 12.2*), and assuming the worst case that seals do not return to the area of likely avoidance between piling events, for the installation of 100 monopiles individuals could be excluded from this likely avoidance area (as outlined above this could be a maximum area of 39.2km^2) for the greatest duration of approximately 87 days or 36% of the eight month concurrent piling period (with active concurrent piling occurring for approximately 3.5% of the eight month concurrent piling period).

303. For harbour porpoise, the areas within the ranges described in *Table 12.17* have been calculated for each modelled location. The greatest area over which likely avoidance could occur at any one time is from pile driving at location 6 (an area of 142.7km^{2}towards the north and east of the East Anglia THREE site, see ETG meeting 3 notes in *Appendix 12.1* for locations). During two concurrent events, the area over which likely avoidance could occur will be approximately doubled, if no overlap in the areas of potential avoidance from the two piling locations. Considering the second worst location for noise propagation (location 17, an area of 138.92km^2) as the second pile driving location there will be no overlap in areas with location 6. This gives a total approximate area of 281.6km^2 over which likely avoidance could occur.

304. The number of harbour porpoise that are likely to avoid the area has been calculated using both the harbour porpoise only site specific densities and the harbour porpoise combined with unidentified dolphin / porpoise sightings (*Table 12.18*). Based on the highest average density estimate for the East Anglia THREE site and buffer, this

would equate to disturbance of 83 harbour porpoise which may be exposed to noise thresholds that can cause the instantaneous onset of TTS.

305. As outlined for seals, based on the average waiting time, and by assuming animals do not return between piling events, individual harbour porpoise could be excluded from this approximate area for an estimated maximum of 7% of the 41 month Single Phase approach construction period. As the Two Phased programme does not include multiple piling events, the Single Phase is considered the worst-case scenario for avoidance.

Table 12.18 Summary of likely avoidance (fleeing response / TTS onset) areas (around mid-water column) and estimated number of individuals affected for pile driving during construction at the East Anglia THREE site

Scenario	Hammer energy	Area (km^2)	Density (individuals per km^2)	No. individuals	Percent of reference population (227,298)
Spatial worst case (two concurrent 12m monopiles)	3,500kJ	281.6	0.179 (harbour porpoise)	50	0.022%
			0.294 (harbour porpoise and unidentified dolphin and porpoise)	83	0.036%
Temporal worst case (jackets)	2,000kJ	72.1	0.179 (harbour porpoise)	13	0.006%
			0.294 (harbour porpoise and unidentified dolphin and porpoise)	21	0.009%

Temporal worst case

306. In the temporal worst case scenario pile driving will be completed by a single vessel. Using the jacket approach and a 1,800kJ hammer (modelled hammer energy of 2,000kJ used as a proxy) pile driving could occur over:

- 1,272 hours for a Single Phase approach (*Table 12.2*); or
- 1,279 hours for a Two Phased approach (*Table 12.2*).

307. *Single Phase approach:* In this approach pile driving would occur for a maximum of 1,272 hours (53 days) or 11.6% of the 15 month piling period. Using a single vessel to install 12m monopiles would lead to a maximum of 412 hours (17.2 days) or 3.8% of the 15 month piling period. If it is assumed that individuals will not return to the area between piling events (average waiting time is 8 hours 46 minutes between piling events for jacket foundations or 37 hours 59 minutes for 12m monopiles) likely avoidance would occur for approximately 67.2% (306.8 days) or 38.1% (173.8 days)

of the 15 month piling period using jackets and 12m monopiles respectively. The use of jackets can therefore be considered the worst case for temporal displacement of marine mammals.

308. *Two Phased approach: In* this approach pile driving would occur for a maximum of 1,279 hours or 10.9% of the two eight month piling periods. Using a single vessel to install 12m monopiles would lead to a maximum of 412 hours or 3.5% of the two eight month piling periods. If it is assumed that individuals will not return to the area between piling events (average waiting time is 8 hours 46 minutes between piling events for jacket foundations or 37 hours 59 minutes for 12m monopiles) likely avoidance would occur for approximately 63.3% (308.5 days) or 35.7% (173.8 days) of the two eight month piling periods using jackets and 12m monopiles respectively. The use of jackets can therefore be considered the worst case for temporal displacement of marine mammals.

309. The number of grey seal that are likely to avoid the area for up to 67.2% of the 15 month piling period during a Single Phase approach or 63.3% of the two eight month piling periods during a Two Phased approach is less than one seal (0.274 individuals) based on a maximum mean at sea density of 0.014 individuals per km^2. In the case of harbour seal, the effect equates to 0.006 individuals (based on a maximum mean at sea density of 0.0003 individuals per km^2).

310. The number of harbour porpoise which are likely to avoid the area for up to 67.2% of the 15 month piling period during a Single Phase approach or 63.3% of the two eight month piling periods during a Two Phased approach is summarised in *Table 12.18*. Based on the higher average density estimate, 21 harbour porpoise are likely to avoid the area (based on the worst case piling location, 6).

311. During the construction of the entire windfarm there is the potential for exposure of new individuals to noise thresholds that could lead to instantaneous TTS. The waiting time between piling events may also affect the potential of exposure of individuals to noise thresholds that could lead to instantaneous TTS. If there are longer gaps between piling events, then there is a greater chance that individuals could return to the vicinity of the piling vessels before the next pile driving event starts.

312. In order to assess the potential magnitude of this effect in harbour porpoise a precautionary approach based on the worst case noise footprint has been used (in order to deal with uncertainty in construction timescales and pile driving locations). This approach considers the total area, and therefore number of individuals, that could be to exposed noise thresholds that could lead to instantaneous TTS during

construction of the entire windfarm (Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*). This precautionary approach assumes that there is no redistribution of animals between piling events, as the assessment assumes baseline densities across the East Anglia THREE site or impact footprint.

313. The total area within the 164 SEL footprint contour based on the 3,500kJ hammer is 957km^2. This equates to 281 individuals based on the harbour porpoise and unidentified dolphin and porpoise densities (or 164 individuals based on the harbour porpoise densities). The total area within the 2,000kJ hammer footprint is 739km^2, or a total of 217 individuals (or 132 individuals based on the harbour porpoise only densities). Using either density estimate for either the spatial or temporal worst case footprint, less than 1% of the reference population could be exposed to TTS or flee response within in a year. The maximum magnitude of effect based on the 3,500kJ footprint is 0.1% of the reference population. This equates to a negligible magnitude of effect.

314. The footprint approach is not considered appropriate for pinnipeds, due to the very low range of effect, and has not been modelled. However, based on the very low densities of harbour and grey seal in the area the potential for exposing either harbour or grey seal to TTS will also be limited to a negligible magnitude of effect.

Likely avoidance/TTS summary

315. The duration of pile driving noise and potential displacement will be greater in the jacket scenario than the monopile scenario. The former is considered the worst case temporal impact and the latter the worst case spatial impact. The assessment makes the precautionary assumption that animals will be excluded from the area from the onset of the first piling event, until the end of the last piling event. During this worst case temporal scenario only a single piling vessel would be operating at once to provide the maximum duration for the construction period. The footprint approach has been used to consider the worst case area over which displacement can occur during pile driving, and given the greater range of noise propagation from the installation of monopiles using a 3,500kJ hammer; this is considered the worst case.

316. There is no evidence to suggest that the East Anglia THREE site is of particular importance for grey or harbour seal (section 12.5.2). Possible avoidance is not assessed in pinnipeds. For both seal species, given the very low at sea densities, the number of individuals likely to avoid the area is effectively no change. However, based on the worst case temporal impact (with avoidance occurring for up to 67.2% of the 15 month piling period during a Single Phase approach or 63.3% of the two eight month piling periods during a Two Phased approach) the magnitude of the effect of TTS is assessed as negligible.

317. For harbour porpoise the magnitude of effect for exposure of individuals to noise levels that could lead to instantaneous TTS over the construction of the entire windfarm is negligible (less than 1% of the population).

318. The assessment of behavioural response to pile driving noise in harbour porpoise also considers the range of possible avoidance. Therefore the magnitude of the combined behavioural effect in harbour porpoise is assessed for both types of behavioural response in the following section.

12.6.1.1.2.4.2 Possible avoidance

319. Ranges of possible avoidance for harbour porpoise are between approximately 37km and 70km for full hammer strike energy at 3,500kJ (Chapter 9 Underwater Noise and Magnetic Fields and *Appendix 9.1*). The spread in these ranges is due to variations in bathymetry and therefore propagation efficiency (*Diagram 12.6*). For lower hammer energies, harbour porpoise are expected to exhibit disturbance over shorter ranges. Using the 2,000kJ hammer for jacket piles the ranges are 29km to 58km.

320. In the simplified assessment that is taken forward, the worst case area of behavioural effect is based on the area over which possible avoidance could occur during the construction of the entire windfarm using the 'footprint' approach.

321. Possible avoidance is not expected to lead to all individuals avoiding the area, nor are all individuals expected to display an equal level of avoidance (as discussed in section 12.6.1.1.1). As such the proportion of individuals that may show avoidance behaviour in response to noise at this threshold has been calculated by assuming between 50%, 75% and 100% avoidance. However, the assessment of the magnitude of behavioural effects in harbour porpoise uses the total number of individuals that could respond to the noise by considering a response by 75% of the individuals within the possible avoidance range. This approach was also agreed in consultation with Natural England (see ETG meeting 3 minutes in *Appendix 12.*1).

Spatial worst case

322. The spatial worst case is the maximum area over which displacement could occur at any one time based on two concurrent monopile foundations being installed. Due to the large range of the possible impact of disturbance, the footprint approach has been used to approximate the maximum area over which possible avoidance could occur from two concurrent piling vessels.

323. The total area within the possible avoidance range is 13,469km^2 using the footprint approach. The numbers of harbour porpoise that would avoid the area are summarised in *Table 12.19*.

324. Based on the 75% response, the magnitude of effect is negligible (less than 1% of the reference population) for the harbour porpoise only density, and low (1.3% of the reference population) in the case of the harbour porpoise and unidentified dolphin and porpoise densities (*Table 12.19*).

Temporal worst case

325. The temporal worst case would be a smaller area of possible avoidance (based on the area of disturbance around jacket installation). At the worst case location for noise propagation for the 145 SEL (location 7 for piled jackets), the area of possible avoidance is 6,311km^2. Based on the footprint approach the area over which disturbance can occur is 10,027km^2. The magnitude of effect is negligible (less than 1% of the reference population) for harbour porpoise only density and for harbour porpoise and unidentified dolphin and porpoise densities, based on a 75% response (*Table 12.19)*.

Table 12.19 Summary of possible avoidance areas distances (around mid-water column) and estimated number of individuals affected based on a response by 100%, 75% and 50% of the individuals within the area for pile driving during construction at the East Anglia THREE site

Scenario	Hammer energy	Footprint area (km^2)	Density (individuals per km^2)	No. individuals (% reference population) potentially affected assuming response by stated % of those exposed to the stimulus		
				50%	75%	100%
Spatial worst case (two concurrent 12MW monopiles)	3,500kJ	13,469	0.179 (harbour porpoise)	1,206 (0.53%)	**1,808 (0.80%)**	2,411 (1.06%)
			0.294 (harbour porpoise and unidentified dolphin and porpoise)	1,980 (0.87%)	**2,970 (1.31%)**	3,960 (1.74%)
Temporal worst case (jackets)	2,000kJ	10,027	0.179 (harbour porpoise)	898 (0.40%)	**1,346 (0.59%)**	1,795 (0.79%)
			0.294 (harbour porpoise and unidentified dolphin and porpoise)	1,474 (0.65%)	**2,211 (0.97%)**	2,948 (1.30%)

12.6.1.1.3 Impact significance

326. As a result of embedded mitigation the only potential impact from pile driving noise will be exposure to noise thresholds than can lead to TTS and avoidance of the area. *Table 12.20* summarises the potential impacts, sensitivity, magnitude and

significance for harbour porpoise, harbour seal and grey seal based on worst case scenarios, for both Single Phase and Two Phased approaches.

327. TTS will be mitigated by embedded mitigation for any low and mid frequency cetacean species which may be rare or occasional visitors to the area.

328. The magnitude of effect of TTS and likely avoidance in both harbour and grey seal is negligible. Both species have low sensitivity to the effects of disturbance; therefore both types of impact are assessed as **negligible**. In the case of harbour seal at the UK level the effect is also assessed as **negligible**.

329. In the case of PTS as a result of a cumulative received noise dose, both species of seal have medium sensitivity and magnitude of effect is low; therefore both types of impact are assessed as **minor adverse**. In the case of harbour seal at the UK level the effect is also assessed as **minor adverse**.

330. Harbour porpoise have medium sensitivity to the onset of TTS and likely avoidance and the magnitude of effect is negligible. Therefore the potential impact of TTS and likely avoidance is assessed as **negligible**.

331. Harbour porpoise have low sensitivity to possible avoidance and the magnitude of effect is low as a worst case. Therefore the potential impact for possible avoidance is assessed as **minor adverse**.

332. The confidence in the data used in this assessment is medium (based on criteria outlined in *Table 6.6* of Chapter 6 EIA Methodology).

333. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

Table 12.20 Summary of impact assessment for pile driving during construction at the East Anglia THREE site for harbour porpoise (HP), grey seal (GS) and harbour seal (HS)

<table>
<tr><th rowspan="2">Impact</th><th colspan="2">Criteria</th><th rowspan="2">Sensitivity</th><th rowspan="2" colspan="2">Magnitude</th><th rowspan="2">Impact Significance</th></tr>
<tr><th>Peak Pressure Level (dB re 1 µPa)</th><th>SEL (dB re 1 µPa^2·s)</th></tr>
<tr><td>Auditory injury (PTS onset)</td><td>HP: 200
HS & GS: 218</td><td>HP 179 (single strike)
HS & GS: 186 (M_{pw} weighted)</td><td>Medium for HP
Low for HS & GS (section 12.6.1.1.1.2)</td><td colspan="2">1,400kJ & 2,00kJ hammer energy: <500m for HP, HS, GS and other cetaceans.
3,500kJ hammer energy: <1km for HP, <500m for HS, GS and other cetaceans.
Low as mitigation zone would ensure no marine mammals exposed to noise levels that could result in instantaneous PTS. (section 12.6.1.1.2.2)</td><td>HP: Minor adverse
HS & GS: Minor adverse</td></tr>
<tr><td>TTS onset</td><td>HP: 194
HS & GS: 212</td><td>HP: 164
HS & GS: 171 (M_{pw} weighted)</td><td>Medium for HP
Low for HS & GS (section 12.6.1.1.1.3)</td><td colspan="2">A fleeing response is assumed to occur at the same noise levels as TTS onset – see below. (section 12.6.1.1.2.3)</td><td>HP: Minor adverse
HS & GS: Negligible</td></tr>
<tr><td rowspan="2">Flee response/likely avoidance</td><td rowspan="2">HP: 194
HS & GS: 212</td><td rowspan="2">HP: 164
HS & GS: 171 (M_{pw} weighted)</td><td rowspan="2">Medium for HP
Low for HS & GS (section 12.6.1.1.1.4.1)</td><td colspan="2">Spatial worst case: two concurrent 12MW monopile
HP: 281.6km^2 = 83 individuals, 0.36% of ref. pop. = low
HS: 19.6km^2 x 2 = 39.2km^2 x 0.0003 individuals = 0.01 individuals, 0.00002% of ref. pop. or 0.0003% of SE MU = negligible
GS: 19.6km^2 x 2 = 39.2km^2 x 0.014 individuals = 0.55 individuals, 0.002% of ref. pop. = negligible</td><td>HP: Minor adverse
HS & GS: Negligible</td></tr>
<tr><td>Temporal worst case: Single Phase
Piling jackets: approx. total duration is 306.8 days
HP: 72.1km^2 = 21 individuals, 0.009% of ref. pop. = negligible
HS: 19.6km^2 = 0.006 individuals, 0.00001% of ref. pop. or 0.0002% of SE MU = negligible
GS: 19.6km^2 = 0.274 individuals,</td><td>Temporal worst case: Two Phased
Piling jackets: approx. total duration is 308.5 days
HP: 72.1km^2 = 21 individuals, 0.009% of ref. pop. = negligible
HS: 19.6km^2 = 0.006 individuals, 0.00001% of ref. pop. or 0.0002% of SE MU = negligible
GS: 19.6km^2 = 0.274 individuals, 0.0009% of ref. pop. = negligible</td><td>HP: Negligible
HS & GS: Negligible</td></tr>
</table>

Impact	Criteria: Peak Pressure Level (dB re 1 µPa)	Criteria: SEL (dB re 1 µPa^2·s)	Sensitivity	Magnitude		Impact Significance
				0.0009% of ref. pop. = negligible		
Possible avoidance	HP: 168	HP: 145	Low for HP N/A for HS & GS (section 12.6.1.1.1.4.2)	Spatial worst case: two concurrent 12MW monopile HP: 13,469km^2 = 2,970 individuals, 1.3% of ref. pop. = low		HP: Minor adverse
				Temporal worst case: Single Phase Piling jackets: approx. total duration is 306.8 days HP: 10,027km^2 = 2,211 individuals = 0.97% of ref. pop. = low	Temporal worst case: Two Phased Piling jackets: approx. total duration is 308.5 days HP: 10,027km^2 = 2,211 individuals = 0.97% of ref. pop. = low	HP: Minor adverse

12.6.1.2 Impact 2: Underwater noise - vessels

334. Chapter 15 Shipping and Navigation provides a description of the baseline conditions and anticipated additional ship movements arising from the construction and operation of the proposed project.

335. A number of busy shipping lanes pass in proximity to the East Anglia THREE site, with a large number of vessels recorded using two Deep Water Routes (DWRs), one passing 2nm to the east and one 1nm west of the site. During the three marine traffic surveys in 2012/2013 there was an average of 14 unique vessels per day passing through the East Anglia THREE site. Approximately 63% of vessels recorded intersecting the East Anglia THREE site during the combined 30 days of survey were cargo ships (including general cargo, chemical tankers and specialised carriers), fishing vessels made up 15% of all traffic and recreational vessels 9%. Excluding the survey vessel tracks, there was an average of 12 unique vessels per day passing through the East Anglia THREE site during the winter validation survey in 2014. During the validation survey approximately 67.5% of vessels recorded intersecting the East Anglia THREE site were cargo vessels, fishing vessels made up for 19% of traffic within the site and 'other' operational vessels accounted for 9.5%.

336. *Appendix 15.1 - Navigational Risk Assessment East Anglia THREE Offshore Windfarm* suggests there would be some re-routing of existing vessels around the East Anglia THREE site (with a minimum passing distance of 2nm from the windfarm boundary) particularly to the south. This is likely to re-route existing large and fast moving vessels (predominantly general cargo ships).

337. There will be a large amount of additional vessels at the site during construction, despite the potential displacement of existing vessel traffic. During the construction of the proposed East Anglia THREE project there will be an increase in vessel traffic within the site associated with installation of the foundations and the wind turbines. *Table 12.2* provides details of the worst case of 55 vessels as the maximum numbers of vessels on site at any one time, with an approximate total of:

- 5,685 two way vessel movements based on a Single Phase approach; and
- 7,636 two way vessel movements for a Two Phased approach.

338. Most noise from construction vessels is likely to be lower frequency, associated with large, slow moving vessels and the use of dynamic positioning systems. Some of the vessels operating in and around the East Anglia THREE site, depending on vessel speed, size, type, age and condition etc., may generate significant noise levels, with the literature indicating maximum one-third octave bands (TOB) source level of over

200dB re 1 µPa/m (Malme et al. 1989) for a large tanker, over 186dB re 1 µPa/m for a cargo vessel (Arveson and Vedittis 2000) and over 170dB re 1 µPa/m for a passenger ferry (Malme et al. 1989) (for the TOB where the source level is maximum).

12.6.1.2.1 Sensitivity

339. A review of the impacts of underwater noise on marine mammals is provided in section 12.6.1.1. The potential for TTS is only likely in very close proximity to vessels, and noise generated for vessels will not be sufficient to cause PTS or other injury to marine mammals. Committing an injury offence to EPS is therefore very unlikely. Disturbance is the only potential effect assessed from vessel noise.

340. Due to the proximity of shipping channels and use of the site by fishing and recreational vessels (Chapter 15 Shipping and Navigation) it is likely that marine mammals using the wider area are habituated to this type and intensity of underwater noise to at least some degree.

341. Thomsen et al. (2006) review the effects of ship noise on harbour porpoise and seal species. As both species use lower frequency sound for communicating (with acute hearing capabilities at 2kHz) there is the potential for detection, avoidance and masking in both species. Thomsen et al. (2006) consider the detection thresholds for harbour porpoises (Hearing threshold = 115dBrms re 1 µPa at 0.25 kHz; Ambient noise = 91dBrms re 1 µPa at 2kHz) and conclude that ship noise around 0.25kHz will be detected by the species at distances of 1km; and ship noise around 2kHz will be detected at around 3km[6].

342. Given this range of predicted response, and observations of harbour porpoise swimming away from vessels (e.g. Polacheck and Thorpe 1990; Evans et al. 1993), harbour porpoise are considered to have low sensitivity to vessel noise.

343. Thomsen et al. (2006) also consider that ship noise around 2kHz will be detected at a distance of approximately 3km for harbour seals (ambient noise = 94 and 91dBrms re 1µPa at 0.25 and 2 kHz respectively); and the zone of audibility will be approximately 20km. However, there is no evidence to suggest that vessel noise does adversely affect seals, suggesting they may have a lower sensitivity than cetacean species. As such, both harbour and grey seal are considered to have a low sensitivity to vessel noise.

[6] These calculations are valid for ambient noise levels typical for the German Bight / North Sea at wind-speeds between 3 and 8m/s.

344. Noise levels reported by Malme et al. (1989) and Richardson et al. (1995) for large surface vessels indicate that physiological damage to marine mammals is unlikely. However, the levels could be sufficient to cause local disturbance of sensitive marine fauna in the immediate vicinity of the vessel, depending on ambient noise levels. As outlined in Chapter 9 Underwater Noise and Magnetic Fields, ambient noise measurements undertaken in UK coastal waters indicate the higher-end one-third octave band (TOB) spectral noise levels to be generally between around 95 and 120dB re 1 $\mu Pa^2 Hz^{-1}$ with these peak band levels occurring between frequencies of a few tens of hertz to a few hundred hertz, depending on location and time.

12.6.1.2.2 Magnitude

345. The construction of the project will last up to 41 months for a Single Phase approach and up to 45 months for a Two Phased approach, but additional vessel movements during construction are likely to be short-term and localised in comparison to existing shipping noise.

346. The densities of harbour porpoise in the East Anglia THREE site are relatively low compared to other parts of their range and the disturbance effects around vessels will only occur over relatively short ranges.

347. Despite the low density of both species of seal in the East Anglia THREE site, increased vessel activity may occur closer to haul out sites, but this will be largely dependent on the choice of port.

348. Based on the definitions in *Table 12.8* the magnitude of effect at the population level of harbour porpoise is predicted to be negligible under either the Single Phase or Two Phased approach, with less than 1% of the reference population being temporality impacted. The total area in which vessels could be located during construction is approximately 876km^2, based on a windfarm area of 305km^2 and the export cable and interconnector cable corridors area of 571km^2. The number of harbour porpoise that could be present in the area is approximately 257.5 individuals (based on a density of 0.294 individuals/km^2), an estimated 0.11% of the reference population. Potentially 12.3 grey seals (0.042% of reference population) could be present in the wind farm site and offshore cable corridor area.

349. In the case of harbour seal (at the UK level) the magnitude of effect is still considered to be negligible (less than 1% of the South-east England MU, or less than 36 seals) under either the Single Phase or Two Phased approach due to the very low at sea densities in this region. The estimated number of harbour seals that could be present in the windfarm site and offshore cable corridor area is approximately 0.263

individuals (based on a density of 0.0003 individuals / km^2), an estimated 0.0074% of the South-east MU.

12.6.1.2.3 Impact significance

350. The significance of the impact on harbour porpoise, harbour seal and grey seal is **negligible**.

351. The confidence in the data used in this assessment is medium to high.

352. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

12.6.1.3 Impact 3: Underwater noise: seabed preparations, rock dumping and cable installation

353. These impacts are assessed as the worst case construction methods for installation of the cables and any other noise not associated with the vessel traffic or worst case foundation installation scenario of pile driving. The worst case (*Table 12.2)* considers ploughing / jetting / pre-trenching or cutting for installation of cables, and rock dumping for protection of the cables:

- For a Single Phase approach: total duration of cable installation would be up to 41 months. There would be 550km of inter-array cables, 195km of platform links, 380km of interconnection cable and 664km of export cables; and
- For a Two Phased approach: total duration of cable installation would be 38 months. There will be 550km of inter-array cables; 240km of platform links, 380km of interconnecting cables and 664km of export cables.

354. Dredging in preparation for pipeline laying emits broadband noise, mainly in the lower frequencies, which could be similar to noise emissions during use of jetting tool or plough for cable laying (OSPAR 2009). There are no records for noise from rock dumping (OSPAR 2009, JNCC 2010a) however it is considered likely to be the noisiest activity associated with cable laying activities. Considering the activity it is expected that the noise will be broadband in nature.

12.6.1.3.1 Sensitivity

355. A review of the impacts of underwater noise on marine mammals is provided in section 12.6.1.1.

356. The potential for TTS is only likely in very close proximity to cable laying or rock dumping activities, and noise generated should not be sufficient to cause PTS or

other injury to marine mammals. Committing an injury offence to EPS is therefore very unlikely (JNCC 2010a). Disturbance is the only potential noise impact from vessels. However, there are limited observational data to support the level of response that harbour porpoise or seals may exhibit as a result of these types of activities.

357. As stated previously, harbour porpoise are considered to have low sensitivity to disturbance from noise, and harbour seal and grey seal are considered to have low sensitivity to disturbance.

12.6.1.3.2 Magnitude

358. The impacts from cable laying and protection are temporary in nature, and will be limited to part of the construction period. There will be no real difference in the overall duration of cabling activities between the Single Phase or Two Phased approach. The export cable corridor does not include areas of high marine mammal density for any species that occur within the southern North Sea. Disturbance responses are likely to occur at significantly shorter ranges than pile driving noise, but may be greater than vessel related disturbance.

359. The magnitude of effect in all species is negligible, with less than 1% of the reference population being likely to be affected. As outlined above, it is estimated that approximately 257.5 harbour porpoise (0.11% of the reference population) could be present in the windfarm site and offshore cable corridor area and potentially 12.3 grey seals (0.042% of reference population).

360. In the case of harbour seal (at the UK level) the magnitude of effect is still considered to be negligible (less than 1% of the South-east England MU, or less than 36 seals) due to the very low at sea densities in this region. As outlined above, it is estimated that approximately 0.263 harbour seals (0.0074% of the South-east MU) could be present in the windfarm site and offshore cable corridor area.

12.6.1.3.3 Impact significance

361. The significance of the impact on harbour porpoise, harbour seal (at the reference population and UK level) and grey seal is **negligible**.

362. The confidence in the data used in this assessment is medium.

363. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

12.6.1.4 Impact 4: Impacts upon prey species

364. Potential impacts on marine mammal prey species have been assessed in Chapter 11 Fish and Shellfish Ecology using the appropriate realistic worst case scenario for these receptors. The existing environment for the assessment has been informed by site specific surveys and a number of existing data sources.

365. A total of eighteen species were caught by the demersal otter trawl sampling at the site; the highest catch rates were recorded for dab followed by plaice and whiting. Plaice and dab were also most abundant in the beam trawl surveys. During the epi-benthic surveys the most abundant fish were small bodied non-commercial species such as e.g. solenette *Buglossidium luteum*, sand goby *Pomatoschistus minutus* and lesser weever *Echiichthys vipera*. International Beam Trawl Surveys (IBTS) recorded high catch per unit effort for sprat *Sprattus sprattus* in the East Anglia THREE site and export cable corridor; but sand goby, herring, greater sandeel *Hyperoplus lanceolatu*s were also recorded in relatively high numbers.

366. Potential impacts on fish species during construction can result from increased suspended sediment concentrations and sediment re-deposition and underwater noise (leading to mortality, physical injury, auditory injury or behavioural responses). None of the potential impacts are assessed as being significant (minor adverse at worst; Chapter 11 Fish and Shellfish Ecology).

12.6.1.4.1 Sensitivity

367. Grey and harbour seal feed on a variety of prey species, and are both considered to be opportunistic feeders, and the species in highest abundance in the area when they feed is usually the predominant component of their diet (see section 12.5.2). In the UK there are currently concerns that prey availability may be limiting harbour seal population growth, although there is no direct evidence (SCOS 2012, 2014). However, harbour seal populations are rapidly increasing in Waddenzee colonies (TSEG 2014b). The grey seal population is increasing within the UK reference population area, and prey availability is therefore not considered to be limiting (SCOS 2014).

368. Grey seal are therefore considered to have low sensitivity to changes in prey resources and harbour seal are also considered to have low sensitivity.

369. The diet of harbour porpoise over recent years is thought to reflect changes in the composition of food resources (section 12.5.3). Re-distribution of harbour porpoise between the 1995 SCANS and 2005 SCANS II surveys (Hammond et al. 2013) are thought to, in part reflect re-distribution of prey species, and over this time the size of the population did not change. However, there is limited data linking prey

abundance to diet trends in this species, and the diet of harbour porpoise had large overlap with commercial fisheries catch (Santos and Pierce, 2003). However, harbour porpoise, have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein et al. 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein et al. 1997). Harbour porpoise are therefore considered to have low sensitivity to this impact.

12.6.1.4.2 Magnitude

370. The conclusions of the Chapter 11 Fish and Shellfish Ecology assessment are that during construction impacts will be minor adverse at worst, and not significant. The impacts are considered to be intermittent and temporary, but could occur over the East Anglia THREE site (and beyond in the case of noise impacts from pile driving) in a limited number of noise sensitive species. Based on this assessment, the magnitude of the effect on marine mammals is considered to be negligible for all species.

371. In the case of harbour seal (at the UK level) the magnitude of effect is still considered to be negligible (less than 1% of the South-east England MU) due to the very low at sea densities in this region. An estimated 0.263 harbour seals (0.0074% of the South-east MU) could be present in the windfarm site and offshore cable corridor area.

12.6.1.4.3 Impact significance

372. For grey seal, harbour seal and harbour porpoise the combination of negligible magnitude of effect and low sensitivity provides an assessment of **negligible** impact.

373. In the case of harbour seal at the UK level, the assessment is also **negligible** impact.

374. No further mitigation measures are considered for this impact beyond those embedded measures presented Chapter 11 Fish and Shellfish Ecology and section 12.3.2.

375. The confidence in the data underpinning the assessment for harbour porpoise is medium. The confidence in the data underpinning the assessment is considered to be high for grey seal, and medium for harbour seal.

12.6.1.5 Impact 5: Vessel interactions – ship strikes

376. During the construction of the proposed East Anglia THREE project there will be an increase in vessel traffic in the region. Vessel use of the site, and potential increases have been summarised in relation to marine mammals in section 12.6.1.2 using data

presented in Chapter 5 Description of the Development. The construction period will use mostly large vessels, which are likely to travel at slow speeds, whilst only small workboats and crew transfer vessels are likely to operate at greater speed.

12.6.1.5.1 Sensitivity

377. Despite the potential for marine mammals to detect and avoid vessels, ship strikes are known to occur in cetaceans and cause injury and death (Wilson et al. 2007). Distraction whilst undertaking other activities such as foraging and social interactions are possible reasons why collisions occur (Wilson et al. 2007). Marine mammals can also be inquisitive, which may increase the risk of collision. It is not possible to fully quantify strike rates, as it is believed that a number go unnoticed. It is also possible that collisions which are non-fatal can leave the animal vulnerable to secondary infection, other complications or predation (Wilson et al. 2007).

378. However, marine mammals are relatively robust to potential collision, as they have a thick sub-dermal layer of blubber, which defends their vital organs from the worst of the impact (Wilson et al. 2007). It is possible that harbour porpoise in this region are habituated to vessel noise and may not respond to or avoid vessels. Furthermore it is possible the masking from other noise during construction (e.g. pile driving noise) may limit the ability of harbour porpoise to detect approaching vessels.

379. Harbour porpoise are small and highly mobile, and given their observed responses to noise (section 12.6.1.2), are expected to largely avoid vessel collision. However, harbour porpoise have been observed with signs of physical trauma (blunt trauma or propeller cuts) indicating vessel strike (4% of all post mortem examinations within the ASCOBANS area; Evans et al. 2011). Of the 1922 reported harbour porpoise strandings in the UK between 2005 and 2010, 478 were investigated by post mortem and cause of death established for 457 individuals, of these 22 had died from physical trauma of unknown origin, which could include vessel strikes (Deaville and Jepson 2011). Of the 563 UK stranded harbour porpoise examined at post mortem between 2000 and 2004 only one had injuries consistent with a fatal boat strike (Jepson 2005). However, 26 other harbour porpoises died of acute physical trauma of unspecified origin and Jepson (2005) suggested that a high proportion of these unidentified trauma cases were probably fatal impacts from watercraft, although some could also be undiagnosed by-catches or bottlenose dolphin attacks.

380. Based on available evidence, harbour porpoise are considered to have low sensitivity to this impact.

381. Ship strikes involving species of seal are not widely reported, and seals are considered to have negligible sensitivity to this impact. Impacts related to ducted propellers are assessed in section 12.6.16, below.

12.6.1.5.2 Magnitude

382. The increase in vessel traffic will be limited to the construction stage of the development and within East Anglia THREE project area, and given the low numbers of animals present, the potential to avoid collisions and the low incidence of strikes likely (from the post mortem data) the potential magnitude of effect is assessed as negligible for grey seal, harbour seal and harbour porpoise.

383. Given the low numbers of animals affected there will be no difference in magnitude of effect between the Single Phase or Two Phased approach.

12.6.1.5.3 Impact significance

384. Any potential impacts on harbour porpoise, grey seal or harbour seal are assessed as **negligible**. In the case of harbour seal at the UK level the impact is also assessed as **negligible**.

385. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

386. The confidence in the data underpinning the sensitivity of harbour porpoise and seal species to ship strikes is considered to be medium to high.

12.6.1.6 Impact 6: Vessel interactions – ducted propellers

387. As identified in section 12.5.2.3 in recent years a number of seal carcasses have washed ashore with 'corkscrew' type injuries with speculation over association of these injuries with particular ducted propellers.

388. Vessel use of the site, and potential increase have been summarised in relation to marine mammals in section 12.6.1.2 using data presented in Chapter 5 Description of the Development. As described in *Table 12.2*, due to the fact that the vessel types cannot be refined at this stage in the project, the worst case assesses there is the potential that all of the vessels will use ducted propellers.

389. This particular type of impact is only assessed for seal species, although harbour porpoise exhibiting large lacerations have been stranded around the UK and southern North Sea in recent years (Thompson et al. 2010b) they have not been associated solely with ducted propellers.

12.6.1.6.1 Sensitivity

390. As identified in section 12.5.2.3 in recent years a large number of seal carcasses have washed ashore with ‘corkscrew’ type injuries. The injuries were described as being consistent with the seals being drawn into a ducted propeller (Thompson et al. 2010b, 2013; Bexton et al. 2013). Recent observations, however, have indicated that such injuries can also be caused by grey seal predation on weaned grey seal pups and young harbour seals (Thompson et al. 2015). The results of trials and the observed predation by seals suggest that there are still a number of uncertainties as to the frequency of occurrence, and mechanisms for this type of injury.

391. In the East Anglia region 11 grey seals were discovered on the north Norfolk coast in the vicinity of Blakeney Point between October 2009 and March 2010. A total of 24 harbour seal and five unidentified seals (though most likely to have been harbour seal based on their description), were found in the same area between April and September 2010 (Thompson et al. 2013). Two unidentified seals with similar injuries had also been reported at Blakeney in March 2009. However, there was an absence of any reports from the East Anglia region between the end of 2010 and early 2013.

392. Throughout the UK, both harbour and grey seal have been found with these characteristic wounds, but perceived risk is higher in juvenile grey seal and adult female harbour seal (Thompson et al. 2013). The greatest numbers of recorded affected carcasses have been found in relatively close proximity to haul out sites.

393. At the time of writing, the SNCB advice is that ducted propellers may not pose any increased risk to seals over and above normal shipping activities (see section 12.5.2.3). Given the current uncertainty a precautionary sensitivity for harbour and grey seal to this impact is considered to be low.

12.6.1.6.2 Magnitude

394. There is a large amount of uncertainty as to the potential magnitude of effect. However, the majority of vessel activity during construction will be in the East Anglia THREE site; an area of extremely low density for both species. The distance between the site and the nearest harbour or grey seal breeding colony is greater than 30nm (~55km), and therefore both seal species are considered to be at low risk (SNCBs 2012).

395. The impact will be spatially limited, although could result in permanent loss of individuals from the population. Despite the extremely low density of both species of seal in the East Anglia THREE site, increased vessel activity may occur closer to haul out sites, but this will be largely dependent on the choice of port during construction.

396. Based on the densities of individuals in the East Anglia THREE site and offshore cable corridor, the magnitude of effect is likely to be negligible. In the case of harbour seal (at the UK level) the magnitude of effect is also considered to be negligible, due to the very low at sea densities in this region. Given the low numbers of animals potentially affected there will be no real difference in magnitude of effect between the Single Phase or Two Phased approach.

12.6.1.6.3 Impact significance

397. At the reference population level, impacts on harbour and grey seal are assessed as **negligible**. In the case of harbour seal (at the UK level) the impact is assessed as **negligible**.

398. Based on the definitions in *Table 12.8*, the impact would equate to the loss of less than one individual seal from the population, and therefore would not be detectable. Furthermore, the harbour seal region in this MU is currently increasing, and is therefore likely to be robust to the loss of more than one individual from the population.

399. The location of the East Anglia THREE site and offshore cable corridor are not in areas of high or medium risk as identified by SNCBs (2012). Therefore, no further mitigation (above that described in section 12.3.2) is deemed necessary. However, best practice and industry guidelines will be followed during construction to minimise the potential impact. EATL are committed to following research developments in this area and incorporating them into the MMMP where appropriate and practicable.

400. The confidence in the data underpinning the sensitivity of seal species to this type of impact is considered to be medium to low.

12.6.2 Potential impacts during operation and maintenance

401. Impacts during the operation and maintenance of the project have been agreed in consultation with Natural England (*Table 12.1*). The impacts assessed are:

- Underwater noise from wind turbines and vessels;
- Underwater noise from any maintenance work, such as additional cable protection or cable burial;
- Impacts upon prey species;
- Vessel interaction; and
- Physical barrier effects.

12.6.2.1 Impact 1: Underwater noise - turbines

402. Noise levels generated by operational wind turbines are much lower than those generated during construction activities. Operational wind turbine noise mainly originates from the gearbox and the generator and has tonal characteristics (Madsen et al. 2006; Tougaard et al. 2009b). However, recordings of underwater noise are only available from a small number of operational windfarm sites. The main contribution to the underwater noise emitted from the wind turbines is expected to be from acoustic transfer of the vibrations of the substructure into the water rather than from transmission of in-air noise from the wind turbines into the water column (Lidell 2003).

403. The MMO (2014) review found that available data on the operational turbine noise, from the UK and abroad, in general showed that noise levels radiated from operational wind turbines are low and the spatial extent of the potential impact of the operational wind turbine noise on marine receptors is generally estimated to be small, with behavioural response only likely at ranges close to the turbine. Although the early measured data were mainly for smaller capacity wind turbines ranging from about 0.2 to 2.0MW, more recently reported measured operational noise data from larger capacity wind turbines also had noise levels and characteristics comparable with previous wind farms reported (MMO 2014).

404. At the Naikun Offshore Wind Farm in British Columbia, JASCO (2009) predicted that sound pressure levels from the centre of the 396MW windfarm (110 x 3.6MW turbines) were greater than 120dB re 1 µPa rms SPL at ranges less than 8.5km.

405. Marmo et al. (2013) modelled the potential noise effects of operational offshore wind turbines, based on a generic 6MW wind turbine across the 10Hz to 2 kHz frequency band. The results for the monopile foundation indicated levels of 149 dB re 1 µPa SPL within 5 m of the foundation at 560Hz. Modelling was also conducted to determine the potential sound field for a theoretical wind farm with 16 turbines at different wind speeds (5, 10 and 15 m/s). The results indicated that a wind farm with on monopile foundations could be audible to marine mammals above background noise out to approximately 20km from the wind farm in all wind speeds (Marmo et al. 2013). Based on the modelled results, potential behavioural response zones were calculated, harbour porpoises were only predicted to exhibit an aversive behavioural response using the M-weighting metric where 10% of animals encountering the noise field were expected to move away, at higher wind speeds the range was up to 18.84km. Avoidance ranges where 50% or 90% of porpoises were predicted to respond were not generated in any of the scenarios and therefore most harbour porpoises are not expected to respond to the operational noise. Neither

seal species were predicted to exhibit a behavioural response to the sounds generated under any of the operational wind turbine scenarios (Marmo et al. 2013).

406. Although turbine noise may be perceived as a loud sound it is unlikely that it would cause TTS and is therefore unlikely to cause permanent hearing damage in seals. Sound levels recorded at existing operational wind farms would also not cause hearing damage to harbour porpoise (or bottlenose dolphin) even at very short ranges. It is also unlikely that the low frequency tonal noise would mask the high frequency signals in harbour porpoise vocalisations (MS 2012). The maximum number of operational wind turbines within the East Anglia THREE site is 172 devices (based on the 7MW design, *Table 12.2*). The minimum spacing between operational turbines will be 675m x 900m.

12.6.2.1.1 Sensitivity

407. The low-level noise generated during operation is likely to be detected by marine mammals only at short distances over background noise levels and below levels which would elicit a response (Madsen et al. 2006; Thomsen et al. 2006). The overall effect of the operational noise and the ability of marine mammals to perceive this noise will be largely dependent on ambient noise levels and wind speed. However, the operational wind turbines within the proposed project are not expected to result in increased noise levels more than a few kilometres from the site boundary.

408. Empirical data exist to support no lasting disturbance or exclusion of small cetaceans or seals around windfarm sites during operation (Tougaard et al. 2005; Scheidat et al. 2011). Data collected suggests that behavioural responses for harbour porpoise and seal may only occur up to a few hundred metres away (Touggard et al. 2009a; McConnell et al. 2012).

409. Touggard et al. (2009b) further show that even masking from operational noise is unlikely to impact harbour porpoise and seal acoustic communication, due to the low frequencies and low levels produced. Scheidat et al. (2011) reported an attraction of harbour porpoise to an operational Dutch windfarm site, where abundance was higher within the windfarm compared to a similar environment in near-by areas. This was assumed to be due to decreased fishing and vessel activity and increased food availability (Scheidat et al. 2011).

410. Lidell (2003) concluded that noise levels of the operating windfarm would be too low to cause injury to marine mammals. No behavioural response estimates are available from modelling of the Naikun offshore windfarm operational noise.

411. Comprehensive environmental monitoring has been carried out at the Horns Rev and Nysted windfarms in Denmark during the operation between 1999 and 2006 (Diederichs et al. 2008). Numbers of harbour porpoise within Horns Rev were thought to be slightly reduced compared to the wider area during the first two years of operation it was, however, not possible to conclude that the windfarm was solely responsible for this change in abundance without analysing other dynamic environmental variables (Tougaard et al. 2009b). Later studies (Diederichs et al. 2008) recorded no noteworthy effect on the abundances of harbour porpoise at varying wind velocities at both of the offshore windfarms, following two years of operation. Monitoring studies at Nysted and Røsand have also suggested that operational activities have had no impact on regional seal populations (Teilmann et al. 2006; McConnell et al. 2012). Tagged harbour seals have been recorded within two operational wind farm sites (Alpha Ventus in Germany and Sheringham Shoal in UK) with the movement of several of the seals suggesting foraging behaviour around the wind turbine structures (Russell et al. 2014).

412. As stated previously, harbour porpoise are considered to have low sensitivity to disturbance from noise, and harbour and grey seal are also considered to have low sensitivity to disturbance.

12.6.2.1.2 Magnitude

413. The area of potential displacement will be limited to a few hundred metres around each device. The impact will be limited to the operation of development.

414. Although, the 25 year operational lifespan could be considered permanent in the context of marine mammal life history, individuals will not be continually displaced due to the highly mobile nature of marine mammals. Furthermore, there is no evidence to suggest that the East Anglia THREE site is of particular importance for any of the species assessed.

415. The magnitude of the temporary effect is considered to be of negligible magnitude, with less than 1% of the reference population being impacted for each receptor. It is estimated that approximately 89.7 harbour porpoise (0.04% of reference population, 0.09 harbour seal (0.0025% of South-east MU) and 4.3 grey seal (0.015% of reference population) could be present in the windfarm site (305km^2).

416. Taking into account the Marmo et al. (2013) modelling results that 10% of harbour porpoise over a 20km range could potentially be disturbed as a result of wind turbine noise. It is estimated that an additional 73.4 harbour porpoises could be disturbed, based on 20km range surrounding wind farm site (2,494.42km^2). Resulting in a worst case 163.1 harbour porpoise or 0.07% of the reference

population potentially being disturbed. The magnitude of effect would still be negligible.

12.6.2.1.3 Impact significance

417. Impacts in all species are assessed as **negligible** and not significant. In the case of harbour seal (at the UK level) the impact is also assessed as **negligible**.

418. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

419. The confidence in the data underpinning the sensitivity of seal species to this type of assessment is considered to be high. The confidence in the data used in this assessment for harbour porpoise is medium.

12.6.2.2 Impact 2: Underwater noise – all vessels

420. Chapter 15 Shipping and Navigation provides a description of the environmental baseline. As outlined in section 12.6.1.2, there is the potential for some re-routing of vessel traffic during and following the construction of the East Anglia THREE site. This is likely to re-route existing large and fast moving vessels (predominantly general cargo ships), and will reduce the level of noise within the East Anglia THREE site from these vessel types.

421. However, during the operation and maintenance of the project there will be an average of 4,000 two-way support vessel trips per year (*Table 12.2*).

422. Noise from service vessels is likely to be lower frequency and some of the vessels operating in and around the East Anglia THREE site, depending on vessel speed, size, type, age and condition etc., may generate significant noise levels over short ranges.

423. Given the change in vessel types, the total amount of vessel noise in the East Anglia THREE site during operation and maintenance may be comparable to current baseline levels.

12.6.2.2.1 Sensitivity

424. A review of the impacts of underwater noise on marine mammals is provided in section 12.6.1.1. The potential for TTS is only likely in very close proximity to vessels, and noise generated for vessels will not be sufficient to cause PTS or other injury to marine mammals. Committing an injury offence to EPS is therefore very unlikely. Disturbance is the only potential effect assessed from vessel noise.

425. Due to the proximity of shipping channels and use of the site by fishing and recreational vessels (Chapter 15 Shipping and Navigation) it is likely that marine

mammals using the region are habituated to this type and intensity of underwater noise to at least some degree.

426. Section 12.6.1.2 reviews the effects of ship noise on harbour porpoise and seal species. Vessel noise during operation could be sufficient to cause local disturbance of sensitive marine fauna in the immediate vicinity of the vessel, depending on ambient noise levels.

427. As discussed previously, harbour porpoise are considered to have low sensitivity to vessel noise, both harbour and grey seal have a low sensitivity to vessel noise.

12.6.2.2.2 Magnitude

428. Vessel movements are likely to be temporary and localised in occurrence, as are potential displacement effects.

429. The 25 year operational lifespan could be considered permanent in the context of marine mammal life history. However, individuals will not be continually displaced due to the highly mobile nature of marine mammals. Furthermore, there is no evidence to suggest that the East Anglia THREE site is of particular importance for any of the species assessed. Harbour porpoise and seal densities are low in the East Anglia THREE site.

430. Increased vessel activity during operation and maintenance may occur closer to seal haul out sites (dependent on the choice of port). However, it is not expected to result in an increase in the potential magnitude of effect, as the waters are already a well established area for shipping and vessel movements.

431. There is the potential that overall the amount of vessel noise may be comparable to baseline levels, although this is not easy to quantify at this stage in the development. Based on the definitions in *Table 12.8*, and following a precautionary approach, the temporary effect is considered to be of negligible magnitude, with less than 1% of the reference population being impacted for each receptor.

12.6.2.2.3 Impact significance

432. The significance of the impact on harbour porpoise, harbour seal and grey seal is **negligible**. In the case of harbour seal (at the UK level) the impact is also assessed as **negligible**.

433. The confidence in the data used in this assessment is medium to high.

434. No further mitigation measures are considered for this impact beyond those embedded measures presented section 12.3.2.

12.6.2.3 Impact 3: Underwater noise from any maintenance work, such as additional rock dumping or cable re-burial

435. As outlined above, there are no records for noise from rock dumping (OSPAR 2009, JNCC 2010a) however it is considered likely to be the noisiest activity associated with cable laying activities. Considering the activity it is expected that the noise will be broadband in nature.

436. The requirements for any potential maintenance work, such as additional rock dumping or cable re-burial, are currently unknown, however the work required and associated impacts would be less than those during construction.

12.6.2.3.1 *Sensitivity*

437. A review of the impacts of underwater noise on marine mammals is provided in section 12.6.1.1.

438. As outlines above, the potential for TTS is only likely in very close proximity to cable laying or rock dumping activities, and noise generated should not be sufficient to cause PTS or other injury to marine mammals. Committing an injury offence to EPS is therefore very unlikely (JNCC 2010a). Disturbance is the only potential noise impact from vessels. However, there are limited observational data to support the level of response that harbour porpoise or seals may exhibit as a result of these types of activities.

439. As stated previously, harbour porpoise are considered to have low sensitivity to disturbance from noise, and harbour seal and grey seal are considered to have low sensitivity to disturbance.

12.6.2.3.2 *Magnitude*

440. The impacts from additional cable laying and protection are temporary in nature, and will be limited to part of the construction period. The cable corridors do not include areas of high marine mammal density for any species that occur within the southern North Sea. Disturbance responses are likely to occur at significantly shorter ranges than pile driving noise, but may be greater than vessel related disturbance.

441. The magnitude of effect in all species is assessed to be negligible.

12.6.2.3.3 *Impact significance*

442. The significance of the impact on harbour porpoise, harbour seal (at the reference population and UK level) and grey seal is **negligible**.

443. The confidence in the data used in this assessment is medium.

444. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

12.6.2.4 Impact 4: Impacts upon prey species

445. Potential impacts on marine mammal prey species have been assessed in Chapter 11 Fish and Shellfish Ecology using the appropriate realistic worst case scenario for these receptors. Potential impacts on fish species during operation are physical disturbance and loss of seabed habitat, introduction of hard substrate, operational noise, and electromagnetic fields (EMF).

12.6.2.4.1 Sensitivity

446. Given the available evidence outlined in section 12.6.1.4, sensitivity of harbour seal to this impact is low, and grey seal is low. Harbour porpoise are also considered to have low sensitivity to this impact.

12.6.2.4.2 Magnitude

447. The conclusions of the Chapter 11 Fish and Shellfish Ecology assessment are that during operational stage of the development the impacts will be minor adverse at worst, and not significant.

448. As outlined previously, Scheidat et al. (2011) reported an attraction of harbour porpoise to an operational Dutch windfarm site which was assumed to be due to decreased fishing and vessel activity and increased food availability (Scheidat et al. 2011). However, Chapter 11 Fish and Shellfish Ecology the assessment does not conclude any positive impacts, and the minor adverse worst case conclusion is taken forward in this assessment.

449. Impacts are likely to be temporary and localised in occurrence. The 25 year operational lifespan could be considered permanent in the context of marine mammal life history. However, individual marine mammals will not be continually impacted due to their highly mobile nature.

450. The temporary effect is considered to be of negligible magnitude, with less than 1% of the reference population being impacted for each receptor.

12.6.2.4.3 Impact significance

451. Impacts on all species of marine mammal are assessed as **negligible**. In the case of harbour seal (at the UK level) the impact is assessed as **negligible**.

452. No further mitigation measures are considered for this impact beyond those embedded measures presented section 12.3.2 and Chapter 11 Fish and Shellfish Ecology.

453. The confidence in the data underpinning the sensitivity marine mammals to changes in prey resource is considered to be medium.

12.6.2.5 Impact 5: Vessel interactions – ship strikes

454. Section 12.6.2.2 provides details of the vessel traffic during the operational stage of the development.

12.6.2.5.1 Sensitivity

455. The sensitivity of marine mammals to ship strikes has been reviewed in section 12.6.1.5.1. Harbour porpoise are considered to have low sensitivity to this impact, grey and harbour seal negligible sensitivity.

12.6.2.5.2 Magnitude

456. The increase in vessel traffic will be mostly within East Anglia THREE site and given the low numbers of animals present, the potential to avoid collisions and the low incidence of strikes, the potential magnitude of effect is assessed as negligible for grey seal, harbour seal and harbour porpoise.

12.6.2.5.3 Impact significance

457. Impacts on harbour porpoise are assessed as **negligible** and not significant; impacts on grey seal are assessed as **negligible**. In the case of harbour seal (at the UK level) the impact is also assessed as **negligible**.

458. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

459. The confidence in the data underpinning the sensitivity of seal species to this type of impact is considered to be medium to high.

12.6.2.6 Impact 6: Vessel interactions - ducted propellers

460. Vessel use of the site, and potential increase have been summarised in relation to marine mammals in section 12.6.2.2 using data presented in Chapter 15 Shipping and Navigation and associated Appendices. This particular type of impact is only assessed for seal species.

12.6.2.6.1 Sensitivity

461. As identified in section 12.6.1.6.1 the sensitivity of harbour and grey seal to this impact is assessed as low.

12.6.2.6.2 Magnitude

462. There is a large amount of uncertainty as to the potential magnitude of effect. However, based on the extremely low densities of individuals in the offshore area, the magnitude of effect is likely to be negligible in both harbour and grey seal.

463. In the case of harbour seal (at the UK level) the magnitude of effect is also considered to be negligible due to the very low at sea densities in this region.

12.6.2.6.3 Impact significance

464. At the reference population level impacts in harbour and grey seal are assessed as **negligible**.

465. In the case of harbour seal (at the UK level) the impact is assessed as **negligible**.

466. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2. However, best practice and industry guidelines would be used to inform the MMMP to be agreed with the MMO prior to construction to minimise the potential impact.

467. The confidence in the data underpinning the sensitivity of seal species to this type of impact is considered to be medium to low.

12.6.2.7 Impact 7: Physical barrier effects

468. The presence of a windfarm could be seen as having the potential to create a physical barrier, preventing movement or migration of marine mammals between important feeding and / or breeding areas, or potentially increasing swimming distances if marine mammals avoid the site and go round it. The East Anglia THREE site is not located on any known migration routes for marine mammals.

469. The minimum spacing between wind turbines will be 675 x 900m. This means that animals can be expected to move between devices and through the operational windfarm irrespective of layout.

470. As outlined above, the operational noise from the wind turbines are unlikely to restrict movements of marine mammals through the East Anglia THREE site or cause potential barrier effects. The limited data available suggest that where harbour porpoise activity was reduced during windfarm construction it returned to normal levels during operation (MS 2012). Similarly, although seals have been shown to move short distance away from simulated turbine noise, telemetry studies suggest that operational wind farms do not affect harbour seal movement patterns (MS 2012; Russell et al. 2014).

12.6.2.7.1 Sensitivity

471. There is no evidence to suggest offshore wind turbines or other associated foundations will cause a physical barrier to movement of marine mammals.

472. The sensitivity of all species considered in the assessment to this impact is negligible.

12.6.2.7.2 Magnitude

473. There is a large amount of uncertainty as to the potential magnitude of any effect. Evidence from the Egmond aan Zee offshore windfarm (Lindeboom et al. 2011) suggests that marine mammals may be attracted to the site for foraging. Scheidat et al. (2011) reported an attraction of harbour porpoise to an operational Dutch windfarm site, where abundance was higher within the windfarm compared to a similar environment in near-by areas. This was assumed to be due to decreased fishing and vessel activity and increased food availability (Scheidat et al. 2011).

474. The impacts are likely to be localised in occurrence. The 25 year operational lifespan could be considered permanent in the context of marine mammal life history. However, individual marine mammals will not be continually impacted due to their highly mobile nature.

475. The magnitude of effect is considered to be negligible.

12.6.2.7.3 Impact significance

476. For all species at the reference population level, and at the UK level for harbour seal, the impact is assessed as **negligible**.

477. The confidence in the data underpinning the sensitivity to this type of impact is considered to be medium.

12.6.3 Potential impacts during decommissioning

478. Decommissioning impacts to be assessed have been agreed in consultation with Natural England (*Table 12.1).* The impacts are:

- Underwater noise (vessel noise, seabed preparation and foundation and cable removal);
- Impacts on prey species; and
- Vessel interactions (ship strikes and ducted propellers).

479. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise).

480. A detailed decommissioning plan will be provided prior to decommissioning that will give details of the techniques to be employed and any relevant mitigation measures.

12.6.3.1 Impact 1: Underwater noise - vessels, seabed preparation and foundation and cable removal

481. The level of noise expected during each of the decommissioning is based on the worst case scenario (*Table 12.2*). Section 12.6.1.2 and section 12.6.1.3 provide details of the noise impacts during construction (other than pile driving).

12.6.3.1.1 Sensitivity

482. The potential for TTS is only likely in very close proximity to cable laying or rock dumping activities, and noise generated should not sufficient to cause PTS or other injury to marine mammals. Committing an injury offence to EPS is therefore very unlikely (JNCC et al. 2010a). Disturbance is the only potential noise related impact assessed during decommissioning.

483. As described previously, harbour porpoise have a low sensitivity to disturbance from underwater noise, harbour seal and grey seal also have low sensitivity.

12.6.3.1.2 Magnitude

484. The noise impacts during decommissioning will be temporary, and limited to this stage of the development.

485. The magnitude of effect will be less than 1% of the reference population for each species considered in the assessment, and therefore negligible. For harbour seal at the UK (South-east England MU) level the effect is also negligible.

12.6.3.1.3 Impact significance

486. The significance of the impact is all species (including harbour seal at the UK level) is assessed as **negligible**.

487. The confidence in the data used in this assessment is medium.

488. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

12.6.3.2 Impact 2: Impacts upon prey species

489. The potential impacts on marine mammal prey species have been assessed in Chapter 11 Fish and Shellfish Ecology using the appropriate realistic worst case scenario for these receptors. Potential impacts on fish species during decommissioning are physical disturbance, loss of habitat, increased suspended sediment concentrations, re-mobilisation of contaminated sediments and underwater noise.

490. The magnitude of effect of prey species is considered to be no greater and in all probability less than considered for construction. Therefore it is anticipated that any

decommissioning impacts would be no greater, and probably less than that assessed for construction. This means at worst, the impact will be minor adverse.

12.6.3.2.1 Sensitivity

491. As outlined previously, harbour porpoise and harbour seal are considered to have low sensitivity to changes in prey resources, and grey seal are considered to have low sensitivity.

12.6.3.2.2 Magnitude

492. The conclusions of the Chapter 11 Fish and Shellfish Ecology assessment are that during construction impacts will be minor adverse at worst. The impacts are considered to be intermittent and temporary, but could occur over the East Anglia THREE site (and beyond in the case of noise impacts from pile driving) in a limited number of noise sensitive species. Based on this assessment, the magnitude of the effect on marine mammals is considered to be negligible for all species.

12.6.3.2.3 Impact significance

493. In grey seal, the combination of negligible magnitude of effect and low sensitivity provides an assessment of **negligible** impact.

494. The negligible magnitude of effect when combined with medium sensitivity in harbour seal and harbour porpoise concludes with an assessment of **negligible** impact.

495. In the case of harbour seal at the UK level, the assessment is also **negligible** impact.

496. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2 and Chapter 11 Fish and Shellfish Ecology.

497. The confidence in the data underpinning the assessment for harbour porpoise is medium. The confidence in the data underpinning the assessment is considered to be high for grey seal, and medium for harbour seal.

12.6.3.3 Impact 3: Vessel interaction – ship strikes

498. Section 12.6.1.5 details the potential changes in vessel activity during the construction of the development. The number and type of vessels used during decommissioning are likely to be similar to these levels.

12.6.3.3.1 Sensitivity

499. As described previously, harbour porpoise have low sensitivity to this impact, and harbour and grey seal have negligible sensitivity.

12.6.3.3.2 Magnitude

500. The magnitude of the potential impact is likely to be negligible for harbour porpoise and grey seal (as described during construction). In the case of harbour seal at the UK level the magnitude of effect is also considered to be negligible.

12.6.3.3.3 Impact significance

501. Impacts on harbour porpoise are assessed as **negligible**; impacts on both species of seal are assessed as **negligible**. In the case of harbour seal (at the UK level) the impact is also assessed as **negligible**.

502. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2.

503. The confidence in the data underpinning the sensitivity of harbour porpoise and seal species to ship strikes is considered to be medium to high.

12.6.3.4 Impact 4: Vessel interactions – ducted propellers

504. As described previously, this impact is only considered for harbour and grey seal. As described in section 12.6.1.6, the assessment of construction impacts assumes that all vessels could use ducted propellers.

12.6.3.4.1 Sensitivity

505. As described previously, given the available evidence, sensitivity of harbour and grey seal to this impact is assessed as low.

12.6.3.4.2 Magnitude

506. The magnitude of effect during decommissioning is assumed to be comparable to that during construction. Based on the extremely low densities of individuals in the East Anglia THREE site and offshore cable corridor, the magnitude of effect is likely to be negligible in harbour and grey seal.

507. In the case of harbour seal (at the UK level) the magnitude of effect is considered to be negligible, due to the very low at sea densities in this region.

12.6.3.4.3 Impact significance

508. At the reference population level impacts on harbour seal and grey seal are assessed as **negligible**.

509. In the case of harbour seal (at the UK level) the impact is assessed as **negligible**.

510. No further mitigation measures are considered for this impact beyond those embedded measures presented in section 12.3.2. However, best practice and

industry guidelines are likely to be followed during construction to minimise the potential impact.

511. The confidence in the data underpinning the sensitivity of seal species to this type of impact is considered to be medium to low.

12.7 Cumulative Impacts

512. As outlined in section 12.4.4 the CIA will consider plans or projects where the predicted impacts have the potential to interact with impacts from the proposed construction, operation and maintenance or decommissioning of the East Anglia THREE project.

513. The worst-case scenario for the proposed East Anglia THREE project has been included in the CIA, based on the spatial worst-case scenario, which is the same for a Single Phase or Two Phased approach and duration based on the Two Phased approach.

514. The types of plans and projects included in the CIA, and the approach to screening, based on the stage of the plan or project (accounting for uncertainty in the tiered approach) as well as the quality of the data available, has been agreed with Natural England at ETG meetings (*Appendix 12.1*) and is provided in *Appendix 12.5*.

515. The plans and projects screened in to the CIA are:

(1) Located in the marine mammal management unit (MU) population reference area.

(2) Offshore wind farm and other renewable developments if there is the potential that the construction period could overlap with the proposed East Anglia THREE project, based on a seven year window from the date of consent during which the projects could be constructed (very precautionary approach).

516. (3) Offshore wind farm and other renewable developments that are likely to be piling at the same time as the proposed East Anglia THREE project based on best available information on when the developments are likely to be piling (more realistic approach and indicative scenario).Types of impact considered in the CIA have also been agreed in consultation and are summarised in *Table 12.21*. The CIA considers the three types of impact (underwater noise, indirect impacts and direct interaction) from all stages of any plan or project where there is the potential to overlap with the proposed East Anglia THREE project. Plans and projects within the agreed reference population boundaries for harbour porpoise, harbour seal and grey

seal (*Table 12.13*) have been screened in for each species as appropriate. Each receptor is assessed for each type of impact.

517. Each plan or project with a potential impact (as outlined in *Table 12.21*) within the reference population boundary for each receptor was assigned to a tier (Table 1 ETG meeting 2 briefing paper in *Appendix 12.1)*. Plans or projects assigned to the tier identified in *Table 12.11* were screened into the assessment. The results of the screening (*Appendix 12.5*) are summarised in *Table 12.22*.

Table 12.21: Impacts considered within the CIA

Impact	Sources of impact and stages of projects	Potential cumulative effects
Underwater Noise	Pile driving noise: • Construction	Cumulative increase in underwater noise from piling during construction at offshore developments has the potential to cause disturbance to marine mammals. Included in the CIA: - Projects with overlapping construction phases with the East Anglia THREE project, resulting in maximum potential for underwater piling noise to interact cumulatively in the regional marine mammal reference population boundaries. o Temporal adverse scenario considers the longest duration of the piling phase for each of the projects. This may include projects whose construction phases do not overlap with that of the East Anglia THREE project but which occur immediately prior to or after and therefore increase the overall duration of sequential piling within the marine mammal reference population boundaries. o Maximum spatial adverse scenario considers the maximum area of which marine mammal could be disturbed as a result of offshore piling.
	Vessel noise: • Construction; • Operation and maintenance; and • Decommissioning	Cumulative increase in vessel traffic arising from construction, operation and maintenance and decommissioning of offshore developments may result in increased noise disturbance to marine mammals. Included in the CIA: - Projects with overlapping construction phases with the East Anglia THREE project, resulting in maximum increase in number of vessel movements. - Projects that could contribute to increased vessel traffic due to operational and maintenance or decommissioning activities.
	Other noise sources: seabed preparation / rock dumping; cable or pipe laying; surveying, including seismic surveys; drilling; disposal noise; dredging noise; wind turbine or other mechanical operational noise; foundation / cable removal; explosives:	Cumulative increase in noise for activities other than piling and vessels arising from construction, operation and maintenance and decommissioning of offshore developments may result in increased noise disturbance to marine mammals. Included in the CIA: - Projects with overlapping construction phases with the East Anglia THREE project, resulting in maximum potential impacts on marine

Impact	Sources of impact and stages of projects	Potential cumulative effects
	• Construction; • Operation and maintenance; and • Decommissioning	mammals. - Projects that could have the potential to disturb marine mammals due to operational and maintenance or decommissioning activities.
Indirect impact - Prey species	Temporary or long term loss / changes in habitats; disturbance from underwater noise (sources as outlined above); increased suspended sediments/sediment deposition; electromagnetic fields (EMF) emitted by subsea cables: • Construction; • Operation and maintenance; and • Decommissioning	Cumulative changes in fish abundance and distribution resulting from construction, operation and maintenance, and decommissioning of offshore developments may lead to a loss or changes in prey resources for marine mammals. Included in the CIA: - Projects with overlapping construction phases with the East Anglia THREE project, resulting in maximum potential impacts on prey species. - Projects that could contribute to changes in prey resources due to operational and maintenance or decommissioning activities.
Direct interaction - Collision risk	Vessels (hull impacts, ducted propellers): • Construction; • Operation and maintenance; and • Decommissioning Wave and tidal devices: • Operation	Cumulative increase in vessel traffic arising from construction, operation and maintenance, and decommissioning of offshore developments may result in increased collision risk to marine mammals. Included in the CIA: - Projects with overlapping construction phases with the East Anglia THREE project, resulting in maximum increase in number of vessel movements in the regional marine mammal study area. - Projects that could contribute to increased vessel traffic due to operational and maintenance or decommissioning activities.

Table 12.22: Number of plans or project from each category which have been screened into the CIA in addition to the East Anglia THREE project for each receptor and the stage of the plan or project where a cumulative impact may occur (C = commissioning / construction O = operation, D = decommissioning, N/A = not assessed as there is no pathway). See *Appendix 12.5* for details on the results of the screening.

Project category	Harbour porpoise			Grey seal			Harbour seal		
	C	O	D	C	O	D	C	O	D
Other UK offshore windfarms	20 (1)*	39	39	16 (1)*	34	34	9 (1)*	25	25
European offshore windfarms	0	24	24	0	8	8	0	2	2
Other renewable developments (tidal and wave)	2	5	5	1	1	1	0	0	0
Aggregate extraction and dredging	N/A	54	N/A	N/A	54	N/A	N/A	45	N/A
Oil and gas installations (including surveying)	557		N/A	429		N/A	135		N/A
Licenced disposal sites	N/A	40	N/A	N/A	40	N/A	N/A	40	N/A

* A second assessment has been undertaken based on an indicative scenario that reflects a realistic situation of what offshore windfarm developments could be piling at the same time as the proposed East Anglia THREE project, these projects are shown in brackets.

518. It should be noted that a large amount of uncertainty is inherent in the completion of a CIA. At the project level, uncertainty in the assessment process has been expressed as a level of the confidence in the data used in the assessment. This relates to confidence in both the understanding of the consequences of the impacts in marine mammals, but also the information on the existing environment used to inform the predicted magnitude of effect.

519. In the CIA, the potential for impacts over wide spatial and temporal scales means that the uncertainty of a large number of plans or projects can lead to low confidence in the information used in the assessment, but also the conclusions of the assessment itself. To take this uncertainty into account, where possible, a precautionary approach has been taken at multiple stages of the assessment process.

520. Two scenarios have been assessed. The first is the worst-case which allows for any delays and changes in project development. All UK tier 3 projects have been given a seven year construction window from the year of consent (as advised by Natural England) to assess their potential overlap with the proposed construction of the East Anglia THREE project. For UK tier 4 projects the possible construction windows are based on the best available information. Where possible, this has been based on values for concurrent piling, including East Anglia THREE.

521. A second assessment has been undertaken based on an indicative scenario to present a more realistic situation of the currently consented UK offshore windfarm developments that could be piling at the same time as the proposed East Anglia THREE project. This indicative scenario is for illustrative purposes only and is likely to change but more accurately reflects the limitations and constraints to project delivery such as:

- The Committee on Climate Change have published their expectations around technology requirements to meet 2030 decarbonisation targets under various scenarios (Committee on Climate Change 2015). The scenarios range from 40GW required (ambitious renewables target) to other scenarios in the region of 20-26GW required by 2030. From the current approximate 5GW installed, this would suggest the need for around 1-1.3GW deployment per year to 2030; this is significantly lower than assessed in the worst-case (12.3GW including East Anglia THREE project) or the indicative case (2.4GW including East Anglia THREE project). It is believed that there would be no advantage in the Government seeking to deliver the 2030 decarbonisation target ahead of schedule and the level of support offered to the industry by Government would reflect the projection. Furthermore, given the need for cost reduction in offshore wind, to ensure consumers are not overpaying for decarbonisation, Government are likely to control the trajectory of deployment to support the sustainable growth of the supply chain (and not drive boom/bust behaviour) (Committee on Climate Change 2015).

- Limitations in the supply chain such as piling vessels and foundation fabrication. Offshore wind projects compete on a global market against other major infrastructure projects for material, fabrication, installation and logistics. The installation of 12.3GW in a single year, as predicted by the worst case scenario, is highly likely to be constrained by supply chain restrictions compounded by the development of a sustainable supply chain.

- The high level of uncertainty in the CIA has been acknowledged by Natural England with particular regard to the construction timing of projects. At the time of application no future Contracts for Difference (CfD) auctions have been announced and the potential budget is unknown, but it is highly likely there will be programme restrictions due to availability of funding regime, competing investment opportunities and government targets.

522. To account for the constraints above the following assumptions have been made for the indicative scenario:

- Only one piling operation per project. In the indicative scenario a piling schedule is assumed where only one piling vessel is operational as this most accurately reflects the majority of the piling programme.
- Only one project piling per year per development zone. This scenario is still in excess of the Committee on Climate Change (CCC) target of 1-1.3GW per year which is roughly equivalent to East Anglia THREE alone.
- Therefore, where possible, this indicative assessment has been based on values for single piling, including East Anglia THREE.

523. The approach to dealing with uncertainty has led to a highly precautionary assessment of the cumulative impacts, especially for pile driving as the CIA is based on the worst case scenarios for all projects being required (ETG meetings, Appendix 12.1).

524. The level of uncertainty in completing a CIA further supports the need for strategic assessment rather than developer led assessment. Ongoing work streams, such as DEPONS projects and the interim PCoD will also allow consideration of the biological fitness consequences of disturbance from underwater noise, and the conclusions of a quantitative impact assessment to be put into a population level context. EATL is supportive of these strategic initiatives, and will continue to work alongside other developers, Regulators and SNCBs in order to further understand the potential for significant cumulative impacts, and lead to reductions in impacts where appropriate.

12.7.1 Underwater noise impacts

525. The potential sources of underwater noise during each stage of a plan or project are summarised in *Table 12.21*. Pile driving could occur during oil and gas platform installation as well as offshore windfarm installation. As discussed previously this type of noise can cause auditory injury to marine mammals if sufficient mitigation measures are not in place (JNCC 2010b). Auditory injury could also occur from underwater explosives (used occasionally during the removal of underwater structures and UXO clearance), and seismic surveys. Guidelines also exist to mitigate

the potential for injury to EPS from these activities (see JNCC 2010c and JNCC 2010d).

526. Other activities such as dredging, drilling, rock dumping and disposal, vessel activity, operational windfarms, oil and gas installations or wave and tidal sites will emit broadband noise in lower frequencies. Therefore, auditory injury from these activities is very unlikely, with the main likely response to these noise stimuli being behavioural changes.

527. For many of the plans or projects screened into the CIA (*Appendix 12.5*) the potential impacts have not been quantified, and there is also a large amount of uncertainty around decommissioning impacts. It is therefore not possible to make a quantified CIA for all of the plans and projects screened in.

528. The potential effects from underwater noise on marine mammals include behavioural avoidance and the potential for PTS from a prolonged noise exposure in an SEL dose. However, there is a large amount of uncertainty around the calculation of the cumulative SEL dose; therefore this potential impact has not been quantified in the CIA.

12.7.1.1 Underwater noise impacts during construction – piling noise

529. The cumulative assessment of underwater noise considers the potential impacts from piling during construction of the proposed East Anglia THREE project and the potential impacts from piling for those projects screened into the CIA that could potentially impact marine mammals during this time. Details of the projects included in the CIA and the periods of construction are outlined in *Table 12.23*.

530. The greatest noise source is likely to result from pile driving during the construction of offshore windfarms. During the completion of EIAs many of the plans and projects screened in to the CIA have made some quantification of impact for the key receptors. Where such information has been provided by the individual developers, it is possible to provide a more quantified assessment of the potential impacts.

Table 12.23: Offshore wind farms included in the marine mammal (HP = harbour porpoise, GS = grey seal, HS = harbour seal) cumulative impact assessment (CIA) for the (i) worst-case scenario for Tier 3 consented projects (based on seven years construction window) and Tier 4 projects where applications are submitted (based on possible construction dates) and (ii) indicative scenario for Tier 3 projects where there is the likely overlap for concurrent piling (details presented are based on the most up to date information for each project at the time of writing)

Name and country of project	Distance from East Anglia THREE (km)	Size (MW)	Maximum number of turbines	Month/year consent authorised (7yr construction window)	Dates of offshore construction / piling[1]	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario[2]	Likely overlap of construction with East Anglia THREE- Indicative scenario[3]
East Anglia THREE	**N/A**	**1,200**	**172**		**Piling: 2020 – 2022**	**Yes**	**Yes**
Tier 3: consented							
Blyth demonstration site, UK	331	100	15	Oct-13 (2013-2020)	2015-2017	Yes (HP, GS)	No
East Anglia One, UK	22	714	102	Jun-14 (2014-2021)	Piling: 2018-2019	Yes (HP, GS, HS)	No
Hornsea Project One, UK	96	Up to 1,200	240	Dec-14 (2014-2012)	Piling: 2018	Yes (HP, GS, HS)	No
Galloper, UK	74	336 (504 consented)	56	May-13 (2013-2020)	Piling: 2016	Yes (HP, GS, HS)	No
Rampion, UK	295	400	116	Jul-14 (2014-2021)	2016-2018	Yes (HP, GS)	No
Dogger Bank Zone Creyke Beck A, UK	218	500-600	200	Feb-15 (2015-2022)	2016-2027	Yes (HP, GS, HS)	No[4]
Dogger Bank Zone Creyke Beck B, UK	242	500-600	200	Feb-15 (2015-2022)	2016-2028	Yes (HP, GS, HS)	Yes[4] (HP, GS, HS)
Beatrice, UK	709	664	95	Mar-14 (2014-2021)	Piling: 2017-2018	Yes (HP)	No
MORL Telford, UK	695	372	62	Mar-14 (2014-2021)	2017-2019	Yes (HP)	No

Name and country of project	Distance from East Anglia THREE (km)	Size (MW)	Maximum number of turbines	Month/year consent authorised (7yr construction window)	Dates of offshore construction / piling[1]	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario[2]	Likely overlap of construction with East Anglia THREE-Indicative scenario[3]
MORL MacColl, UK	688	372	62	Mar-14 (2014-2021)	2017-2019	Yes (HP)	No
MORL Stevenson, UK	696	372	62	Mar-14 (2014-2021)	2017-2019	Yes (HP)	No
Inch Cape, UK	516	784	110	Oct-14 (2014-2021)	2017-2019	Yes (HP, GS)	No
Neart na Gaoithe, UK	500	448	75	Oct-14 (2014-2021)	2015-2017	Yes (HP, GS)	No
Firth of Forth Phase 1 Seagreen Alpha and Bravo, UK	515	1,050	150	Oct-14 (2014-2021)	2015-2017	Yes (HP, GS)	No
European Offshore Wind Deployment Centre EOWDC, UK	581	84	11	Mar-13 (2013-2020)	2017	Yes (HP, GS)	No
Dogger Bank Zone Teesside A, UK	231	1,200	200	Aug-15 (2015-2022)	2017-2028	Yes (HP, GS, HS)	No[4]
Dogger Bank Zone Teesside B, UK	245	1,200	200	Aug-15 (2015-2022)	2017-2028	Yes (HP, GS, HS)	No[4]
Tier 4: application submitted							
Triton Knoll phase 1-3, UK[5]	137	300-900	Up to 288	Jul-13[4] (2013-2020)	Possible construction: 2016-2021 (to be confirmed once consent granted)	Yes (HP, GS, HS)	No
Hornsea Project Two, UK	Approx. 120	900	120-360		Possible construction: 2017-2023 (to be confirmed once consent granted)	Yes (HP, GS, HS)	No
Hywind 2, UK	624	30	5		Possible construction: 2016/2017 (to be confirmed once consent granted)	Yes (HP, GS)	No

[1]Piling and offshore construction dates are based on the latest dates and information available.

[2]Worst-case scenario: Projects where construction does not currently overlap with that of the proposed East Anglia THREE project but have been included in part of CIA as a precautionary approach to cover seven year window from date of consent for all consented projects. However, it should be noted that this is not a realistic approach and does not reflect the reality of actual construction. Therefore, a more realistic indicative has also been conducted.
[3]Indicative scenario: Projects for which consent has been granted (Tier 3 projects) and proposed piling is likely to overlap with the proposed piling of the East Anglia THREE project.
[4]The most likely potential for overlap of piling has been assessed based on known piling scenarios and what would be achievable. It is highly unlikely that all four Dogger Bank projects would be piling at the same time and concurrent piling would take place at the site, therefore only one project has been included as potentially overlapping with East Anglia THREE.
[5]TritonKnoll awaiting cable consent, so has been classed as tier 4 and included in the worst-case scenario.

12.7.1.1.1 Harbour seal

531. The potential behavioural avoidance of harbour seal from underwater noise resulting from piling has been assessed in the CIA.

Sensitivity

532. As previously discussed, harbour seal are assessed as having low sensitivity to behavioural disturbance from underwater noise.

Magnitude

533. Potential impacts from underwater noise during the construction of the proposed East Anglia THREE project has been estimated as 0.01 harbour seal being disturbed as a result of underwater noise during pile driving (based on spatial worst case scenario).

534. During the construction of the proposed East Anglia THREE project there is the potential overlap with impacts from the construction, operations, maintenance and decommissioning of offshore windfarms; aggregate extraction and dredging noise; operational noise from disposal sites (including the East Anglia Offshore site where underground coal gasification takes place); and possible exploration / commission and / or production activities of oil and gas Licence areas (see *Table 12.22 and 12.23* and *Appendix 12.5* for further details). It should be noted, that some of these plans and projects occur in areas of higher harbour seal density than the East Anglia THREE site.

535. A quantified assessment of the magnitude of this temporary effect during the period of construction of the East Anglia THREE project can only be made for pile driving during the construction of offshore wind farms where sufficient data have been provided within full or draft Environmental Statements (*Table 12.24*).

536. The number of harbour seal that could be potentially be disturbed as a result of pile driving during the construction of the proposed East Anglia THREE project and projects where the impacts of pile driving are likely to overlap (indicative scenario) and are quantified is one harbour seal (individual numbers for each wind farm rounded up to nearest whole number; *Table 12.24*), which is approximately 0.002% of the reference population or 0.02% of the UK South-east England MU (see *Table 12.13*).

537. Based on the available evidence, the magnitude of the temporary effect of piling for the indicative scenario is assessed as negligible for the reference population and negligible for the UK South-east England MU.

538. The total number of harbour seal that could be potentially be disturbed as a result of pile driving during the construction of the proposed East Anglia THREE project and for the projects where the impacts of pile driving could possibly overlap (worst-case scenario, based on seven year construction window and concurrent piling) and are quantified is 233 harbour seals (individual numbers for each wind farm rounded up to nearest whole number, *Table 12.24*), which is approximately 0.55% of the reference population or 6.5% of the UK South-east England MU (see *Table 12.13*). When considering the projects where the magnitude of effect is not quantified (including projects other than offshore windfarms) there is the potential for more harbour seal to be disturbed.

539. Based on the available evidence, the magnitude of the temporary effect for the worst-case scenario is assessed as negligible for the reference population and medium for the UK South-east England MU.

540. The closest site to the East Anglia THREE site is East Anglia ONE and the estimated distance between the maximum ranges for potential behavioural disturbance for seals is estimated to be 19.2km with no overlap (*Table 12.24*).

Impact significance

541. Given the low sensitivity of harbour seal to behavioural disturbance from underwater noise the cumulative impact is assessed as **negligible** at the reference population level and for the UK South-east England MU for the indicative scenario.

542. The cumulative impact is assessed as **negligible** at the reference population level and **minor adverse** and not significant at the UK level for the worst-case scenario.

543. Notably the piling of the proposed East Anglia THREE project would only make a small contribution (disturbing less than one individual) to this impact due to the very low densities of harbour seal in the East Anglia THREE site and offshore cable corridor.

544. The confidence in this type of cumulative assessment is low and includes a large amount of uncertainty in the data used to inform the assessment, the quantification of impacts, and in the potential for concurrent piling of the offshore windfarms considered in the CIA. However, confidence that the assessment is precautionary in nature is high.

Table 12.24 Cumulative impact assessments (CIA) for the potential behavioural disturbance of pinnipeds (harbour seal (HS) and grey seal (GS)) for the (i) worst-case scenario (based on seven years construction window and concurrent piling) and (ii) indicative scenario where there is the likely overlap of piling at consented offshore wind farm projects with piling at the East Anglia THREE site (single piling). Note: these figures relate to the scenarios modelled in the respective EIAs rather than any subsequent revisions in the DCOs.

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE - Indicative scenario*
East Anglia THREE	**Spatial worst case: installation of 12m diameter monopiles (3,500 kJ hammer)**	**-**	**Single: <2.5**	**Single: 19.6 Concurrent: 39.2**	**HS = 0.006 (single); 0.01 (concurrent) GS = 0.3 (single); 0.55(concurrent)**	**Negligible**	**Yes (GS, HS: concurrent)**	**Yes (GS, HS; single)**
Blyth Demonstration Site, UK (Narec, 2012)	2 x 4 MW monopiles (piling over 2 days)	331	Not modelled	Not modelled	HS = outwith CIA range GS = not modelled	Low impact and magnitude	Yes (GS)	No
East Anglia One, UK (EAOWFL, 2012)	2.5 m pin piles, 900kJ hammer energy	22	0.3	0.566	HS = not provided in ES GS = not provided in ES	Not significant	Yes (GS, HS)	No
Hornsea Project One, UK (SMart Wind 2013)	Up to 2,300 kJ hammer energy (monopiles or jackets). Maximum 332 x 5–8 MW turbines	96	<1.7	4.36 – 8.44	HS = <1 GS = 6.3	Minor adverse	Yes (GS, HS)	No

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE - Indicative scenario*
Galloper, UK (GWFL 2011)	7m diameter monopiles	74	34	N/A	HS = not provided in ES GS = not assessed	Minor adverse	Yes (GS, HS)	No
Rampion, UK (ROWF 2013)	1 x 6.5m monopile, 1,500kJ hammer energy	295	43.7[1]	N/A	HS = not provided in ES GS = not assessed	Minor adverse	Yes (GS)	No
Dogger Bank Zone Creyke Beck A, UK (Forewind 2013a)	10+MW, 3,000kJ hammer energy	218	1.8	Single: 10 Concurrent: 670	HS = not assessed GS = 8.5 (single); 147 (concurrent)	Negligible (single) to low (concurrent) (only grey seal assessed)	Yes (GS, HS; concurrent)	No
Dogger Bank Zone Creyke Beck B, UK (Forewind 2013a)	10+MW, 3,000kJ hammer energy	242	<1.9	Single: 10 Concurrent: 268	HS = not assessed GS = 8.5 (single); 268(concurrent)	Low (single) to medium (concurrent) (only grey seal assessed)	Yes (GS, HS; concurrent)	Yes (GS, HS; single)
Inch Cape, UK (ICOL 2013)	2.438m diameter pin piles, 1,200kJ hammer energy	516	151.1	N/A	HS = outwith CIA range GS = 669[1]	Minor adverse	Yes (GS)	No
Neart na Gaoithe, UK (NnGOWL 2012)	3.5m diameter, 1,635kJ hammer energy	500	N/A	4,133	HS = outwith CIA range	Minor adverse	Yes (GS)	No

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE - Indicative scenario*
					GS = 289[1]			
Firth of Forth Phase 1 Seagreen Alpha and Bravo, UK (Seagreen 2012)	2m diameter pile, 1,800kJ hammer energy	515	17	868.5	HS = outwith CIA range GS = 398[1]	Minor adverse	Yes (GS)	No
European Offshore Wind Deployment Centre, UK (EOWDC 2011)	3m diameter pile	581	16	N/A	HS = outwith CIA range GS = not provided in ES	Minor	Yes (GS)	No
Dogger Bank Zone Teesside A, UK (Forewind 2013b)	10+MW, 3,000 kJ hammer energy	231	<1.7	9 (single) 18 (concurrent)	HS = not assessed GS = single: 0.8, concurrent: 1.5	Negligible (single) to low (concurrent) (only grey seal assessed)	Yes (GS, HS; concurrent)	No
Dogger Bank Zone Teesside B, UK (Forewind 2013b)	10+MW, 3,000 kJ hammer energy	245	<1.7	9 (single) 18 (concurrent)	HS = not assessed GS = 2 (single); 4 (concurrent)	Negligible (single) to low (concurrent) (only grey seal assessed)	Yes (GS, HS; concurrent)	No
Triton Knoll, UK (TKOWFL 2012)	8.5 m diameter monopiles, 2,700kJ hammer energy	137	12.1 [1]	465[1]	HS = 230[1] GS = 230[1]	Minor adverse	Yes (GS, HS)	No
Hornsea Project Two, UK	120 x 15 MW jacket	120	<2.0	14.12 –	HS = 0.78	Minor adverse	Yes (GS, HS;	No

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE - Indicative scenario*
(SMart Wind 2015)	foundations (3,000kJ hammer energy) to 180 x 5 MW jackets (1,700kJ)			25.12 (concurrent)	(single); 0.8 (concurrent) GS = 1.29 (single); 1.35 (concurrent)		concurrent)	
Hywind 2, UK	No project ES available (outwith CIA range for HS)						Yes (GS)	No

[1] Based on dBht criteria

*See *Table 12.23* footnote for details.

12.7.1.1.2 Grey seal

545. The potential behavioural avoidance of grey seal from underwater noise associated with piling has been assessed in the CIA.

546. The East Anglia THREE project is in an area of very low grey seal at sea density (see section 12.5.2).

12.7.1.1.2.1 Sensitivity

547. As previously discussed grey seal are assessed as having low sensitivity to behavioural disturbance from underwater noise.

12.7.1.1.2.2 Magnitude

548. Potential impacts from underwater noise during the piling of the proposed East Anglia THREE project has been estimated as potentially 0.55 grey seal being disturbed (based on spatial worst case scenario for concurrent piling).

549. During the construction of the proposed East Anglia THREE project there is the potential overlap with impacts from the construction, operations, maintenance and decommissioning of offshore windfarms; aggregate extraction and dredging noise; operational noise from disposal sites (including the East Anglia Offshore site where underground coal gasification takes place); and possible exploration / commission and / or production activities of oil and gas Licence areas (see *Table 12.22 and 12.23* and *Appendix 12.5* for further details). Many of these plans and projects occur in areas of higher grey seal density that the East Anglia THREE site.

550. A quantified assessment of the magnitude of this temporary effect during the period of construction of the proposed East Anglia THREE project has only been made for pile driving during the construction of other offshore wind farms where sufficient data have been provided within full or draft Environmental Statements (*Table 12.24*).

551. The number of grey seal that could be potentially be disturbed as a result of pile driving during the construction of the proposed East Anglia THREE project and projects where the impacts of pile driving are likely to overlap (indicative scenario based on known construction dates and single piling) and are quantified is 10 grey seals (individual numbers rounded up to nearest whole number; *Table 12.24*), which is approximately 0.03% of the reference population (see *Table 12.13*).

552. The total number of grey seal that could be disturbed as a result of underwater noise from piling during the construction of the proposed East Anglia THREE project and for the projects where the impacts of pile driving could possibly overlap (worst-case scenario based on seven year construction window and concurrent piling) and are

quantified is 2,074 grey seals (7% of the reference population). However, projects where the magnitude of effect is not quantified (including projects other than offshore windfarms) should also be included in the assessment. Although the impacts are not quantified, the total impact of disturbance from pile driving has the potential to increase as a result of pile driving at these projects.

553. The closest site to the East Anglia THREE site is East Anglia ONE and the estimated distance between the maximum ranges for potential behavioural disturbance for seals is estimated to be 19.2km with no overlap (*Table 12.24*).

554. Based on the available evidence, the magnitude of the effect is assessed as negligible for projects likely to overlap (indicative scenario) and medium for projects where there is a possibility of overlap (worst-case scenario).

12.7.1.1.2.3 Impact significance

555. Given the low sensitivity of grey seal to behavioural disturbance from underwater noise and the potential for a medium magnitude of effect, the cumulative impact is assessed as having the potential to be **minor adverse** and not significant, for the worst-case scenario. When the cumulative impact is based on what is thought to be a more indicative scenario the impacts significance is **negligible**.

556. Notably the piling of the proposed East Anglia THREE project would only make a small contribution (disturbing less than one individual) to this overall impact due to the very low densities of grey seal in the East Anglia THREE site and offshore cable corridor.

557. The confidence in this type of cumulative assessment is low and includes a large amount of uncertainty in the data used to inform the assessment, the quantification of impacts, and in the potential for concurrent construction of the offshore windfarms considered in the CIA. However, confidence that the assessment is precautionary in nature is high.

12.7.1.1.3 Harbour porpoise

558. During the assessment of the proposed East Anglia THREE project the potential for PTS was assessed as no impact, as the implementation of embedded mitigation measures should prevent this impact from occurring. No other activities were identified that could lead to PTS in this receptor. As such, the proposed East Anglia THREE project will not contribute any cumulative impact of this nature, and therefore CIA for underwater noise only considers possible avoidance effects.

12.7.1.1.3.1 Sensitivity

559. As previously discussed harbour porpoise are assessed as having low sensitivity to behavioural disturbance and possible avoidance from underwater noise.

12.7.1.1.3.2 Magnitude

560. Potential impacts from underwater noise during the construction of the proposed East Anglia THREE project have been estimated as potentially up to 2,970 harbour porpoise being disturbed as a result of underwater noise during pile driving (based on spatial worst case scenario).

561. During the construction of the proposed East Anglia THREE project there is the potential overlap with impacts from the construction, operations, maintenance and decommissioning of offshore windfarms; aggregate extraction and dredging noise; operational noise from disposal sites (including the East Anglia Offshore site where underground coal gasification takes place); and possible exploration / commission and / or production activities of oil and gas Licence areas (see *Table 12.22 and 12.23* and *Appendix 12.5* for further details)..

562. A quantified assessment of the magnitude of this temporary effect during the period of construction of the proposed East Anglia THREE project has only been made for pile driving during the construction of offshore windfarms where sufficient data have been provided within Environmental Statements (*Table 12.25*).

563. The number of harbour porpoise that could be potentially be disturbed as a result of pile driving during the construction of the proposed East Anglia THREE project and projects where the impacts of pile driving are likely to overlap (indicative scenario based on known construction dates and single piling) and are quantified is 3,761 harbour porpoise (individual numbers rounded up to nearest whole number; *Table 12.25*; *Table 12.26*), which is approximately 1.6% of the reference population (see *Table 12.13*).

564. The total number of harbour porpoise that could be disturbed as a result of underwater noise from piling during the construction of the proposed East Anglia THREE project and for the projects where the impacts of pile driving could possibly overlap (worst-case scenario based on seven year construction window and concurrent piling, *Table 12.25*; *Table 12.26*) and are quantified is 54,992 harbour porpoise (24.2% of the reference population). However, projects where the magnitude of effect is not quantified (including projects other than offshore windfarms) should also be included in the assessment. Although the impacts are not quantified, the total impact of disturbance from pile driving has the potential to increase as a result of pile driving at these projects.

565. There is a predicted overlap in the estimated distance between the maximum ranges for potential behavioural disturbance of harbour porpoise for the East Anglia THREE project and East Anglia ONE, Hornsea One, Galloper and Hornsea Two based on the worst-case scenario (*Table 12.25*). For the indicative scenario where there is a likely overlap in construction periods between projects, there is a predicted overlap in the estimated distance between the maximum ranges for potential behavioural disturbance for the East Anglia THREE project and Hornsea Two (*Table 12.25*).

566. Based on the available evidence, the magnitude of the effect is assessed as low for projects likely to overlap (indicative scenario) and high for projects where there is a possibility of overlap (worst-case scenario).

567. It is important to note that contribution of the East Anglia THREE project to the predicted worst-case cumulative impact total is relatively small, approximately 5.4% of the 54,992 harbour porpoise that could potentially be disturbed by the 17 wind farm projects.

568. The construction periods for other offshore wind farms and potential for cumulative impacts on harbour porpoise during the piling for the proposed East Anglia THREE project is summarised in *Table 12.26*.

569. This assessment takes account of all of the UK based offshore windfarm projects that could be piling at the same time as the East Anglia THREE project. However, there is a large amount of uncertainty as to when pile driving may occur on the various projects, and timing will be affected by available infrastructure and supply chain as well as economic decisions. The assessment, where possible, has taken into consideration potential delays in the commencement of the construction of projects. This quantification does not provide any contribution from other European projects as this type of assessment was not accessible or not made available for many of these projects.

12.7.1.1.3.3 Impact significance

570. Given the low sensitivity of harbour porpoise to possible avoidance from underwater noise and the potential for a low magnitude of effect, the cumulative impact is assessed as having the potential to be **minor adverse**, based on the indicative scenario.

571. For the worst-case scenario the cumulative impact is assessed as having the potential to be **moderate adverse**. However, the construction of the proposed East Anglia THREE project would only make a relatively small contribution to this impact

with a worst-case of 1.3% of the reference population assessed as being disturbed during piling operations.

572. The confidence in this type of cumulative assessment is low and includes a large amount of uncertainty in the data used to inform the assessment, the quantification of impacts, and in the potential for concurrent construction of the offshore windfarms considered in the CIA. However, confidence that the assessment is precautionary in nature is high.

Table 12.25 Cumulative impact assessments (CIA) for the potential behavioural disturbance of harbour porpoise for the (i) worst-case scenario (based on seven years construction window and concurrent piling) and (ii) indicative scenario where there is the likely overlap of piling of consented offshore wind farm projects with piling at the East Anglia THREE site (single piling). Note: these figures relate to the scenarios modelled in the respective EIAs rather than any subsequent revisions in the DCOs.

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE Indicative scenario*
East Anglia THREE	**Spatial worst case: installation of 12m diameter monopiles (3,500 kJ hammer)**	**-**	**Single: 70**	**Single: 6,734.5 Concurrent: 13,469**	**Single: 1,485 Concurrent: 2,970**	**Single: Negligible Concurrent: Minor adverse**	**Yes (concurrent)**	**Yes (single)**
Blyth Demonstration Site, UK (Narec, 2012)	2 x 4 MW monopiles (piling over 2 days)	331	Not modelled	Not modelled	Not modelled	Low	Yes	No
East Anglia One, UK (EAOWFL, 2012)	2.5 m pin piles, 900kJ hammer energy	22	19	1,433	2,006 (site data) 1,433 (SCANS II data)	Not significant	Yes	No
Hornsea One, UK (SMart Wind 2013)	Up to 2,300 kJ hammer energy (monopiles or jackets). Maximum 332 x 5–8 MW turbines	96	28.8 - 46.6	2,544 – 3,555	6,849	Minor to moderate adverse (short to medium term) and minor adverse in long term	Yes	No
Galloper, UK (GWFL	7m diameter	74	49	N/A	1,780[1]	Minor adverse	Yes	No

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE Indicative scenario*
2011)	monopiles							
Rampion, UK (ROWF 2013)	1 x 6.5m monopile, 1,500kJ hammer energy	295	50.6km	N/A	Not modelled	Moderate	Yes	No
Dogger Bank Zone Creyke Beck A, UK (Forewind 2013a)	10+MW, 3,000kJ hammer energy	218	28.5	1,971 (single) and 4,772 (concurrent)	1,288 (single) 3,119 (concurrent)	Negligible (single) to medium (concurrent)	Yes (concurrent)	No
Dogger Bank Zone Creyke Beck B, UK (Forewind 2013a)	10+MW, 3,000kJ hammer energy	242	43	3,483 (single) and 6,723 (concurrent)	2,276 (single) 4,394 (concurrent)	Negligible (single) to medium (concurrent)	Yes (concurrent)	Yes (single)
Beatrice, UK (BOWLL 2012)	2.4m diameter pin piles, 2,300kJ hammer energy	709	N/A	N/A	4,337	Minor adverse	Yes	No
MORL Telford, UK (MORL 2012)	2.5m diameter pin piles	695	21[1]	N/A	5,149[1]	Minor adverse	Yes	No
MORL MacColl, UK (MORL 2012)	2.5m diameter pin piles	688	21[1]	N/A	Included in Telford total	Minor adverse	Yes	No
MORL Stevenson, UK (MORL 2012)	2.5m diameter pin piles	696	21[1]	N/A	Included in Telford total	Minor adverse	Yes	No
Inch Cape, UK (ICOL 2013)	2.438m diameter pin piles, 1,200kJ hammer	516	53.9[1]	N/A	326[1]	Minor adverse	Yes	No

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE - Indicative scenario*
	energy							
Neart na Gaoithe, UK (NnGOWL 2012)	3.5m diameter, 1,635kJ hammer energy	500	N/A	4,668.6[1]	887[1]	Minor adverse	Yes	No
Firth of Forth Phase 1 Seagreen Alpha and Bravo, UK (Seagreen 2012)	2m diameter pile, 1,800kJ hammer energy	515	59[1]	7,173.5[1]	2,543	Negligible	Yes	No
European Offshore Wind Deployment Centre, UK (EOWDC 2011)	3m diameter pile	581	22km	N/A	N/A	Minor adverse	Yes	No
Dogger Bank Zone Teesside A (Forewind 2013b)	200 jackets, 3,000 kJ hammer energy	231	33	2,618 (single) and 6,008 (concurrent)	1,920 (single) 4,302 (concurrent)	Negligible (single) to medium (concurrent)	Yes (concurrent)	No
Dogger Bank Zone Teesside B , UK(Forewind 2013b)	200 jackets, 3,000 kJ hammer energy	245	33.5	2,834 (single) and 5,489 (concurrent)	2,035 (single) 3,931 (concurrent)	Low (single) to medium (concurrent)	Yes (concurrent)	No
Triton Knoll, UK (TKOWFL 2012)	8.5 m diameter monopiles, 2,700kJ hammer energy	137	16.6 [1]	863 [1]	948[1]	Minor adverse	Yes	No

Name of Project	Noise modelling scenario	Distance from EA3 (km)	Maximum range for potential behavioural disturbance (km)	Total area affected (km^2)	Maximum number of individuals disturbed	Predicted significance of impact	Possible 7 year construction window overlaps with East Anglia THREE - Worst-case scenario*	Likely overlap of construction with East Anglia THREE - Indicative scenario*
Hornsea Two, UK (SMart Wind 2015)	120 x 15 MW jacket foundations (3,000 kJ hammer energy) to 180 x 5 MW jackets (1,700 kJ)	120	62	3,758 – 5,201 (concurrent)	7,855 (single) and 11,451 (concurrent)	Moderate adverse	Yes (concurrent)	No
Hywind 2, UK	No project ES available						Yes	No

[1] Based on dB_{ht} criteria

*See *Table 12.23* footnote for details.

Table 12.26 Summary of construction programme for other offshore wind farms included in the cumulative assessment for harbour porpoise showing the maximum and indicative (in BOLD) numbers of animals within the zone of possible avoidance and potentially affected by piling noise on any one day during piling for each year of construction. These numbers are for the spatial maximum scenarios, with the potential temporal overlap of the offshore construction periods are shown by cells shaded grey.

Name of Project	Tier	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
East Anglia THREE (single; concurrent)							**1,485**; 2,970	**1,485**; 2,970	**1,485**; 2,970			
Blyth Demonstration Site, UK (Narec, 2012)	3	N/A	N/A	N/A								
East Anglia One, UK (EAOWFL, 2012)	3		2,006	2,006								
Hornsea One, UK (SMart Wind 2013)	3				6,849	6,849						
Galloper, UK (GWFL 2011)	3		1,780[1]	1,780[1]								
Rampion, UK (ROWF 2013)	3		N/A	N/A	N/A							
Dogger Bank Creyke Beck A, UK (Forewind 2013a) (single; concurrent)	3		1,288; 3,119	1,288; 3,119	1,288; 3,119	1,288; 3,119	1,288; 3,119[+]	1,288; 3,119[+]	1,288; 3,119[+]	1,288; 3,119	1,288; 3,119	1,288; 3,119
Dogger Bank Creyke Beck B, UK (Forewind 2013a) (single; concurrent)	3		2,276; 4,394	2,276; 4,394	2,276; 4,394	2,276; 4,394	**2,276;** 4,39[+]	**2,276;** 4,394[+]	**2,276;** 4,394[+]	2,276; 4,394	2,276; 4,394	2,276; 4,394
Beatrice, UK (BOWL 2012)	3			4,337	4,337							
MORL Telford, UK (MORL 2012)	3			5,149[1]	5,149[1]	5,149[1]						
MORL MacColl, UK (MORL 2012)	3			Included in Telford total								
MORL Stevenson, UK (MORL 2012)	3			Included in Telford total								
Inch Cape, UK (ICOL 2013)	3			326[1]	326[1]	326[1]						
Neart na Gaoithe, UK (NnGOWL 2012)	3	887[1]	887[1]	887[1]								
Seagreen Alpha and Bravo, UK (Seagreen 2012)	3	2,543	2,543	2,543								
European Offshore Wind	3			N/A								

Name of Project	Tier	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Deployment Centre, UK (EOWDC 2011)												
Dogger Bank Teesside A (Forewind 2013b) (single; concurrent)	4			1,920; 4,302	1,920; 4,302	1,920; 4,302	1,920; 4,302[+]	1,920; 4,302[+]	1,920; 4,302[+]	1,920; 4,302	1,920; 4,302	1,920; 4,302
Dogger Bank Teesside B , UK(Forewind 2013b) (single; concurrent)	4			2,035; 3,931	2,035; 3,931	2,035; 3,931	2,035; 3,931[+]	2,035; 3,931[+]	2,035; 3,931[+]	2,035; 3,931	2,035; 3,931	2,035; 3,931
Triton Knoll, UK (TKOWFL 2012)	3		948[1]	948[1]	948[1]	948[1]	948[1]	948[1]				
Hornsea Two, UK (SMart Wind 2015) (single; concurrent)	4			7,855; 11,451	7,855; 11,451	7,855; 11,451	7,855; 11,451	7,855; 11,451	7,855; 11,451	7,855; 11,451		
Hywind 2, UK			N/A	N/A								

[1] Based on dB_{ht} criteria

[+] The most likely potential for overlap of piling has been assessed based on known piling scenarios and what would be achievable. It is highly unlikely that all four Dogger Bank projects would be piling at the same time and concurrent piling would take place at the site, therefore only one project has been included as potentially overlapping with East Anglia THREE.

12.7.1.2 Underwater noise from vessels and other noise sources

573. During the construction, operation and maintenance, and decommissioning of the proposed East Anglia THREE project there is the potential cumulative effects from increased noise disturbance to marine mammals that may arise from vessel traffic and other noise sources with other offshore developments (*Table 12.21*).

574. Underwater noise levels during the operational phase are predicted to be considerably lower than those of the construction phase, for example being limited to fewer numbers of maintenance vessel traffic. However, due to the potentially overlapping construction and operation and maintenance timeframes, the cumulative assessment for increased vessel and other sources of noise is considered for construction through to operation and maintenance and decommissioning.

575. Vessel transits to and from offshore developments will, as far as possible, remain within existing shipping routes and construction/operation and maintenance activity will be localised within the offshore development site. Most vessels will be slow moving and can generate low-frequency noise, which could be carried over several kilometres. Studies indicate that harbour porpoise and harbour seal can detect ship noise of 2kHz up to around 3km and the zone of audibility will be approximately 20km (Thomsen et al. 2006).

576. For other sources of underwater noise, for example ploughing / jetting / pre-trenching or cutting for installation of cables and rock dumping for protection of the cables, although potentially covering large distances, the effects would be temporary and any disturbance from noise will tend to be localised and less than the ranges predicted for vessel noise.

577. Very little research has been carried out into the effects of dredging and aggregate extraction on the behaviour of marine mammals. However, Diederichs et al. (2010) found short-term avoidance in harbour porpoises at ranges of 600 m from a Trailer Suction Hopper Dredger (TSHD).

578. The installation of wave/tidal projects is typically using drilled pins or gravity bases; percussive piling is not anticipated to be used as an installation method, and therefore the noise impacts during construction will have a very limited range, especially compared to offshore wind farms.

579. Noise modelling of the potential noise effects of operational offshore wind turbines indicated that harbour porpoise were only predicted to exhibit a behavioural response, where 10% of animals encountering the noise field were expected to move away, up to 18.84km (Marmo et al. 2013).

580. The exploration, development and commissioning of oil and gas fields could involve seismic surveys, drilling or other activities which could result in additional noise sources. However, it is impossible to determine which, if any, of these activities could be taking place during the proposed construction, operation and maintenance, or decommissioning of the East Anglia THREE project.

581. During the construction, operation and maintenance and decommissioning of the proposed East Anglia THREE project there is the potential overlap with impacts from the construction, operations, maintenance and decommissioning of offshore windfarms; aggregate extraction and dredging noise; operational noise from disposal sites (including the East Anglia Offshore site where underground coal gasification takes place); and possible exploration / commission and / or production activities of oil and gas Licence areas (see *Table 12.22 and 12.23* and *Appendix 12.5* for further details).

582. For many of the plans or projects screened into the CIA (*Appendix 12.5*) the potential impacts have not been quantified, and there is also a large amount of uncertainty around decommissioning impacts. It is therefore not possible to make a quantified CIA for all of the plans and projects screened in.

12.7.1.2.1 Sensitivity

583. As stated previously, harbour porpoise are considered to have low sensitivity to disturbance from noise, and harbour and grey seal are also considered to have low sensitivity to disturbance.

12.7.1.2.2 Magnitude

584. Although there is a high level of existing noise in the area, to which marine mammals appear to have acclimatised, and the ranges of potential disturbance from vessels and other sources are generally localised, the cumulative increase represents a potential long term increase in noise disturbance. The magnitude of effect is therefore, considered to be low.

12.7.1.2.3 Impact significance

585. Impacts in all species are assessed as **minor adverse** and not significant. In the case of harbour seal (at the UK level) the impact is also assessed as **minor adverse**.

586. The confidence in the data used in this assessment is medium.

12.7.2 Indirect impacts - prey species

587. Potential impacts on fish species during construction can result from increased suspended sediment concentrations and sediment re-deposition and underwater noise (leading to mortality, physical injury, auditory injury or behavioural responses);

the potential impacts on fish species during operation and maintenance are physical disturbance and loss or changes of seabed habitat, introduction of hard substrate, operational noise, and electromagnetic fields (EMF); and during decommissioning potential impacts on fish species include physical disturbance, loss or changes of habitat, increased suspended sediment concentrations, re-mobilisation of contaminated sediments and underwater noise (*Table 12.21*). Some of the impacts could be negative with fish species moving away or being lost from an area, some impacts could have a negative or positive effect, such as possible changes in species composition, and other impacts could result in a positive effect, such as the aggregation of prey around seabed structures.

588. All of the plans and projects summarised in *Table 12.22* have the potential to have indirect impacts on marine mammals through effects on prey species. The effects on marine mammals could include changes in distribution, abundance and community structure, increased competition with other marine mammal species, increased susceptibility to disease and contaminants, and implications for reproductive success, which could potentially impact individuals throughout their range or at different times of the year. However, any changes to prey tend to be localised and temporary in nature. In addition, if prey species are disturbed from an area, it is highly likely that marine mammals will also be disturbed from the area over a potentially wider range than prey species.

589. During the construction, operation and maintenance and decommissioning of the proposed East Anglia THREE project there is the potential overlap with impacts on prey species associated with the construction, operation, maintenance and decommissioning of offshore windfarms and wave and tidal projects; aggregate extraction and dredging noise; operational noise from disposal sites and possible exploration / commission and / or production activities of oil and gas Licence areas (*Table 12.22*).

590. For many of the plans or projects screened into the CIA (*Appendix 12.5*) the potential impacts have not been quantified, and there is also a large amount of uncertainty around decommissioning impacts. It is therefore not possible to make a quantified CIA for all of the plans and projects screened in. In addition, given the distance of the majority of the projects screened in to the in-combination assessment from the East Anglia THREE site, there would be few pathways for a cumulative impact on prey within the East Anglia THREE site.

12.7.2.1 Sensitivity

591. As previously discussed harbour seal are assessed as having low sensitivity to changes in prey availability, grey seal are considered to have low sensitivity to

changes in prey resources, and harbour porpoise are also considered to have low sensitivity to this impact.

12.7.2.2 Magnitude

592. It is not possible to make an overall quantified assessment of the potential magnitude of the potential changes on prey species on marine mammals during the construction, operation and maintenance and decommissioning of the proposed East Anglia THREE project, in conjunction with other projects that could simultaneously be having an impact on prey species within their range. The impacts on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. However, there is the potential long term duration; therefore the magnitude for all marine mammal species is considered to be low, rather than negligible.

12.7.2.2.1 Impact significance

593. Based on the sensitivity of harbour seal, and the magnitude of effect, the cumulative impact is assessed as having the potential to be **minor adverse** for the reference population and for the UK South-east England MU.

594. Based on the sensitivity of grey seal and the magnitude of effect the cumulative impact is assessed as having the potential to be **minor adverse**.

595. Based on the sensitivity of harbour porpoise and the magnitude of effect the cumulative impact is assessed as having the potential to be **minor adverse**.

596. The confidence in this cumulative assessment is low due to the large amount of uncertainty in quantifying the potential magnitude of effect from the plans and projects included in the assessment. However, confidence that the assessment is precautionary in nature is high.

12.7.3 Direct interaction - collision risk

597. A cumulative increase in vessel traffic to and from the East Anglia THREE site during construction, operation and maintenance and decommissioning activities along with the potential increased vessel movements associated with other offshore developments may increase the potential risk of collision and possible injury to marine mammals. In addition, wave and tidal arrays also pose a potential collision risk for marine mammals.

598. There is a possible risk to marine mammals from collision with vessels, which has the potential to cause mortality and injury. The injuries caused are typically either

lacerations from the propellers or blunt traumas from impact with the hull, which can result in fractured skulls, jaws or vertebrae. It is possible that collisions which are non-fatal can leave the animal vulnerable to secondary infection, other complications or predation (Wilson et al. 2007). Marine mammals are able to detect the presence of vessels and are highly mobile, and would be expected to largely avoid vessel collision. However, there have been observed signs of physical trauma (blunt trauma or propeller cuts) possibly indicating vessel strike in other areas. It is possible that distraction whilst undertaking other activities, such as foraging, and social interactions are reasons why collisions occur. Marine mammals in the area may be habituated to the presence of vessels and therefore be expected to be able to detect and avoid construction vessels. However, it is also possible the masking from other noise may limit the ability of cetaceans to detect vessels.

599. Corkscrew injuries to seals and the potential interaction with ducted propellers has been an issue that has been discussed since 2008 when there was increasing concern over the number of seal carcasses washed up at various locations on the UK coast all displaying the same fatal injuries. Interaction with ship's propellers, and more specifically ducted propellers, was considered the most likely cause, based, to some extent, on the conclusion that such a wound could not be inflicted by any natural predator and the results of scale model trials. However, there is now incontrovertible evidence that such injuries can be caused by grey seal predation. At the same time, however, it would be premature to completely discount the possibility that some of the corkscrew injuries are caused by interactions with propellers. The model trials carried out by SMRU showed that similar injury patterns could be caused by ducted propellers (Thompson et al. 2010; Russel and McConnell 2014). The advice from the SNCBs (i.e. Scottish Natural Heritage, Natural England, Natural Resources Wales, Joint Nature Conservation Committee) in February 2015 is that, based on the latest information it is considered very likely that the use of vessels with ducted propellers may not pose any increased risk to seals over and above normal shipping activities, although all possible care should be taken in the vicinity of major seal breeding and haul-out sites to avoid collisions.

600. Wave and tidal arrays pose a potential collision risk for marine mammals. However, the interaction of wave and tidal energy devices and marine mammals is largely unknown. The likelihood for collision may depend on many variables such as underwater visibility, detectability of the devices, the size and type of devices, location and the rotation speed of the rotor blades.

601. All of the plans and projects summarised in *Table 12.22* have the potential to have permanent impacts on marine mammals through direct physical impacts (e.g. as a

result of ship strikes, ducted propellers in vessels or collision with tidal turbines). These impacts on marine mammals could potentially impact individuals throughout their range and therefore have possible population effects, if levels of impact are high enough to have a significant effect.

602. During the construction, operation and maintenance and decommissioning of the proposed East Anglia THREE project there is the potential collision risk from vessels associated with the construction, operation, maintenance and decommissioning of offshore windfarms and wave and tidal projects; aggregate extraction and dredging noise; operational noise from disposal sites and possible exploration / commission and / or production activities of oil and gas Licence areas (*Table 12.22*).

603. For many of the plans or projects screened into the CIA (*Appendix 12.5*) the potential impacts have not been quantified, and there is also a large amount of uncertainty around decommissioning impacts. It is therefore not possible to make a quantified CIA for all of the plans and projects screened in.

12.7.3.1 Sensitivity

604. As previously discussed, harbour seal and grey seal are assessed as having negligible to low sensitivity to this type of impact and harbour porpoise have a low sensitivity.

12.7.3.2 Magnitude

605. It is not possible to make a quantified assessment of the potential magnitude of effect associated with collision risk for harbour seal, grey seal and harbour porpoise throughout the relevant reference population boundaries during the construction, operation and maintenance and decommissioning of the proposed East Anglia THREE project, in conjunction with other projects that could also have a possible collision risk.

606. Although all projects will increase the amount of vessel activity over the range of each species, there are already large numbers of vessel movements across the area. The cumulative effects of all the projects have the potential to increase the magnitude of effect from negligible to low for the proposed East Anglia THREE project.

12.7.3.3 Impact significance

607. Based on the sensitivity of harbour seal and grey seal, and the magnitude of effect, the cumulative impact is assessed as having the potential to be **minor adverse** for the reference population, and also potentially be **minor adverse** for the UK South-east England MU.

608. However, the proposed East Anglia THREE project would only make a very small contribution (0.042% of reference population for grey seal and an estimated 0.0074% of the harbour seal South-east MU) to this cumulative impact due to the very low densities of harbour seal and grey seal in the East Anglia THREE site and offshore cable corridor. The confidence in this assessment is low due to the large amount of uncertainty surrounding the mechanism of this impact, and the potential for plans and projects included in the CIA to mitigate the potential impact where they occur in high risk areas. The proposed East Anglia THREE project is in a low risk area. However, confidence that the assessment is precautionary in nature is high.

609. Based on the sensitivity of harbour porpoise and the magnitude of effect the cumulative impact is assessed as having the potential to be **minor adverse**.

610. However, the proposed East Anglia THREE project would only make a small contribution (an estimated 0.11% of the harbour porpoise reference population) to this cumulative impact. The confidence in this assessment is low due to the large amount of uncertainty. However, confidence that the assessment is precautionary in nature is high.

12.7.4 Mitigation of Cumulative Impacts

611. It is important to consider apportionment in relation to CIA. Given the low densities of marine mammals within the East Anglia THREE site, it is clear that the larger part of any cumulative impact on the species assessed is due to other projects. Indeed in many cases there is little evidence to demonstrate influence of East Anglia THREE on the significance of the cumulative impact assessment.

612. EATL confirms their ongoing support of strategic initiatives and will continue to work with other developers, Regulators and SNCBs in order to understand and reduce cumulative impacts where possible and improve the evidence base.

613. EATL and both parent companies are strong supporters of industry projects established to understand the consequences of displacement on harbour porpoise based on empirical data. Both parties are financially supporting Depons (www.depons.au.dk) and AK Schallschutz (The study aims to address three specific topics: i) analyses of small-scale spatiotemporal disturbance effects of pile driving on porpoises in relation to piling-related parameters such as noise mitigation, noise level and piling duration, ii) analyses of trans-regional changes in porpoise abundance and distribution in parts of the German North Sea in relation to wind farm construction activities taking into account cumulative effects and iii) predicting consequences of such disturbances caused by offshore wind farm construction for the population of harbour porpoises in parts of the German Bight).

12.8 Transboundary Impacts

614. The highly mobile nature of marine mammals species considered in this assessment means that there are potential transboundary impacts for each receptor (*Table 12.27*). These transboundary impacts are already considered in the assessment.

615. For harbour porpoise the extent of the reference population includes UK, Dutch, German, French, Belgian, Danish and Swedish waters. For harbour seal the extent of the reference population includes UK, Dutch, German, Belgian and French waters. For grey seal the extent of the reference population includes UK, Dutch, German, Belgian, Danish and French waters.

Table 12.27 List of Other EU Member States Retained in the Transboundary Impact Assessment in Relation to the Topic

EU member state	Commentary
Netherlands	See section 12.5 for justification.
Germany	See section 12.5 for justification.
Belgium	See section 12.5 for justification.
Denmark	See section 12.5 for justification.
France	See section 12.5 for justification.
Sweden	See section 12.5 for justification.

12.9 Inter-relationships

616. Inter-relationships are covered as part of the assessment, this sections serves as a sign-posting for inter-relationships (*Table 12.28*).

Table 12.28 Chapter topic inter-relationships

Topic and description	Related Chapter	Where addressed in this Chapter
Prey species	Chapter 11 Fish and Shellfish Ecology	Section 12.6.1.4 Section 12.6.2.4 Section 12.6.3.2
Vessel noise, ship strikes and ducted propellers	Chapter 15 Shipping and Navigation	Section 12.6.1.2, 12.6.1.5 and 12.6.1.6 Section 12.6.2.2, 12.6.2.5 and 12.6.2.6 Section 12.6.3.3 and 12.6.3.4
Underwater noise (pile driving and operational noise)	Chapter 9 Underwater Noise and Electromagnetic Fields	Section 12.6.1.1

12.10 Summary

617. The results of the impact assessment are summarised in *Table 12.29*. At a project level the impacts from the proposed East Anglia THREE project are assessed as **minor adverse** at worst. No significant impacts were identified. The conclusions of the assessment are based on varying levels of confidence in the data used in the assessment. However the conclusions of the assessment are of a precautionary nature where there is high uncertainty or low confidence in the data.

618. The results of the CIA are summarised in *Table 12.30* showing that potential significant cumulative impacts (**moderate adverse**) are predicted from underwater noise due to piling for harbour porpoise, based on the worst-case scenario, however based on the indicative scenario the potential impacts are not predicted to be significant (**minor adverse**). However, it should be noted that the contribution of the proposed East Anglia THREE project to this cumulative assessment is very small.

619. The cumulative assessment includes a large amount of uncertainty, especially in consideration of which other offshore windfarms could be pile driving at the same time as the proposed East Anglia THREE project. In dealing with uncertainty and low confidence in the data used in the CIA, a precautionary approach has been taken in which it is assumed that the worst-case scenario for each project is taken forward.

620. The cumulative impact of piling noise on harbour porpoise is concluded to have the potential to be significant in EIA terms using the definitions of sensitivity, magnitude and impact significance set out in this assessment. It is important to remember that the potential for significance is based on a very simplistic approach. In biological terms, however, it is likely that some of the impacts identified in the CIA do not have

a significant impact on the conservation status of the reference population. Ongoing work streams, such as DEPONS projects and the PCoD will, when results are available, allow consideration of the biological fitness consequences of disturbance from underwater noise, and the conclusions of a quantitative impact assessment to be put into a population level context.

Table 12.29 Assessment of potential impacts for marine mammals based on worst-case scenario

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction						
Underwater noise – pile driving – Lethal and physical injury effects	Harbour porpoise, grey seal and harbour seal	High	No change	**No impact**	No further mitigation suggested beyond embedded mitigation (soft start and MMMP)	**No impact**
Underwater noise – pile driving – auditory injury (PTS)	Harbour porpoise	High	No change	**No impact**		**No impact**
	Grey seal and harbour seal	Medium	Low	**Minor adverse**		**Minor adverse**
Underwater noise – pile driving – TTS onset/fleeing response/likely avoidance	Harbour porpoise	Medium	Negligible	**Negligible**		**Negligible**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Underwater noise – pile driving – behavioural response (possible avoidance of area)	Harbour porpoise	Low	Low	**Minor adverse**		**Minor adverse**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Underwater noise – vessels – possible avoidance	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Underwater noise - seabed preparations, rock dumping and cable installation – possible avoidance	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Impacts upon prey species	Harbour porpoise	Low	Negligible	**Negligible**	No further mitigation suggested beyond embedded	**Negligible**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
					mitigation.	
Vessel interactions – ship strikes	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey and harbour seal	Negligible	Negligible	**Negligible**		**Negligible**
Vessel interactions – ducted propellers	Grey seal and harbour seal	Low	Negligible	**Negligible**	None	**Negligible**
Operation						
Underwater noise – turbines – possible avoidance	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Underwater noise – vessels – possible avoidance	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Underwater noise from any maintenance work, such as additional rock dumping or cable re-burial – possible avoidance	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Impacts upon prey species	Harbour seal and harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey seal	Low	Negligible	**Negligible**		**Negligible**
Vessel interactions – ship strikes	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey and harbour seal	Negligible	Negligible	**Negligible**		**Negligible**
Vessel interactions – ducted propellers	Grey seal and harbour seal	Low	Negligible	**Negligible**	None	**Negligible**
Physical barrier	Harbour porpoise, grey seal and harbour seal	Negligible	Negligible	**Negligible**	None	**Negligible**
Decommissioning						
Underwater noise	Harbour	Low	Negligible	**Negligible**	None	**Negligible**

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
– all sources – possible avoidance	porpoise					
	Grey seal and harbour seal	Low	Negligible	**Negligible**		**Negligible**
Impacts upon prey species	Harbour seal and harbour porpoise	Low	Negligible	**Negligible**	No further mitigation suggested beyond embedded mitigation.	**Negligible**
	Grey seal	Low	Negligible	**Negligible**		**Negligible**
Vessel interactions – ship strikes	Harbour porpoise	Low	Negligible	**Negligible**	None	**Negligible**
	Grey and harbour seal	Negligible	Negligible	**Negligible**		**Negligible**
Vessel interactions – ducted propellers	Grey seal and harbour seal	Low	Negligible	**Negligible**	None	**Negligible**

Table 12.30 Potential cumulative impacts identified for marine mammals

Potential Impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Underwater noise – piling – possible avoidance	Harbour porpoise	Low	Low* to High**	**Minor* to Moderate** adverse**	No further mitigation suggested beyond embedded mitigation (soft start and MMMP)	**Minor* to Moderate** adverse**
	Grey seal	Low	Negligible* to Medium**	**Negligible* to Minor adverse****		**Negligible* to Minor adverse****
	Harbour seal [UK level]	Low	Negligible*&** [Negligible* to Medium**]	**Negligible*&** [Negligible* to Minor adverse**]**		**Negligible*&** [Negligible* to Minor adverse**]**
Underwater noise – all other sources – possible avoidance	Harbour porpoise	Low	Low	**Minor adverse**	None	**Minor adverse**
	Grey seal	Low	Low	**Minor adverse**		**Minor adverse**
	Harbour seal	Low	Low	**Minor adverse**		**Minor adverse**
Indirect impacts - prey species	Harbour porpoise	Low	Low	**Minor adverse**	None	**Minor adverse**
	Grey seal	Low	Low	**Minor adverse**		**Minor adverse**
	Harbour seal	Low	Low	**Minor adverse**		**Minor adverse**
Direct interactions – collision risk	Harbour porpoise	Low	Low	**Minor adverse**	None	**Minor adverse**
	Grey seal	Negligible to Low	Low	**Minor adverse**		**Minor adverse**
	Harbour seal	Negligible to Low	Low	**Minor adverse**		**Minor adverse**

* Indicative scenario: consented projects where construction is likely to overlap with construction of East Anglia THREE (based on known construction/piling dates and single piling)

** Worst-case scenario: projects where construction could possibly overlap with construction of East Anglia THREE (based on seven year construction window from date of consent and concurrent piling)

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Chapter 12 Ends Here