East Anglia Offshore Wind

VATTENFALL

SCOTTISHPOWER RENEWABLES

East Anglia THREE

Chapter 13

Offshore Ornithology

Environmental Statement
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Author – MacArthur Green
East Anglia THREE Limited
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13 OFFSHORE ORNITHOLOGY

13.1 Introduction

1. This chapter has been prepared by MacArthur Green from survey and assessment work initiated by APEM Ltd, and presents the assessment of the potential impacts on ornithological receptors that might arise from construction, operation and decommissioning of the offshore components of the proposed East Anglia THREE project.

2. This chapter describes the offshore components of the proposed project in relation to ornithology; the consultation that has been held with stakeholders; the scope and methodology of the assessment; the avoidance and mitigation measures that have been embedded through project design; the baseline data on birds and important sites and habitats for birds acquired through desk study and surveys and assesses the potential impacts on birds.

3. Full details of the baseline data acquired through the surveys specifically carried out within the East Anglia THREE site and a 4km buffer can be found in *Appendix 13.2 Baseline Offshore Ornithology Technical Report*.

13.2 Consultation

4. This chapter also draws upon the information gathered and assessment carried out for East Anglia ONE. The East Anglia ONE project was subject to consultation prior to the submission of its application for consent in November 2012. The record of consultation on the offshore ornithology component of the East Anglia ONE project is presented in section 12.2 of Chapter 12 Ornithology Marine and Coastal of the East Anglia ONE Environmental Statement (this has been included in *Appendix 13.1*).

5. The East Anglia ONE project was also subject to further consultation as part of the Hearing process that took place between June and December 2013. An Offshore Statement of Common Ground (SoCG) was developed and agreed jointly with Natural England and the Joint Nature Conservation Committee (JNCC) through a series of meetings and correspondence, with that SoCG agreed and signed in July 2013. This was prior to the submission of Written Representations by Natural England and JNCC and discussions and agreement on issues continued through the examination process. East Anglia ONE was consented in June 2014 and the decisions

made in relation to potential ornithological impacts have been reviewed and taken into consideration in the assessment for the proposed East Anglia THREE project.

6. Detailed consultation and iteration of the overall approach to the impact assessment on ornithological receptors was undertaken through the Evidence Plan process for the proposed East Anglia THREE project. An Ornithology Expert Technical Group (OETG) was convened, involving Natural England and the Royal Society for the Protection of Birds (RSPB). The Schedule of Agreement and Non-agreement produced as part of the minutes to the Ornithology Expert Technical Group of the Evidence Plan is provided in *Appendix 13.1*. The OETG has provided a forum for consultation from 2013 up to the submission of this ES.

7. Further consultation took place as a result of the publication of the Preliminary Environmental Information Report (PEIR) in May 2014, with formal consultee comments taking the form of a section 42 consultation response.

8. The comments arising from the consultation process (scoping, PEIR and Evidence Plan Process) and the Applicant's response made to each are summarised in *Tables 13.1a*, *13.1b, 13.1c and 13.1d*.

Table 13.1a Consultation Responses

Consultee	Date / Document	Comment	Response / where addressed in the ES
East Anglia ONE			
NE and JNCC	Offshore SoCG July 2013	Agreed (subject to caveats expressed in their Written Representation): • The techniques used to analyse the data • The impact assessment methodologies applied • Characterisation of the baseline • The application of a correction factor for diving auks	The proposed East Anglia THREE project builds on the approach that was agreed for East Anglia ONE.
East Anglia THREE Scoping			
JNCC/NE PINS	Scoping Opinion from PINS, Dec 2012	• Defining magnitude of impact and sensitivity of receptor • Assessment methodology should be agreed with the relevant statutory consultees • To consider impacts on red-throated diver of Outer Thames Estuary SPA • To consider ornithological impacts across EEA state boundaries	Discussed as part of Evidence Plan process (*Appendix 13.1*) and methodology given in section 13.4.3 In section 13.7.1 In section 13.9

Consultee	Date / Document	Comment	Response / where addressed in the ES
East Anglia THREE Evidence Plan			
NE and RSPB	OETG Mtg 1 Sept 2013	In principle agreement: • Sufficient baseline survey data have been collected to inform the assessment • No additional survey required for the offshore cable corridor • Population estimates will be design based Further information sought on: • Use of flight height bands in CRM • Validation of method for flight heights • Determination of bio-periods • Definition of magnitude Amendment to approach such that: • SPA and SSSI Assemblage species assessed	Agreement on topics and how unresolved issues are to be addressed was recorded in the Schedule attached to the meeting minutes. A copy is provided in Appendix 13.1.
NE and RSPB	OETG Mtg 2 Nov 2013	In principle agreement: • The following impacts will be assessed: Construction Disturbance / Displacement Indirect through prey species Operation Disturbance / Displacement Indirect through prey species Collision risk Barrier effect Decommissioning Disturbance / Displacement Indirect through prey species Further information sought on: • Comparison of offshore surveys from East Anglia ONE, THREE and FOUR • Refining bio-periods to account for overlap of migration and breeding Amendment to approach such that: • Migration model better accounts for seabird passage All noted that cumulative assessment required strategic decisions outside of the project level discussions	Agreement on topics and how unresolved issues are to be addressed was recorded in the Schedule attached to the meeting minutes. A copy is provided in *Appendix 13.1*.
NE, RSPB and SCC	OETG Mtg 3 Mar 2014	In principle agreement (based on draft meeting minutes): • The process of high level HRA screening Further information sought on:	Agreement on topics and how unresolved issues are to be addressed was recorded in the

Consultee	Date / Document	Comment	Response / where addressed in the ES
		• Apportionment between bio-periods • Site specific and generic flight height data • Sensitivity of CRM outputs to flight height and avoidance rate Amendment to approach such that: • Potential scale of construction impacts on red-throated diver examined by comparing density within each past survey due to changing survey methods • Additional coastal SPAs are screened in for detailed assessment in HRA	Schedule attached to the meeting minutes. A copy is provided in *Appendix 13.1*.

Table 13.1b Detailed comments on PEIR and following workshop provided by Natural England, and East Anglia THREE Limited response

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
Section 13.5.2	Baseline environment and assessment of nature conservation value for each bird species Potential impacts during construction - in terms of the assessment of bird disturbance consideration should also be given to potential overlap in works associated with East Anglia FOUR. It was noted that Kittiwake, LBBG and Herring gull are listed under local importance; we query whether this should be changed to Regional importance	It was agreed in the workshop that East Anglia THREE Limited would provide Programme Activities work log to inform assessment of impacts. It was agreed that the proposed East Anglia THREE project would review the importance levels.	Detailed construction programme is provided in Chapter 5. Nature conservation levels have been updated in light of comments and reflecting recent reviews (e.g. BDMPS work, Furness 2015).
Table 13.14	Table 13.14 (page 35) covers species for disturbance and displacement screening – this presumably means species will be screened in or out for EIA assessment. We note and agree that red throated diver,	Natural England advised that a complete audit trail should be included for this species.	Puffin included in displacement assessment (section 13.7.1.1)

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	guillemot and razorbill are screened in. However, we disagree that the puffin's sensitivity to disturbance and displacement is low, and with the proposal to screen them out. We advise that puffin should be screened in for further assessment.		
	We disagree that the conclusions for impacts of displacement during the construction phase on guillemot and razorbill (page 38) are considered negligible. In addition to any impacts of displacement in the construction phase, there may be impacts that are ongoing into the operational phase.	Natural England refers East Anglia THREE to the latest deadline VI response for Dogger Bank Creyke Beck in which displacement is considered for guillemot and razor bill.	Construction displacement assessment has been updated (Section 13.7).
Table 13.5	We note that Red throated divers were screened out on basis that regionally important numbers are within the migration season only. We would question the rationale not considering the importance of migration peaks, and suggest they are screened in.	East Anglia THREE explained in the workshop that the offshore cable route was screened in, but the windfarm was not due to limited numbers of birds in that area.	Red-throated diver screened in. Assessment considers impacts during different seasons and presents rationale for impacts screened in / out.
Table 13.19	Presenting displaced guillemots between 20% and 40% and mortality of 1%. As per the JNCC/ NE guidance, we recommend using a range of figures from 30-70% displacement and 1-10% mortality.	Natural England explained that presenting a range of displacement and mortality percentages in the conclusions would ensure a risk based approach.	Displacement and mortality ranges have been presented as requested (section 13.7.1.1).
114	We welcome the commitment to refine the Band model and use the	Repeat of earlier comment, but included again to aid East Anglia THREE in	A range of collision model outputs is presented in the technical reports for this

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	appropriate avoidance rates to use with each version of the model. It should be noted that Avoidance rates cannot be directly transferred from one model to another. The generic 98% AR based on use with the Basic Band Models is not directly transferable for use with the Extended Band Model and, in order to use the Extended Band Model, different ARs based on the no avoidance collision rate outputs of the Extended Model need to be generated. Natural England recommends that that the ES shows outputs from a range of models and avoidance rates.	identifying all sections that require potential amendment.	chapter and the collision sections as requested.
117	Natural England welcomes the inclusion of Option 1 with 98% AR but advise that the appropriate equivalent avoidance rate is calculated for Option 3.		Collision estimates have been presented as per the Statutory Nature Conservation Bodies' (SNCBs) recommendations following the BTO review (Cook et al. 2014).
119	Skuas and terns estimated using a basic broad front migration simulation. It states "see Appendix 13.4" but there is no explanation of the migration simulation. We would need more details of the method of migration estimates. We advise not using either the SOSS method or Migropath model for these species as they do not follow a coast to coast path. Instead we advise adopting the Marine Scotland migrant	It was agreed in the workshop that further explanation of the methodology associated with the migration simulation would be provided in the Environmental Statement.	The collision risk assessment for migrant seabirds has been updated following the methods suggested (WWT & MacArthur Green 2013) and is provided in section 13.7.2.3.

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	method approach. However, we would welcome chance to discuss refinements to that general approach of modelling migration along a front perpendicular to a coastline.		
121	This section states "The seasonal mortality numbers were then compared to the relevant seasonal population mortality estimates for each species on an international, national and regional scale." However, it is not clear what these scales are based on. We recommend making this clear in the ES.	It was agreed that appropriate signposting would be included in the forthcoming ES.	Seasonal population estimates have been taken from the BDMPS review work (Furness 2014) commissioned by NE.
Table 13.26:	Table 13.26 should include Option 1 with 98% alongside. Natural England notes that the mortality rates are presented using Band Model 3 in Table 13.26, and recommend that the table includes mortality rates from a range of Band model Options and Avoidance Rates. Also in addition to calculating the percentage increase in mortality from the predicted mortality using Option 1 with 98% AR, we recommend basing the impacts on the cumulative total throughout the year, and not separated into different biological seasons. Until the summed impact across the seasons, and the greater mortality predictions from	Avoidance Rates to be used as per the Statutory Nature Conservation Bodies' (SNCBs) recommendations following the BTO review (Cook et al. 2014 with Basic Band Model Option 1 and 2 , and outputs calculated using i) mean AR and ± 2 SD and ii) mean, upper and lower 95% CLs of flight density data by month.	Collision estimates are presented using alternative Band model Options and avoidance rates as appropriate for each species. Impacts are presented as annual and seasonal totals and in relation to appropriate seasonal populations. Impacts in relation to SPAs are considered in the Habitats Regulation Assessment. (section 13.7.2.3)

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	a range of Band model Options and Avoidance Rates are considered the greater the likelihood that the impacts are above the 1% of the SPA population which raises concerns.		
Table 13.27	As Table 13.27 is based on collisions predicted using Band Option 3 at 98% then the figures are not suitably precautionary. As already stated the 98% AR for Option 3 is not directly transferable as it is based on the no avoidance collision rate, and outputs of the no-avoidance collision mortality rate using the Extended Model need to be generated in order to arrive at an AR appropriate to use with the Extended model. Therefore we suggest that Table 13.27 uses data generated by using the appropriate AR with Option 3, and including the figures in brackets, using Band Option 1 with 98% AR.	See previous comments on the use of Band Option 3. With reference to the use of Band option 3, Statutory Nature Conservation Bodies' (SNCBs) recommendations following the BTO review (Cook et al. 2014) advise that no avoidance rate is available for use with option 3 for kittiwake or gannet.	See previous response.
Table 13.27	Table 13.27 shows that only three of the six seabird species assessed for collision risk are predicted to have an increase in mortality (number of individual birds) relative to current mortality greater than 1% in at least one biological season. However, we would like clarify if more species would be at risk if the mortality was calculated using Band Option 1 and/or the	No further comment	See previous response.

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	population scales were different.		
129	Tables 13.28 to 13.33 present results for collision risk that do not represent precautionary figures or an appropriate range.	No further comment	See previous response.
132	We agree that based on the information provided, that the impact of fulmar is likely to be negligible.	No further comment	This is reflected in the fulmar assessment.
Gannet			
	The predicted mortality in the breeding season for gannet is quoted as 30. However, this is based on Option 3 at 98%. The predicted mortality using Option 1 at a range of avoidance rates should also be presented.	No further comment	A range of collision model outputs is presented for all species, derived using model Options and avoidance rates as per SNCB guidance.
	Whilst acknowledging that EA3 may be beyond the 'normal' foraging range (need to define 'normal', is this mean-max foraging range?) of breeding adult gannets from North Sea colonies, we disagree with the statement that there will be no impact. Birds in the breeding season will originate from somewhere even if they are sub-adults yet to recruit, and if their collision mortality was sufficient there could be a long term impact on the population. Also mortality to gannets needs to be considered at other times of year in addition to the breeding season. Therefore, we, suggest the impact would be at least minor.	East Anglia Three Limited explained in the workshop that the wintering population was based on the SOSS report. Natural England advised that further detail needs to be provided in the ES.	In relation to breeding season collisions, since gannet breeding colonies in the North Sea are almost exclusively SPAs this aspect is assessed in the HRA. Annual and seasonal collisions are assessed in section 13.7.2.3. It should also be noted that collision mortality estimates are lower in the ES than presented in the PEIR due to assessment based on birds in flight only.

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	We would welcome further discussion on what is considered as a Biologically Defined Minimum Population Scale, and what is defined as the regional population. We note that even using Band Option 3 with 98% the level of predicted mortality exceeds 1% of the Regional population. Due to the fact that we do not know what the rationale for the selecting the regional population used, the regional population may well be lower than presented. Also the number of birds subject to mortality may be higher. Therefore the combination of these factors may result in the predicted increase in mortality relative to baseline mortality may be greater than the figures quoted in table 13.32.	East Anglia Three Limited explained in the workshop that the wintering population was based on the SOSS report. Natural England advised that further detail needs to be provided in the ES.	BDMPS populations and season definitions have been taken from Furness (2015).
Kittiwake			
	We note that the predicted mortality in breeding season is 20 birds, and using Option 3 at 98% the likely impact is stated to be minor. However, rather than focussing on discrete seasonal impact, we would advise that the cumulative year round impact on that a population should also be presented. As stated above under 'gannet' due to the fact that we do not know what the rationale for the selecting the regional	Comments acknowledged in the workshop	Collision estimates are presented using alternative Band model Options and avoidance rates as appropriate for each species. Impacts are presented as annual and seasonal totals and in relation to appropriate seasonal populations. Impacts in relation to SPAs are considered in the Habitats Regulation Assessment. (section 13.7.2.3)

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	population used, the Regional population may well be lower than presented, depending on how the regional population has been defined. This in turn will increase the impact of mortality rates against baseline mortality. Also the number of birds subject to mortality will be different depending on the Band model and avoidance rate used. Therefore we suggest presenting the range of mortality from different Band Models and Avoidance Rates, with an agreed defined population.		BDMPS populations and season definitions have been taken from Furness (2015).
Lesser black backed gull			
	The 51 birds predicted to be subject to mortality in the breeding season is stated as 0.78% of the Regional population. If Band model Option 1 at 98% is used the figure will be significantly more than 51 and likely to exceed 1% of any Regional population. It is not clear what populations are used, and the figure for Regional population quoted as 442,713 seems high. We would therefore like to know what population scales have been used, and the rationale for selecting particular populations. We would therefore question whether the impact is minor, particularly if a significant proportion is apportioned to Alde-Ore Estuary SPA.	Comments acknowledged in the workshop and that further referencing would be provided in the ES	Collision estimates are presented using alternative Band model Options and avoidance rates as appropriate for each species. Impacts are presented as annual and seasonal totals and in relation to appropriate seasonal populations. Impacts in relation to SPAs are considered in the Habitats Regulation Assessment. (section 13.7.2.3) BDMPS populations and season definitions have been taken from Furness (2015).

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	We would welcome discussions on how the details of apportionment will be arrived at, and how birds from continental SPAs will be taken into account.		
Herring gull			
	Predicted mortality of 72 breeding herring gull is based on Option 3 at 98% AR and will be higher using Option 1 at 98%. The same comments made in relation to presenting a range of CRM outputs and providing references for population sizes are relevant for herring gull.	No further comment	Collision estimates are presented using alternative Band model Options and avoidance rates as appropriate for each species. Impacts are presented as annual and seasonal totals and in relation to appropriate seasonal populations. Impacts in relation to SPAs are considered in the Habitats Regulation Assessment. (section 13.7.2.3) BDMPS populations and season definitions have been taken from Furness (2015).
	Great black backed gull		
	The predicted mortality in breeding season of 60 birds and is 1.69% of national population, using Band Option 3 is not a minor impact. Using Band Option 3 there is a greater than 1% increase in mortality compared to background mortality. The impact is moderate to high, particularly considering that the predicted mortality will be more using Band Option1 or a lower AR with Option 3.	No further comment	Collision estimates are presented using alternative Band model Options and avoidance rates as appropriate for each species. Impacts are presented as annual and seasonal totals and in relation to appropriate seasonal populations. Impacts in relation to SPAs are considered in the Habitats Regulation Assessment.

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	Natural England suggests that all estimates of mortality should include a range of figures based on different Band models and Avoidance rates to reflect uncertainty. We would also suggest that an example of the Band spreadsheet used for a number of species is included in the finalised ES so the figures can be checked.		(section 13.7.2.3) BDMPS populations and season definitions have been taken from Furness (2015).
Migrants			
Section 13.7.2.3.9	Natural England would welcome more discussions on the results of predicted collisions for common tern on the basis of 23,239 birds passing through the site.		Further discussion is provided in section 13.7.2.3.
Section 13.7.2.3.10	Natural England notes that migrant non seabird have been modelled and will be presented at the next phase of the Evidence Plan Process and will be presented in the final Environmental State. We will comment on this separately once the additional information has been provided. We advise that modelling should be carried out for all, or for a significant representative sample, of species. This should apply to EA3 alone and cumulatively. Also, we advise any individual SPA that are identified due to their location relative to EA3 and that have a disproportionate percentage of birds passing through EA3		Migropath modelling has been conducted and presented in Technical Appendix 13.1. The results are summarised in section 13.7.2.3 of this ES.

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	relative to the national average should be included in a site specific assessment.		
The Cumulative Assessment			
Section 13.8.2	Scroby Sands, Kentish Flats, and Beatrice (demonstration) OWFs have all been screened out on the basis that they have been operational for a sufficiently long time and forms part of the baseline. Natural England cannot accept this unless it can be demonstrated that the baseline mortality already captures the residual impact of those operational sites. To do this it needs to be demonstrated that the baseline mortality figures entirely post date the start of the operation of these sites.		These sites have been included in the cumulative assessment (section 13.8).
	Cumulative risk assessment for gannet Table 13.37 uses either 99% AR with Option 1 or 98% with Option 3. This does not allow the data to be considered in common currency. Therefore figures for Option 1 98% should be presented alongside other Options.		A range of collision model outputs is presented for all species, derived using model Options and avoidance rates as per SNCB guidance. Cumulative figures have been calculated using an appropriate common currency (section 13.8.1.5).
Table 13.38	Kittiwake – table 13.38 shows data for 98% AR – is this using Option 3? If so, figures for 98% AR using Option 1 should be presented as well The same comments apply to greater black-backed gull (Table 13.39), lesser		A range of collision model outputs is presented for all species, derived using model Options and avoidance rates as per SNCB guidance. Cumulative figures have been calculated using an appropriate common

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	black-backed gull (Table 13.40)		currency (section 13.8.1.5).
Section 13.8.4	Cumulative direct disturbance and displacement Puffin should be screened in for further assessment (see comment on Table 13.14)		Puffin has been screened in for cumulative assessment (section 13.8.1.4).
	40% displacement rate and 1% mortality rate is applied to wintering season abundance to guillemot and razorbill. We recommend presenting a range from 1-10% mortality and 30-70% displacement.	Repeat of earlier comment, but included again to aid East Anglia Three Limited in identifying all sections that require potential amendment.	Cumulative displacement is assessed across the ranges of values requested by Natural England (section 13.8.1.4).
	This section states "there is considerable uncertainty concerning these displacement mortality predictions. As a result a firm conclusion on the predictions. of the magnitude and significance of impacts cannot be made at this stage and this will be discussed further as part of the Evidence Plan process" Due to the acknowledged level of uncertainty, we recommend presenting a range of values (from 1-10% mortality and 30-70% displacement) in the Environmental Statement as advised in the NE/JNCC guidance note. We also advise, as noted above that consideration is given to highlighting cells within this "area of interest" within the matrices according to whether the	Repeat of earlier comment, but included again to aid East Anglia Three Limited in identifying all sections that require potential amendment.	Cumulative displacement is assessed across the ranges of values requested by Natural England (section 13.8.1.4).

Section	NE Comment on PEIR	NE comment following workshop	Response / where addressed in the ES
	numbers fall within or outside any appropriate mortality threshold derived from e.g. PBR or PVA. This will help inform a risk based assessment of the likelihood of a significant impact arising – in the face of total uncertainty.		
224	This section states "all birds that have reached 1% regional, national or international importance have been taken through to impact assessment Natural England advises that the 1% of regional, national or international is not appropriate criteria to assess for further assessment. Before Natural England can fully consider the impacts from this project alone and in combination more information is required by presenting a greater range of potential impacts from collision risk and displacement. Another key factor is agreeing what an appropriate Biologically Defined Minimum Population Scale should be for the key species.	In the workshop the summary points were acknowledged following detailed discussion on collision risk, displacement and cumulative impacts.	The summary section reflects the updated approach to the assessment as detailed in the responses to previous comments.

Table 13.1c Comments on PEIR from other stakeholders and East Anglia THREE Limited response

Stakeholder	Comment on PEIR	Response / where addressed in the ES
Danish Nature Agency	The Danish Nature Agency does not have any objections to the proposed project "Offshore Wind Farm in North Sea East Anglia Zone".	None required
Ministry of Transport and the environment. Rijkswaterstaat	The bird impact assessment should contain information on whether or not the sites the South-western Delta ('Westerschelde', 'Oosterschelde', 'Grevelingen') and the	These sites have been considered in the Habitats Regulation Assessment.

Stakeholder	Comment on PEIR	Response / where addressed in the ES
Zee en Delta.	'Waddensea' to the Wash will be impacted by wind turbines in East Anglia THREE.	
	Research in other wind farms shows that Guillemots are considered to have a high sensitivity for wind farms, as far as disturbance is concerned. We therefore emphasize the need for reconsideration of the category 'low to medium sensitivity' for this species.	The research to which this refers has been used to inform the assessment (section 13.7.2.1).
	Large east-west fluxes of migrating birds can be impacted by the presence of hundreds of rotors on the location of East Anglia THREE. Especially migration routes from Dutch Natura 2000 areas in the South-western Delta 'Westerschelde', 'Oosterschelde', 'Grevelingen') and the 'Waddensea' to the Wash could be impacted by wind turbines in East Anglia THREE. The impact assessment should contain information on whether or not these sites and appointed species will be impacted by East Anglia Three wind farm.	Potential collision risk for migrants is assessed in section 13.7.2.3.
RSPB	Impact significance. The RSPB are unable to agree at this stage that no impacts greater than minor significance will occur to ornithological interests as a result of offshore elements of the project. Our concerns relate principally to collision risk to lesser black backed gull, great black backed gull, gannet and kittiwake and displacement of razorbill and guillemot. We consider that collision risk to these species will need to be assessed against appropriate biogeographic populations and results presented for at least two Band Options (Option 3 alongside Option 1 and/or 2) at appropriate avoidance rates.	Impacts for these species have been assessed against appropriate population sizes and following approaches proposed by Natural England. The relevant sections can be found here: 13.7.2.1, 13.7.2.3
	Assessment of displacement will require presentation of a wider range of potential displacement and mortality figures. We also raise concerns about impacts of the onshore works on brent geese of the Deben Estuary SPA and the necessity for appropriate mitigation.	Complete displacement matrices are presented in the assessment (Section 13.7.2.1). Potential impacts on brent geese are considered in Chapter 24 (Onshore ornithology),
	The extended Band model may be more sophisticated than the basic model, but the input data remain basic and are subject to error, notably in respect of flight height estimation from boats, even by experienced field surveyors. The RSPB does not consider that this form of estimation forms a satisfactory basis for	Results from the extended Band model (Option 3) are presented for information (Section 13.7.2.3). However the collision assessment does not depend on these results.

Stakeholder	Comment on PEIR	Response / where addressed in the ES
	determining flight height distributions at the resolution required to allow for the extended version of the Band model to be used.	
	CRM requires an "avoidance rate" correction factor on the model outputs. This accounts for birds which take evasive action, and encompasses a range of factors influencing the CRM predictions. We welcome the avoidance rates presented, but disagree that the same rate should be used in all three models. 98% is recommended for the basic Band model (Options 1 and 2), but the same avoidance rate is not suitable for the extended model (Option 3), as the estimated proportion of birds at risk height is incorporated into the model in a different way. We would therefore recommend that the in the presentation of a range avoidance rates, 95% is also included. Marine Scotland Science's review of avoidance rates will report in 2014. It will have significant implications for the assessment of this scheme's impacts.	The avoidance rates used in the collision risk assessment are those recommended for use by the Statutory Nature Conservation Bodies (JNCC et al. 2014). This guidance was issued in relation to the Marine Scotland Science review referred to in this comment.
	The Band (2012) model includes a component, Stage F, for incorporating error and uncertainty into the model outputs. In the absence of model validation, the RSPB would recommend that this stage is included in the presentation of collision predictions. This stage includes specific guidance for using the confidence limits presented with the generic height distributions required for Option 3, but the Applicant has not carried out this calculation.	Band model Option 1 has been used as the basis of the collision risk assessment, with a range of values presented as recommended by JNCC et al. (2014). Therefore East Anglia THREE Limited would consider that this comment is no longer relevant.
	We therefore consider that the Applicant should present outputs from all three Options at a range of avoidance rates within the ES (rather than solely in the Appendices). However, please note that whilst presentation of this range will make assessment clearer, it will not overcome all our concerns with the use of Option 3 as these concerns involve further aspects of Option 3 than avoidance rate, as set out above.	A range of collision mortality estimates, as calculated using different Band model Options and avoidance rates is presented in Section 13.7.2.4.
	Habitats Regulation Assessment (HRA). We note that apportioning of offshore impacts (collision risk and displacement) both alone and in-combination with other projects has not yet been carried out and that this will need to be addressed to ensure compliance with the Habitat Regulations requirements, particularly	A full Habitat Regulations Assessment is presented in the Information for Habitats Regulations Assessment.

Stakeholder	Comment on PEIR	Response / where addressed in the ES
	considering the proximity to the Outer Thames Estuary Special Protection Area (SPA) and that the connecting cable passes through the Deben Estuary SPA. As you are aware the HRA has to be a separate document focusing purely on the designated sites and their species.	
	The Habitat Regulations for this development are the Conservation of Habitats and Species Regulations 2010 (as amended) and Offshore Marine Conservation (Natural Habitats, &c) Regulations 2007 (as amended) in respect of the European Sites/European Offshore Marine Sites and, as a matter of Government policy, Ramsar sites. In basic terms, these Regulations require that the nature and scale of potential impacts on those sites be thoroughly assessed. If it is not possible to ascertain that the development will not have an adverse effect on the integrity of one or more of these protected sites, then the application must be subject to the derogation tests set out in the regulations i.e. no alternative solutions, imperative reasons of overriding public interest, and compensatory measures which must be secured to protect the overall coherence of the Natura 2000 network.	A full Habitat Regulations Assessment is presented in the Information for Habitats Regulations Assessment.
	As discussed at previous Evidence Plan Meetings, the Magnitude of Effects Tables require some refinement. We would be pleased to discuss this further through the Evidence Plan Process.	
	The RSPB consider that the derivation of all biogeographic population estimates referred to in the PEIR should be explained and justified in full, and sources of data quoted.	The recent BDMPS review (Furness 2015) has been used throughout. These supercede the reference populations used in the PEIR.
	Where a species is to be screened out from further assessment (for example, puffin and red-throated diver from displacement impacts), we consider that evidence to support this decision should be presented.	The impact assessment sections include details of evidence supporting screening for impacts.
	We note that, for the purposes of HRA, the apportioning of impacts to individual SPAs will be required. We also note that in-combination assessments of offshore ornithology impacts have not been completed at this stage. We would be pleased to discuss both these areas further.	A full Habitat Regulations Assessment is presented in the Information for Habitats Regulations Assessment.
	Benacre-Easton Bavents SPA (designated for	All SPAs with potential for

Stakeholder	Comment on PEIR	Response / where addressed in the ES
	breeding little tern and marsh harrier, and breeding and wintering bittern) has been omitted from Table 13.10. This should be included for completeness.	impacts have been considered in the Habitat Regulations Assessment.
	As raised through previous projects, the RSPB disagree with the use of a 99% avoidance rate for breeding gannet, as it does not account for seasonal behavioural differences and constraints on breeding birds. We consider that the provision of peer reviewed evidence would be necessary before any change to the standard 98% avoidance rate can be supported for gannets.	The collision risk assessment has been conducted using the avoidance rates recommended by JNCC et al. (2014).
	Para. 152 states that East Anglia Three is outside the maximum and mean maximum foraging range for great black-backed gull during the breeding season. We request that details are presented to support this statement as we were unable to find figures for this species in the reference provided.	There are no published estimates for great black-backed gull foraging ranges in the breeding season. However the nearest SPA is over 600km from East Anglia THREE, which will be far in excess of the maximum foraging range of this species.
	We welcome the commitment in para. 158 to carry out additional modelling for migrant nonseabirds. However, the Appendix containing details of species to be covered appears to be missing from the PEIR documentation. We would welcome the opportunity to comment on this through the Evidence Plan process.	Collision risk for migrant non-seabirds is included in the assessment (section 13.7.2.4) and is supported by modelling presented in Technical Appendix 13.1
	The RSPB note the high number of migrant seabirds predicted to pass through the East Anglia Three site, and in particular the figure of 23, 239 common terns. We would welcome the opportunity for further discussion of these figures and the modelling approach used.	Collision risk for migrant seabirds is included in the assessment (section 13.7.2.4) and is supported by modelling presented in Technical Appendix 13.1
	The RSPB supports the inclusion of matrices presenting the full range of possible displacement and mortality rates for guillemot and razorbill. However, the RSPB are concerned that the figures emphasised within the assessment are restricted to displacement of 20 to 40% and mortality of 1%. As there are few robust studies of displacement, results differ, and we do not know the consequences for mortality or population trajectories, it is appropriate to consider a range of putative displacement and mortality rates. The RSPB therefore consider that displacement of up to 70% and mortality of up to	The displacement sections present the range of potential impact magnitudes following the matrix approach recommended by Natural England and the assessment is based on Natural England's recommended rates.

Stakeholder	Comment on PEIR	Response / where addressed in the ES
	10% represents an appropriate level of precaution.	
	We note that in-combination assessment of displacement on species of the Outer Thames Estuary SPA (including potential additions) should be considered, and that this assessment should account for vessel movements associated with the proposed development of Sizewell C Nuclear Power Station.	The cumulative impact assessment considers all potential realistic sources of cumulative impact.
	As noted above (Point. 5) the RSPB consider that any decision to screen species out from further assessment should be justified. In particular we would like to see further evidence relating to the screening out of displacement impacts on red throated divers and puffin.	The impact assessment sections include details of evidence supporting screening for impacts.
	The RSPB note the statement in para. 212 that where wintering season abundance data were not available for the assessment of cumulative displacement impacts, the annual figure was halved to generate a figure for this assessment. The RSPB have concerns regarding the likely accuracy of this approach and would expect to see further evidence presented in the final ES.	This approach has not been used in this assessment. The impact assessment sections include details of the evidence used to support the impact assessment methods.
	In order to aid understanding and assessment of construction impacts resulting from this project in-combination with the construction of East Anglia One and East Anglia Four, we recommend that an indicative timeline and maps showing the possible construction scenarios be provided. To aid understanding of the level of disturbance we recommend including details such as, but not limited to, noise, vehicle passes and artificial lighting.	The cumulative assessment considers the potential for overlapping periods of construction.
	The RSPB welcome the consideration of black-tailed godwit as a ‘key non-breeding bird’, but recommend that the distribution of this species within the estuary should be given explicit treatment in para. 62 due to its likely addition as an interest feature to the Deben Estuary SPA.	Onshore ornithological impacts are assessed in Chapter 24 (Onshore ornithology)
	We note that under Scenario 2 an area of reedbed which has previously provided nesting habitat for a pair of marsh harriers could be lost for one to two breeding seasons (para. 80). The RSPB recommend that compensation for habitat lost should be considered in order to ensure no net loss of nesting habitat. This could take the form of ditch enhancements in agricultural areas, which should include; planting of common reed	Onshore ornithological impacts are assessed in Chapter 24 (Onshore ornithology)

Stakeholder	Comment on PEIR	Response / where addressed in the ES
	in the ditch, the establishment of a buffer zone alongside the ditch where natural regeneration of vegetation will be allowed, and deepening of the ditch where necessary to allow it to retain water throughout the year.	

Table 13.1d Evidence Plan agreement log for meetings 4, 5 & 6. Note that the agreement log for meetings 1 to 3 has not been reproduced here as this was superceded by the PEIR and comments received (all Evidence Plan documents, meeting minutes and agreement logs are provided in *Appendix 13.1*.)

Consultee	Date / Document	Comment	Response / where addressed in the ES
NE and RSPB	OETG Mtg 4, March 2015	Discussions focussed on points raised on the detail of the PEIR assessments, the meeting worked through points provided as a draft response to the PEIR by Natural England.	
NE and RSPB	OETG Mtg 5, May 2015	Use of BDMPS season definitions and minimum population sizes is appropriate.	Agreed in principle. See section 13.5.2.
		Revised collision estimates for East Anglia ONE should be used in the CIA.	Agreed in principle. See section 13.8.1.5.
		That potential phasing of construction of offshore components has little / no bearing on assessment	RSPB would like to see more detail re factors which could increase displacement of red-throated diver, e.g. increase in vessel numbers (as noted in the Phase 3 consultation). EATL response: this has been included in section 13.3.4.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		That approach for assessing displacement (alone and cumulative) is appropriate and outputs do not indicate significant impacts.	NE agree with following caveats: • EATL to include full tables of ranges of displacement • There needs to be a consideration of how to determine annual mortalities • Red throated diver assessment to use a flat displacement rate across buffer. RSPB agree with following additional caveat: • EATL to include consideration of Sizewell C in CIA for red-throated diver. EATL response: These aspects have been included in the assessment (sections 13.7.2.1 and 13.8.1.4) where data permit.
		That approach for assessing collision risk (alone and cumulative) is appropriate and outputs do not indicate significant impacts.	NE agree with following caveats: • EATL to provide confirmation of source of cumulative numbers. • If the argument is made that impacts below previously consented totals are acceptable, the full referencing /audit trail must be provided. RSPB: • We will comment on this point once we have seen the PVA outputs for gannet and kittiwake. We also support NE's comments. EATL response: Full details provided in section 13.8.1.5.
		That impacts are of such small magnitude that population modelling (PBR or PVA) is unnecessary.	NE & RSPB agree with following caveats: • PVA required for gannet & kittiwake EATL response: Results of analysis using PVA are included in section 13.8.1.5.
		That gannet avoidance rate is likely to be >98.9% and this should be reflected in the assessment.	NE advise continue to use 98.9% AR for gannet with Basic Band Model Option 1 and 2 , and outputs calculated using i) mean AR and ± 2 SD and ii) mean, upper and lower 95% CLs of flight density data by month. EATL acknowledges NE position and have used 98.9% in the collision

Consultee	Date / Document	Comment	Response / where addressed in the ES
			assessment (sections 13.7.2.3, 13.8.1.5).
		That nocturnal activity factor used in CRM is overestimated and that use of evidence based values is appropriate for the assessment. However, the intention is not to re-work the CRM figures but to provide additional text.	NE agree, and will discuss this matter further with SNCBs if nocturnal activity factors are amended. RSPB cannot agree at this stage. We agree that this may provide useful context within the narrative (as noted in the minutes), but consider that it is too early to use this in the assessment. EATL response: see section 13.8.1.5.
		That the SPA features identified in the screening report are the only ones for which HRA will be required.	NE & RSPB agree with following caveats: • Red throated diver (Outer Thames Estuary SPA) screened in • Kittiwake (Flamborough and Filey Coast) screened in EATL response: see Information for Habitats Regulations Assessment.
NE and RSPB	OETG Mtg 6, July 2015	SPA features identified in the updated screening report are the only ones for which HRA will be required. • Deben Estuary SPA (dark-bellied brent goose); • Outer Thames Estuary SPA (red-throated diver); • Alde-Ore Estuary SPA (lesser black-backed gull); Flamborough and Filey Coast pSPA (gannet, kittiwake).	Agreed. See Information for Habitats Regulations Assessment.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		Updated gannet collision nos. are correct, use of SOSS-04 Gannet PVA report is appropriate and cumulative mortality is not significant.	NE agree that the method is correct in principle. Project only impact is non-significant. Reserve judgement on the significance of cumulative impact. RSPB disagree with the use of a 98.9% AR during the breeding season. Project only impact is non-significant for populations considered under EIA. Reserve judgement on the significance of impact in-combination. Attribution of mortality to SPAs is required. EATL response: gannet cumulative collision assessment presented in Section 13.8.1.5.
		Updated kittiwake collision numbers are correct, proposed PVA methods are appropriate and preliminary results indicate that cumulative mortality is not significant.	NE agree that the method is correct in principle. Project only impact is non-significant. Reserve judgement on the significance of cumulative impact. RSPB agree that the method is correct in principle but consider that density independent outputs should be retained and assessed along with density dependent outputs. Project only impact is non-significant for populations considered under EIA. Reserve judgement on the significance of cumulative impact. Attribution of mortality to SPAs is required. EATL response: kittiwake cumulative collision assessment presented in Section 13.8.1.5.
		Evidence base for cumulative gull collisions provides appropriate level of comfort to conclude that current totals are below previously consented levels.	NE and RSPB, subject to confirming the numbers used, would agree that the totals are lower. EATL response: full details of assessments provided in Section 13.8.1.5.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		Following a review of methods, it is concluded that the existing approach for assessing displacement (based on peak season) remains precautionary and appropriate. Alternatives introduce considerable uncertainty due to population overlaps, although could base on highest proportional abundance rather than highest absolute abundance.	NE would like to see monthly numbers and will respond on the appropriate population baseline for assessing the impact. RSPB agree that mortality should be loaded onto seasonal peak numbers, for species present primarily during non-breeding periods. However, this approach should be considered on a species by species basis -where reasonable numbers of an individual species are present during the breeding season it may be appropriate to consider the potential impacts on these birds (and their survival/productivity) even if this doesn't represent the highest proportion of the seasonal BDMPS population. EATL response: seasonal assessments presented in full in Section 13.7.2.1. These have been derived from the monthly abundance estimates presented in *Appendix 13.2*.
		Nocturnal activity factor sensitivity review indicates a precautionary minimum reduction of 7% should be applied to all collision mortalities for a reduction of 1 level (e.g. from 3 to 2).	NE: There is no agreed SNCB position on how to use this information at the current time. RSPB cannot agree the proposed reduction in flight activity of 7% for gannet and kittiwake at this stage. The derivation of this figure should be more clearly supported before it can be used. As the degree of adjustment for large gulls is not supported by a strong evidence base we do not consider it will be possible to apply any reduction in collision estimates for these species.). EATL response: the evidence for nocturnal activity scores is provided in *Appendix 13.1*.

13.3 Scope

9. This chapter describes the ornithological interests of the East Anglia THREE site, the export cable corridor to landfall and the interconnector cable corridor between the East Anglia THREE site and East Anglia ONE and evaluates the potential impacts of the proposed project on these interests.

10. The baseline section describes the distribution and abundance of bird species recorded during surveys of the site. This includes flight characteristics (e.g. height and direction), ecology, seasonality and behaviour.

11. The predicted magnitude of impacts and significance of effects arising due to construction, operation and decommissioning of the windfarm on the ornithological interests of the site are assessed on the basis of the worst case development scenario. Measures to prevent or reduce significance of the possible effects are discussed where appropriate. Cumulative impacts arising from the site and offshore cable corridor and other offshore operations are assessed as appropriate.

13.3.1 Study Area

12. A study area was defined that was relevant to the consideration of potential impacts on offshore ornithological receptors. The suitability of the study area for the purpose of environmental impact assessment was agreed with Natural England and the RSPB during the Evidence Plan Process (*Appendix 13.1*).

13. This study area includes the East Anglia THREE site and a 4km buffer placed around it within which monthly aerial surveys were conducted over a period of two years (September 2011 to August 2013, 24 surveys in total). The data collected during these surveys have been used to identify the species present and their seasonal abundance. The study area was originally defined on the basis of the location of the site boundary at the outset of surveys (September 2011). The analysis presented in the PEIR was also on the basis of this original layout. Subsequently, the East Anglia THREE site has reduced in area (from 370km^2 to 305km^2) due to the incorporation of a two nautical mile buffer from the adjacent shipping lane. The revised area is shown in *Figure 13.1*. All technical reporting and assessment has been conducted on the basis of the revised area (*Appendix 13.2, Figure 13.1*).

14. The study area over which potential impacts on offshore bird species were considered included (in addition to the windfarm area covered by aerial surveys) the offshore cable corridor to the Mean Low Water Spring (MLWS) at its landfall location

at Bawdsey. Refer to the Onshore Ornithology Chapter 24 for assessment of impacts above the MLWS.

13.3.2 Project Characteristics

15. The characteristics of the proposed project are described in Chapter 5 Description of the Development.

16. In summary, they are:

- Offshore wind turbines and associated foundations (anticipated to be up to a maximum of 172 wind turbines, each having a rated capacity of between 7MW and 12MW, with an installed capacity of up to 1,200MW).
- Scour protection around foundations and on inter-array and export cables as required.
- Offshore collector and converter station platforms with foundations (up to six).
- Sub-sea cables between the wind turbines and substation platforms and between offshore platforms and East Anglia ONE.
- Sub-sea export cables to transmit electricity from the offshore platforms to the landfall location.
- Up to two meteorological masts and one accommodation platform.

13.3.3 Phasing

17. The offshore elements of the proposed East Anglia THREE project may be installed in a Single Phase lasting 41 months or two overlapping phases (Two Phased approach) lasting a total of 45 months.

18. It has been assumed here that the potential for these two approaches to generate different impact magnitudes in relation to ornithological receptors is sufficiently small that only a Two Phased approach need be assessed as in terms of the construction assessment as it is the worst case scenario (i.e. the longest duration of construction activity).

13.3.4 Worst Case

19. The worst case scenarios with regard to potential impacts of the proposed project on offshore ornithology receptors from the construction, operation and decommissioning phases are described and presented in *Table 13.2*. All potential impacts are assessed in accordance with the Chapter 6 EIA Methodology.

Table 13.2 Worst Case Assumptions

Potential Impact	Key design parameters forming the realistic worst case scenario	Rationale
Construction		
Impact 1: Disturbance and Displacement from increased vessel activity	Up to 55 vessels on site at any one time under either approach (for breakdown please refer to Chapter 5 Description of Development, Section 5.5.15.8).	Maximum estimated number of vessel movements would cause greatest displacement to birds on site. This assumes a maximum construction schedule of 24 hours a day, 7 days a week for a maximum construction period of 42 months. Note, however, that construction is expected to be intermittent, with periods of downtime.
Impact 2: Indirect effects as a result of displacement of prey species due to increased noise and disturbance to seabed	Spatial worst case impact (maximum area of impact at one time and maximum anticipated pile energy) Monopiles: 2 concurrent piling events, 172 12m diameter wind turbine foundations, 6 offshore collector and converter stations, 1 accommodation platform and 2 met masts 3,500kJ hammer. Temporal worst case impact (greatest duration of pile driving) Jackets: No concurrent piling, 172 wind turbine foundations (with 4 piles each) , 6 offshore collector and converter stations, 1 accommodation platform and 2 met masts 1,800kJ hammer.	See Chapter 11 Fish and shellfish ecology
	Disturbance/displacement from increased suspended sediment concentration.	Total sediment release over the 2.5 year build period is listed in Chapter 10 Benthic ecology, Table 10.2. However, the release on a daily basis would be temporary and localised with sediment

Potential Impact	Key design parameters forming the realistic worst case scenario	Rationale
		settling out quickly.
	The maximum area of disturbance to benthic habitats during construction would be approximately 90.07km^2 across the East Anglia THREE site and offshore cable corridor.	Breakdown is given in Chapter 10 Benthic ecology, Table 10.2.
Operation		
Impact 3: Disturbance and displacement from offshore infrastructure and due to increased vessel and helicopter activity	An area of 305km^2 plus 4km buffer with maximum of 172 wind turbines, with a minimum spacing of 675 x 900m between turbines. Maximum 6 offshore collector and converter stations, 1 accommodation platform and 2 met masts. Maximum of 11 support vessels making approximately 4,000 two-way vessel movements per annum for supporting windfarm operations. Maximum of 365 two-way helicopter movements per annum for scheduled and unscheduled maintenance.	Maximum density of turbines and structures across the offshore project area, which maximises the potential for avoidance and displacement. Other development options represent a smaller total area occupied and reduced density of turbines. Assessment assumes varying displacement from site and a buffer, where appropriate. See Chapter 5 Description of Development, section 5.5.17.2.
Impact 4: Indirect effects due to habitat loss / change for key prey species	The maximum possible above sea bed footprint of the project including scour or scour protection plus any cable protection. The overall total footprint is 3.23km^2	Breakdown is given in Chapter 10 Benthic ecology, Table 10.2.
Impact 5: Collision risk	Maximum of 172 7MW turbines.	Collision risk modelling shows that 172 x 7 MW turbines have largest collision impact risk. Other development options (e.g. 12 MW turbines) provide a reduced number of turbines (100). Although 100 x 12 MW has a greater swept volume ratio per MW installed capacity the Band CRM model approach produces higher risk using a larger number of small turbines. (Appendix 13.2)
Impact 6: Barrier effects	Maximum offshore project area of 305km^2 with maximum of 172 wind turbines, with a minimum spacing of 675 x 900m between turbines. Maximum 6 offshore collector and converter stations, 1 accommodation	Maximum density of turbines and structures across the offshore project area, which maximises the potential barrier to foraging grounds and migration routes for bird species. Other development options result in

Potential Impact	Key design parameters forming the realistic worst case scenario	Rationale
	platform and 2 met masts.	reduced number and density of turbines.
Decommissioning		
Impact 7: Disturbance and displacement from decommissioning activities	Up to 55 vessels on site at any one time (for breakdown please refer to Chapter 5 Description of Development, Table 5.24). Assumed similar to construction.	Maximum estimated number of vessel movements would cause greatest displacement to birds on site. Based on previous estimates and experience it is anticipated that decommissioning of the proposed East Anglia THREE project would take approximately 1 year.
Impact 8: Indirect effects due to habitat loss / change for key prey species	As above for construction, there would be habitat disturbance effects up to 3.56km^2 across the East Anglia THREE site and offshore cable corridor. There would be limited noise disturbance to prey (as no piling and no use of explosives).	Breakdown is given in Chapter 10 Benthic ecology, Table 10.2.

13.3.5 Embedded Mitigation

20. Mitigation measures which are embedded into the proposed project design and are relevant to offshore ornithology receptors are listed in *Table 13.3*. In that Table the general mitigation measures, which would apply to all parts of the offshore works, are set out first. Below that are set out the mitigation measures which apply specifically to the wind turbine specification.

Table 13.3 Embedded Mitigation Relating to Offshore Ornithology

Parameter	Mitigation Measures Embedded in the Proposed Project Design
General	
Site Selection	The East Anglia THREE site was identified through the Zonal Appraisal and Planning process (Chapter 4 Site Selection and Alternatives) and avoids European sites.
Offshore Cable Corridor	In order to reduce the spatial extent of potential disturbance and displacement impacts the decision was taken to use only one offshore cable corridor in near shore for multiple projects. This measure avoids potential impacts over a wider area.
Wind turbine specification	
Minimum power output	The option of using a larger number of 5MW wind turbines has been dropped from the proposed project design. That decision reduces the potential for collision mortality and the magnitude of potential displacement.

13.4 Assessment Methodology

13.4.1 Legislation, Policy and Guidance

13.4.1.1 Legislation

21. *Table 13.4* identifies the relevant legislation and summarises the important measures derived from it.

Table 13.4 Legislation and relevant measures

Legislation	Relevant Measures
Birds Directive - Council Directive 79/409/EEC on the Conservation of Wild Birds	This Directive provides a framework for the conservation and management of wild birds in Europe. The most relevant provisions of the Directive are the identification and classification of Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex I of the Directive and for all regularly occurring migratory species (required by Article 4). It also establishes a general scheme of protection for all wild birds (required by Article 5). The Directive requires national Governments to establish SPAs and to have in place mechanisms to protect and manage them. The SPA protection procedures originally set out in Article 4 of the Birds Directive have been replaced by the Article 6 provisions of the Habitats Directive.
Wildlife and Countryside Act 1981	The Wildlife and Countryside Act 1981 (as amended) is the principal mechanism for the legislative protection of wildlife in Great Britain. It provides protection for all birds by establishing the system of Sites of Special Scientific Interest (SSSI).

Legislation	Relevant Measures
The Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007	The Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 (as amended), (referred to here as the 'Offshore Regulations') transposes the Birds Directive and the Habitats Directive into national law in the offshore environment. The Offshore Regulations place an obligation on 'competent authorities' to carry out an appropriate assessment of any proposal likely to affect a SAC or SPA, to seek advice from Natural England and / or JNCC, and to not approve an application that would have an adverse effect on a SAC or SPA (except under very tightly constrained conditions that involve decisions by the Secretary of State).
The Conservation of Habitats and Species Regulations 2010	The Conservation of Habitats and Species Regulations 2010 (hereafter called the 'Habitats Regulations'), transposes the Birds Directive and the Habitats Directive into national law in the onshore environment, operating in conjunction with the Wildlife and Countryside Act 1981. The Habitats Regulations place an obligation on 'competent authorities' to carry out an appropriate assessment of any proposal likely to affect a SAC or SPA, to seek advice from Natural England and / or JNCC, and to not approve an application that would have an adverse effect on a SAC or SPA (except under very tightly constrained conditions that involve decisions by the Secretary of State).

13.4.1.2 Policy

22. *Table 13.5* identifies policy and summarises the important measures derived from it that are relevant to offshore ornithology.

Table 13.5 Policy and relevant measures

Policy	Relevant Measures
Overarching NPS for Energy (NPS EN-1) (July 2011)	Paragraph 5.3.3 states that the applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. Paragraph 5.3.4 states that the applicant should also show how the proposed project has taken advantage of opportunities to conserve and enhance biodiversity interests. Paragraph 5.3.18 states that the applicant should include appropriate mitigation measures as an integral part of the proposed development.
NPS for Renewable Energy Infrastructure (NPS EN-3) (July 2011)	Paragraph 2.6.64 states that the assessment of offshore ecology and biodiversity should be undertaken by the applicant for all stages of the lifespan of the proposed offshore windfarm. Paragraph 2.6.102 states that the scope, effort and methods required for ornithological surveys should have been discussed with the relevant statutory advisor. Paragraph 2.6.104 states that it may be appropriate for the assessment to include collision risk modelling for certain bird species.
National Planning Policy Framework	The National Planning Policy Framework sets out the Government's planning policies for England and how these are expected to be applied. The document establishes a number of core land-use planning principles that should underpin both plan-making and decision-taking, including contributing to conserving and enhancing the natural environment. Paragraph 109 states that "the planning system should contribute to and enhance the natural and local environment by minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures".
UK Post-2010 Biodiversity Framework	The 'UK Post-2010 Biodiversity Framework' succeeds the UK Biodiversity Action Plan. The Framework demonstrates how the work of the four countries and the UK contributes to achieving the Aichi Biodiversity Targets, and identifies the activities required to complement the country biodiversity strategies in achieving the targets. The following seabirds are identified as a priority for action: common scoter, black-throated diver, Balearic shearwater, Arctic skua, herring gull and roseate tern.

13.4.1.3 Guidance

23. The most relevant guidance on EIA for marine ecology receptors, including birds, is the *Guidelines for Ecological Impact Assessment in Britain and Ireland: Marine and Coastal* published by the Institute of Ecology and Environmental Management (IEEM

2010). The EIA methodology described in *section 13.4.3* and applied in this chapter is based on that IEEM guidance.

24. Additional guidance on the assessment of the potential impacts of renewable energy generation on birds has been produced by a number of statutory bodies, NGOs and consultants including, but not limited to the following:

- Assessment methodologies for offshore windfarms (Maclean et al. 2009).
- Guidance on ornithological cumulative impact assessment for offshore wind developers (King et al. 2009).
- Advice on assessing displacement of birds from offshore windfarms (Natural England and JNCC 2012).
- Collision risk modelling to assess bird collision risks for offshore windfarms (Band 2012).
- Assessing the risk of offshore windfarm development to migratory birds (Wright et al. 2012).
- Vulnerability of seabirds to offshore windfarms (Furness and Wade 2012; Furness et al. 2013).
- The avoidance rates of collision between birds and offshore turbines (Cook et al. 2014).
- Joint Response from the Statutory Nature Conservation Bodies to the Marine Scotland Science Avoidance Rate Review (JNCC et al. 2014).

13.4.2 Data Sources

Desk based assessment

25. The desk based assessment has drawn on a wide variety of published literature, covering both peer reviewed scientific literature and the ‘grey literature’ such as windfarm project submissions and reports. It includes the published literature on seabird ecology and distribution and on the potential impacts of windfarms (both derived from expert judgement and post-construction monitoring studies) The key topics for which the literature has been examined include:

- Potential impacts of windfarms (Garthe and Hüppop 2004; Drewitt and Langston 2006; Stienen et al. 2007; Speakman et al. 2009; Langston 2010; Band 2012; Cook et al. 2012; Furness and Wade 2012; Wright et al. 2012; Furness et al. 2013; Johnston et al. 2014a,b).

- Bird population estimates (Mitchell et al. 2004; BirdLife International 2004; Holling et al. 2011; Holt et al. 2012; Musgrove et al. 2013; Furness 2015).

- Bird breeding ecology (Cramp and Simmons 1977-94; Del Hoyo et al. 1992-2011; Robinson 2005).

- Bird distribution (Stone et al. 1995; Brown and Grice 2005; Kober et al. 2010; Balmer et al. 2013).

- Bird migration and foraging movements (Wernham et al. 2002; Thaxter et al. 2012).

- Red-throated diver densities in the Outer Thames Estuary SPA (JNCC 2013) and data from an unpublished report on surveys carried out in 2013 by APEM for Natural England.

- East Anglia Offshore Wind: Zonal Assessment Report (APEM 2011).

26. Information on statutory sites and their interest features has been drawn from the web-based resource Multi-Agency Geographic Information for the Countryside (MAGIC www.magic.defra.gov.uk) and the Natural England and JNCC web sites (www.naturalengland.org.uk; www.jncc.defra.gov.uk).

13.4.2.1 Site Specific Surveys

27. To assess the temporal and spatial abundance and distribution of birds, specific data were collected by aerial surveys across the windfarm site and a four kilometre buffer placed around it. APEM Ltd undertook these aerial surveys over the 24 months from September 2011 to August 2013 inclusive. Further details of how these surveys were carried out, how the images acquired were analysed and the results of the surveys are provided in *Appendix 13.2 Baseline Offshore Ornithology Technical Report*.

13.4.3 Impact Assessment Methodology

28. The impact assessment methodology applied in this Chapter is based on that described in Chapter 6 EIA Methodology, adapted to make it applicable to

ornithology receptors and aligned with the key guidance document produced on impact assessment on ecological receptors (IEEM 2010). The impact assessment methodology applied in this chapter has also been the subject of extensive consultation with Natural England and RSPB through the Evidence Plan process for the proposed East Anglia THREE project and discussion during the examination process for the consented East Anglia ONE project.

29. The assessment approach uses the conceptual 'source-pathway-receptor' model. The model identifies likely environmental impacts resulting from the proposed construction, operation and decommissioning of the offshore infrastructure. This process provides an easy to follow assessment route between impact sources and potentially sensitive receptors, ensuring a transparent impact assessment. The parameters of this model are defined as follows:

- Source – the origin of a potential impact (noting that one source may have several pathways and receptors) e.g. an activity such as cable installation and a resultant effect such as re-suspension of sediments.
- Pathway – the means by which the effect of the activity could impact a receptor e.g. for the example above, re-suspended sediment could settle and smother the seabed.
- Receptor – the element of the receiving environment that is impacted e.g. for the above example, bird prey species living on or in the seabed are unavailable to foraging individuals.

13.4.3.1 Sensitivity

30. *Table 13.6* provides example definitions of the different sensitivity levels for ornithology receptors using as its example the potential impact of disturbance through construction activity.

Table 13.6 Example Definitions of the Different Sensitivity Levels for Ornithology Receptors

Sensitivity	Definition
High	Bird species has very limited tolerance of sources of disturbance such as noise, light, vessel movements and the sight of people
Medium	Bird species has limited tolerance of sources of disturbance such as noise, light, vessel movements and the sight of people
Low	Bird species has some tolerance of sources of disturbance such as noise, light, vessel movements and the sight of people
Negligible	Bird species is generally tolerant of sources of disturbance such as noise, light, vessel movements and the sight of people

31. It should be noted that high conservation value (defined below) and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high conservation value (e.g. an interest feature of a SPA) but have a low or negligible physical/ecological sensitivity to an effect and vice versa. Potential impact significance will not be inflated simply because a feature is 'valued'. Similarly, potentially highly significant impacts will not be deflated simply because a feature is not "valued". The narrative behind the assessment is important here; the conservation value of an ornithological receptor can be used where relevant as a modifier for the sensitivity (to the effect) already assigned to the receptor.

13.4.3.2 Conservation Value

32. The conservation value of ornithological receptors is based on the population from which individuals are predicted to be drawn. This reflects current understanding of the movements of species, with site based protection (e.g. Special Protection Areas, SPA) generally limited to specific periods of the year (e.g. the breeding season). Therefore, conservation value can vary through the year depending on the relative sizes of the number predicted to be at risk of impact and the population from which they are estimated to be drawn. Ranking therefore corresponds to the degree of connectivity which is predicted between the windfarm site and protected populations. Using this approach the conservation importance of a species seen at different times of year may fall into any of the defined categories (*Table 13.7*).

Table 13.7 Example Definitions of the Conservation Value Levels for Ornithology Receptors

Value	Example Definition
High	A species for which individuals at risk can be clearly connected to a particular SPA.
Medium	A species for which individuals at risk are probably drawn from particular SPA populations, although other colonies (both SPA and non-SPA) may also contribute to individuals observed on the windfarm.
Low	A species for which it is not possible to identify the SPAs from which individuals on the windfarm have been drawn, or for which no SPAs are designated.

13.4.3.3 Magnitude

33. The definitions of the magnitude levels for ornithology receptors are set out in *Table 13.8*. This set of definitions has been determined on the basis of changes to bird populations.

Table 13.8 Definitions of the Magnitude Levels for Ornithology Receptors

Magnitude	Definition
High	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is predicted to irreversibly alter the population in the short-to-long term and to alter the long-term viability of the population and / or the integrity of the protected site. Recovery from that change predicted to be achieved in the long-term (i.e. more than 5 years) following cessation of the development activity.
Medium	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that occurs in the short and long-term, but which is not predicted to alter the long-term viability of the population and / or the integrity of the protected site. Recovery from that change predicted to be achieved in the medium-term (i.e. no more than five years) following cessation of the development activity.
Low	A change in the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site that is sufficiently small-scale or of short duration to cause no long-term harm to the feature / population. Recovery from that change predicted to be achieved in the short-term (i.e. no more than one year) following cessation of the development activity.
Negligible	Very slight change from the size or extent of distribution of the relevant biogeographic population or the population that is the interest feature of a specific protected site. Recovery from that change predicted to be rapid (i.e. no more than circa 6 months) following cessation of the development related activity.

Magnitude	Definition
No change	No loss of, or gain in, size or extent of distribution of the relevant biogeographic population or the population that is the interest features of a specific protected site.

13.4.3.4 Impact significance

34. Following the identification of the receptor value and sensitivity and the determination of the magnitude of the effect, the significance of the impact will be determined. That determination will be guided by the matrix as presented in *Table 13.9*. Impacts shaded red or orange represent those with the potential to be significant in EIA terms.

Table 13.9 Matrix to Guide Determination of Impact Significance

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

35. It is important that the matrix (and indeed the definitions of sensitivity and magnitude) is seen as a framework to aid understanding of how a judgement has been reached from the narrative of each impact assessment and it is not a prescriptive formulaic method. Expert judgement has been applied to the assessment of likelihood and ecological significance of a predicted impact. For the purpose of this assessment we will follow the IEEM (2010) guidance which states that an ecologically-significant impact is:

'an impact that has a negative, or positive, effect on the integrity of a site or ecosystem and/or the conservation objectives for habitats or species populations within a given geographical area. In this way significant impacts are distinguished from other, lesser (and, in the context of EIA, unimportant) effects'

13.4.4 Project Design Envelope

36. Section 3.5 of Chapter 3 Policy and Legislative Context provides a background to the project design envelope approach.

37. The project design envelope sets out a series of design options for the project. The project design envelope has a reasoned minimum and maximum extent for a number of key parameters. The final design would lie between the minimum and the maximum extent of the consent sought, for all aspects of the project; this includes spatial, temporal and installation methodology. The project design envelope is used to establish the extent to which the project would impact on the environment. The detailed design of the project could then vary within this 'envelope' without rendering the assessment inadequate.

13.4.5 Cumulative Impact Assessment

38. The impact assessment methodology applied in this Chapter is based on that described in Chapter 6 EIA Methodology, adapted to make it applicable to ornithology receptors.

39. The methodology has also been aligned with the approach to the assessment of cumulative impacts that has been applied by Ministers when consenting offshore windfarms and confirmed in recent consent decisions. It also follows the approach set out in recent guidance from the Planning Inspectorate (Planning Inspectorate 2012) and from the renewables industry (RenewableUK 2013).

13.4.6 Transboundary Impact Assessment

40. The transboundary impact assessment methodology applied in this Chapter is based on that described in Chapter 6 EIA Methodology, adapted to make it applicable to ornithology receptors.

41. The potential for transboundary impacts is identified by consideration of potential linkages to non-UK protected sites and sites with large concentrations of breeding, migratory or wintering birds (including the use of available information on tagged birds).

13.5 Existing Environment

42. This Section details the baseline ecological information based on the desk based assessment and the surveys listed above in paragraph 27 and detailed in *Appendix 13.2*.

43. A summary of the ornithological receptors potentially affected by the offshore components is provided at the end of this section in *Table 13.13*.

13.5.1 Statutory Designated Sites

44. Four classes of statutory designated sites that can have birds included as interest features are considered in this section: SPAs, pSPAs, Ramsar sites and SSSIs.

45. Statutory designated sites been considered in this assessment on the basis of their potential connectivity to the East Anglia THREE site. These sites can be broadly separated into those designated for their breeding seabird interests and those for their terrestrial / coastal bird interests (typically for overwintering aggregations).

46. Seabird breeding sites may be connected during the breeding season (e.g. the windfarm lies within foraging range of breeding birds) or during the non-breeding season (e.g. birds pass through during spring and autumn migration or are present overwinter), or during both periods.

47. Terrestrial / coastal sites designated for migrant species outside the breeding season may be connected on the grounds of passage movements through the windfarm.

48. Those sites that have been identified are listed in *Table 13.10*. In each case their ornithological interest features are listed. The legal process of the designation of SPAs and Ramsar sites in the UK means that, other than marine sites, each SPA and Ramsar site is supported by a complementary SSSI that covers the same area (sometimes the SSSI may cover a larger area because of SSSI interest features that are not relevant to the international designation).

49. The assessment of likely significant effect on the interest features of the internationally designated sites (SPAs and Ramsar sites) is carried out through the Habitats Regulations Assessment (HRA) process and this is reported separately in the Information for Habitats Regulations Assessment (EAOW 2015).

Table 13.10 SPAs, Ramsar sites and SSSI, Ornithological Interest Features and minimum distance to EA3, listed in increasing distance.

Site	Designation	Ornithological Interest Features	Distance to the East Anglia THREE site (km)
Great Yarmouth and North Denes	SPA, SSSI	Classified for its populations of breeding seabirds.	77km
Winterton-Horsey Dunes	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	80km
Breydon Water	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	82km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	
Pakefield to Easton Bavents	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	84km
Broadland	SPA	Classified for its populations of wintering and passage waterbirds.	89km
Minsmere-Walberswick Heaths and Marshes	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	92km
Minsmere - Walberswick	SPA, Ramsar	Classified for its populations of breeding, wintering and passage waterbirds	94km
Sizewell Marshes	SSSI	Notified for its populations of breeding birds.	98km
Alde-Ore Estuary	SPA, Ramsar	Classified for its populations of breeding marsh harrier and breeding and non-breeding waterbirds.	109km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	
Voordelta (Netherlands)	SPA	A marine and coastal SPA classified for non-breeding seabirds and waterbirds.	117km
Outer Thames Estuary	SPA	A marine SPA classified for its non-breeding population of a seabird.	123km
Deben Estuary	SPA, Ramsar	Classified for its populations of non-breeding waterbirds, including population of brent goose at levels of international importance	124km
	SSSI	Notified for its populations of breeding and overwintering waders and wildfowl	
Orwell Estuary	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	133km

Site	Designation	Ornithological Interest Features	Distance to the East Anglia THREE site (km)
Stour & Orwell Estuaries	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	138km
Stour Estuary	SSSI	Notified for its populations of non-breeding (wintering and migration) birds.	140km
Hamford Water	SPA	Classified for its populations of wintering and passage waterbirds.	141km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations	
North Norfolk Coast	SPA	Classified for its populations of wintering and passage waterbirds.	142km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	
Holland Haven Marshes	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations	146km
Cattawade Marshes	SSSI	Notified for its populations of breeding Waders and wildfowl	147km
Upper Colne Marshes	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	157km
Colne Estuary	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	159km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	
Hunstanton Cliffs	SSSI	Notified for its populations of breeding birds.	162km
Abberton Reservoir	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	165km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations.	
Dengie	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	169km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	
Thanet Coast	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	172km
Blackwater Estuary	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	173km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations	
Gibraltar Point	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	176km

Site	Designation	Ornithological Interest Features	Distance to the East Anglia THREE site (km)
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	
The Wash	SPA	Classified for its populations of wintering and passage waterbirds.	176km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	
Foulness	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	180km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) waders and wildfowl populations.	
Thanet Coast and Sandwich Bay	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	181km
Crouch & Roach Estuary	SPA	Classified for its populations of wintering and passage waterbirds.	186km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	
Waddenzee (Netherlands)	SPA	A coastal SPA classified for breeding and non-breeding seabirds, waterbirds and a raptor species	192km
Saltfleetby – Theddlethorpe Dunes	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of wildfowl and waders.	194km
Benfleet & Southend Marshes	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	196km
	SSSI	Notified for its populations of non-breeding (wintering and migration) populations of waders and wildfowl.	
The Swale	SPA	Classified for its populations of wintering and passage waterbirds.	199km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	
Holehaven Creek	SSSI	Notified for its populations of non-breeding (wintering) birds	203km
Pitsea Marsh	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	203km
South Thames Estuary and Marshes	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations	204km
Thames Estuary and Marshes	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	204km
Vange and	SSSI	Notified for its population of breeding and non-breeding	204km

Site	Designation	Ornithological Interest Features	Distance to the East Anglia THREE site (km)
Fobbing Marshes		(wintering and migration) bird population.	
Medway Estuary & Marshes	SPA	Classified for its populations of wintering and passage waterbirds.	206km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) populations of waders and wildfowl.	
Mucking Flats and Marshes	SSSI	Notified for its populations of non-breeding (wintering and migration) and passage bird populations.	211km
The Lagoons	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	212km
Humber Estuary	SPA, Ramsar, SSSI	Classified for its populations of wintering and passage waterbirds.	226km
Hornsea Mere	SPA	Classified for its populations of wintering and passage waterbirds.	246km
	SSSI	Notified for its populations of breeding and non-breeding (wintering and migration) bird populations.	
Flamborough and Filey Coast [pSPA]	SPA	Classified for its populations of breeding seabirds.	257km
Flamborough Head	SSSI	Notified for its populations of breeding birds.	259km
Filey Brigg	SSSI	Notified for its population of non-breeding (wintering and migration) birds	270km
Borkum-Riffgrund (Germany)	SPA	A marine SPA classified for its non-breeding populations of seabirds	272km
Chichester & Langstone Harbour	SPA	Classified for its populations of migratory waterbirds.	334km
Pentland Firth Islands	SPA	Classified for its populations of breeding seabirds.	343km
Portsmouth Harbour	SPA	Classified for its populations of migratory waterbirds.	343km
Teesmouth and Cleveland Coast	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	345km
Littoral Seino-Marin (France)	SPA	A marine, coastal and terrestrial SPA classified for its breeding seabirds and a raptor and non-breeding seabirds, waterbirds and a raptor.	350km
Solent & Southampton Water	SPA	Classified for its populations of migratory waterbirds.	359km

Site	Designation	Ornithological Interest Features	Distance to the East Anglia THREE site (km)
Sylter Auβenriff (Germany)	SPA	A marine SPA classified for its non-breeding seabirds.	381km
Östliche Deutsche Bucht (Germany)	SPA	A marine SPA classified for its populations of non-breeding seabirds.	398km
Coquet Island	SPA	Classified for its populations of breeding seabirds.	414km
Northumbria Coast	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	414km
Seevogelschutzgebiet Helgoland (Germany)	SPA	A marine and island SPA classified for its populations of breeding and non-breeding seabirds.	425km
Ramsar-Gebiet S-H Wattenmeer und angrenzende Küstengebiete (Germany)	SPA	A coastal SPA classified for its breeding, wintering and passage waterbirds, other migrant species and Annex 1 species (82 species listed)	425km
Chesil Beach & The Fleet SPA	SPA	Classified for its populations of migratory waterbirds.	437km
Farne Islands	SPA	Classified for its populations of breeding seabirds.	441km
Baie de Seine Occidentale (France)	SPA	A coastal SPA classified for its populations of breeding and non-breeding seabirds and waterbirds	447km
Lindisfarne	SPA, Ramsar	Classified for its populations of wintering and passage waterbirds.	453km
Falaise du Bessin Occidental (France)	SPA	A marine, coastal and terrestrial SPA classified for its breeding populations of seabirds and a passerine and non-breeding populations of seabirds and raptors.	451km
St Abbs Head to Fast Castle	SPA	Classified for its populations of breeding seabirds.	489km
Exe Estuary	SPA	Classified for its populations of migratory waterbirds.	490km
Forth Islands (Fife/East Lothian)	SPA	Classified for its populations of breeding seabirds.	528km
Imperial Dock Lock, Leith	SPA	Classified for its populations of breeding seabirds.	538km
Firth of Forth	SPA	Classified for its populations of wintering and passage	546km

Site	Designation	Ornithological Interest Features	Distance to the East Anglia THREE site (km)
		waterbirds.	
Firth of Tay & Eden Estuary	SPA	Classified for its populations of wintering and passage waterbirds.	563km
Montrose Basin	SPA	Classified for its populations of wintering and passage waterbirds.	568km
Fowlsheugh	SPA	Classified for its populations of breeding seabirds.	573km
Ythan Estuary, Sands of Forvie and Meikle Loch	SPA	Classified for its populations of wintering and passage waterbirds.	605km
Buchan Ness to Colleston Coast	SPA	Classified for its populations of breeding seabirds.	606km
Loch of Strathbeg	SPA	Classified for its populations of wintering and passage waterbirds.	628km
Troup, Pennan and Lion`s Heads	SPA	Classified for its populations of breeding seabirds.	648km
Moray and Nairn Coast	SPA	Classified for its populations of wintering and passage waterbirds.	690km
Inner Moray Firth	SPA	Classified for its populations of wintering and passage waterbirds.	704km
Lough Foyle	SPA	Classified for its populations of migratory waterbirds.	704km
Cromarty Firth	SPA	Classified for its populations of wintering and passage waterbirds.	715km
Dornoch Firth and Loch Fleet	SPA	Classified for its populations of wintering and passage waterbirds.	725km
East Caithness Cliffs	SPA	Classified for its populations of breeding seabirds.	725km
North Caithness Cliffs	SPA	Classified for its populations of breeding seabirds.	771km
Copinsay	SPA	Classified for its populations of breeding seabirds.	775km
Hoy (Orkney)	SPA	Classified for its populations of breeding seabirds.	791km
Calf of Eday	SPA	Classified for its populations of breeding seabirds.	810km
Fair Isle (Shetland)	SPA	Classified for its populations of breeding seabirds.	813km
Rousay	SPA	Classified for its populations of breeding seabirds.	814km
Marwick Head	SPA	Classified for its populations of breeding seabirds.	815km
West Westray	SPA	Classified for its populations of breeding seabirds.	825km
Papa Westray	SPA	Classified for its populations of breeding seabirds.	827km

Site	Designation	Ornithological Interest Features	Distance to the East Anglia THREE site (km)
(North Hill and Holm)			
Sumburgh Head	SPA	Classified for its populations of breeding seabirds.	840km
Mousa	SPA	Classified for its populations of breeding seabirds.	853km
Noss (Shetland).	SPA	Classified for its populations of breeding seabirds.	866km
Foula (Shetland)	SPA	Classified for its populations of breeding seabirds.	885km
Papa Stour	SPA	Classified for its populations of breeding seabirds.	899km
Fetlar (Shetland)	SPA	Classified for its populations of breeding seabirds.	913km
Hermaness, Sax Vord and Valla Field (Shetland)	SPA	Classified for its populations of breeding seabirds.	937km
Ronas Hill - North Roe and Tingon	SPA	Classified for its populations of breeding seabirds.	916km
Bruine Bank (Brown Ridge) [pSPA] (Netherlands)	SPA	A potential marine SPA identified for its populations of non-breeding seabirds.	n/a*
Frisian Front (Netherlands)	SPA	A marine SPA classified for its populations of non-breeding seabirds.	n/a*

Table Note: n/a = as yet undefined sites that have no boundary to measure distance from.

13.5.2 Baseline Environment and Assessment of Nature Conservation Value for each Bird Species

13.5.2.1 Seabirds

50. The bird abundance estimates and how they were derived are presented in detail in *Appendix 13.2*. No unnecessary details from the baseline report have been repeated within this chapter in order to present a clear and concise impact assessment. Bird abundances and assemblages have been estimated from site-specific surveys in the most part for the East Anglia THREE site and East Anglia THREE site plus a 4km buffer. Additional abundance estimates have been estimated through modelling in the case of some migrant seabirds and non-seabirds relevant to the proposed East Anglia THREE project. For the offshore cable corridor, no site-specific surveys were

completed and only one species has been assessed, red-throated diver, with data provided from an SPA study commissioned by Natural England.

51. Species assessed for impacts are those which were recorded during surveys and which are considered to be at potential risk either due to their abundance, potential sensitivity to windfarm impacts or due to biological characteristics (e.g. commonly fly at rotor heights) which make them potentially susceptible. The conservation status of these species is provided in *Table 13.11*. The locations of all species observed are plotted on figures in *Appendix 13.2*.

Table 13.11 Summary of Nature Conservation Value

Bird Species	Conservation Status
Red-throated diver	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Black-throated diver	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Great northern diver	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Fulmar	BoCC Amber listed, Birds Directive Migratory Species
Gannet	BoCC Amber listed, Birds Directive Migratory Species
Arctic skua	BoCC Red listed, Birds Directive Migratory Species
Great skua	BoCC Amber listed, Birds Directive Migratory Species
Kittiwake	BoCC Amber listed, Birds Directive Migratory Species
Lesser black-backed gull	BoCC Amber listed, Birds Directive Migratory Species
Herring gull	BoCC Red listed, Birds Directive Migratory Species
Great black-backed gull	BoCC Amber listed, Birds Directive Migratory Species
Common tern	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Arctic tern	BoCC Amber listed, Birds Directive Migratory Species, Birds Directive Annex 1
Common guillemot	BoCC Amber listed, Birds Directive Migratory Species
Razorbill	BoCC Amber listed, Birds Directive Migratory Species
Puffin	BoCC Amber listed, Birds Directive Migratory Species

52. Impacts have been assessed in relation to relevant biological seasons, as defined by Furness (2015). For the non-breeding period, the seasons and relevant biologically defined minimum population scales (BDMPS) were taken from Furness (2015) (*Table*

13.12). For the breeding period, the potential for connectivity to known breeding populations has been considered. However, it should be noted that bird abundance was low for all species during the breeding season, with many species absent in one or more of the summer months. This indicated that very few breeding birds utilise the East Anglia THREE site. The seasonal definitions in Furness (2015) include overlapping months in some instances due to variation in the timing of migration for birds which breed at different latitudes (i.e. individuals from breeding sites in the north of the species' range may still be on spring migration when individuals farther south have already commenced breeding). Due to the very low presence of breeding birds it was considered appropriate to define breeding as the migration-free breeding period (see *Table 13.12*), sometimes also referred to as the core breeding period. This ensured that any late or early migration movements which were observed were assessed in relation to the appropriate reference populations.

Table 13.12 Species specific seasonal definitions and biologically defined minimum population sizes (in brackets) have been taken from Furness (2015). Shaded cells indicate the appropriate non-breeding season periods used in the assessment for each species.

Species	Breeding	Migration-free breeding	Migration - autumn	Winter	Migration - spring	Non-breeding
Red-throated diver	Mar-Aug	May-Aug	Sep-Nov (13,277)	Dec-Jan (10,177)	Feb-Apr (13,277)	-
Black-throated diver	Not included in Furness 2015					
Great northern diver	-	-	Sep-Nov	Dec-Feb	Mar-May	Sep-May (200)
Fulmar	Jan-Aug	Apr-Aug	Sep-Oct (957,502)	Nov (568,736	Dec-Mar (957,502)	-
Gannet	Mar-Sep	Apr-Aug	Sep-Nov (456,298)	-	Dec-Mar (248,385)	-
Arctic skua	May-Jul	Jun-Jul	Aug-Oct (6,427)	-	Apr-May (1,227)	-
Great skua	May-Aug	May-Jul	Aug-Oct (19,556)	Nov-Feb (143)	Mar-Apr (8,485)	-
Lesser black-backed gull	Apr-Aug	May-Jul	Aug-Oct (209,007)	Nov-Feb (39,314)	Mar-Apr (197,483)	-
Herring gull	Mar-Aug	May-Jul	Aug-Nov	Dec	Jan-Apr	Sep-Feb (466,511)
Great black-backed gull	Mar-Aug	May-Jul	Aug-Nov	Dec	Jan-Apr	Sep-Mar (91,399)
Kittiwake	Mar-Aug	May-Jul	Aug-Dec (829,937)	-	Jan-Apr (627,816)	-
Commic tern *	May-Aug	Jun	Jul-Sep (308,841)	-	Apr-May (308,841)	-

Species	Breeding	Migration-free breeding	Migration - autumn	Winter	Migration - spring	Non-breeding
Common guillemot	Mar-Jul	Mar-Jun	Jul-Oct	Nov	Dec-Feb	Aug-Feb (1,617,306)
Razorbill	Apr-Jul	Apr-Jul	Aug-Oct (591,874)	Nov-Dec (218,622)	Jan-Mar (591,874)	-
Puffin	Apr-Aug	May-Jun	Jul-Aug	Sep-Feb	Mar-Apr	Mid-Aug-Mar (231,957)

*** Combined population presented due to difficulty of separating these species in survey data.**

53. The mean peak abundance within species specific season (as defined in *Table 13.12)* recorded within the East Anglia THREE site boundary and the East Anglia THREE site plus 4km buffer are provided in *Table 13.13*. The mean peak in any given season was the highest of the monthly average abundances for all months in that season. It should be noted that due to differences in the timing of migration for birds which breed at different latitudes some months are included within adjacent seasons (e.g. breeding and migration), and therefore the same peak abundance may be identified in two seasons. These have been highlighted in *Table 13.13*.

Table 13.13 Mean peak seabird abundances within the East Anglia THREE site. Figures in italics identify the same peak occurring in different seasons due to overlapping months.

Species	Breeding	Migration-free breeding	Migration - autumn	Winter	Migration - spring	Non-breeding
Red-throated diver	*106*	8	25	17	*106*	NA
Great northern diver	NA	NA	0	0	*61*	*61*
Fulmar	*592*	*592*	653	49	443	NA
Gannet	89	46	545	NA	185	NA
Arctic skua	0	0	15	NA	0	NA
Great skua	0	0	43	0	0	NA
Lesser black-backed gull	*166*	28	*166*	57	25	NA
Herring gull	*310*	13	*310*	*646*	87	*646*
Great black-backed gull	*215*	26	*215*	*368*	310	*368*
Kittiwake	141	98	2301	NA	438	NA
Commic tern *	*299*	0	16	NA	*299*	NA
Guillemot	*712*	*712*	532	189	*1371*	*1371*
Razorbill	*1123*	*1123*	599	693	1118	
Puffin	*108*	16	31	*195*	*108*	*195*

*** Combined population presented due to difficulty of separating these species in survey data.**

13.5.2.2 Non-seabird migrants

54. Migrant terrestrial bird species are not typically well represented in offshore surveys. In recognition of this an assessment was conducted to estimate the potential risk of collisions on the basis of knowledge of migration flight paths and migratory population sizes (*Appendix 13.1*).

55. A screening exercise identified 23 species as at potential collision risk at the East Anglia THREE site on migration (*Appendix 13.1).* The proportion of the flyway population predicted to pass through the East Anglia THREE site was estimated using the approach described in the SOSS 05 Project (Wright et al. 2012). Collisions were estimated using the Band collision risk model Option 1 using the Migrant sheet to calculate the number of potential collisions in each migration season (with a 98% avoidance rate).

56. Outputs from the modelling (*Appendix 13.1*) indicated that no species were at risk of significant collisions whilst on migration and therefore non-seabird migrants were screened out of further assessment. Indeed the impacts were of such small magnitude that the potential for the proposed East Anglia THREE project to contribute to cumulative impacts was also ruled out and no cumulative assessment was therefore necessary.

13.6 Screening of Potential Impacts

57. The impacts that could potentially arise during the construction, operation and decommissioning of the proposed East Anglia THREE project were discussed with Natural England and the RSPB as part of the Evidence Plan process (*Appendix 13.1*). As a result of those discussions it was agreed that the potential impacts that required assessment were:

In the construction phase

- Impact 1: Disturbance / displacement; and
- Impact 2: Indirect impacts through effects on habitats and prey species.

In the operational phase

- Impact 3: Disturbance / displacement;
- Impact 4: Indirect impacts through effects on habitats and prey species;

- Impact 5: Collision risk; and
- Impact 6: Barrier effect.

In the decommissioning phase

- Impact 7: Disturbance / displacement; and
- Impact 8: Indirect impacts through effects on habitats and prey species.

13.7 Assessment of Potential Impacts

58. In the assessment of potential impacts below they are assessed:

- In the order of construction, operation and decommissioning;
- Following the impact assessment methodology that is described in *section 13.4.3* above;
- On the basis of the worst case potential impacts set out in *section 13.3.3* above; and
- Accounting for the embedded mitigation that is described in *section 13.3.4* above.

13.7.1 Potential Impacts during Construction

13.7.1.1 Impact 1: Direct Disturbance and Displacement

59. The construction phase of the proposed project has the potential to affect bird populations in the marine environment through disturbance due to construction activity leading to displacement of birds from construction sites. This would effectively result in temporary habitat loss through reduction in the area available for feeding, loafing and moulting. The worst case scenario, outlined in *Table 13.2*, describes the elements of the proposed project considered within this assessment.

60. The maximum duration of offshore construction for the proposed project would be 45 months which would overlap with a maximum of four breeding seasons, four winter periods and up to eight migration periods.

61. The construction phase would require the mobilisation of vessels, helicopters and equipment and the installation of foundations, export cables and other infrastructure. These activities have the potential to disturb and displace birds from

within and around the offshore elements of the proposed East Anglia THREE project, including the windfarm and the sub-sea cables. The level of disturbance at each work location would differ dependent on the activities taking place, but there could be vessel movements at any time of day or night over the 45 month construction period.

62. Any impacts resulting from disturbance and displacement from construction activities are considered likely to be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, with birds expected to return to the area once construction activities have ceased. Construction related disturbance and displacement is most likely to affect foraging birds.

63. Some species are more susceptible to disturbance than others. Gulls are not considered susceptible to disturbance, as they are often associated with fishing boats (e.g. Camphuysen 1995; Hüppop and Wurm 2000) and have been noted in association with construction vessels at the Greater Gabbard offshore windfarm (GGOWL 2011) and close to active foundation piling activity at the Egmond aan Zee (OWEZ) windfarm, where they showed no noticeable reactions to the works (Leopold and Camphuysen 2007). However, species such as divers and scoters have been noted to avoid shipping by several kilometres (Mitschke et al. 2001 from Exo et al. 2003; Garthe and Hüppop 2004).

64. There are a number of different measures used to assess bird disturbance and displacement from areas of sea in response to activities associated with an offshore windfarm. Garthe and Hüppop (2004) developed a scoring system for such disturbance factors, which is used widely in offshore windfarm EIAs. Furness and Wade (2012) developed disturbance ratings for particular species, alongside scores for habitat flexibility and conservation importance. These factors were used to define an index value that highlights the sensitivity of a species to disturbance and displacement. As many of these references relate to disturbance from helicopter and vessel activities, these are considered relevant to this assessment.

65. Birds recorded during the species specific spring and autumn migration periods are assumed to be moving through the area between breeding and wintering areas. As these individuals will be present in the site for a short time and the potential zone of construction displacement will be comparatively small (that located around two construction vessels) it has been assumed that there are negligible risks of impact at

these times of year. Consequently the following assessment considers the breeding and nonbreeding periods only (seasons following Furness 2015).

66. In order to focus the assessment of disturbance and displacement, a screening exercise was undertaken to identify those species most likely to be at risk (*Table 13.14*). Any species with a low sensitivity to displacement or recorded only in very small numbers within the Study Area (including the offshore cable corridor) was screened out of further assessment. This process screened out black-throated diver (recorded on one survey) and great northern diver (recorded in two surveys). The species screened in for assessment were assessed for impacts during the period (breeding or non-breeding) when effects were potentially likely to occur.

Table 13.14 Disturbance and Displacement Screening

Receptor	Sensitivity to Disturbance and Displacement	Screening Result (IN or OUT)
Red-throated diver	Very High	**Screened IN** for the offshore cable corridor only and in response to discussions with NE and RSPB in the Evidence Plan process.
Fulmar	Very Low	**Screened OUT** as the species has a Very Low sensitivity and is not known to avoid vessels or wind turbines.
Gannet	Low	**Screened OUT** as has a Low sensitivity to disturbance and displacement.
Kittiwake	Low	**Screened OUT** as has a Low sensitivity to disturbance and displacement.
Lesser black-backed gull	Low	**Screened OUT** as has a Low sensitivity to disturbance and displacement.
Herring gull	Low	**Screened OUT** as has a Low sensitivity to disturbance and displacement.
Great black-backed gull	Low	**Screened OUT** as has a Low sensitivity to disturbance and displacement.
Guillemot	Low to Medium	**Screened IN** due to numbers recorded and classified as of Low to Medium sensitivity to disturbance and displacement.
Razorbill	Low to Medium	**Screened IN** due to numbers recorded and classified as of Low to Medium sensitivity to disturbance and displacement.
Puffin	Low to Medium	**Screened IN** as classified of Low to Medium sensitivity to disturbance and displacement, and following advice from NE.

Red-throated Diver

67. Red-throated diver has been identified as being particularly sensitive to human activities in marine areas, including through the disturbance effects of ship and helicopter traffic (Garthe and Hüppop 2004; Schwemmer et al. 2011; Furness and Wade 2012; Bradbury et al. 2014).

68. There is potential for disturbance and displacement of non-breeding red-throated divers resulting from the presence of a vessel installing the offshore cable, including when it is laid through the Outer Thames Estuary SPA. However, cable laying vessels are static for large periods of time, and move only short distances as cable installation takes place. Offshore cable installation activity is also a relatively low noise emitting operation, particularly when compared to activities such as piling.

69. The magnitude of disturbance to red-throated diver has been estimated on a 'Worst Case' basis. This assumes that there would be 100% displacement of those birds in a 2km buffer surrounding the source, in this case a maximum of two cable laying vessels. This 100% displacement is consistent with Garthe and Hüppop (2004) and Schwemmer et al. (2011) since they suggested that all red-throated divers present fly away from approaching vessels at a distance of more than 1km.

70. In order to calculate the number of red-throated divers that would potentially be at risk of displacement from the offshore cable corridor during the cable laying process, the density of red-throated diver in the SPA and along the offshore cable corridor was estimated. This was carried out in GIS by overlaying the offshore cable corridor, buffered by 2km, on to the observed distribution of red-throated diver in the area.

71. There has been a series of surveys of red-throated diver in the broader area of the greater Thames Estuary and specifically of the Outer Thames Estuary SPA from which the information on the distribution and density can be drawn. These have been divided in to two groups:

A) JNCC / Natural England aerial visual surveys undertaken during the winter (October – March) between 2001/01 and 2009/10 (data supplied by JNCC). This information was also used in the assessment of the impacts of East Anglia ONE.

B) Two high resolution digital aerial surveys flown in January and February 2013 by APEM Ltd under contract to Natural England (permission to use these data was received from Natural England in an email dated 21st February 2014).

72. These two sets of information were used to calculate independent mean density estimates of red-throated diver within the offshore cable corridor and its 2km buffer. Those estimates were 0.74 birds/km^2 (JNCC/Natural England data, 2000/1-2009/10) and 0.91 birds/km^2 (Natural England 2013). It should be noted that in winter 2012/13 higher numbers than previously recorded were present, although the offshore cable corridor is located in one of the areas of lower density, since the overall density within the SPA is estimated to be 1.7 birds per km^2 (designated population of 6,466 divided by the total SPA area of 3,792.7km^2).

73. The 'worst case' area from which birds could be displaced was defined as a circle with a 2km radius around each cable laying vessel, which is 25.2km^2 (2 x 12.6km^2). If 100% displacement is assumed to occur within this area, then between 18.6 and 22.8 divers would be displaced at any given time. This would lead to a 0.6% increase in diver density in the remaining areas of the SPA. As the vessels move it is assumed that displaced birds return and therefore any individual will be subjected to a brief period of impact. It is considered reasonable to assume that birds will return following passage of the vessel since the cable laying vessels will move at a maximum speed of 400m per hour if surface laying, 300m per hour for ploughing and 80m per hour if trenching (Chapter 5, Description of the Development). This represents a maximum speed of 7m per minute. For context, a modest tidal flow rate for the Outer Thames would be in the region of 0.5m per second. The tide would therefore be flowing at least four times faster than the cable laying vessel. Consequently, for the purposes of this assessment it can be assumed that the estimated number displaced represents the total number displaced over the course of a single winter.

74. Definitive mortality rates associated with displacement for any seabird are not known and precautionary estimates have to be used. There is no evidence that birds displaced from windfarms suffer any mortality as a consequence of displacement; any mortality due to displacement would be most likely a result of increased density in areas outside the affected area, resulting in increased competition for food where density was elevated. Such impacts are most likely to be negligible, and below levels that could be quantified. Impacts of displacement are also likely to be context-dependent. In years when food supply has been severely depleted, as for example by unsustainably high fishing mortality of sandeel stocks as has occurred several times in recent decades (ICES 2013), displacement of sandeel-dependent seabirds from optimal habitat may increase mortality. In years when food supply is good,

displacement is unlikely to have any negative effect on seabird populations. Red-throated divers may feed on sandeels, but take a wide diversity of small fish prey, so would be buffered to an extent from fluctuations in abundance of individual fish species. It is not possible for the proposed East Anglia THREE project to predict future fishing effort. However, this assessment has assumed the precautionary maximum mortality rate associated with the displacement of red-throated diver in the wintering period is 10% (i.e. 10% of displaced individuals suffer mortality as a direct consequence). At this level of mortality then only two birds would be expected to die across the entire winter period (September to April) as a result of any potential displacement effects from the offshore cable installation activities. Even when compared to the smaller winter BDMPS for this species (10,177; Furness 2015) it is clear that this highly precautionary assessment will generate an effect of negligible magnitude.

75. The construction works, specifically offshore cable laying, are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of high sensitivity to disturbance, the impact significance is **minor** adverse.

Guillemot

76. Guillemots have been recorded in the East Anglia THREE site year round, with numbers peaking in January (mean density on East Anglia THREE site 5.92/km^2) and at their lowest in June (mean density on East Anglia THREE site 0.047/km^2). Guillemots are considered to have a low to medium general sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Furness and Wade (2012), Furness et al. (2013) and Bradbury et al. (2014).

77. There is potential for disturbance and displacement of guillemots due to construction activity, including wind turbine construction and associated vessel traffic. However, construction will not occur across the whole of the proposed wind turbine array area simultaneously or every day but will be phased, with no more than one foundation expected to be installed at any time. Consequently the effects will occur only in the areas where vessels are operating at any given point and not the entire East Anglia THREE site.

78. During the nonbreeding season, at a mean peak density of 5.92/km^2 and with a highly precautionary 2km radius of disturbance around each construction vessel, 148

individuals (5.92 x 12.56 x 2) could be at risk of displacement. The nonbreeding season BDMPS for common guillemot is 1.6 million birds (Furness 2015). Displacement of up to 148 birds will have a negligible influence on the population density across the BDMPS region (UK North Sea and Channel) and therefore the effect on 148 individuals during the nonbreeding season will be negligible.

79. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

80. During the breeding season the maximum mean peak density on the East Anglia THREE site was 3.016/km^2 (March) which suggests that 76 individuals (3.016 x 12.56 x 2) could be at risk of displacement.

81. The mean maximum foraging range for breeding guillemot is 84.2km (Thaxter et al. 2012) which places the East Anglia THREE site considerably beyond the range of any guillemot breeding colonies. It should be noted that some recent tagging studies have recorded larger apparent distances than this (one guillemot was recorded travelling 340km from Fair Isle) which would indicate connectivity to breeding colonies. However, further consideration of this apparent potential for connectivity indicates how exceptional this result is. The 340km figure is derived from an individual guillemot on Fair Isle in a year when the local sandeel stock collapsed and breeding success was close to zero (this bird's chick died). A common guillemot flies at about 19m per second (Pennycuick 1997) so would take almost 10 hours to complete this round trip even if it spent no time on the water or diving for food. This is incompatible with bringing enough food back to keep a chick alive. The species carries only one fish at a time and common guillemot chicks need about 5 feeds per day. Yet chicks are normally attended and protected by one adult at the nest site while the partner is foraging (Uttley et al. 1994), so there are simply not enough hours in the day to allow successfully breeding guillemots to make such long trips to provision a chick. At 19m per second the East Anglia THREE site is 3.7 hours direct flight time away from the nearest guillemot breeding colony (Flamborough Head). A return trip would take 7.5 hours, not allowing for foraging. As for the Fair Isle example, travelling such distances is incompatible with successful breeding. On the basis of 5 feeds per day, the furthest away a bird could fly per trip to achieve this in 24 hours is 164km (i.e. a round trip of 328km), with no allowance for foraging time.

Even if the bird spends a maximum of only 30 minutes foraging, this reduces the farthest distance to 147km.

82. On the basis of the above evidence, it can be stated with certainty that there are no breeding colonies for guillemot within foraging range of the East Anglia THREE site, therefore it is reasonable to assume that individuals seen during the breeding season are nonbreeding (e.g. immature birds). Since immature seabirds are known to remain in wintering areas, the number of immature birds in the relevant population during the breeding season may be estimated as 43% (the proportion of the population that is of immature status) of the total wintering BDMPS population (Furness 2015). This gives a breeding season population of 695,441 (BDMPS for the UK North Sea and Channel, 1,617,306 x 43%). Therefore an impact on 76 (likely immature) individuals during the breeding season will be negligible.

83. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

Razorbill

84. Razorbills have been recorded in the East Anglia THREE site year round, with numbers peaking in January (mean density on East Anglia THREE site 4.42/km^2) and at their lowest in June (mean density on East Anglia THREE site 0.022/km^2). Razorbills are considered to have a low to medium general sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004) and Furness and Wade (2012).

85. There is potential for disturbance and displacement of razorbills due to construction activity, including wind turbine construction and associated vessel traffic. However, construction will not occur across the whole of the proposed wind turbine array area simultaneously or every day but will be phased with a maximum of two foundations expected to be installed simultaneously. Consequently the effects will occur only in the areas where vessels are operating at any given point and not the entire East Anglia THREE site.

86. During the autumn migration season, at a peak mean density of 2.37/km^2 and with a highly precautionary 2km radius of disturbance around each construction vessel, 59 individuals (2.37 x 12.56 x 2) could be at risk of displacement. The autumn migration

BDMPS for razorbill is 591,874 (Furness 2015), therefore the effect on this many individuals during the nonbreeding season will be negligible.

87. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

88. During the nonbreeding season, at a peak mean density of 2.74/km^2 and with a highly precautionary 2km radius of disturbance around each construction vessel, 69 individuals (2.74 x 12.56 x 2) could be at risk of displacement. The nonbreeding season BDMPS for razorbill is 218,622 (Furness 2015), therefore the effect on this many individuals during the nonbreeding season will be negligible.

89. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

90. During the spring migration season, at a peak mean density of 4.42/km^2 and with a highly precautionary 2km radius of disturbance around each construction vessel, 111 individuals (4.42 x 12.56 x 2) could be at risk of displacement. The spring migration BDMPS for razorbill is 591,874 (Furness 2015), therefore the effect on this many individuals during the nonbreeding season will be negligible.

91. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

92. During the breeding season the maximum mean peak density on the site was 4.35/km^2 (April) which suggests that 109 individuals (4.35 x 12.56 x 2) could be at risk of displacement.

93. The mean maximum foraging range for breeding razorbill is 48.5km (Thaxter et al. 2012) which places the East Anglia THREE site considerably beyond the range of any razorbill breeding colonies. It should be noted that some recent tagging studies have recorded larger apparent distances than this (one razorbill was recorded travelling 312km from Fair Isle) which would indicate connectivity to breeding colonies. However, further consideration of this apparent potential for connectivity indicates how exceptional this result is. A razorbill flies at about 16m per second (Pennycuick 1997) so would take almost 11 hours to complete this round trip even if it spent no

time on the water or diving for food. This is incompatible with bringing enough food back to keep a chick alive as razorbill chicks receive about 3 feeds per day (Harris and Wanless 1989). Yet chicks are normally attended and protected by one adult at the nest site while the partner is foraging (Wanless and Harris 1986), so there are simply not enough hours in the day to allow successfully breeding razorbills to make such long trips to provision a chick. At 16m per second the East Anglia THREE site is 4.5 hours direct flight time away from the nearest razorbill breeding colony (Flamborough Head). A return trip would take 9 hours, not allowing for foraging. As for the Fair Isle example, travelling such distances is incompatible with successful breeding. On the basis of 3 feeds per day, the furthest away a bird could fly per trip to achieve this in 24 hours is 115km (i.e. a round trip of 230km), with no allowance for foraging time. Even if the bird spends a maximum of only 30 minutes foraging, this reduces the farthest distance to 108km.

94. On the basis of the above evidence, it can be stated with certainty that there are no breeding colonies for razorbill within foraging range of the East Anglia THREE site, therefore it is reasonable to assume that individuals seen during the breeding season are nonbreeding (e.g. immature birds). Since immature seabirds are known to remain in wintering areas, the number of immature birds in the relevant population during the breeding season may be estimated as 43% of the total wintering BDMPS population (Furness 2015). This gives a breeding season population of 94,007 (BDMPS for the UK North Sea and Channel, 218,622 x 43%). Therefore an impact on 109 (likely immature) individuals during the breeding season will be negligible.

95. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

Puffin

96. Puffins have been recorded in the East Anglia THREE site in low numbers in most months, with numbers peaking in November (mean density on East Anglia THREE site 0.63/km^2) and with none present in June and September. Puffins are considered to have a low to medium general sensitivity to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004) and Furness and Wade (2012).

97. There is potential for disturbance and displacement of puffins due to construction activity, including wind turbine construction and associated vessel traffic. However, construction will not occur across the whole of the proposed wind turbine array area simultaneously or every day, but will be phased with a maximum of two foundations expected to be installed simultaneously. Consequently the effects will occur only in the areas where vessels are operating at any given point and not the entire East Anglia THREE site.

98. During the nonbreeding season, at a mean peak density of 0.63/km^2 and with a highly precautionary 2km radius of disturbance around each construction vessel, 16 individuals (0.63 x 12.56 x 2) could be at risk of displacement. The nonbreeding season BDMPS for puffin is 231,957 (Furness 2015), therefore the effect on this many individuals during the nonbreeding season will be negligible.

99. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

100. During the breeding season the maximum mean peak density on the site was 0.35/km^2 (April) which suggests that 9 individuals (0.35 x 12.56 x 2) could be at risk of displacement. There are no breeding colonies for puffin within foraging range of the East Anglia THREE site, therefore it is reasonable to assume that individuals seen during the breeding season are nonbreeding (e.g. immature birds). Since immature seabirds are known to remain in wintering areas, the number of immature birds in the relevant population during the breeding season may be estimated as 45% of the total wintering BDMPS population (Furness 2015). This gives a breeding season population of 104,381 (BDMPS for the UK North Sea and Channel, 231,957 x 45%). Therefore an impact on 9 (likely immature) individuals during the breeding season will be negligible.

101. The construction works are temporary and localised in nature and the magnitude of effect has been determined as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

13.7.1.2 Impact 2: Indirect Impacts Through Effects on Habitats and Prey Species

102. Indirect disturbance and displacement of birds may occur during the construction phase if there are impacts on prey species and the habitats of prey species. These indirect effects include those resulting from the production of underwater noise (e.g.

during piling) and the generation of suspended sediments (e.g. during preparation of the seabed for foundations) that may alter the behaviour or availability of bird prey species. Underwater noise may cause fish and mobile invertebrates to avoid the construction area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the construction area and may smother and hide immobile benthic prey. These mechanisms result in less prey being available within the construction area to foraging seabirds. Such potential effects on benthic invertebrates and fish have been assessed in Chapter 10 Benthic Ecology and Chapter 11 Fish and Shellfish Ecology and the conclusions of those assessments inform this assessment of indirect effects on ornithology receptors.

103. With regard to noise impacts on fish, Chapter 11 Fish and Shellfish Ecology discusses the potential impacts upon fish relevant to ornithology as prey species. With regard to physical injury or behavioural changes underwater noise impacts on fish during construction of the proposed East Anglia THREE project are considered to be minor or negligible (see *Tables 11.22* and *11.23*) for species such as herring, sprat and sandeel which are the main prey items of seabirds such as gannet and auks. With a minor or negligible impact on fish that are bird prey species, it could be concluded that the indirect impact significance on seabirds occurring in or around the proposed East Anglia THREE project during the construction phase is similarly a **minor** or **negligible** adverse impact.

104. With regard to changes to the seabed and to suspended sediment levels, Chapter 10 Benthic Ecology discusses the nature of any change and impact. Such changes are considered to be temporary, small scale and highly localised (see Chapter 10, section *10.6.2*). The consequent indirect impact on fish through habitat loss is considered to be minor or negligible (see *Table 11.25*) for species such as herring, sprat and sandeel which are the main prey items of seabirds such as gannet and auks. With a minor or negligible impact on fish that are bird prey species, it could be concluded that the indirect impact significance on seabirds occurring in or around the proposed East Anglia THREE project during the construction phase is similarly a **minor** or **negligible** adverse impact.

13.7.2 Potential Impacts during Operation

105. There are four potential impacts that may affect bird populations during the operational phase of the proposed project that have been screened in. These are:

- Impact 3: Disturbance / displacement;
- Impact 4: Indirect impacts through effects on habitats and prey species;
- Impact 5: Collision risk; and
- Impact 6: Barrier effect.

13.7.2.1 Impact 3: Direct Disturbance and Displacement

106. The presence of wind turbines has the potential to directly disturb and displace birds from within and around the East Anglia THREE site. This is assessed as an indirect habitat loss, as it has the potential to reduce the area available to birds for feeding, loafing and moulting. Vessel activity and the lighting of wind turbines and associated ancillary structures could also attract (or repel) certain species of birds and affect migratory behaviour on a local scale.

107. Seabird species vary in their reactions to the presence of operational infrastructure (e.g. wind turbines, substations and met mast) and to the maintenance activities that are associated with it (particularly ship and helicopter traffic), with Garthe and Hüppop (2004) presenting a scoring system for such disturbance factors, which is used widely in offshore windfarm EIAs. As offshore windfarms are a new feature in the marine environment, there is limited evidence as to the disturbance and displacement effects of the operational infrastructure in the long term.

108. Natural England and JNCC issued a joint Interim Displacement Guidance Note (Natural England and JNCC 2012), which provides recommendations for presenting information to enable the assessment of displacement effects in relation to offshore windfarm developments. This guidance note has shaped the assessment provided below.

109. There are a number of different measures used to determine bird displacement from areas of sea in response to activities associated with an offshore windfarm. Furness and Wade (2012), for example, use disturbance ratings for particular species, alongside scores for habitat flexibility and conservation importance to define an index value that highlights the sensitivity to disturbance and displacement. These authors also recognise that displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals.

110. Both the presence of the infrastructure and the operational activities associated with the proposed East Anglia THREE project have the potential to directly disturb birds. These activities could potentially displace birds from important areas for feeding, moulting and loafing. Reduced access to some areas could result, at the extreme, in changes to feeding and other behavioural activities resulting in a loss of fitness and a reduction in survival chances. This would be unlikely for seabirds that have large areas of alternative habitat available, but would be more likely to affect seabirds with highly specialised habitat requirements that are limited in availability (Furness and Wade 2012; Bradbury et al. 2014).

111. The methodology presented in the Natural England / JNCC joint Interim Advice Note (Natural England and JNCC 2012) recommends a matrix is presented for each key species showing bird losses at differing rates of displacement and mortality. This assessment uses the range of predicted losses, in association with the scientific evidence available from post-construction monitoring studies, to quantify the level of displacement and the potential losses as a consequence of the proposed project. These losses are then placed in the context of the relevant population (e.g. SPA or BDMPS) to determine the magnitude of effect.

112. Birds are considered to be most at risk from operational disturbance and displacement effects when they are resident (e.g. during the breeding season or wintering season). The small risk of impact to migrating birds is better considered in terms of barrier effects, which are discussed in the following section.

113. Following installation of the offshore cable, the required operational and maintenance activities (in relation to the cable) may have short-term and localised disturbance and displacement impacts on birds using the East Anglia THREE site. However, disturbance from operational activities would be temporary and localised, and is unlikely to result in detectable effects at either the local or regional population level. Therefore no impact due to cable operation and maintenance is predicted. The focus of this section is therefore on the disturbance and displacement of birds due to the presence and operation of wind turbines, other offshore infrastructure and any maintenance operations associated with them.

114. In order to focus the assessment of disturbance and displacement, a screening exercise was undertaken to identify those species most likely to be at risk (*Table 13.15*), focussing on the main species described in the Baseline Offshore Ornithology Technical Report (*Appendix 13.1*). The species identified as at risk were then

assessed within the biological seasons within which effects were potentially likely to occur. Any species with a low sensitivity to displacement, or recorded only in very small numbers within the East Anglia THREE site during the breeding and wintering seasons, was screened out of further assessment. As described above, any effects from displacement during the migration seasons are covered through an assessment of the barrier effect, which is discussed in the following sections.

115. *Table 13.15* presents the general sensitivity to disturbance and displacement for each species. Displacement rates (based on observations of macro-avoidance, that is avoidance at the level of the whole windfarm rather than the wind turbine) are derived from a review of monitoring reports at constructed windfarms (Krijgsveld et al., 2011, Leopold et al., 2011, Mendel et al. 2014, Vanermen et al. 2013, Braasch et al. 2015, Walls et al., 2013).

Table 13.15 Disturbance and Displacement Screening

Receptor	Sensitivity to Disturbance and Displacement (Garthe and Hüppop 2004; Furness and Wade 2012)	Displacement Rate based on OWEZ (Krijgsveld et al. 2011, Leopold et al. 2011)	Displacement Rate based on Robin Rigg (Walls et al. 2013)	Biological Season/s with peak numbers	Screening Result (IN or OUT)
Red-throated diver	Very High	68%	n/a (sample size small)	Spring migration	**Screened IN** for potential effects during spring migration and at NE request.
Fulmar	Very Low	28%	n/a	Breeding & migration periods	**Screened OUT** as the species is not known to avoid wind turbines (with a low macro avoidance rate) and has a maximum habitat flexibility score of 1 in Furness & Wade (2012), suggesting species utilises a wide range of habitats over a large area.
Gannet	Low	64%	50%	Autumn migration	**Screened IN** for autumn and spring migration seasons, as has a high macro avoidance rate.
Kittiwake	Low	18%	0% (No clear evidence of Displacement)	Migration periods	**Screened OUT** as migration numbers low relative to BDMPS and not known to avoid wind turbines (low macro avoidance rate)

Receptor	Sensitivity to Disturbance and Displacement (Garthe and Hüppop 2004; Furness and Wade 2012)	Displacement Rate based on OWEZ (Krijgsveld et al. 2011, Leopold et al. 2011)	Displacement Rate based on Robin Rigg (Walls et al. 2013)	Biological Season/s with peak numbers	Screening Result (IN or OUT)
Lesser black-backed gull	Low	18%	0% (No difference in gull presence)	n/a	**Screened OUT** as present in low numbers in all seasons and not known to avoid wind turbines (low macro avoidance rate)
Herring gull	Low	18%	0% (No difference in gull presence)	Breeding	**Screened OUT** as present in low numbers in all seasons and not known to avoid wind turbines (low macro avoidance rate)
Great black-backed gull	Low	18%	0% (No difference in gull presence)	Breeding & Wintering	**Screened OUT** as present in low numbers in all season and not known to avoid wind turbines (low macro avoidance rate)
Guillemot	Low to Medium	68%	30% (Some evidence of displacement)	Migration periods	**Screened IN** as present in moderate numbers in nonbreeding season and due to medium sensitivity to disturbance and displacement.

Receptor	Sensitivity to Disturbance and Displacement (Garthe and Hüppop 2004; Furness and Wade 2012)	Displacement Rate based on OWEZ (Krijgsveld et al. 2011, Leopold et al. 2011)	Displacement Rate based on Robin Rigg (Walls et al. 2013)	Biological Season/s with peak numbers	Screening Result (IN or OUT)
Razorbill	Low to Medium	68%	30% (Some evidence of displacement for all auks)	Nonbreeding season	**Screened IN** as present in moderate numbers in nonbreeding season and due to medium sensitivity to disturbance and displacement.
Puffin	Low	68%	30% (Some evidence of displacement for all auks)	Nonbreeding season	**Screened IN** as present in moderate numbers in nonbreeding season and due to medium sensitivity to disturbance and displacement.

116. The impact of mortality caused by displacement on the population is assessed in terms of the change in the baseline mortality rate which could result. It has been assumed that all age classes are equally at risk of displacement (i.e. in proportion to their presence in the population), therefore it is necessary to calculate an average baseline mortality rate for all age classes for each species screened in for assessment (*Table 13.15*). These were calculated using the different rates for each age class and their relative proportions in the population.

117. The first step is to calculate an average survival rate. The demographic rates for each species were taken from (Horswill and Robinson 2015) and entered into a matrix population model. This was used to calculate the expected proportions in each age class. Each age class survival rate was multiplied by its proportion and the total for all ages summed to give the average survival rate for all ages. Taking this value from 1 gives the average mortality rate. The demographic rates and the age class proportions and average mortality rates calculated from them are presented in *Table 13.16*.

Table 13.16. Average mortality calculated using age related survival and productivity and estimates of the relative proportions of each age class.

Age class	Red-throated diver		Gannet		Guillemot		Razorbill		Puffin	
	Survival	Prop.	Survival	Prop.	Survival	Prop.	Survival	Prop.	Survival	Prop.
0 to 1	0.6	0.179	0.424	0.191	0.56	0.168	0.630	0.159	0.709	0.162
1 to 2	0.62	0.145	0.829	0.081	0.792	0.091	0.630	0.102	0.709	0.115
2 to 3			0.891	0.067	0.917	0.069	0.895	0.065	0.76	0.082
4 to 5	-		0.895	0.060	0.939	0.062	0.895	0.059	0.805	0.063
5 to 6	-	-	-	-	0.939	0.056	-	-	-	-
Adult	0.84	0.705	0.912	0.600	0.939	0.552	0.895	0.613	0.906	0.577
Productivity	0.571	-	0.7	-	0.672	-	0.57	-	0.617	-
Average mortality		0.228		0.191		0.14		0.174		0.167

Red-throated diver

118. Red-throated divers are considered to have a very high general sensitivity to disturbance and displacement and they are notoriously shy and prone to avoiding disturbed areas (Garthe & Hüppop 2004; Petersen 2006; Furness and Wade 2012;

Percival 2014). Monitoring studies of red-throated divers at the Kentish Flats offshore windfarm found an observable shift of birds away from the turbines, particularly within 500m of the site (Percival 2010). This is consistent with a study of pre-construction and post-construction abundance and distribution of birds conducted at Horns Rev, Denmark, around one operational offshore windfarm. This study found that red-throated divers avoided areas of sea that were apparently suitable (favoured habitat, suitable depth and abundant food sources) following the construction of an offshore windfarm, and that this effect remained for a period of three years (Peterson et al. 2006). Further pre-construction and post-construction abundance and distribution studies published more recently on red-throated divers at the Kentish Flats site (Percival 2010) have provided displacement values for both the site footprint and within distance bands away from the site boundary, which have been replicated for use in this assessment.

119. The assessment is based on the assumption that birds will be displaced from the East Anglia THREE site to a decreasing extent with increasing distance from wind turbines. Displacement values from Percival (2010) have been used to estimate the impact on red-throated divers from the East Anglia THREE site and a 4km buffer. Percival (2010) used survey data on the distribution and abundance of red-throated divers at the Kentish Flats windfarm during the pre-construction, construction and post-construction phases of the windfarm development over an eight year period. The percentage change in red-throated diver abundance was then calculated between pre- and post-construction surveys within the site's footprint and within a buffer surrounding the site boundary (*Table 13.17*). It should be noted that beyond 2km Percival (2010) reported an *increase* in red-throated diver abundance. It has been assumed here that no change will occur beyond 2km, therefore the figures used in the assessment represent a conservative interpretation of the scale of the change in red-throated diver abundance.

Table 13.17 Distance zones within the 4km buffer and their corresponding areas (km^2), percentage changes in abundance from Percival (2010) and predicted numbers of red-throated divers affected. Note that data were not available for the 0-0.5km and the 2-3km bands. To estimate the number at risk of displacement a precautionary approach has been adopted: it was assumed that half of the total found in the following band were present in the missing ones. Following a request from Natural England the total number at risk assuming no gradient in displacement is also provided (the peak mean abundance in each period)..

Zone	Percentage change	Area (km^2)	Autumn migration (Sep-Nov)		Midwinter (Dec-Jan)		Spring migration (Feb-Apr)	
			Peak mean number recorded	Number predicted to be displaced	Peak mean number recorded	Number predicted to be displaced	Peak mean number recorded	Number predicted to be displaced
Site	-94	304.92	25	23.5	17	15.98	106	99.6
0-0.5km buffer	-83	41.63	0	0	0.5	0.415	4	3.32
0.5-1.0km buffer	-77	42.83	0	0	0.5	0.385	4	3.08
1.0-2.0km buffer	-59	91.42	16	9.44	0	0	43	25.37
2.0-3.0km buffer*	0	96.96	3.5	0	6	0	20	0
3.0-4.0km buffer*	0	103.81	3.5	0	6	0	19	0
Total	NA	NA		32.94		16.78		131.41
100% displacement assuming no gradient up to 4km			64		30		196	

* Note that Percival (2010) actually found that red-throated diver numbers increased beyond 2km from the windfarm. However, a precautionary assumption of no change (0%) has been made here.

120. The autumn migration, midwinter and spring migration BDMPS for red-throated diver are 13,277, 10,177 and 13,277 respectively (Furness 2015). The total displacement estimates in *Table 13.17* indicate that, assuming a gradient in effect, displacement from the East Anglia THREE site and appropriate buffers will affect 0.2%, 0.1% and 0.9% of the population in each season respectively (calculated as the seasonal total in *Table 13.17* divided by the seasonal BDMPS). If no gradient in displacement effect is assumed across the buffer and 100% displacement out to 4km

from the windfarm is assumed these percentages are 0.3%, 0.3% and 1.4% respectively.

121. At an assumed precautionary displacement mortality rate of 10% the estimated maximum number of red-throated divers subject to mortality during the autumn migration period is 6 (no gradient in displacement) or 3 if an evidence based gradient is assumed. At an average baseline mortality rate of 0.228 (*Table 13.16*), the number of individuals expected to die in the autumn BDMPS is 3,027 (13,277 x 0.228). The addition of a maximum of 6 to this increases the mortality rate by 0.2%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of effect is assessed as negligible. As the species is of high sensitivity to disturbance, the impact significance is **minor** adverse**.**

122. At an assumed precautionary displacement mortality rate of 10% the estimated maximum number of red-throated divers subject to mortality during the midwinter period is 3 (no gradient in displacement) or 2 if an evidence based gradient is assumed. At an average mortality rate of 0.228 (*Table 13.16*), the number of individuals expected to die in the autumn BDMPS is 2,320 (10,177 x 0.228). The addition of a maximum of 3 to this increases the mortality rate by 0.1%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the midwinter period, the magnitude of effect is assessed as negligible. As the species is of high sensitivity to disturbance, the impact significance is **minor** adverse**.**

123. At an assumed precautionary displacement mortality rate of 10% the estimated maximum number of red-throated divers subject to mortality during the spring migration period is 20 (no gradient in displacement) or 13 if an evidence based gradient is assumed. At an average mortality rate of 0.228 (*Table 13.16*), the number of individuals expected to die in the autumn BDMPS is 3,027 (13,277 x 0.228). The addition of a maximum of 20 to this increases the mortality rate by 0.66%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of effect is assessed as negligible. As the species is of high sensitivity to disturbance, the impact significance is **minor** adverse**.**

Gannet

124. Gannets show a low level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004, Furness and Wade, 2012); however a detailed study (Krijgsveld *et al*., 2011) using radar and visual observations to monitor the post-construction effects of the Windpark Egmond aan Zee OWEZ established that 64% of gannets avoided entering the windfarm (macro-avoidance). However, Leopold et al. (2013) reported that most gannets avoided Dutch offshore windfarms and did not forage within these.

125. The displacement matrices in *Tables 13.18* and *13.19* have been populated with data for gannets during the autumn and spring migration periods within the site and those calculated within a 2km buffer in line with recommendations within the guidance (Natural England and JNCC 2012). The numbers within the windfarm and 2km buffer were calculated using the average peak density of birds within the 4km buffer (autumn, 1.86 birds per km^2; spring, 0.768 birds per km^2) as these were more precautionary than the average density within the windfarm site alone. It should be noted that the inclusion of all birds within the 2km buffer, to determine the total number of birds subject to displacement, is also precautionary, as in reality the avoidance rate is likely to fall with distance from the site. This has been demonstrated in a recent study of gannet distribution in relation to the Greater Gabbard windfarm (*Appendix 13.1*).

126. For the purpose of this assessment the percentage displacement rates at 10% intervals (0% - 100%), with an additional column for 1%, are presented. The cells highlighted in green are for displacement rates of 60% to 80%, as the OWEZ data suggests the actual rate lies between these two figures based on macro-avoidance. The cells highlighted in pink represent the most likely mortality rate for gannets during the winter season, which is assumed to be 1%, as they score highly for habitat flexibility (Furness and Wade 2012). A high score in habitat flexibility is given to species that use a wide range of habitats over a large area, and usually with a relatively wide range of foods (Furness and Wade 2012).

127. Within the range of 60-80% displacement and 0-1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement during the autumn migration period has been estimated as 7 individuals (*Table 13.18*). The BDMPS for gannet in autumn is 456,298 (Furness 2015).

128. At the average baseline mortality rate for gannet of 0.191 (*Table 13.16*) the number of individuals expected to die in the autumn BDMPS is 87,153 (456,298 x 0.191). The addition of a maximum of 7 to this increases the mortality rate by 0.008%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of effect is assessed as negligible. As the species is of low sensitivity to disturbance, the impact significance is **negligible.**

129. Within the range of 60-80% displacement and 0-1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement during the spring migration period has been estimated as 3 individuals (*Table 13.19*). The BDMPS for gannet in spring is 248,385 (Furness 2015).

130. At the average baseline mortality rate for gannet of 0.191 (*Table 13.16*) the number of individuals expected to die in the spring BDMPS is 47,441 (248,385 x 0.191). The addition of a maximum of 3 to this increases the mortality rate by 0.006%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of effect is assessed as negligible. As the species is of low sensitivity to disturbance, the impact significance is **negligible.**

131. Within the range of 60-80% displacement and 0-1% mortality, the maximum number of individual gannets which could potentially suffer mortality as a consequence of displacement during the autumn and spring migration periods combined has been estimated as 5 individuals. The biogeographic gannet population is 1,180,000 (Furness 2015).

132. At the average baseline mortality rate for gannet of 0.191 (*Table 13.16*) the number of individuals expected to die during the autumn and spring migration periods is 225,380 (1,180,000 x 0.191). The addition of a maximum of 5 to this increases the mortality rate by 0.002%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of effect is assessed as negligible. As the species is of low sensitivity to disturbance, the impact significance is **negligible.**

Table 13.18 Displacement matrix presenting the number of gannets in the East Anglia THREE site (and 2km buffer) during the autumn migration season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	2	3	4	4	5	6	7	8	9
10	0	1	9	18	27	36	45	54	63	72	81	90
20	0	2	18	36	54	72	90	107	125	143	161	179
30	0	3	27	54	81	107	134	161	188	215	242	269
40	0	4	36	72	107	143	179	215	251	286	322	358
50	0	4	45	90	134	179	224	269	313	358	403	448
60	0	5	54	107	161	215	269	322	376	430	483	537
70	0	6	63	125	188	251	313	376	439	501	564	627
80	0	7	72	143	215	286	358	430	501	573	644	716
90	0	8	81	161	242	322	403	483	564	644	725	806
100	0	9	90	179	269	358	448	537	627	716	806	895

Table Notes: a) Green shaded cells highlight most likely displacement range of 60% to 80% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (0% to 1%) during the wintering season.

Table 13.19 Displacement matrix presenting the number of gannets in the East Anglia THREE site (and 2km buffer) during the spring migration season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	1	1	2	2	3	3	3	4
10	0	0	4	7	11	15	18	22	26	30	33	37
20	0	1	7	15	22	30	37	44	52	59	66	74
30	0	1	11	22	33	44	55	66	77	89	100	111
40	0	1	15	30	44	59	74	89	103	118	133	148
50	0	2	18	37	55	74	92	111	129	148	166	185
60	0	2	22	44	66	89	111	133	155	177	199	221
70	0	3	26	52	77	103	129	155	181	207	232	258
80	0	3	30	59	89	118	148	177	207	236	266	295
90	0	3	33	66	100	133	166	199	232	266	299	332
100	0	4	37	74	111	148	185	221	258	295	332	369

Table Notes: a) Green shaded cells highlight most likely displacement range of 60% to 80% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (0% to 1%) during the wintering season.

Auks (Guillemot, Razorbill and Puffin)

133. Auks are considered to have low to medium sensitivities to disturbance and displacement, based on their sensitivity to ship and helicopter traffic in Garthe and Hüppop (2004), Langston (2010) and an interpretation of the Furness and Wade (2012) species concern index value in the context of disturbance and/or displacement from a habitat.

134. Displacement of foraging seabirds due to the presence of wind turbines cannot readily be assessed from observing birds in flight as only a very small proportion of flying seabirds land in any particular location. There is not yet very much empirical data on displacement of foraging seabirds from offshore windfarms with the consequence that assessment of the amount of displacement arising from developments is somewhat speculative. Available pre- and post-construction data have yielded variable results, but indicate that auks may be displaced to some extent by some windfarms, but is partial and apparently negligible at others.

135. Common guillemots were displaced at Blighbank (Vanermen et al. 2012), were displaced only in a minority of surveys at two Dutch windfarms (OWEZ and PAWP; Leopold et al. 2011, Krijgsveld et al. 2011), but were not significantly displaced at Horns Rev (although the data suggest that slight displacement was probably occurring; Petersen et al. 2006) or Thornton Bank (Vanermen et al. 2012). Razorbills were displaced in one out of six surveys at two Dutch windfarms (OWEZ and PAWP; Leopold et al. 2011, Krijgsveld et al. 2011), but not at Horns Rev (Petersen et al. 2006), Thornton Bank or Blighbank (Vanermen et al. 2012).

136. Following statutory guidance (Natural England and JNCC 2012) the abundance estimates for the most relevant biological periods have each been placed into individual displacement matrices. Each displacement matrix completed for this assessment has been prepared to present the abundances of each auk species within the East Anglia THREE site and a 2km buffer only.

137. Each matrix displays displacement rates and mortality rates for each species (*Tables 13.20* to *13.30*). For the purpose of this assessment a displacement rate range of 30 - 70% and a mortality rate range of 1 - 10% are highlighted in each matrix, as recommended by Natural England, with the 70% / 10% representing the worst case scenario.

138. During the Evidence Plan process (*Appendix 13.1*) Natural England requested that displacement effects estimated in different seasons should be combined to provide an annual effect for assessment which should then be assessed in relation to the largest of the component BDMPS populations. However, summing in the manner suggested will almost certainly over-estimate the number of individuals at risk through double counting (i.e. some individuals may potentially be present in more than one season) and under-estimate the population from which they are drawn (which must be at least the size of the largest BDMPS). For these reasons this approach is considered over precautionary, particularly since the evidence that displacement results in elevated mortality remains equivocal at best.

139. A more appropriate and proportionate approach to summing effects is proposed. This method is based on the following:

- The number at risk of mortality within each season for which a BDMPs has been identified is summed and divided by the number of seasons included. For example, as there are three non-breeding seasons defined for razorbill, including the breeding season the annual assessment has four seasons. Therefore, prior to summing the seasonal matrices the mortality for each was divided by four (note if there are three seasons the seasonal mortality would be divided by three, etc.).
- The effects have been assessed against the biogeographic populations (Furness 2015).

140. There are no breeding colonies for any of these species within foraging range of the East Anglia THREE site (see *section 13.7.1.1* for further supporting evidence), therefore it is reasonable to assume that individuals seen during the breeding season are nonbreeding individuals (e.g. immature birds). Since immature seabirds are known to remain in wintering areas, the number of immature birds in the relevant populations during the breeding season may be estimated as 43% of the total wintering BDMPS population for guillemot and razorbill and 45% for puffin (Furness 2015). This gives breeding season populations of nonbreeding individuals of 695,441 guillemot (BDMPS for the UK North Sea and Channel, 1,617,306 x 43%), 94,007 razorbills (BDMPS for the UK North Sea and Channel, 218622 x 43%) and 104,381 puffins (BDMPS for UK North Sea and Channel, 231,957 x 45%). For guillemot and puffin there is only one defined nonbreeding season (August - February and mid-August to March respectively), while for razorbill there are three (August - October,

November - December and January - March; *Table 13.12*). The number of birds which could potentially be displaced has been estimated for each species specific relevant season.

Guillemot

141. The estimated number of guillemots subject to mortality during the breeding period (*Table 13.20*) is between 5 and 117 individuals (from 30% / 1% to 70% / 10%). From a breeding season BDMPS of 695,441 this represents a maximum loss of 0.01%.

142. At the average baseline mortality rate for guillemot of 0.140 (*Table 13.16*) the number of individuals expected to die in the breeding season is 97,362 (695,441 x 0.140). The addition of a maximum of 117 to this increases the mortality rate by 0.12%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

143. The estimated number of guillemots subject to mortality during the wintering period (*Table 13.21*) is between 9 and 200 individuals (from 30%/1% to 70%/10%). From a nonbreeding season BDMPS of 1,617,306 this represents a maximum loss of 0.01%.

144. At the average baseline mortality rate for guillemot of 0.140 (*Table 13.16*) the number of individuals expected to die in the nonbreeding season is 226,423 (1,617,306 x 0.140). The addition of a maximum of 200 to this increases the mortality rate by 0.09%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding migration period, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

145. The estimated number of guillemots subject to mortality combined across all seasons (*Table 13.22*) is between 7 and 158 individuals (from 30% / 1% to 70% / 10%). From a biogeographic population of 4,125,000 this represents a maximum loss of 0.004%.

146. At the average baseline mortality rate for guillemot of 0.140 (*Table 13.16*) the number of individuals expected to die across all seasons is 577,500 (4,125,000 x 0.140). The addition of a maximum of 158 to this increases the mortality rate by

0.027%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during all seasons combined, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

Table 13.20 Displacement matrix presenting the number of guillemots in the East Anglia THREE site and 2km buffer during the breeding season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	2	3	5	7	8	10	12	13	15	17
10	0	2	17	33	50	67	83	100	117	134	150	167
20	0	3	33	67	100	134	167	200	234	267	300	334
30	0	5	50	100	150	200	250	300	350	401	451	501
40	0	7	67	134	200	267	334	401	467	534	601	668
50	0	8	83	167	250	334	417	501	584	668	751	835
60	0	10	100	200	300	401	501	601	701	801	901	1001
70	0	12	117	234	350	467	584	701	818	935	1051	1168
80	0	13	134	267	401	534	668	801	935	1068	1202	1335
90	0	15	150	300	451	601	751	901	1051	1202	1352	1502
100	0	17	167	334	501	668	835	1001	1168	1335	1502	1669

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%) during the breeding season.

Table 13.21 Displacement matrix presenting the number of guillemots in the East Anglia THREE site and 2km buffer during the wintering season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	3	6	9	11	14	17	20	23	26	29
10	0	3	29	57	86	114	143	172	200	229	257	286
20	0	6	57	114	172	229	286	343	400	457	515	572
30	0	9	86	172	257	343	429	515	600	686	772	858
40	0	11	114	229	343	457	572	686	801	915	1029	1144
50	0	14	143	286	429	572	715	858	1001	1144	1287	1430
60	0	17	172	343	515	686	858	1029	1201	1372	1544	1715
70	0	20	200	400	600	801	1001	1201	1401	1601	1801	2001
80	0	23	229	457	686	915	1144	1372	1601	1830	2058	2287
90	0	26	257	515	772	1029	1287	1544	1801	2058	2316	2573
100	0	29	286	572	858	1144	1430	1715	2001	2287	2573	2859

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%) during the wintering season.

Table 13.22 Displacement matrix presenting the number of guillemots in the East Anglia THREE site and 2km buffer combined across all seasons that may be subject to mortality (highlighted in pink). Note that the seasonal components have been halved prior to combination.

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	2	5	7	9	11	14	16	18	20	23
10	0	2	23	45	68	91	113	136	158	181	204	226
20	0	5	45	91	136	181	226	272	317	362	408	453
30	0	7	68	136	204	272	340	408	475	543	611	679
40	0	9	91	181	272	362	453	543	634	724	815	906
50	0	11	113	226	340	453	566	679	792	906	1019	1132
60	0	14	136	272	408	543	679	815	951	1087	1223	1358
70	0	16	158	317	475	634	792	951	1109	1268	1426	1585
80	0	18	181	362	543	724	906	1087	1268	1449	1630	1811
90	0	20	204	408	611	815	1019	1223	1426	1630	1834	2038
100	0	23	226	453	679	906	1132	1358	1585	1811	2038	2264

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%) during the wintering season.

Razorbill

147. The estimated number of razorbills subject to mortality during the breeding period (*Table 13.23*) is between 5 and 126 individuals (from 30% / 1% to 70% / 10%). From a breeding season BDMPS of 94,007 this represents a maximum loss of 0.13%.

148. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the breeding season is 16,941 (94,007 x 0.174). The addition of a maximum of 126 to this increases the mortality rate by 0.77%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

149. The estimated number of razorbills subject to mortality during the autumn migration period (*Table 13.24*) is between 3 and 79 individuals (from 30% / 1% to 70% / 10%). From an autumn season BDMPS of 591,874 this represents a maximum loss of 0.01.

150. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the autumn migration season is 102,986 (591,874 x 0.174). The addition of a maximum of 79 to this increases the mortality rate by 0.077%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

151. The estimated number of razorbills subject to mortality during the midwinter period (*Table 13.25*) is between 4 and 105 individuals (from 30% / 1% to 70% / 10%). From a midwinter season BDMPS of 218,622 this represents a maximum loss of 0.04%.

152. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the midwinter period is 38,040 (218,622 x 0.174). The addition of a maximum of 105 to this increases the mortality rate by 0.27%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the midwinter period, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

153. The estimated number of razorbills subject to mortality during the spring migration period (*Table 13.26*) is between 5 and 107 individuals (from 30% / 1% to 70% / 10%). From a spring migration BDMPS of 591,874 this represents a maximum loss of 0.02%.

154. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the spring migration period is 102,986 (591,874 x 0.174). The addition of a maximum of 107 to this increases the mortality rate by 0.1%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration period, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

155. The estimated number of razorbills subject to mortality combined across all seasons (*Table 13.27*) is between 4 and 104 individuals (from 30% / 1% to 70% / 10%). From a biogeographic population of 1,707,000 this represents a maximum loss of 0.006%.

156. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die across all seasons combined is 297,018 (1,707,000 x 0.174). The addition of a maximum of 104 to this increases the mortality rate by 0.03%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during all seasons combined, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

Table 13.23 Displacement matrix presenting the number of razorbills in the East Anglia THREE site and 2km buffer during the breeding season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	2	4	5	7	9	11	13	14	16	18
10	0	2	18	36	54	72	90	108	126	145	163	181
20	0	4	36	72	108	145	181	217	253	289	325	361
30	0	5	54	108	163	217	271	325	379	434	488	542
40	0	7	72	145	217	289	361	434	506	578	651	723
50	0	9	90	181	271	361	452	542	632	723	813	904
60	0	11	108	217	325	434	542	651	759	867	976	1084
70	0	13	126	253	379	506	632	759	885	1012	1138	1265
80	0	14	145	289	434	578	723	867	1012	1156	1301	1446
90	0	16	163	325	488	651	813	976	1138	1301	1464	1626
100	0	18	181	361	542	723	904	1084	1265	1446	1626	1807

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

Table 13.24 Displacement matrix presenting the number of razorbills in the East Anglia THREE site and 2km buffer during the autumn season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	2	3	4	6	7	8	9	10	11
10	0	1	11	22	34	45	56	67	79	90	101	112
20	0	2	22	45	67	90	112	135	157	180	202	224
30	0	3	34	67	101	135	168	202	236	269	303	337
40	0	4	45	90	135	180	224	269	314	359	404	449
50	0	6	56	112	168	224	281	337	393	449	505	561
60	0	7	67	135	202	269	337	404	471	539	606	673
70	0	8	79	157	236	314	393	471	550	628	707	785
80	0	9	90	180	269	359	449	539	628	718	808	898
90	0	10	101	202	303	404	505	606	707	808	909	1010
100	0	11	112	224	337	449	561	673	785	898	1010	1122

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

Table 13.25 Displacement matrix presenting the number of razorbills in the East Anglia THREE site and 2km buffer during the midwinter season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	3	4	6	7	9	10	12	13	15
10	0	1	15	30	45	60	75	90	105	120	135	150
20	0	3	30	60	90	120	150	180	210	240	270	300
30	0	4	45	90	135	180	225	270	315	360	405	450
40	0	6	60	120	180	240	300	360	420	480	540	600
50	0	7	75	150	225	300	375	450	525	600	675	750
60	0	9	90	180	270	360	450	540	630	720	809	899
70	0	10	105	210	315	420	525	630	735	839	944	1049
80	0	12	120	240	360	480	600	720	839	959	1079	1199
90	0	13	135	270	405	540	675	809	944	1079	1214	1349
100	0	15	150	300	450	600	750	899	1049	1199	1349	1499

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

Table 13.26 Displacement matrix presenting the number of razorbills in the East Anglia THREE site and 2km buffer during the spring season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)										
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	2	3	5	6	8	9	11	12	14	15
10	0	2	15	30	46	61	76	91	107	122	137	152
20	0	3	30	61	91	122	152	183	213	244	274	305
30	0	5	46	91	137	183	229	274	320	366	411	457
40	0	6	61	122	183	244	305	366	427	488	549	610
50	0	8	76	152	229	305	381	457	533	610	686	762
60	0	9	91	183	274	366	457	549	640	732	823	914
70	0	11	107	213	320	427	533	640	747	853	960	1067
80	0	12	122	244	366	488	610	732	853	975	1097	1219
90	0	14	137	274	411	549	686	823	960	1097	1234	1372
100	0	15	152	305	457	610	762	914	1067	1219	1372	1524

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

Table 13.27 Displacement matrix presenting the number of razorbills in the East Anglia THREE site and 2km buffer during all seasons combined that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	1	3	4	6	7	9	10	12	13	15
10	0	1	15	30	45	60	74	89	104	119	134	149
20	0	3	30	60	89	119	149	179	208	238	268	298
30	0	4	45	89	134	179	223	268	312	357	402	446
40	0	6	60	119	179	238	298	357	417	476	536	595
50	0	7	74	149	223	298	372	446	521	595	670	744
60	0	9	89	179	268	357	446	536	625	714	804	893
70	0	10	104	208	312	417	521	625	729	833	937	1042
80	0	12	119	238	357	476	595	714	833	952	1071	1190
90	0	13	134	268	402	536	670	804	937	1071	1205	1339
100	0	15	149	298	446	595	744	893	1042	1190	1339	1488

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

Puffin

157. The number of puffins within the site and 2km buffer during the breeding season was calculated using the average peak density of birds within the 4km buffer (0.377 birds per km^2, April) as this was more precautionary than the average density within the windfarm site alone (0.354 birds per km^2, April). The estimated number of puffins subject to mortality during the breeding period (*Table 13.28*) is between 1 and 13 individuals (from 30% / 1% to 70% / 10%). From a breeding season BDMPS of 104,381 this represents a maximum loss of 0.01%.

158. At the average baseline mortality rate for puffin of 0.168 (*Table 13.16*) the number of individuals expected to die in the breeding season is 17,432 (104,381 x 0.167). The addition of a maximum of 13 to this increases the mortality rate by 0.07%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the breeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, in EIA terms the impact significance is **negligible.**

159. The number of puffins within the site and 2km buffer during the nonbreeding season was calculated using the average peak density of birds within the windfarm site (0.682 birds per km^2, November) as this was more precautionary than the average density within the windfarm site plus 4km buffer (0.261 birds per km^2, November). The estimated number of puffins subject to mortality during the nonbreeding season (*Table 13.29*) is between 1 and 21 individuals (from 30% / 1% to 70% / 10%). From a nonbreeding season BDMPS of 231,957 this represents a maximum loss of 0.009%.

160. At the average baseline mortality rate for puffin of 0.168 (*Table 13.16*) the number of individuals expected to die in the nonbreeding season is 38,737 (231,957 x 0.167). The addition of a maximum of 21 to this increases the mortality rate by 0.05%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, in EIA terms the impact significance is **negligible.**

161. The estimated number of puffins subject to mortality during all seasons combined (*Table 13.30*) is between 1 and 17 individuals (from 30% / 1% to 70% / 10%). From a

biogeographic population of 11,840,000 this represents a maximum loss of <0.0001%.

162. At the average baseline mortality rate for puffin of 0.168 (*Table 13.16*) the number of individuals expected to die across all seasons combined is 1,977,280 (11,840,000 x 0.168). The addition of a maximum of 21 to this increases the mortality rate by 0.001%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during all seasons combined, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, in EIA terms the impact significance is **negligible.**

Table 13.28 Displacement matrix presenting the number of puffins in the East Anglia THREE site and 2km buffer during the breeding season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	1	1	1	1	1	2	2
10	0	0	2	4	5	7	9	11	13	14	16	18
20	0	0	4	7	11	14	18	22	25	29	33	36
30	0	1	5	11	16	22	27	33	38	43	49	54
40	0	1	7	14	22	29	36	43	51	58	65	72
50	0	1	9	18	27	36	45	54	63	72	81	91
60	0	1	11	22	33	43	54	65	76	87	98	109
70	0	1	13	25	38	51	63	76	89	101	114	127
80	0	1	14	29	43	58	72	87	101	116	130	145
90	0	2	16	33	49	65	81	98	114	130	147	163
100	0	2	18	36	54	72	91	109	127	145	163	181

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

Table 13.29 Displacement matrix presenting the number of puffins in the East Anglia THREE site and 2km buffer during the nonbreeding season that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	1	1	2	2	2	2	3	3
10	0	0	3	6	9	12	15	18	21	25	28	31
20	0	1	6	12	18	25	31	37	43	49	55	61
30	0	1	9	18	28	37	46	55	64	74	83	92
40	0	1	12	25	37	49	61	74	86	98	111	123
50	0	2	15	31	46	61	77	92	107	123	138	154
60	0	2	18	37	55	74	92	111	129	147	166	184
70	0	2	21	43	64	86	107	129	150	172	193	215
80	0	2	25	49	74	98	123	147	172	196	221	246
90	0	3	28	55	83	111	138	166	193	221	249	276
100	0	3	31	61	92	123	154	184	215	246	276	307

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

Table 13.30 Displacement matrix presenting the number of puffins in the East Anglia THREE site and 2km buffer during all seasons combined that may be subject to mortality (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	1	1	1	2	2	2	2
10	0	0	2	5	7	10	12	15	17	20	22	24
20	0	0	5	10	15	20	24	29	34	39	44	49
30	0	1	7	15	22	29	37	44	51	59	66	73
40	0	1	10	20	29	39	49	59	68	78	88	98
50	0	1	12	24	37	49	61	73	85	98	110	122
60	0	1	15	29	44	59	73	88	102	117	132	146
70	0	2	17	34	51	68	85	102	120	137	154	171
80	0	2	20	39	59	78	98	117	137	156	176	195
90	0	2	22	44	66	88	110	132	154	176	198	220
100	0	2	24	49	73	98	122	146	171	195	220	244

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

13.7.2.2 Impact 4: Indirect Impacts Through Effects on Habitats and Prey Species

163. Indirect disturbance and displacement of birds may occur during the operational phase if there are impacts on prey species and the habitats of prey species. These indirect effects include those resulting from the production of underwater noise (e.g. the turning of the wind turbines), electro-magnetic fields (EMF) and the generation of suspended sediments (e.g. due to scour or maintenance activities) that may alter the behaviour or availability of bird prey species. Underwater noise and EMF may cause fish and mobile invertebrates to avoid the operational area and also affect their physiology and behaviour. Suspended sediments may cause fish and mobile invertebrates to avoid the operational area and may smother and hide immobile benthic prey. These mechanisms could result in less prey being available within the operational area to foraging seabirds. Changes in fish and invertebrate communities due to changes in presence of hard substrate (resulting in colonisation by epifauna) may also occur, and changes in fishing activity could influence the communities present.

164. With regard to noise impacts on fish, Chapter 11 Fish and Shellfish Ecology discusses the potential impacts upon fish relevant to ornithology as prey species. With regard to behavioural changes related to underwater noise impacts on fish during the operation of the proposed East Anglia THREE project, section 11.6.2 identifies that the sensitivity of fish and shellfish species to operational noise is considered to be low and the magnitude of effect negligible. It concludes a negligible impact on fish (see section 11.6.2). With a negligible impact on fish that are bird prey species, it could be concluded that the indirect impact on seabirds occurring in or around the East Anglia THREE site during the operational phase is similarly a **negligible** adverse impact.

165. With regard to changes to the seabed and to suspended sediment levels, Chapter 10 Benthic Ecology discusses the nature of any change and impact. It identifies that the small quantities of sediment released due to scour processes would rapidly settle within a few hundred metres of each wind turbine or cable protection structure. Therefore, the magnitude of the impact is likely to be negligible to low (see Chapter 10, section 10.6.2) and that smothering due to increased suspended sediment during operation of the project would result in an impact of minor adverse significance. With a minor impact on benthic habitats and species, it could be concluded that the indirect impact on seabirds occurring in or around the East Anglia THREE site during the operational phase is similarly a **minor** adverse impact.

166. With regard to EMF effects these are identified as highly localised with the majority of cables being buried to up to 5m depth, further reducing the effect of EMF (see

Chapter 10, section 10.6.2). The magnitude of impact is considered negligible on benthic invertebrates and low on fish. With a minor or negligible impact on invertebrates and fish, it could be concluded that the indirect impact on seabirds occurring in or around the East Anglia THREE site during the operational phase is similarly a **minor** or **negligible** adverse impact.

167. Very little is known about potential long term changes in invertebrate and fish communities due to colonisation of hard substrate and changes in fishing pressures at the East Anglia THREE site. Whilst the impact of the colonisation of introduced hard substrate is seen as a minor adverse impact in terms of benthic ecology (as it is a change from the baseline conditions), the consequences for seabirds may be positive or negative locally, but are unlikely to be significant at a wider scale.

13.7.2.3 Impact 5: Collision Risk

168. There is a potential risk of collision with the wind turbine rotors and associated infrastructure resulting in injury or fatality to birds which fly through the East Anglia THREE site whilst foraging for food and commuting between breeding sites and foraging areas.

169. Collision Risk Modelling (CRM) has been used in this assessment to estimate the risk to birds associated with the proposed project. CRM, using the Band model (Band 2012), has been used to produce predictions of mortality for particular species across set time periods (biological seasons). The approach to CRM is summarised here and further details are provided in *Appendix 13.2*.

170. For each of the key seabirds assessed for collision risk, three different CRM Options have been used, Band CRM Option 1 with site-specific Potential Collision Height (PCH), Band Option 2 (identical to Option 1 but uses PCH values estimated across a large generic dataset) and Band Option 3 (which integrates rotor heights and estimated bird flight height distributions from the large generic dataset).

171. Band CRM Option 1 with site-specific PCH uses site-specific data gathered from the surveys on the percentage of birds flying at PCH within the site and 4 km Buffer. This information is presented in the Baseline Technical Report (*Appendix 13.2*). Band Option 2 uses the percentage of birds flying at PCH derived from data presented in Cook et al. (2012). Band Option 3 takes the process a step further and utilises frequency distributions of bird flight heights in relation to rotor swept heights to generate more realistic estimates of the number of rotor transits. This differs from Options 1 and 2 which assume that birds are evenly spread across all rotor swept heights, rather than being concentrated closer to the sea surface as actually occurs.

172. Continued offshore wind development has led to greater scrutiny of CRM methods, with the consequence that a great deal of research and evidence gathering has been undertaken in an effort to reduce areas of uncertainty and reduce the degree of precaution adopted in assessments. The most significant update to methods has come about following a review of avoidance rates conducted by the BTO on behalf of Marine Scotland (Cook et al. 2014). This review led Cook et al. (2014) to recommend increases in the avoidance rates for use with Option 1 for gannet (98.9%), kittiwake (99.2%), herring gull, lesser black-backed gull and great black-backed gull (all 99.5%). For the large gull species Option 3 avoidance rates were also estimated as follows; herring gull (99%), lesser black-backed gull (98.9%) and great black-backed gull (98.9%).

173. The UK Statutory Nature Conservation Bodies (SNCBs) provided joint guidance (JNCC et al. 2014) following this which accepted these rates, although recommended that for kittiwake 98.9% be used (with Option 1). These (latter) values have been used in the current assessment.

174. The above guidance notwithstanding, a recent study on gannet behaviour in relation to offshore windfarms (APEM 2014, *Appendix 13.1*) has gathered evidence which suggests that this species may exhibit a higher avoidance rate (than 98.9%). This work, conducted during the autumn migration period, recorded gannet densities within and around the Greater Gabbard windfarm. Analysis of these data indicated that overall wind turbine avoidance was 100%, although a suitably precautionary rate of 99.5% was proposed (for the autumn period at least). Although this rate has not been applied to the estimates presented in this assessment, it indicates that the values in this assessment (and indeed for other windfarms) are likely to overestimate gannet collisions by at least 50% compared with an avoidance rate of 98.9 and by up to 75% compared with the previous recommended rate of 98%.

175. One of the parameters used in the CRM defines the level of nocturnal activity of each seabird species relative to its daytime level. Thus a value of 50% for this nocturnal activity factor is appropriate for a species which is half as active at night as during the day ('activity' in the current context refers to flight activity). This is required to estimate for collision risks at night on the basis of survey data collected during the day. The values for each species have been taken from reviews of seabird activity reported in Garthe and Hüppop (2004). This review presented values from 1 to 5 (1 low, 5 high) for relative nocturnal activity, which have become modified for the purposes of CRM into 0% to 100% relative to daytime. This approach was not anticipated by Garthe and Hüppop (2004), who considered that their 1 to 5 scores were simply categorical, and were not intended to represent a scale of 0 to 100% of

daytime activity (not least because the lowest score given was 1 and not 0). This is clear from their descriptions of the scores: for example for score 1 'hardly any flight activity at night'.

176. Recently however, a number of studies have deployed loggers on seabirds, and data from those studies can provide empirical evidence of the actual flight activity level. These studies indicate that the rates derived from Garthe and Hüppop (2004) almost certainly overestimate the levels of nocturnal activity in the species studied. For example, across four studies of gannet nocturnal activity relative to daytime was reported as between 0% and 2%, across four studies of kittiwake nocturnal activity relative to daytime was reported as between 0% and 12% and in one study of lesser black backed gull nocturnal activity relative to daytime was reported as 25%. These compare to the much higher values recommended for used in CRM of 25%, 50% and 50% for gannet, kittiwake and lesser black-backed gull respectively (see *Appendix 13.1* for details).

177. As the relative proportion of day to night varies considerably during the year at the UK's latitude, the effect of changes in the nocturnal activity factor for CRM outputs depends on the relative abundance of birds throughout the year. The extent of mortality reduction obtained by reducing the categorical score for five species (gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull) by 1 (i.e. from 3 to 2 for kittiwake) was investigated (*Appendix 13.1*). This revealed annual mortality reductions of between 14.5% (lesser black-backed gull) and 27.7% (gannet). This indicates that current nocturnal activity factors based on arbitrary conversions of Garthe and Hüppop (2004) scores into percentages are over-estimated with the consequence that CRM outputs are overly precautionary.

178. For seabirds the CRM is based upon the monthly mean density of flying birds, derived from the surveys carried out between 2011 and 2013. The mortality rate estimates for each month have been summed according to the species-specific biological seasons (see species accounts in *Appendix 13.2*).

179. A number of the seabird species which were not recorded in large numbers through the survey programme were identified as potential migrants through the East Anglia THREE site (i.e. great skua, Arctic skua, Arctic tern and common tern). Collision risk has been estimated for these species following the methods described in WWT (2013).

180. Collision risk for non-seabird migrants, passing through the site were estimated using a bespoke modelling tool, Migropath (APEM), with detailed methodology and results provided in *Appendix 13.1*.

181. The magnitude of effect of collision mortality was assessed using the following process. The CRM for the worst case wind turbine array was carried out to produce predictions of the numbers of each species subject to mortality for the defined breeding, migration and wintering seasons.

182. The seasonal mortality numbers were then compared to the relevant BDMPS and the effect on the population of the predicted increase in mortality estimated.

13.7.2.4 Assessment of Collision Risk Modelling Results

Seabirds

183. The CRM results for the proposed East Anglia THREE project are presented in the following sections; full details of the collision risk modelling undertaken for each species are provided within *Appendix 13.3*. Species which typically fly below rotor height (e.g. auks and divers) were screened out of this assessment.

184. *Table 13.31* provides a summary of the seasonal CRM outputs. This includes the model Option and avoidance rate used and the number of collisions predicted annually and in each species specific season (following Furness 2015). More details of the modelling and monthly outputs are provided in *Appendix 13.3*.

Table 13.31 Seasonal breakdown of collision mortality estimates at the East Anglia THREE site. Shaded cells indicate values used in the assessment.

Species	CRM used	Avoidance rate (%)	Spring Migration	Breeding	Autumn Migration	Wintering	Annual total
Fulmar	Option 1	98	0	0	0	NA	0
Gannet	Option 1	98.9	11	7	38	NA	56
	Option 2		16	9	55	NA	80
Kittiwake	Option 1	98.9	49	8	90	NA	147
	Option 2		57	9	104	NA	170
Lesser black-backed gull	Option 1	99.5	2	4	11	3	20
	Option 2		1	2	6	2	11
	Option 3	98.9	1	2	6	2	11
Herring gull	Option 1	99.5	NA	0	NA	19	19
	Option 2		NA	0	NA	25	25
	Option 3	99.0	NA	0	NA	25	25
Great black-backed gull	Option 1	99.5	NA	7	NA	48	55
	Option 2		NA	5	NA	37	42
	Option 3	98.9	NA	5	NA	40	45

185. In line with the joint statutory agency advice on presenting collision mortality (JNCC et al. 2014), estimates derived using variance around the avoidance rates and the upper and lower flight height distributions (Johnston et al. 2014a,b) are presented in *Table 13.32*.

Table 13.32 Annual collision mortality estimates at the East Anglia THREE site including avoidance rate variance and upper and lower confidence intervals on generic flight height distributions (for Options 2 and 3). The annual mortality estimates used in the assessment are highlighted (shaded). Note that due to rounding of individual month values the annual totals may differ by 1 from the summed seasonal totals in Table 13.31. AR = avoidance rate.

Species	Option 1 (AR variance)		Option 2 (AR variance and flight height variance)			Option 3 (AR variance and flight height variance)			
	AR	CRM	Lower 95% c.i.	Median CRM	Upper 95% c.i.	AR	Lower 95% c.i.	Median CRM	Upper 95% c.i.
Gannet	98.7	66	42	95	160	n/a	n/a	n/a	n/a
	98.9	56	36	80	135				
	99.1	46	29	66	111				
Kittiwake	98.7	173	150	201	240				
	98.9	146	127	170	203				
	99.1	120	104	139	166				
Lesser black-backed gull	99.4	24	8	12	21	98.7	7	12	26
	99.5	20	7	10	17	98.9	6	10	22
	99.6	16	6	8	14	99.1	5	8	18
Herring gull	99.4	23	23	31	43	98.8	18	27	46
	99.5	19	19	26	36	99.0	16	25	42
	99.6	15	16	21	29	99.2	13	20	34
Great black-backed gull	99.4	66	40	50	68	98.7	38	54	88
	99.5	55	33	42	56	98.9	32	46	75
	99.6	44	27	33	45	99.1	26	38	61

186. As the East Anglia THREE site is beyond the mean maximum (and maximum) foraging ranges (Thaxter et al. 2012) for most species assessed or towards the limit of those foraging ranges it is likely that birds present during the breeding season are non-breeders. While RSPB's FAME studies have shown some extremely long foraging ranges for seabirds, those extreme values tend to occur at colonies where food supply is extremely poor and breeding success is low (for example Orkney and

Shetland). Daunt et al. (2002) point out that seabirds, as central place foragers, will have an upper limit set to their potential foraging range from the colony that is set by time constraints. For example, they assess this to limit to be 73km for kittiwake based on foraging flight speed and time required to catch food as observed for birds from the Isle of May. Kittiwakes would be unable to consistently travel more than 73km from the colony and provide enough food to keep chicks alive. Hamer et al. (1993) recorded a foraging range exceeding 40km in 1990 when sandeel stock biomass was very low and breeding success at the study colony in Shetland was 0.0 chicks per nest, but <5km in 98% of trips in 1991 when sandeel abundance was higher and breeding success was 0.98 chicks per nest. Kotzerka et al. (2010) reported a maximum foraging range of 59 km, with a mean range of around 25 km for a kittiwake colony in Alaska.

187. In addition, since the predicted breeding season collisions for all species are very small (fewer than 10) this period has been excluded from assessment of individual seasons (although the annual totals include collisions at all times of year). Impacts during the non-breeding periods have been assessed in relation to the relevant BDMPS (Furness 2015).

188. It is preferable to use site specific estimates of the proportion of individuals at potential collision height (PCH) where sufficient data have been collected to generate robust estimates. For the species in *Table 13.32* the number of individuals for which height was estimated were; gannet 251, kittiwake 208, lesser black-backed gull 11, herring gull 29 and great black-backed gull 38. Advice from Natural England states that Option 2 (generic flight height estimates) should be used for sample sizes below 100. This indicates that Option 2 should be used for the large gulls, and Option 1 is appropriate for gannet and kittiwake. The estimated percentage of gannet at collision height was slightly lower (6.7%) than that derived from generic data (12.6%). Further consideration of this difference is provided below.

189. The 'generic' flight height data for gannet (for use with Option 2) are derived from boat-based visual estimates from 27 different sites. Data from 44,851 estimates classifying birds into three categories 'below PCH', 'at PCH' and 'above PCH' were transformed into a best-fit smoothed continuous distribution (Cook et al. 2012). Originally, (Cook et al. 2012; Johnston et al. 2014a) suggested that 9.6% of flight occurred at PCH, but this value was later re-calculated at 12.6% after finding an error in the original calculations (Johnston et al. 2014b). The accuracy of boat based visual estimates of flight height is unknown and has not been validated, but is likely to be low. The curve fitting by Cook et al. (2012) and Johnston et al. (2014a, 2014b) represents a statistically thorough method of transforming raw data, but the

smoothing process also results in only a moderately good fit of curves to the raw data. Nevertheless, the flight height estimates are based on a very large sample size. More importantly in the case of gannet, the data include birds carrying out quite different behaviours, including migrating, commuting from breeding sites to foraging grounds, and foraging.

190. Unlike most other seabirds, flight heights during different activities are not comparable for gannet because it varies considerably and systematically depending on activity. Nelson (1978) describes this: 'when flying to cover distance rather than searching an area intently gannets fly low over the surface'. When foraging they fly higher, 'and dive from as much as 45 metres though 10-15 metres is probably the usual range'. Nelson (1978) also describes how flight height during foraging varies depending on the prey being attacked. Gannets dive from higher and more vertically when diving on deep prey (usually large fish such as mackerel) and dive from lower heights and at an angle when diving on small fish close to the surface.

191. Commuting and migrating gannets therefore show a very different distribution of flight heights to foraging gannets. The former are unlikely to fly at PCH, whereas the latter are very likely to spend time at PCH. Unlike most other seabirds, the behaviour of gannets is a crucial factor to consider when assessing collision risk at offshore wind farms. This suggests that for gannet, all else being equal, use of Option 1 (site-specific flight height data) will be very much more appropriate than Option 2 (generic estimates from Johnston et al. 2014b).

192. Recent studies provide further quantitative support for the descriptions by Nelson (1978). GPS tracking studies of gannets show that they typically travel (commute) at flight heights below 10m, but may climb to over 20m when searching for prey (Garthe et al. 2014). While GPS loggers provide spatial location on X and Y coordinates to an accuracy of a few metres they can only provide relatively poor estimates of height. Much more accurate data on height can be obtained by deployment of purpose-built altimeter loggers. In 2011 and 2012, small samples of breeding adult gannets at the Bass Rock were equipped with both GPS loggers and altimeters, so that their flight heights could be monitored during breeding season foraging trips. This project (Cleasby et al. 2015), funded by DECC, has confirmed that commuting gannets predominantly flew considerably below PCH while foraging ones spent much time at PCH.

193. Consequently, the evidence is clear: gannets fly at PCH predominantly when foraging and rarely fly at PCH when travelling from one area to another.

194. Over 87% of all gannets recorded in surveys at the East Anglia THREE site were seen during the autumn and spring migration periods between September to March (*Appendix 13.2*). Therefore, the gannets observed were primarily on migration, from which it would be predicted (on the evidence discussed above) that most birds would be flying below PCH. This prediction was borne out in the survey data, with an estimated 6.7% of gannets recorded at PCH on the East Anglia THREE site (*Appendix 13.2*).

195. The site-specific flight height data for gannets at East Anglia THREE were obtained from aerial surveys (APEM 2015). These data are not only likely to be considerably more accurate than visual estimates from boat-based surveys, but are also relevant to the specific behaviour of gannets while passing through the area. A total of 252 gannets were recorded in flight, of which height was estimated for 251. This sample size is well above the recommended minimum of 100. Furthermore, the behaviour-specific flight height of gannet means that site-specific data (rather than generic) are much more appropriate for collision assessments. The data clearly indicate that gannets on the East Anglia THREE site primarily show 'flying to cover distance' behaviour whilst migrating through the area rather than showing foraging activity.

196. For the proposed East Anglia THREE project there is, therefore, a very strong case that the collision risk assessment for gannet should be based on Option 1 (site specific flight height data) rather than Option 2 (generic data from multiple sites where gannet behaviour is likely to differ). The results from Option 1 have been used in this assessment.

197. Since seabird surveys are conducted during daylight, an adjustment is included in collision risk calculations to allow for nocturnal flights which may also be at risk. Nocturnal activity is entered into the collision risk model on a 1 to 5 scale, where 1 = 0% and 5 = 100%, with these percentages representing the equivalence in flight activity between day and night (i.e. a score of 3, or 50%, indicates that a species is half as active at night as during the day). A review of nocturnal activity in seabirds has indicated that the values currently used for this parameter for gannet (25%), kittiwake (50%), herring gull (50%), lesser black-backed gull (50%) and great black-backed gull (50%) almost certainly overestimate true nocturnal activity levels (*Appendix 13.1*). Reducing nocturnal activity factors for each species by one point on the 1 to 5 scale (i.e. by 25%) is supported by this review (as a minimum). This would reduce the collision estimates by a minimum of 7%, although this is higher for winter estimates due to the longer period of darkness. Consequently, the collision mortality estimates in *Table 13.31* and *Table 13.32* (and subsequent species accounts) should be considered precautionary as they do not include this additional 7% reduction.

198. The impact of mortality caused by collisions on the populations are assessed in terms of the change in the baseline mortality rate which could result. It has been assumed that all age classes are equally at risk of collisions (i.e. in proportion to their presence in the population), therefore it is necessary to calculate an average baseline mortality rate for all age classes for each species assessed. These were calculated using the different survival rates for each age class and their relative proportions in the population.

199. The first step is to calculate an average survival rate. The demographic rates for each species were taken from (Horswill and Robinson 2015) and entered into a matrix population model. This was used to calculate the expected proportions in each age class. For each age class the survival rate was multiplied by its proportion and the total for all ages summed to give the average survival rate for all ages. Taking this value away from 1 gives the average mortality rate. The demographic rates and the age class proportions and average mortality rates calculated from them are presented in *Table 13.33 (*Note gannet is provided in *Table 13.16)*.

Table 13.33. Average mortality calculated using age related survival and productivity and estimates of the relative proportions of each age class. Note adult survival has been assumed when no age specific rate is available.

Age class	Kittiwake		Lesser black-backed gull		Herring gull		Great black-backed gull	
	Survival	Prop.	Survival	Prop.	Survival	Prop.	Survival	Prop.
0 to 1	0.790	0.155	0.82	0.134	0.798	0.178	0.93	0.194
1 to 2	0.854	0.123	0.885	0.109	0.834	0.141	0.93	0.156
2 to 3	0.854	0.105	0.885	0.085	0.834	0.117	0.93	0.126
4 to 5	0.854	0.089	0.885	0.084	0.834	0.067	0.93	0.102
Adult	0.854	0.527	0.885	0.577	0.834	0.467	0.93	0.422
Productivity	0.690	-	0.53	-	0.92	-	1.139	-
Average mortality		0.156		0.126		0.172		0.07

200. *Table 13.34* provides the baseline survival rates, the relevant BDMPS and the percentage increase in mortality for each seabird species due to collisions (note fulmar is excluded from further assessment as there are no predicted collisions).

Table 13.34 Percentage increase in seasonal BDMPS and annual biogeographic mortality due to collisions at the East Anglia THREE site.

Species	Baseline average mortality (Tables 13.33 and 13.16)	Band model	Reference population and percentage increase in mortality							
			Spring Migration		Wintering		Autumn Migration		Annual	
			BDMPS	Increase in mortality (%)	BDMPS	Increase in mortality (%)	BDMPS	Increase in mortality (%)	Biogeographic population	Increase in mortality (%)
Gannet	0.191	1	248385	0.027	n/a		456298	0.041	1,180,000	0.025
Kittiwake	0.156	1	627816	0.050	n/a		829937	0.069	5,100,000	0.018
Lesser black-backed gull	0.126	2	197483	0.004	39314	0.040	209007	0.023	864,000	0.010
		3		0.004		0.040		0.023		0.010
Herring gull	0.172	2	n/a		466511	0.031	n/a		1,098,000	0.013
		3				0.031				0.013
Great black-backed gull	0.07	2	n/a		91399	0.575	n/a		235,000	0.255
		3				0.621				0.273

201. The levels of predicted collision mortality are all very small. On the basis of seasonal populations, in no case does the background mortality increase by more than 1%. This result will also hold for collisions summed across the year since the population sizes against which annual collisions are assessed can be no smaller than those defined for the BDMPS and in most cases will be larger.

202. It should also be added that as discussed above, the collision estimates are likely to be overestimates due to the elevated nocturnal activity factors used, and in the case of gannet the higher avoidance rate which is likely to be appropriate.

203. As the level of collisions predicted to occur at the East Anglia THREE site are all very small and will result in negligible increases in the background mortality rates the magnitude of effects is considered to be negligible for all species. This results in impacts of **negligible** or **minor** adverse significance for all species.

Migrant Seabirds

204. In addition to the seabirds assessed in this section on collision risk some migratory birds may not have been accounted for from the standard survey methods as they may move across seas in large numbers, but over a short time period. These movements are also often at night and sometimes in bad weather (Cook et al. 2012). Most of the seabirds migrating through the East Anglia THREE site were frequently

detected on surveys, but four other species (great skua, Arctic skua, common tern and Arctic tern) were identified, through consultation with Natural England and the RSPB (*Appendix 13.1*), as potentially flying through the East Anglia THREE site during migration seasons in large numbers in the SOSS 05 report (Wright et al. 2012).

205. Collision risk for the migrant seabirds was estimated following the approach in WWT & MacArthur Green (2013) and used population estimates in Furness (2015). The key parameters to be considered for these species were the migration corridors (i.e. the routes followed on passage through the North Sea) and the percentage at collision height (*Table 13.35*).

Table 13.35 Key parameters for predicting collision risk for migrant seabirds in the East Anglia THREE site.

Species	Migration corridor (WWT & MacArthur Green 2013)	Percentage at rotor height (Cook et al. 2012)
Great skua	0 – 40km	4.3
Arctic skua	0 - 20km	3.8
Common tern	0 – 10km	12.7
Arctic tern	0 – 10km	2.8

206. The East Anglia THREE site is located 68km from the coast at its nearest point. This is farther offshore than any of the corridor widths for the migrant seabird species in *Table 13.35.* While a few individuals may travel beyond the outer edges of these corridors, given the low percentages at collision height the overall collision risk will be very small. Consequently, any effects from the East Anglia THREE site will be negligible and cause no material difference to current baseline mortality rates. The magnitude of effects is considered to be negligible for all species. Therefore, **no impact** would result from collisions for any of these migrant seabird species.

Migrant non-seabirds

207. Additional modelling to estimate the occurrence of other migrant birds, including waders and wildfowl was undertaken using Migropath (see *Appendix 13.1* for full details*)*.

208. Twenty three non-seabird species which potentially migrate through the East Anglia THREE site were assessed. Migrant collision modelling using the migrant option in the Band model Option 1 estimated that 17 of these species would be subject to one or less collisions per year and three would be subject to five or fewer collisions per year. The remaining species were dark bellied brent goose, golden plover and dunlin with an estimated 6, 10 and 10 collisions per year. On the basis of these extremely

low collision risks no further assessment is required and the significance of all migrant non-seabird collision impacts is assessed as **negligible**.

Table 13.36 Key parameters and outputs for migrant non-seabird migrant collision risk at the East Anglia THREE site (see Appendix 13.1 for details). Percentages at collision height and reference populations for GB and Ireland from Wright et al. (2012).

Species	Reference population	Percentage at collision height	Annual collision mortality
Dark bellied brent goose	91000	30	6
Wigeon	522,370	15	2
Gadwall	25,630	15	0
Teal	255,010	15	1
Pintail	30,235	15	0
Shoveler	20,545	15	0
Pochard	75,780	15	0
Tufted duck	146,610	15	1
Common Scoter	123,190	1	0
Goldeneye	29,665	15	0
Marsh Harrier	201 females	50	n/a
Oystercatcher (non-breeding)	200,000	25	2
Oystercatcher (breeding)	226,000	25	n/a
Ringed Plover	48,580	25	0
Golden Plover (non-breeding)	566,700	25	10
Golden Plover (breeding)	45,200	25	n/a
Grey Plover	49,315	25	0
Lapwing	465,000	25	3
Knot	338,970	25	1
Sanderling	22,680	25	0
Dunlin	438,480	25	10
Bar-tailed godwit	54,280	25	0
Curlew	124,650	25	1
Redshank (non-breeding totanus)	25,000	25	0
Redshank (breeding britannica)	38,800	25	0
Redshank (non-breeding robusta)	150,000	25	1
Turnstone	48,000	25	0

13.7.2.5 Impact 6: Barrier Effect

209. The presence of the proposed East Anglia THREE project could potentially create a barrier to bird migratory and foraging routes, and as a consequence, the proposed project has the potential to result in long-term changes to bird movements. It has been shown that some species (divers and scoters) avoid windfarms by making detours around wind turbine arrays which potentially increases their energy expenditure (Petersen et al. 2006; Petersen and Fox 2007) and potentially decreases survival chances. Such effects may have a greater impact on birds that regularly

commute around a windfarm (e.g. birds heading to / from foraging grounds and roosting / nesting sites) than migrants that would only have to negotiate around a windfarm once per migratory period, or twice per annum, if flying the same return route (Speakman et al. 2009).

210. During the spring and autumn migration periods, the route taken by migrating individuals may change due to the barrier effect created by the wind turbines. Although migrating birds may have to increase their energy expenditure to circumvent the East Anglia THREE site at a time when their energy budgets are typically restricted, this effect is likely to be small for one-off avoidances. Masden et al. (2010, 2012) and Speakman et al. (2009) calculated that the costs of one-off avoidances during migration were small, accounting for less than 2% of available fat reserves. Therefore, the impacts on birds that only potentially migrate (including seabirds, waders and waterbirds on passage) through the site could be considered negligible and these species have been scoped out of detailed assessment.

211. Several species of seabirds could be susceptible to a barrier effect, outside of passage movements, if the presence of wind turbines prevented access to foraging grounds or made the journey to or from foraging grounds more energetically expensive, particularly during the breeding season. The East Anglia THREE site is located beyond the foraging range of the majority of species during the breeding season, with the exception of fulmar, gannet and lesser black-backed gull. However, even for these species, the East Anglia THREE site is towards the periphery of their mean maximum foraging ranges (Thaxter et al. 2012) so it is highly unlikely that anything other than a negligible magnitude barrier effect would be created. All of these species are considered to have a low sensitivity to barrier effects (Maclean et al. 2009) and are generally tolerant of the presence of operational wind turbines, with the exception of gannet. Assessment of barrier effects of offshore windfarms in the Forth and Tay area for gannets breeding in the Forth Islands SPA also concluded that even in this situation where windfarms were planned in close proximity to the Bass Rock gannet colony, the barrier effect for that population would be negligible (Searle et al. 2014). The impact significance of the barrier effect for all of these species is assessed as **negligible**.

13.7.3 Potential Impacts during Decommissioning

212. There are two potential impacts that may affect bird populations during the decommissioning phase of the proposed project that have been screened in. These are:

- Disturbance / displacement; and

- Indirect impacts through effects on habitats and prey species.

213. Any effects generated during the decommissioning phase of the proposed East Anglia THREE project are expected to be similar or of reduced magnitude to those generated during the construction phase, as certain activities such as piling would not be required. This is because it would generally involve a reverse of the construction phase through the removal of structures and materials installed, while offshore cables are anticipated to remain buried in-situ.

214. Potential impacts predicted during the decommissioning phase include those associated with disturbance and displacement and indirect effects on birds through effects on habitats and prey species. Disturbance and displacement is likely to occur due to the presence of working vessels and crews and the movement and noise associated with these. Indirect effects would occur as structures are removed.

215. As no offshore windfarms have been decommissioned, it is anticipated that any future activities would be programmed in close consultation with the relevant statutory marine and nature conservation bodies, to allow any future guidance and best practice to be incorporated to minimise any potential impacts.

13.7.3.1 Impact 7: Direct Disturbance and Displacement

216. Disturbance and displacement is likely to occur due to the presence of working vessels and crews and the movement and noise associated with these. Such activities have already been assessed for relevant bird species in the construction section above and have been found to be of negligible magnitude.

217. Any impacts generated during the decommissioning phase of the proposed East Anglia THREE project are expected to be similar, but likely of reduced magnitude compared to those generated during the construction phase; therefore the magnitude of effect is predicted to be negligible. This magnitude of impact on a range of species of low to high sensitivity to disturbance is of negligible to **minor** adverse significance.

13.7.3.2 Impact 8: Indirect Impacts Through Effects on Habitats and Prey Species

218. Indirect effects such as displacement of seabird prey species is likely to occur as structures are removed. Such activities have already been assessed for relevant bird species in the construction section above and have been found to be of negligible magnitude.

219. Any impacts generated during the decommissioning phase of the proposed project are expected to be similar, but likely of reduced magnitude compared to those generated during the construction phase; therefore the magnitude of effect is

predicted to be negligible. This magnitude of impact on a range of species of low to high sensitivity to disturbance is of negligible to **minor** adverse significance.

13.8 Cumulative Impacts

13.8.1 Screening for Cumulative Impacts

220. The screened in potential effects arising from the proposed East Anglia THREE project alone that have been identified above are presented in *Table 13.37* below, within which they are assessed for their potential to create a cumulative impact.

Table 13.37. Potential Cumulative Impacts Arising from the Proposed East Anglia THREE Project

Impact	Potential for cumulative impact	Comment
1. Construction: Disturbance and displacement	No	The likelihood that there would be a cumulative impact is low because the contribution from the proposed project is small and it is dependent on a temporal and spatial co-incidence of disturbance / displacement from other plans or projects.
2. Construction: Indirect impacts through effects on habitats and prey species	No	The likelihood that there would be a cumulative impact is low because the contribution from the proposed project is small and it is dependent on a temporal and spatial co-incidence of disturbance / displacement from other plans or projects.
3. Operation: Disturbance and displacement	Yes	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
4. Operation: Indirect impacts through effects on habitats and prey species	No	The likelihood that there would be a cumulative impact is low because the contribution from the proposed project is small.
5. Operation: Collision risk	Yes	There is a sufficient likelihood of a cumulative impact to justify a detailed, quantitative cumulative impact assessment.
6. Operation: Barrier effect	No	The likelihood that there would be a cumulative impact is low because the contribution from the proposed project is small.
7. Decommissioning: Disturbance and displacement	No	The likelihood that there would be a cumulative impact is low because the contribution from the proposed project is small and it is dependent on a temporal and spatial co-incidence of disturbance / displacement from other plans or proposed projects.

Impact	Potential for cumulative impact	Comment
8. Decommissioning: Indirect impacts through effects on habitats and prey species	No	The likelihood that there would be a cumulative impact is low because the contribution from the proposed project is small and it is dependent on a temporal and spatial co-incidence of disturbance / displacement from other plans or projects.

221. The classes of projects that could potentially be considered for the cumulative assessment of offshore ornithological receptors include:

- Offshore windfarms;
- Marine aggregate extraction;
- Oil and gas exploration and extraction;
- Sub-sea cables and pipelines; and
- Commercial shipping.

222. The identification of plans and projects to include in the cumulative assessment of offshore ornithological receptors has been based on:

- Approved plans;
- Constructed projects;
- Approved but as yet unconstructed projects; and
- Projects for which an application has been made, are currently under consideration and may be consented before the proposed East Anglia THREE project.

223. 'Foreseeable' projects, that is those for which an application has not been made but they have been the subject of consultation by the developer, or they are listed in plans that have clear delivery mechanisms, have been included for consideration, but the absence of firm or any relevant data could preclude a quantitative cumulative assessment being carried out.

13.8.1.1 Screened In Sources of Effect for the Cumulative Assessment

224. Potential plans and projects have been considered for how they might act cumulatively with the proposed project and a screening process carried out.

Benthic Habitats

225. The potential for cumulative indirect impacts acting through adverse effects on benthic habitats and consequently on bird prey species was considered as part of Chapter 10 Benthic Ecology, section *10.7.1*. This identified that the potential cumulative impacts to the benthos caused by interactions of the proposed East Anglia THREE project and other activities are:

- Physical disturbance and habitat loss;
- Increased suspended sediment concentrations;
- Re-mobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Colonisation of foundations and cable protection.

226. The cumulative assessment identified that these impacts would mostly be temporary, small scale and localised. Given the distances to other activities in the region (e.g. other offshore windfarms and aggregate extraction) and the highly localised nature of the impacts above, it concluded that there is no pathway for interaction between impacts cumulatively. Whilst it is recognised that across the East Anglia Zone and wider southern North Sea there would be additive impacts, the combined magnitude of these would be negligible relative to the scale of the habitats affected. Accordingly, the cumulative impacts on birds through these effects could be no more than negligible and these are screened out from further assessment.

Shipping and Navigation

227. Wide ranging species such as gannet and fulmar have low sensitivity to human activity disturbance and are relatively flexible in their habitat choice (Garthe & Hüppop 2004). These species are therefore unlikely to be subject to cumulative effects of disturbance from the proposed East Anglia THREE project and existing ship traffic.

228. Gulls are undisturbed by the close proximity of boats, and therefore no potential adverse cumulative effects are expected for kittiwake, common gull, lesser black-backed gull, herring gull or great black-backed gull.

229. Divers, particularly red-throated divers, are known to be sensitive to disturbance from shipping. Consequently, they usually occur in areas with light sea traffic (Mitschke et al. 2001). It has been noted from aerial survey data that while red-

throated divers avoid shipping lanes (tending to prefer areas 1km or more away), they do not display complete absence, and activity in these shipping lanes is considerably higher than any proposed windfarm service boat activity (DTI 2006). The high shipping activity in the Thames Strategic Area due to bulk carriers, tankers and passenger ferries, does not seem to affect the overwintering population of red-throated divers inside and outside of the SPA. Auks also tend to move away from vessels, although their responses are less marked than for divers. While it can be expected that red-throated divers, guillemots and razorbills will be displaced from shipping lanes, it is reasonable to assume that such effects are accounted for in the baseline data which underpins this assessment.

230. In conclusion, it is likely that the seabirds present in the vicinity of the proposed East Anglia THREE project have already adapted to shipping operations in the area. The increase in shipping activities associated with construction of the East Anglia THREE site would be short-term and temporary. Therefore, no significant cumulative disturbance and displacement effects are predicted for any seabird species and shipping and navigation is screened out of further cumulative assessment.

231. In the offshore environment other windfarms that were operational, under construction, consented but not constructed, subject to current applications, subject to consultation or listed in the future plans by developers were screened in. This list of windfarms with their status is provided in *Table 13.38*

232. The windfarms listed in Table *13.38* have been assigned to Tiers following the approach proposed by Natural England and JNCC (Natural England 2013d) as follows:

1. Built and operational projects;
2. Projects that are under construction;
3. Consented application(s) not yet implemented;
4. Submitted application(s) not yet determined; and
5. Future projects (e.g. pre-scoping stage).

Table 13.38 Summary of Projects included in the Cumulative Impact Assessment (CIA) in Relation to the Ornithology Receptors

Project	Tier	Status	Key Date	Project Data Status	Rationale for inclusion
Greater Gabbard	1	Built and operational	Fully commissioned Aug 2013	Complete for the ornithology receptors being assessed	Included as an operational project that does not yet form part of the baseline.
Gunfleet Sands	1	Built and operational	Fully commissioned Jun 2010	Complete for the ornithology receptors being assessed	Included as an operational project that does not yet form part of the baseline.
Kentish Flats	1	Built and operational	Fully commissioned Dec 2005	Complete but limited quantitative species assessment	Operational for a sufficiently long time that its effects will have been incorporated in surveys but not yet in population responses
Lincs	1	Built and operational	Fully commissioned Sep 2013	Complete but limited quantitative species assessment	Included as an operational project that does not yet form part of the baseline.
London Array (Phase 1)	1	Built and operational	Fully commissioned Apr 2013	Complete but limited quantitative species assessment	Included as an operational project that does not yet form part of the baseline.
Lynn and Inner Dowsing	1	Built and operational	Fully commissioned Mar 2009	Complete but limited quantitative species assessment	Included as an operational project that does not yet form part of the baseline.
Scroby Sands	1	Built and operational	Fully commissioned Dec 2004	Complete but limited quantitative species assessment	Operational for a sufficiently long time that its effects will have been incorporated in surveys but not yet in population responses
Sheringham Shoal	1	Built and operational	Fully commissioned Sep 2012	Complete but limited quantitative species assessment	Included as an operational project that does not yet form part of the baseline.
Beatrice (demonstrator)	1	Built and operational	Fully commissioned Sep 2007	Complete but limited quantitative species assessment	Included as an operational project that does not yet form part of the baseline.
Thanet	1	Built and operational	Fully commissioned Sep 2010	Complete for the ornithology receptors being assessed	Included as an operational project that does not yet form part of the baseline.

Project	Tier	Status	Key Date	Project Data Status	Rationale for inclusion
Teesside	1	Built and operational	Fully commissioned Aug 2013	Complete but limited quantitative species assessment	Included as an operational project that does not yet form part of the baseline.
Westermost Rough	1	Built and operational	Full power output May 2015 currently being commissioned.	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Humber Gateway	1	Built and operational	Final turbine installed April 2015, currently being commissioned.	Complete but limited quantitative species assessment	Included as a consented project that does not yet form part of the baseline.
Dogger Bank Creyke Beck A & B	3	Consented but not constructed	Consent Feb 2015, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Dudgeon	3	Consented but not constructed	Consent Jul 2012, no construction start date	Complete but limited quantitative species assessment	Included as a consented project that does not yet form part of the baseline.
EOWDC (Aberdeen OWF)	3	Consented but not constructed	Consent August 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Galloper	3	Consented but not constructed	Consent May 2013, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Hornsea Project 1	3	Consented but not constructed	Consent Dec 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Inch Cape	3	Consented but not constructed	Consent Sep 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Neart ne Goithe	3	Consented but not constructed	Consent Oct 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Race Bank	3	Consented but not constructed	Consent Jul 2012, no construction start date	Complete but limited quantitative species assessment	Included as a consented project that does not yet form part of the baseline.

Project	Tier	Status	Key Date	Project Data Status	Rationale for inclusion
Rampion	3	Consented but not constructed	Consent Aug 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Beatrice	3	Consented but not constructed	Consent Mar 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Blyth (NaREC Demonstration)	3	Consented but not constructed	Consent Nov 2013, no construction start date	Complete but limited quantitative species assessment	Included as a consented project that does not yet form part of the baseline.
East Anglia ONE	3	Consented but not constructed	Consent Jun 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Firth of Forth Alpha and Bravo	3	Consented but not constructed	Consent Oct 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Moray Firth (EDA)	3	Consented but not constructed	Consent Mar 2014, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Dogger Bank Teesside A & B	3	Consented but not constructed	Consent Aug 2015, no construction start date	Complete for the ornithology receptors being assessed	Included as a consented project that does not yet form part of the baseline.
Hornsea Project 2	4	Application submitted, Examination in progress	Submission 2015	Complete for the ornithology receptors being assessed	Included as a foreseeable project.
Triton Knoll	4	Partial consent (windfarm consented, cable consent submitted)	Windfarm consent Jul 2013, export cable not consented (Oct 2015). No construction start date.	Complete for the ornithology receptors being assessed	Included as a foreseeable project.
East Anglia THREE	4	Application submitted	Consent decision 2016	Complete for the ornithology receptors being assessed	The project that is the subject of this assessment.
East Anglia Future Projects	5	Identified in Round 3 programme	n/a	Not yet available	In the absence of data, the inclusion of this project is only on a qualitative basis.

Project	Tier	Status	Key Date	Project Data Status	Rationale for inclusion
Hornsea Future Projects	5	Identified in Round 3 programme	n/a	Not yet available	In the absence of data, the inclusion of this project is only on a qualitative basis.

233. The level of data available and the ease with which impacts can be combined across the windfarms in *Table 13.38* is quite variable, reflecting the availability of relevant data for older projects and the approach to assessment taken. Wherever possible the cumulative assessment is quantitative (i.e. where data in an appropriate format have been obtained). Where this has not been possible (e.g. for older projects) a qualitative assessment has been undertaken.

234. Within the two impacts identified for assessment (operational displacement and collision risk), each windfarm listed in *Table 13.38* up to and including those in Tier 4 (submitted applications, not yet determined) was screened in for inclusion in the cumulative assessment for each species assessed.

13.8.1.2 Bird species and windfarms included in the cumulative assessment of operation displacement

235. The species assessed for project alone displacement impacts (and the relevant seasons) were red-throated diver (non-breeding), gannet (migration), guillemot (nonbreeding), razorbill (nonbreeding) and puffin (nonbreeding). As all of the impacts were outside the breeding season the assessments have been conducted in relation to the relevant BDMPS and the windfarms located within them.

236. A review of the BDMPS regions for each species indicated that for gannet, guillemot, razorbill and puffin, all of the windfarms identified for inclusion in the CIA in *Table 13.38* have the potential to contribute a cumulative effect. For red-throated diver, windfarms located in the north-west North Sea were excluded (following Furness 2015). Consequently, all windfarms located from the Firth of Forth northwards were therefore considered not likely to contribute to a cumulative displacement effect for the relevant BDMPS population of this species.

13.8.1.3 Bird species and windfarms included in the cumulative assessment of collision risk

237. The species assessed for project alone collision impacts (and the relevant seasons) were those for which a collision mortality greater than 10 individuals for the project alone was estimated, on the grounds that the potential for the proposed East Anglia THREE project to contribute to a cumulative mortality effect was negligible for annual mortalities below this. Thus cumulative collision risk both annually and for key seasons was assessed for gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull.

238. A review of the BDMPS regions for each species indicated that for gannet, lesser black-backed gull and herring gull all of the windfarms identified for inclusion in the CIA in *Table 13.38* have the potential to contribute to a cumulative effect. For kittiwake and great black-backed gull windfarms located in the English Channel were excluded (following Furness 2015).

13.8.1.4 Cumulative Assessment of Operation Displacement Risk

Red-throated diver

239. The project alone assessment concluded that during the midwinter period when divers are most at risk of impacts due to displacement, the maximum number of individuals at risk of mortality due to displacement was sufficiently small (<2 birds) and that there was no risk of a significant impact (based on a 10% mortality rate of 16.7 displaced individuals. Although a higher number was considered to be at risk of displacement-caused mortality during spring migration (13, maximum prediction), this includes birds passing through the site for a brief period on migration and therefore the consequences of displacement are minimal and no significant project alone effects were predicted.

240. With regards the potential for cumulative effects of displacement from offshore windfarms, the recent assessment and decision for the nearby East Anglia ONE windfarm was reviewed. The assessment of impacts for this project concluded there would be no significant impacts on red-throated diver due to operational displacement. Natural England agreed that East Anglia ONE, both alone and in-combination, would not have a likely significant effect on the nearest designated site for red-throated diver (Outer Thames Estuary SPA; Natural England 2013).

241. The proposed East Anglia THREE project, with a maximum predicted impact from the project alone of 2 additional deaths during the midwinter period, will contribute a very small addition to the cumulative risk assessed for East Anglia ONE. This is clearly insufficient to alter the previous conclusion (of no likely significant effect on the Outer Thames Estuary SPA population), not least as it was based on the smaller SPA population of 6,466 individuals rather than the wider BDMPS of 10,177. Due to the extremely low numbers of birds predicted to be affected by operational displacement the magnitude of effect has been determined as negligible. As the species is of high sensitivity to disturbance, the impact significance of cumulative displacement is **minor** adverse**.**

Gannet

242. The East Anglia THREE site is located beyond the mean maximum foraging range of gannets from breeding colonies in the North Sea. Therefore, displacement risk is only of concern outside the breeding season. There is evidence that gannets avoid flying through windfarms (Krijgsveld et al. 2011). If this prevents them accessing important foraging areas this could have an impact on affected individuals. However, for the reasons set out below the potential for the proposed East Anglia THREE project to contribute to a cumulative effect such as this is considered to be very unlikely. The period when gannet displacement is of potential concern is during autumn migration. At this time very large numbers of gannets are migrating from breeding colonies in Northern Europe to wintering areas farther south (off the coast of West Africa). Thus, displacement due to windfarms in the North Sea is trivial when compared with the range over which individuals of this species travel (Garthe et al. 2012, see also Masden et al. 2010, 2012). Furthermore, gannets are considered to be highly flexible in their foraging requirements, and exclusion from windfarms in the southern North Sea which, on the basis of the low overall numbers of seabirds present, is very unlikely to represent a loss of any importance. Consequently, the potential for the proposed East Anglia THREE project to contribute to a significant cumulative displacement effect on gannets during migration is considered to be very small and the impact significance of cumulative displacement is **negligible**.

Guillemot

243. The East Anglia THREE site is located beyond the mean maximum foraging range of any guillemot breeding colonies (see *section 13.7.1.1* for supporting evidence). Outside the breeding season, guillemots disperse from their breeding sites with an overall southward trend. Thus large numbers are found throughout the North Sea in the nonbreeding season (defined as August to February). Consequently it was during this period that numbers peaked on East Anglia THREE (plus 2km buffer), with a mean maximum of 2,859 individuals.

244. In the recent cumulative assessment for the Hornsea 2 project (Smart Wind 2015b) an estimate of the impact on nonbreeding guillemots was presented for 23 of the windfarms listed in *Table 13.38* (exceptions were: Gunfleet Sands, Kentish Flats, Lynn and Inner Dowsing, Scroby Sands, Rampion, Blyth and the possible future Round 3 developments). The total nonbreeding number of guillemot in the North Sea was estimated to be 63,111 individuals (Smart Wind 2015b). This number was calculated

from a combination of figures presented in project Environmental Statements and estimates derived from Natural England guidance (WWT and MacArthur Green 2013). In the cumulative assessment for the Dogger Bank Teesside A & B project (Forewind 2014), the total number of guillemot predicted to be displaced from North Sea windfarms was obtained from project Environmental Statements and estimated as 75,144 across all periods of the year, derived from data obtained for 11 windfarms (in addition to the Dogger Bank windfarms these were: Beatrice, East Anglia ONE, EOWDC, Firth of Forth Alpha and Bravo, Galloper, Hornsea Project One, Inch Cape, London Array, Moray Firth, Neart na Goithe and Thanet).

245. These two estimates provide similar numbers of guillemot at risk of displacement in the North Sea. Since guillemots were predominantly present on the East Anglia THREE site outside the breeding season, the nonbreeding estimate presented in Smart Wind (2015b) has been used in the current cumulative assessment. To this number, the proposed East Anglia THREE project adds 2,859. While this omits windfarms for which no data are available (as listed above), this is also likely to over-estimate the number present due to the use of peak numbers at each site which probably leads to double counting as birds move through the North Sea.

246. On the basis of a cumulative total of 65,970 birds at risk of displacement, the estimated number of guillemots subject to potential mortality during the non-breeding season is between 198 and 4,618 individuals (from 30% displaced and 1% mortality to 70% displaced and 10% mortality, a range advised by Natural England; *Table 13.39*). Thus the key question for assessing the impact is where within this range (198 to 4,618) is the most realistic value.

Table 13.39 Displacement matrix presenting the cumulative number of guillemots at risk of displacement and mortality during the wintering season (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	7	66	132	198	264	330	396	462	528	594	660
10	0	66	660	1319	1979	2639	3299	3958	4618	5278	5937	6597
20	0	132	1319	2639	3958	5278	6597	7916	9236	10555	11875	13194
30	0	198	1979	3958	5937	7916	9896	11875	13854	15833	17812	19791
40	0	264	2639	5278	7916	10555	13194	15833	18472	21110	23749	26388
50	0	330	3299	6597	9896	13194	16493	19791	23090	26388	29687	32985
60	0	396	3958	7916	11875	15833	19791	23749	27707	31666	35624	39582
70	0	462	4618	9236	13854	18472	23090	27707	32325	36943	41561	46179
80	0	528	5278	10555	15833	21110	26388	31666	36943	42221	47498	52776
90	0	594	5937	11875	17812	23749	29687	35624	41561	47498	53436	59373
100	0	660	6597	13194	19791	26388	32985	39582	46179	52776	59373	65970

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%) during the wintering season.

247. Post-construction monitoring of nonbreeding season auks has found evidence of windfarm avoidance behaviour, with indications that wind turbine density may affect the magnitude of avoidance (Leopold et al. 2011; Krijgsveld et al. 2011). The estimated guillemot avoidance rate from these studies was around 68%, although it should be noted that this was based on observations of flying birds and this value may not be appropriate for swimming birds. Furthermore these studies were conducted at sites with relatively closely spaced wind turbines (e.g. 550m), while the minimum spacing at East Anglia THREE will be 675m (within rows) and 900m (between rows). Thus, a figure of 70% displacement represents a precautionary estimate.

248. The pressures on nonbreeding birds in terms of energy requirements are lower outside the breeding season when they only need to obtain sufficient food to maintain their own survival. In addition, for species such as auks they can remain at sea for extended periods and thus flight costs are minimised. Recoveries of ringed guillemots have indicated a wide distribution in winter, with birds spread throughout the North Sea (Furness 2015). This pattern has received further support from recent studies using geolocator tags, which have revealed that birds from Scottish colonies spread out through much of the North Sea (S. Wanless pers. comm.). These studies have also found quite marked levels of variation between years, which suggests that birds are relatively flexible in terms of where they spend the winter and are not dependent on particular foraging locations. Hence, the consequence of winter displacement from windfarms in terms of increased mortality is likely to be minimal. Given that, even when fish stocks have collapsed, adult survival rates have shown declines of no more than 6 - 7% (e.g. kittiwake, Frederiksen et al. 2004) an increase in mortality due to displacement from windfarm sites seems likely to be at the low end of the proposed 1 - 10% range, and a value of 1% when combined with the precautionary 70% displacement rate is considered appropriate. On this basis a precautionary cumulative nonbreeding displacement figure of 462 is obtained (65,970 x 0.7 x 0.01).

249. The nonbreeding guillemot BDMPS is 1,617,306 (Furness 2015). Additional mortality of 462 individuals from this population is a loss of only 0.03% of the population.

250. At the average baseline mortality rate for guillemot of 0.140 (*Table 13.16*) the number of individuals expected to die in the nonbreeding season is 226,423 (1,617,306 x 0.140). The addition of a maximum of 462 to this increases the

mortality rate by 0.2%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the potential for the proposed East Anglia THREE project to contribute to a significant displacement effect on guillemot during the nonbreeding season is considered to be very small and the impact significance of cumulative displacement is **negligible**.

Razorbill

251. The East Anglia THREE site is located beyond the mean maximum foraging range of any razorbill breeding colonies (see *section 13.7.1.1* for supporting evidence). Outside the breeding season razorbills migrate southwards in a similar manner to guillemots, although they tend to move further south. Three nonbreeding seasons were identified for razorbill (spring and autumn migration and winter), with numbers in the North Sea during the migration period estimated to be 591,874 and in midwinter 218,622.

252. At these times the total numbers on the East Anglia THREE site (and 2km buffer) were 1,122, 1,499 and 1,524 respectively.

253. In the recent cumulative assessment for the Hornsea 2 project (Smart Wind 2015b) an estimate of the impact on nonbreeding razorbills was presented for 23 of the windfarms listed in *Table 13.38* (exceptions were: Gunfleet Sands, Kentish Flats, Lynn and Inner Dowsing, Scroby Sands, Rampion, Blyth and the possible future Round 3 developments). The total autumn migration, nonbreeding and spring migration number of razorbills in the North Sea were estimated to be 26,371, 13,010 and 20,284 individuals respectively (Smart Wind 2015b). These numbers were calculated from a combination of figures presented in project Environmental Statements and estimates derived from Natural England guidance (WWT and MacArthur Green 2013). In the cumulative assessment for the Dogger Bank Teesside A & B project (Forewind 2014), the total number of razorbills predicted to be displaced from North Sea windfarms was obtained from project Environmental Statements and estimated as 22,215 across all periods of the year, derived from data obtained for 11 windfarms (in addition to the Dogger Bank windfarms these were: Beatrice, East Anglia ONE, EOWDC, Firth of Forth Alpha and Bravo, Galloper, Hornsea Project One, Inch Cape, London Array, Moray Firth, Neart na Goithe and Thanet).

254. These two estimates provide similar numbers of razorbills at risk of displacement in the North Sea. Since razorbills were predominantly present on the East Anglia THREE site outside the breeding season, the estimates presented in Smart Wind (2015b) have been used in the current cumulative assessment. To these numbers, the numbers for the proposed East Anglia THREE project can be added (1,122, 1,499 and 1,524 respectively) giving cumulative totals of 27,493, 14,509 and 21,808 for each season. While these omit windfarms for which no data are available (as listed above), they are also likely to over-estimate the number present due to the combination of peak numbers at each site which probably leads to double counting as birds move through the North Sea.

255. On the basis of a cumulative total of 27,493 birds at risk of displacement, the estimated number of razorbills subject to potential mortality during the autumn migration period is between 82 and 1,925 individuals (from 30% displaced and 1% mortality to 70% displaced and 10% mortality, a range advised by Natural England; *Table 13.40*). Thus the key question for assessing the impact is where within this range (82, 1,925) is the most realistic value.

Table 13.40 Displacement matrix presenting the cumulative number of razorbills at risk of displacement and mortality during the autumn season (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	3	27	55	82	110	137	165	192	220	247	275
10	0	27	275	550	825	1100	1375	1650	1925	2199	2474	2749
20	0	55	550	1100	1650	2199	2749	3299	3849	4399	4949	5499
30	0	82	825	1650	2474	3299	4124	4949	5774	6598	7423	8248
40	0	110	1100	2199	3299	4399	5499	6598	7698	8798	9897	10997
50	0	137	1375	2749	4124	5499	6873	8248	9623	10997	12372	13747
60	0	165	1650	3299	4949	6598	8248	9897	11547	13197	14846	16496
70	0	192	1925	3849	5774	7698	9623	11547	13472	15396	17321	19245
80	0	220	2199	4399	6598	8798	10997	13197	15396	17596	19795	21994
90	0	247	2474	4949	7423	9897	12372	14846	17321	19795	22269	24744
100	0	275	2749	5499	8248	10997	13747	16496	19245	21994	24744	27493

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

256. The evidence for displacement and consequent mortality is based on the same observations made for guillemot (see above). Therefore, the same precautionary rates (70% displacement and 1% mortality) have been applied. On this basis a precautionary cumulative autumn migration displacement figure of 192 is obtained (27,493 x 0.7 x 0.01).

257. The autumn migration nonbreeding razorbill BDMPS is 591,874 (Furness 2015). Additional mortality of 192 individuals from this population is a loss of only 0.03% of the population.

258. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the autumn migration period is 102,986 (591,874 x 0.174). The addition of a maximum of 192 to this increases the mortality rate by 0.19%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the autumn migration period, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the potential for the proposed East Anglia THREE project to contribute to a significant displacement effect on razorbill during the autumn migration period is considered to be very small and the impact significance of cumulative displacement is **negligible**.

259. On the basis of a cumulative total of 14,509 birds at risk of displacement, the estimated number of razorbills subject to potential mortality during the non-breeding season is between 44 and 1,016 individuals (from 30% displaced and 1% mortality to 70% displaced and 10% mortality, a range advised by Natural England; *Table 13.41*). Thus the key question for assessing the impact is where within this range (45 to 1,016) is the most realistic value.

Table 13.41 Displacement matrix presenting the cumulative number of razorbills at risk of displacement and mortality during the midwinter season (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	15	29	44	58	73	87	102	116	131	145
10	0	15	145	290	435	580	725	871	1016	1161	1306	1451
20	0	29	290	580	871	1161	1451	1741	2031	2321	2612	2902
30	0	44	435	871	1306	1741	2176	2612	3047	3482	3917	4353
40	0	58	580	1161	1741	2321	2902	3482	4063	4643	5223	5804
50	0	73	725	1451	2176	2902	3627	4353	5078	5804	6529	7255
60	0	87	871	1741	2612	3482	4353	5223	6094	6964	7835	8705
70	0	102	1016	2031	3047	4063	5078	6094	7109	8125	9141	10156
80	0	116	1161	2321	3482	4643	5804	6964	8125	9286	10446	11607
90	0	131	1306	2612	3917	5223	6529	7835	9141	10446	11752	13058
100	0	145	1451	2902	4353	5804	7255	8705	10156	11607	13058	14509

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

260. The evidence for displacement and consequent mortality is based on the same observations made for guillemot (see above). Therefore, the same precautionary rates (70% displacement and 1% mortality) have been applied. On this basis a precautionary cumulative autumn migration displacement figure of 102 is obtained (14,509 x 0.7 x 0.01).

261. The midwinter nonbreeding razorbill BDMPS is 218,622 (Furness 2015). Additional mortality of 102 individuals from this population is a loss of only 0.05% of the population.

262. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the midwinter nonbreeding season is 38,040 (218,622 x 0.174). The addition of a maximum of 102 to this increases the mortality rate by 0.26%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the midwinter nonbreeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

263. On the basis of a cumulative total of 21,808 birds at risk of displacement, the estimated number of razorbills subject to potential mortality during the spring migration period is between 65 and 1,527 individuals (from 30% displaced and 1% mortality to 70% displaced and 10% mortality, a range advised by Natural England; *Table 13.42*). Thus the key question for assessing the impact is where within this range (65 to 1,527) is the most realistic value.

Table 13.42 Displacement matrix presenting the cumulative number of razorbills at risk of displacement and mortality during the spring season (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	2	22	44	65	87	109	131	153	174	196	218
10	0	22	218	436	654	872	1090	1308	1527	1745	1963	2181
20	0	44	436	872	1308	1745	2181	2617	3053	3489	3925	4362
30	0	65	654	1308	1963	2617	3271	3925	4580	5234	5888	6542
40	0	87	872	1745	2617	3489	4362	5234	6106	6979	7851	8723
50	0	109	1090	2181	3271	4362	5452	6542	7633	8723	9814	10904
60	0	131	1308	2617	3925	5234	6542	7851	9159	10468	11776	13085
70	0	153	1527	3053	4580	6106	7633	9159	10686	12212	13739	15266
80	0	174	1745	3489	5234	6979	8723	10468	12212	13957	15702	17446
90	0	196	1963	3925	5888	7851	9814	11776	13739	15702	17664	19627
100	0	218	2181	4362	6542	8723	10904	13085	15266	17446	19627	21808

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

264. The evidence for displacement and consequent mortality is based on the same observations made for guillemot (see above). Therefore, the same precautionary rates (70% displacement and 1% mortality) have been applied. On this basis a precautionary cumulative spring migration displacement figure of 153 is obtained (21,808 x 0.7 x 0.01).

265. The spring migration nonbreeding razorbill BDMPS is 591,874 (Furness 2015). Additional mortality of 153 individuals from this population is a loss of only 0.03% of the population.

266. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the spring migration period is 102,986 (591,874 x 0.174). The addition of a maximum of 153 to this increases the mortality rate by 0.15%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the spring migration season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

267. Displacement combined across the three non-breeding seasons gives a cumulative total of 21,270 (27,497 + 14,509 + 21,808 divided by 3, autumn, mid-winter and spring respectively) birds at risk of displacement, the estimated number of razorbills subject to potential mortality during the non-breeding season is between 64 and 1,489 individuals (from 30% displaced and 1% mortality to 70% displaced and 10% mortality, a range advised by Natural England; *Table 13.43*). Thus the key question for assessing the impact is where within this range (64 to 1,489) is the most realistic value.

Table 13.43 Displacement matrix presenting the cumulative number of razorbills at risk of displacement and mortality during all nonbreeding seasons combined (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	2	21	43	64	85	106	128	149	170	191	213
10	0	21	213	425	638	851	1064	1276	1489	1702	1914	2127
20	0	43	425	851	1276	1702	2127	2552	2978	3403	3829	4254
30	0	64	638	1276	1914	2552	3191	3829	4467	5105	5743	6381
40	0	85	851	1702	2552	3403	4254	5105	5956	6806	7657	8508
50	0	106	1064	2127	3191	4254	5318	6381	7445	8508	9572	10635
60	0	128	1276	2552	3829	5105	6381	7657	8933	10210	11486	12762
70	0	149	1489	2978	4467	5956	7445	8933	10422	11911	13400	14889
80	0	170	1702	3403	5105	6806	8508	10210	11911	13613	15314	17016
90	0	191	1914	3829	5743	7657	9572	11486	13400	15314	17229	19143
100	0	213	2127	4254	6381	8508	10635	12762	14889	17016	19143	21270

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

268. The evidence for displacement and consequent mortality is based on the same observations made for guillemot (see above). Therefore, the same precautionary rates (70% displacement and 1% mortality) have been applied. On this basis a precautionary cumulative annual nonbreeding displacement figure of 149 is obtained (21,270 x 0.7 x 0.01).

269. The biogeographic population for razorbill is 1,707,000 (Furness 2015). Additional mortality of 149 individuals from this population is a loss of only 0.009% of the population.

270. At the average baseline mortality rate for razorbill of 0.174 (*Table 13.16*) the number of individuals expected to die in the complete nonbreeding season is 297,018 (1,707,000 x 0.174). The addition of a maximum of 149 to this increases the mortality rate by 0.05%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the complete nonbreeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

Puffin

271. The East Anglia THREE site is located beyond the mean maximum foraging range of any puffin breeding colonies. Outside the breeding season puffins disperse from their breeding sites with an overall southward trend. Thus large numbers are found throughout the North Sea in the nonbreeding season (defined as August to February). Consequently it was during this period that numbers peaked on the East Anglia THREE site with a mean maximum of 195 individuals.

272. In the recent cumulative assessment for the Hornsea 2 project (Smart Wind 2015b) an estimate of the impact on nonbreeding puffins was presented for 23 of the windfarms listed in *Table 13.38* (exceptions were: Gunfleet Sands, Kentish Flats, Lynn and Inner Dowsing, Scroby Sands, Rampion, Blyth and the possible future Round 3 developments). The total nonbreeding number of puffins in the North Sea was estimated to be 13,237 individuals (Smart Wind 2015b). This number was calculated from a combination of figures presented in project Environmental Statements and estimates derived from Natural England guidance (WWT and MacArthur Green 2013). In the cumulative assessment for the Dogger Bank Teesside A & B project (Forewind 2014), the total number of puffins predicted to be displaced from North Sea windfarms was obtained from project Environmental Statements and estimated

as 14,334 across all periods of the year, derived from data obtained for 11 windfarms (in addition to the Dogger Bank windfarms these were: Beatrice, East Anglia ONE, EOWDC, Firth of Forth Alpha and Bravo, Galloper, Hornsea Project One, Inch Cape, London Array, Moray Firth, Neart na Goithe and Thanet).

273. These two estimates provide similar numbers of puffins at risk of displacement in the North Sea. Since puffins were predominantly present on the East Anglia THREE site outside the breeding season, the nonbreeding estimate presented in Smart Wind (2015b) has been used in the current cumulative assessment. To this number, the proposed East Anglia THREE project adds 195. While this omits windfarms for which no data are available (as listed above), this is also likely to over-estimate the number present due to the use of peak numbers at each site which probably leads to double counting as birds move through the North Sea.

274. On the basis of a cumulative total of 13,432 birds at risk of displacement, the estimated number of puffins subject to potential mortality during the non-breeding season is between 40 and 940 individuals (from 30% displaced and 1% mortality to 70% displaced and 10% mortality, a range advised by Natural England; *Table 13.44*). Thus the key question for assessing the impact is where within this range (40 to 940) is the most realistic value.

275. The evidence for displacement and consequent mortality is based on the same observations made for guillemot (see above). Therefore, the same precautionary rates (70% displacement and 1% mortality) have been applied. On this basis a precautionary cumulative nonbreeding season displacement figure of 94 is obtained (13,432 x 0.7 x 0.01).

276. The nonbreeding puffin BDMPS is 231,957 (Furness 2015). Additional mortality of 94 individuals from this population is a loss of only 0.04% of the population.

277. At the average baseline mortality rate for puffin of 0.167 (*Table 13.16*) the number of individuals expected to die during the nonbreeding season is 38,737 (231,957 x 0.167). The addition of a maximum of 94 to this increases the mortality rate by 0.24%. This magnitude of increase in mortality would not materially alter the background mortality of the population and would be undetectable. Therefore, during the nonbreeding season, the magnitude of effect is assessed as negligible. As the species is of low to medium sensitivity to disturbance, the impact significance is **negligible.**

Table 13.44 Displacement matrix presenting the cumulative number of puffins at risk of displacement and mortality during the nonbreeding season (highlighted in pink)

Displacement (%)	Mortality Rates (%)											
	0	1	10	20	30	40	50	60	70	80	90	100
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	1	13	27	40	54	67	81	94	107	121	134
10	0	13	134	269	403	537	672	806	940	1075	1209	1343
20	0	27	269	537	806	1075	1343	1612	1880	2149	2418	2686
30	0	40	403	806	1209	1612	2015	2418	2821	3224	3627	4030
40	0	54	537	1075	1612	2149	2686	3224	3761	4298	4836	5373
50	0	67	672	1343	2015	2686	3358	4030	4701	5373	6044	6716
60	0	81	806	1612	2418	3224	4030	4836	5641	6447	7253	8059
70	0	94	940	1880	2821	3761	4701	5641	6582	7522	8462	9402
80	0	107	1075	2149	3224	4298	5373	6447	7522	8596	9671	10746
90	0	121	1209	2418	3627	4836	6044	7253	8462	9671	10880	12089
100	0	134	1343	2686	4030	5373	6716	8059	9402	10746	12089	13432

Table Notes: a) Green shaded cells highlight most likely displacement range of 30% to 70% as appropriate from the evidence base; b) Pink shaded cells represent the most likely range of mortality associated with displaced birds (1% to 10%).

13.8.1.5 Cumulative Collision Risk Assessment

Gannet

278. The cumulative gannet collision risk prediction is set out in the form of a 'tiered approach' in *Table 13.45.* This collates collision predictions from other windfarms which may contribute to the cumulative total. This table includes revised estimates for East Anglia ONE following a revision to the analysis (*Appendix 13.1*).

279. Seasonal gannet collisions at the East Anglia THREE site were; breeding season 7, autumn migration 36 and spring migration 13 (*Table 13.31*), estimated using Option 1 (see *section 13.7.2.3.1* for evidence in support of this model option for gannet). The potential for the proposed East Anglia THREE project to contribute to impacts on the relevant populations due to collisions during spring migration and the breeding season was considered to be sufficiently small that these seasons did not require individual assessment. Therefore, the collision values presented in *Table 13.45* cover the annual period (i.e. including spring migration and breeding season collisions) and the autumn migration period. Values for other windfarms were taken from windfarm assessments, recent cumulative assessments in other windfarm submissions and written representations provided by Natural England on other windfarm projects (e.g. Natural England 2013b).

280. Assessments at other windfarms have been conducted using a range of avoidance rates and alternative collision model Options. In order to simplify interpretation of the data across sites and also to bring these assessments up to date with the current Natural England Advice the values in *Table 13.45* are those estimated using the Band model Option 1 (or 2, if that was the one presented) at an avoidance rate of 98.9%.

Table 13.45. Cumulative Collision Risk Assessment for Gannet. Shaded cells indicate all projects up to Tier 3.

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 98.9% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Autumn migration	Autumn migration Cumulative total
1	Beatrice Demonstrator 1 / A	4.9	4.9	2.1	2.1
1	Greater Gabbard 4 / B	27.5	32.5	8.8	10.9
1	Gunfleet Sands 4 / A	0.0	32.5	0.0	10.9
1	Kentish Flats 4 /B	3.3	35.8	0.8	11.7
1	Lincs 4 / A	5.0	40.8	1.3	12.9
1	London Array (Phase 1) 4 / B	5.1	45.9	1.4	14.3
1	Lynn and Inner Dowsing 4 / A	0.5	46.4	0.1	14.4
1	Scroby Sands 4 / A	0.0	46.4	0.0	14.4
1	Sheringham Shoal 4 / B	17.0	63.4	3.4	17.8
1	Teesside 4 / B	6.7	70.1	1.7	19.6
1	Thanet 4 / B	2.2	72.3	0.6	20.1
1	Humber Gateway 4 / A	4.5	76.8	1.1	21.2
1	Westermost Rough 4 / A	0.5	77.4	0.1	21.4
3	Beatrice 4 / C	95.7	173.1	48.8	70.2
3	Blyth (NaREC Demonstration) 4 / C	8.4	181.5	2.1	72.3
3	Dogger Bank Creyke Beck A & B 4 / B	16.5	198.0	6.6	78.9
3	Dudgeon 4 / C	80.3	278.3	38.9	117.8
3	East Anglia ONE 3 / C	213.0	491.3	198.0	315.8
3	EOWDC (Aberdeen OWF) 4 / B	9.3	500.7	5.1	321.0
3	Firth of Forth Alpha and Bravo 4 / B	915.9	1416.6	49.3	370.3
3	Galloper 4 / A	61.6	1478.2	30.9	401.1
3	Hornsea Project 1 4 / C	64.9	1543.1	30.8	431.9
3	Inch Cape 4 / B	367.4	1910.5	29.7	461.6
3	Moray Firth (EDA) 4 / C	124.9	2035.3	35.4	497.0
3	Neart na Goithe 4 / B	570.1	2605.5	26.1	523.1

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 98.9% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Autumn migration	Autumn migration Cumulative total
3	Race Bank 4 / B	49.5	2655.0	11.7	534.8
3	Rampion 4 / A	101.8	2756.7	63.5	598.4
3	Dogger Bank Teesside A & B 4 / B	35.7	2792.4	10.1	608.5
4	Triton Knoll 4 / B	121.0	2913.4	64.1	672.6
4	Hornsea Project 2 2 / C	101.6	3015.0	53.0	725.6
4	East Anglia THREE 3 / C	56	3071.0	38.0	763.6
	Total	3071.0		763.6	

Annual data sources: 1 = Natural England (2013b) submission for Rampion gannet assessment; 2 = Hornsea Project 2 submission; 3 = Developer assessment; 4 = Dogger Bank Teesside A & B submission
Autumn data sources: A = no seasonal data, collisions apportioned equally among months; B = Dogger Bank Teesside A & B submission ; Hornsea Project 2 submission; C = Developer assessment

281. On the basis of the values in *Table 13.45*, the cumulative gannet annual mortality is 3,071, of which the proposed East Anglia THREE project contributes 56. Note, however that many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. Therefore, this value is an overestimate of the total risk. All but three of the windfarms in *Table 13.45* are either operational, under construction or fully consented. The cumulative annual mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 2,913. The two tier 4 projects (excluding Triton Knoll) contribute an additional 158 to this, of which approximately 35% is attributable to the proposed East Anglia THREE.

282. Previous gannet collision assessments for the windfarms listed in *Table 13.45* have been made on the basis of Band model Option 1 and a range of avoidance rates between 95% and 99%. The current rate of 98.9% dates from November 2014 (JNCC et al. 2014) and followed the review conducted by Cook et al. (2014). Therefore, the decisions for some of the projects consented prior to this date were on the basis of estimated cumulative collision mortality numbers which were higher than the values presented in *Table 13.45*. However, given the variation in rates presented in different assessments and the rates used in reaching consent decisions, it is difficult

to confidently determine the avoidance rate used for each windfarm consent decision. Nonetheless, it can be stated with a good degree of certainty that none of the previous windfarms has been consented on the basis of an avoidance rate higher than 99%, and many will have been based on assessment at 98%. As a result the cumulative total of 3,071 is almost certainly lower than those on which recent consent decisions have been granted.

283. Work conducted at the Greater Gabbard windfarm (APEM 2014, *Appendix 13.1*) has also found that gannet avoidance of windfarms during the autumn migration period may be even higher than 98.9%, which would further reduce the total collision mortality: out of 336 gannets observed during these surveys only 8 were recorded within the windfarm, indicating a high degree of windfarm (macro) avoidance. Analysis of their data indicated a macro-avoidance rate in excess of 95% compared with the current guidance value of 64%.

284. Furthermore, following a methodological update to the East Anglia ONE collision assessment (with the removal of birds on the water from the calculation the annual East Anglia ONE mortality decreased from 467 to 213 at an avoidance rate of 98.9%) the cumulative annual total decreased by 254 which is over 4 times higher than the contribution from the proposed East Anglia THREE project (*Appendix 13.1*).

285. On the basis of the autumn migration values in *Table 13.45*, the cumulative gannet autumn migration mortality is 764, of which East Anglia THREE contributes 38 (although many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built). All but three of the windfarms in *Table 13.45* are either operational, under construction or fully consented. The cumulative autumn mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 673. The two tier 4 projects (excluding Triton Knoll) contribute an additional 91 to this, of which approximately 42% is attributable to the proposed East Anglia THREE project.

286. As discussed above, previous gannet collision assessments for the windfarms listed in *Table 13.45* were made on the basis of Band model Option 1 and a range of avoidance rates between 95% and 99%. Therefore, some of the projects consented prior to this date were on the basis of estimated cumulative collision mortality which was higher than the values presented in *Table 13.45*. As a result the cumulative autumn migration total of 764 is almost certainly lower than those on which recent consent decisions have been granted.

287. A review of nocturnal activity in seabirds (*Appendix 13.1*) has indicated that the value currently used for this parameter (25%) to estimate collision risk at night for gannet is almost certainly an overestimate (i.e. study data suggest that during the breeding season 0% is more appropriate and 2.5% in the non-breeding season). Reducing the nocturnal activity factor to 0% reduces collision estimates by around 28% at the East Anglia THREE site (*Appendix 13.2*). A correction along these lines would reduce the overall collision estimate for all windfarms by a significant amount (e.g. between 7% and 32%; note the magnitude of reduction varies depending on the time of year and windfarm latitude due to the variation in day and night length, see *Appendix 13.1* for details). Incorporating the *minimum* mortality reduction which could be applied to all windfarm estimates on this basis (7%), the cumulative annual mortality figure decreases by 215 birds, from 3,071 to 2,856 birds. This further emphasises the precautionary nature of the current assessment.

288. Demographic data were collated for the British gannet population to produce a population model which was used to consider the potential impact of additional mortality (WWT 2012). Two versions of the model were developed, with and without density dependence. Of these two models, the density independent one was considered to provide more reliable predictions since it predicted baseline growth at a rate close to that recently observed (1.28% per year compared with an observed rate of 1.33%) while the density dependent model predicted baseline growth of 0.9%.

289. The study concluded that, using the density independent model, on average population growth would remain positive until additional mortality exceeded 10,000 individuals per year while the lower 95% confidence interval on population growth remained positive until additional mortality exceeded 3,500 individuals, which is greater than the cumulative total in *Table 13.45*. Consideration was also given to the risk of population decline. The risk of a 5% population decline was less than 5% for additional annual mortalities below 5,000 (using either the density dependent or density independent model; WWT 2012).

290. It is important to note that the gannet model presented in WWT (2012) was based on the whole British population, so collisions at windfarms on the west coast (e.g. Irish Sea) also need to be added for consistency. However, a review of applications in the Irish Sea and Solway Firth (Barrow, Burbo Bank, Burbo Bank Extension, Gwynt Y Mor, North Hoyle, Ormonde, Rhyl Flats, Robin Rigg, Walney 1 and 2, Walney

Extension and West of Duddon Sands) gave a gannet annual collision cumulative total of 32.4 at an avoidance rate of 98.9%. Therefore, inclusion of these windfarms in the assessment does not alter the conclusion that cumulative collisions are below a level at which a significant impact on the British gannet population would result.

291. Furthermore, the WWT (2012) analysis was conducted using the estimated gannet population in 2004 (the most recent census available at that time), when the British population was estimated to be 261,000 breeding pairs. The most recent census indicates the equivalent number of breeding pairs is now a third higher at 349,498 (Murray et al. 2015). This increase in size will raise the thresholds at which impacts would be predicted and therefore further reduces the risk of significant impacts.

292. In conclusion, the cumulative impact on the gannet population due to collisions both year round and during autumn migration is considered to be of low magnitude, and the relative contribution of the proposed East Anglia THREE project to this cumulative total is very small indeed. The impact significance is **minor** adverse**.**

Kittiwake

293. The cumulative kittiwake collision risk prediction is set out in the form of a 'tiered approach' in *Table 13.46*. This table collates collision predictions from other windfarms which may contribute to the cumulative total. This table includes updated estimates for East Anglia ONE following a revision to the analysis (*Appendix 13.1*).

294. Seasonal kittiwake collisions at the East Anglia THREE site only exceeded 10 during spring and autumn migration (breeding season 8, autumn migration 90, spring migration 49). Therefore the project mainly contributes to a cumulative impact during the migration periods. The collision values listed in *Table 13.46* include annual, spring and autumn period collisions. The data have been obtained from recent windfarm submissions and Natural England responses (e.g. Natural England 2013c).

295. The original assessments were conducted using a range of avoidance rates and alternative collision model Options. In order to simplify interpretation of the data across sites and also to bring these assessments up to date with the current Natural England Advice the values in *Table 13.46* are those estimated using the Band model Option 1 (or 2, if that was the one presented) at an avoidance rate of 98.9%.

Table 13.46. Cumulative Collision Risk Assessment for kittiwake. Shaded cells indicate all projects up to Tier 3.

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 98.9% avoidance rate, Band Model Option 1 or 2)					
		Annual	Annual migration Cumulative total	Spring migration	Spring migration Cumulative total	Autumn migration	Autumn migration Cumulative total
1	Beatrice Demonstrator [1/A]	4.9	4.9	1.6	1.6	2.1	2.1
1	Greater Gabbard [2/B]	27.5	32.4	11.4	13.1	15.0	17.1
1	Gunfleet Sands [2/B]	0.0	32.4	0.0	13.1	0.0	17.1
1	Kentish Flats [2/B]	0.0	32.4	0.0	13.1	0.0	17.1
1	Lincs [2/B]	2.7	35.2	0.9	14.0	1.2	18.2
1	London Array (Phase 1) [2/B]	5.5	40.7	1.8	15.9	2.3	20.5
1	Lynn and Inner Dowsing [2/B]	0.0	40.7	0.0	15.9	0.0	20.5
1	Scroby Sands [2/B]	0.0	40.7	0.0	15.9	0.0	20.5
1	Sheringham Shoal [2/B]	0.0	40.7	0.0	15.9	0.0	20.5
1	Teesside [2/B]	77.0	117.7	15.0	30.8	24.0	44.5
1	Thanet [2/B]	1.1	118.8	0.4	31.2	0.4	45.0
1	Humber Gateway [2/B]	7.7	126.5	2.6	33.7	3.2	48.1
1	Westermost Rough [2/B]	0.5	127.0	0.2	33.9	0.2	48.4
3	Beatrice [2/B]	145.2	272.2	39.8	73.7	10.7	59.1
3	Blyth (NaREC Demonstration) [2/B]	5.5	277.7	1.8	75.5	2.3	61.4
3	Dogger Bank Creyke Beck A & B [2/B]	718.3	996.0	362.4	437.9	135.1	196.5
3	Dudgeon [2/B]	0.0	996.0	0.0	437.9	0.0	196.5
3	East Anglia ONE [1/C]	314.0	1310.0	71.0	508.9	242.0	438.5
3	EOWDC (Aberdeen OWF) [2/B]	18.7	1328.7	1.1	510.0	5.9	444.4
3	Firth of Forth Alpha	715.0	2043.7	247.6	757.6	313.1	757.5

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 98.9% avoidance rate, Band Model Option 1 or 2)					
		Annual	Annual migration Cumulative total	Spring migration	Spring migration Cumulative total	Autumn migration	Autumn migration Cumulative total
	and Bravo 2 / B						
3	Galloper 2 / B	66.0	2109.7	31.8	789.5	27.8	785.3
3	Hornsea Project 1 2 / B	123.2	2232.9	24.7	814.2	53.9	839.2
3	Inch Cape 2 / B	301.4	2534.3	63.5	877.7	224.8	1064.0
3	Moray Firth (EDA) 2 / B	82.5	2616.8	35.0	912.7	3.9	1067.9
3	Neart na Goithe 2 / B	93.5	2710.3	4.4	917.1	56.6	1124.5
3	Race Bank 2 / B	31.3	2741.7	5.6	922.7	23.9	1148.4
3	Rampion 2 / B	121.0	2862.7	29.7	952.4	37.4	1185.8
3	Dogger Bank Teesside A & B 2 / B	444.4	3307.1	256.6	1209.0	90.7	1276.5
4	Triton Knoll 2 / B	209.0	3516.1	50.2	1259.2	138.9	1415.4
4	Hornsea Project 2 3 / C	340.4	3856.5	19.0	1278.2	28.0	1443.4
4	East Anglia THREE 3 / C	146.3	4002.8	49.0	1327.2	90.0	1533.4
	Total	4002.8		1327.2		1533.4	

Annual data sources: 1 = Natural England (2013c) submission for Rampion kittiwake assessment; 2 = Teesside A & B submission;3 = Developer Assessment;
Spring and Autumn data sources: A = no seasonal data, collisions apportioned equally among months; B = Teesside A & B submission; C = Developer assessment

296. On the basis of the values in *Table 13.46*, the cumulative kittiwake annual migration mortality is 4,003, of which the proposed East Anglia THREE project contributes 146. Note, however that many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. Therefore, this value is an overestimate of the total risk. All but three of the windfarms in *Table 13.46* are either operational, under construction or fully consented. The cumulative annual mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 3,516. The two tier 4 projects (excluding Triton Knoll) contribute an additional 487 to this, of which 30% is attributable to the proposed East Anglia THREE project.

297. Previous kittiwake collision assessments were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 98.9% dating from November 2014 (JNCC et al. 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 1.8 times that presented in *Table 13.46*. The only projects consented after November 2014 were Hornsea Project 1 (123 annual collisions at 98.9%), Dogger Bank Creyke Beck A&B (718 annual collisions at 98.9%) and Dogger Bank Teesside A&B (444 annual collisions at 98.9%). Therefore, the previous cumulative annual collision total (at 98%) excluding these three projects would have been 4,016 (3,516 - (123 + 718 + 444) x 1.8; note this includes the Triton Knoll estimate as the windfarm was consented in July 2013). The current cumulative total of 4,003, including all consented and still to be consented projects, is therefore below the previously accepted cumulative total.

298. Furthermore, with the recently applied update to the East Anglia ONE collision assessment (with the removal of birds on the water from the calculation the annual East Anglia ONE mortality decreased from 580 to 314 at an avoidance rate of 98.9%) the cumulative annual total decreased by 266 which is 1.8 times bigger than the contribution from the proposed East Anglia THREE project.

299. On the basis of the values in *Table 13.46*, the cumulative kittiwake spring migration mortality is 1,327, of which the proposed East Anglia THREE project contributes 49 (although many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built). All but three of the windfarms in *Table 13.46* are either operational, under construction or fully consented. The cumulative spring mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 1,259. The two tier 4 projects (excluding Triton Knoll) contribute an additional 68 to this, of which approximately 72% is attributable to the proposed East Anglia THREE project. With the recently applied correction to the East Anglia ONE collision assessment the cumulative total decreased by 219, which is 4.5 times higher than the contribution from the proposed East Anglia THREE project.

300. On the basis of the values in *Table 13.46*, the cumulative kittiwake autumn migration mortality is 1,533, of which the proposed East Anglia THREE project contributes 90 (although many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built). All but three of the windfarms in *Table 13.46* are either operational, under construction or fully consented. The cumulative

autumn mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 1,415. The two tier 4 projects (excluding Triton Knoll) contribute an additional 118 to this, of which approximately 76% is attributable to the proposed East Anglia THREE project.

301. A review of nocturnal activity in seabirds (*Appendix 13.1*) has indicated that the value currently used for this parameter (50%) to estimate collision risk at night for kittiwake is almost certainly an overestimate (i.e. study data suggest that during the breeding season 0% is more appropriate and 12% in the non-breeding season). Reducing the nocturnal activity factor to 25% reduces collision estimates by around 23% at the East Anglia THREE site (*Appendix 13.2*). A correction along these lines would reduce the overall collision estimate for all windfarms by a significant amount (e.g. between 7% and 25%; note the magnitude of reduction varies depending on the time of year and windfarm latitude due to the variation in day and night length, see *Appendix 13.1* for details). Incorporating the *minimum* mortality reduction which could be applied to all windfarm estimates on this basis (7%), the cumulative annual mortality figure decreases by 280 birds, from 4,003 to 3,723 birds. This further emphasises the precautionary nature of the current assessment.

302. Recent windfarm assessments have included use of Potential Biological Removal (PBR) to identify mortality impacts which exceed allowable thresholds during particular periods of the year (e.g. Smart Wind 2015).

303. During the autumn migration period the BDMPS for kittiwake is 829,937 and during spring is 627,816 (Furness 2015). A PBR conducted by Smart Wind (2015) on a population of 843,077 (i.e. very similar to the autumn BDMPS) indicated that even with precautionary parameters the PBR estimate of allowable mortality would exceed the cumulative collisions (e.g. at f=0.2, PBR=10,316). The same conclusion was reached on the basis of calculations conducted for a spring migration population of 639,742 (i.e. very similar to the spring BDMPS), which revealed a precautionary mortality threshold of 7,828 (f=0.2). The smallest of these seasonal thresholds (7,828) is greater than the maximum annual mortality (4,003), and this is based on a BDMPS population size which cannot be smaller than that against which the total annual collisions would be assessed. Therefore, the cumulative annual total remains below the level identified by PBR as the threshold for allowable mortality.

304. Natural England, in their Supplementary Ornithological Expert Report for Deadline VI of the Dogger Bank Creyke Beck assessment (Natural England 2014), calculated that

an annual cumulative collision total of 6,500 would not exceed a sustainable PBR threshold (with an f value 0.17). The current cumulative total of 4,003 is less than two-thirds of the total assessed by Natural England for Creyke Beck, and the PBR modelling was based on a total population of 604,385. This is smaller than either the spring BDMPS (627,816) or the autumn BDMPS (843,077). Thus, the equivalent PBR threshold would be at least 4% higher and possibly as much as 39% higher. It is clear, therefore that the update to the avoidance rate for kittiwake and the review of seabird populations (Furness 2015) has resulted in large decreases in the cumulative collision total (such that it is now less than that on which recent windfarm decisions have been based) and increases in the estimated population against which assessments are made. Taken together, the cumulative collision mortality for kittiwake is therefore not considered to be at a level likely to result in adverse effects on the population.

305. Following a request from Natural England, a population model was developed to assess the potential effects of cumulative mortality on the kittiwake BDMPS populations (*Appendix 13.4*). Two alternative sets of demographic rates were used in the modelling. The first set was obtained from a review of the available literature and the second was taken from a recent review of seabird demographic data (Horswill and Robinson 2015). Both density independent and density dependent models were developed, of which the density dependent one was concluded to provide the more realistic predictions. In all cases it is not appropriate to treat the absolute growth predictions as a reliable guide, but rather to compare simulations with and without additional impacts (sometimes referred to as counterfactual outputs). Using the density dependent model, cumulative annual mortality of 4,000 individuals (assessed against the larger autumn BDMPS population) was predicted to result in the population after 25 years being 3.3% to 4.5% smaller than that predicted in the absence of additional mortality (for parameter sets 1 and 2 respectively). Of this reduction, the contribution from the proposed East Anglia THREE project was only 3.6% (i.e. between 0.12% and 0.16% of the total). To place these predicted changes in context, over three approximate 15 year periods the British kittiwake population changed by +24% (1969 to 1985), -25% (1985 to 1998) and -61% (2000 to 2013) (http://jncc.defra.gov.uk/page-3201 accessed 26th August 2015). Changes of up to 4% within a longer (25 year) period against a background of natural changes an order of magnitude larger will almost certainly be undetectable.

306. At the BDMPS scale kittiwake is considered to be of low to medium sensitivity (*Table 13.6*), low to medium conservation value (*Table 13.7*) and the magnitude of effect described above is considered to be low to medium (*Table 13.8*).

307. In conclusion, the proposed East Anglia THREE project contributes a small amount to the cumulative effect for this species and the cumulative impacts on the kittiwake population due to annual and seasonal collisions are considered to be of low to medium magnitude, resulting in impacts of **minor to moderate** adverse significance. However, it should be noted that kittiwake collisions are expected to have been over-estimated at all windfarms due to the use of elevated nocturnal activity values (*Appendix 13.1*). Application of a precautionary 7% reduction in nocturnal activity (the minimum reduction estimated for mid-summer) would reduce the cumulative collision risk impact magnitude to low, and the impact to minor adverse significance. Furthermore, since the effect of reducing nocturnal activity has a greater effect in winter (due to the relatively greater period of night time) and over 70% of the annual mortality was predicted to occur outside the breeding season (*Table 13.46*), the overall reduction would be higher than 7% (e.g. up to 25% in midwinter, *Appendix 13.1*) and the impact magnitude smaller still.

Lesser Black-backed Gull

308. The cumulative lesser black-backed gull collision risk prediction is set out in the form of a 'tiered approach' in *Table 13.47.* This collates collision predictions from other windfarms which may contribute to the cumulative total. This table includes revised estimates for East Anglia ONE following a revision to the analysis (*Appendix 13.1*).

309. Using either Band Option 2 (at 99.5% avoidance) or Band Option 3 (at 98.9% avoidance) the total annual collisions at the East Anglia THREE site was 11 (1, 2, 6, 2 in the spring, breeding, autumn and wintering periods respectively). The collision values presented in *Table 13.47* include both annual and nonbreeding season collisions with values taken from windfarm assessments and recent cumulative assessments in other windfarm submissions. However, as very few projects provide a seasonal breakdown of collision impacts it is not possible to extract data from this period for cumulative assessment. Natural England has previously noted that an 80:20 split between the nonbreeding and breeding seasons is appropriate for this species in terms of collision estimates (Natural England 2013a). Therefore, the annual numbers in *Table 13.47* have been multiplied by 0.8 to estimate the nonbreeding component.

310. Assessments at other windfarms have been conducted using a range of avoidance rates and alternative collision model Options. In order to simplify interpretation of the data across sites and also to bring these assessments up to date with the current Natural England advice the values in *Table 13.47* are those estimated using the Band model Option 1 (or 2, if that was the one presented) at an avoidance rate of 99.5%. (Note that estimates for the Dogger Bank projects have only been presented using Band model Option 3. Therefore these values in *Table 13.47* have been converted to the Natural England advised rate for this model of 98.9%).

Table 13.47. Cumulative Collision Risk Assessment for lesser black-backed gull. Shaded cells indicate all projects up to Tier 3.

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 98.9% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Nonbreeding	Nonbreeding Cumulative total
1	Beatrice Demonstrator	0.0	0.0	0.0	0.0
1	Greater Gabbard	62.0	62.0	49.6	49.6
1	Gunfleet Sands	0.0	62.0	0.0	49.6
1	Kentish Flats	1.6	63.6	1.3	50.9
1	Lincs	8.5	72.1	6.8	57.7
1	London Array (Phase 1)	0.0	72.1	0.0	57.7
1	Lynn and Inner Dowsing	0.0	72.1	0.0	57.7
1	Scroby Sands	0.0	72.1	0.0	57.7
1	Sheringham Shoal	8.3	80.3	6.6	64.3
1	Teesside	0.0	80.3	0.0	64.3
1	Thanet	16.0	96.3	12.8	77.1
1	Humber Gateway	1.3	97.7	1.1	78.2
1	Westermost Rough	0.3	98.0	0.3	78.5
3	Beatrice	0.0	98.0	0.0	78.5
3	Blyth (NaREC Demonstration)	0.0	98.0	0.0	78.5
3	Dogger Bank Creyke Beck A & B	18.7	116.7	15.0	93.5
3	Dudgeon	76.5	193.2	61.2	154.7
3	East Anglia ONE	61.0	254.2	53.0	207.7
3	EOWDC (Aberdeen OWF)	0.0	254.2	0.0	207.7

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 98.9% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Nonbreeding	Nonbreeding Cumulative total
3	Firth of Forth Alpha and Bravo	10.5	264.7	8.4	216.1
3	Galloper	112.5	377.2	90.0	306.1
3	Hornsea Project 1	21.8	398.9	17.4	323.5
3	Inch Cape	0.0	398.9	0.0	323.5
3	Moray Firth (EDA)	0.0	398.9	0.0	323.5
3	Neart na Goithe	0.5	399.4	0.4	323.9
3	Race Bank	32.0	431.4	25.6	349.5
3	Rampion	7.9	439.3	6.3	355.8
3	Dogger Bank Teesside A & B	18.1	457.4	14.5	370.3
4	Triton Knoll	37.0	494.4	29.6	399.9
4	Hornsea Project 2	16.5	510.9	13.2	413.1
4	East Anglia THREE	11.0	521.9	9.0	422.1
	Total	521.9		422.1	

311. On the basis of the values in *Table 13.47*, the cumulative lesser black-backed gull annual mortality is 522, of which the proposed East Anglia THREE project contributes 11 (CRM Options 2 or 3). Note, however that many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. Therefore, this value is an overestimate of the total risk. All but three of the windfarms in *Table 13.47* are either operational, under construction or fully consented. The cumulative annual mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 494. The two tier 4 projects (excluding Triton Knoll) contribute an additional 27.5 to this, of which approximately 40% is attributable to the proposed East Anglia THREE project.

312. Previous lesser black-backed gull collision assessments were made on the basis of Band model Option 1 or 2 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC et al. 2014; although note that recent projects may have only presented estimates using Option 3). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality up to 4 times

that presented in *Table 13.47*. The only projects consented after November 2014 were Hornsea Project 1 (22 annual collisions at 99.5%), Dogger Bank Creyke Beck A&B (19 annual collisions at 98.9% Option 3) and Dogger Bank Teesside A&B (18 annual collisions at 98.9% Option 3). Therefore, the previous cumulative collision total (at 98%) excluding these three projects would have been 1,740 ((494 - (22 + 19 + 18)) x 4; note this includes the Triton Knoll estimate as the windfarm was consented in July 2013). The current cumulative total of 522, including all consented and still to be consented projects, is therefore much lower than the previously accepted cumulative total. Indeed, even if all of the previous consents had been granted on the basis of an avoidance rate of 99% this would still be much higher than the current cumulative prediction.

313. It is of note that, with the recently applied update to the East Anglia ONE collision assessment the cumulative annual total decreased by 37 which is 3.4 times bigger than the contribution from the proposed East Anglia THREE project (following removal of birds on the water from the calculation, the annual East Anglia ONE mortality decreased from 98 to 61 at an avoidance rate of 99.5%, CRM Option 1).

314. On the basis of the nonbreeding season values in *Table 13.47*, the cumulative lesser black-backed gull nonbreeding mortality is 422, of which the proposed East Anglia THREE project contributes 9, although many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. All but three of the windfarms in *Table 13.47* are either operational, under construction or fully consented. The cumulative nonbreeding season mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 400. The two tier 4 projects (excluding Triton Knoll) contribute an additional 22 to this, of which approximately 41% is attributable to the proposed East Anglia THREE project.

315. Previous lesser black-backed gull collision assessments were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC et al. 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 4 times that presented in *Table 13.47*. The only projects consented after November 2014 were Hornsea Project 1 (17 nonbreeding collisions at 99.5%), Dogger Bank Creyke Beck A&B (15 nonbreeding collisions at 98.9% Option 3) and Dogger Bank Teesside A&B (14 nonbreeding collisions at 98.9% Option 3). Therefore, the previous cumulative

nonbreeding collision total (at 98%) excluding these three projects would have been 1,416 (400 - (17 + 15 + 14) x 4; note this includes the Triton Knoll estimate as the windfarm was consented in July 2013). The cumulative total of 422, including all consented and still to be consented projects, is therefore much lower than the previously accepted cumulative total. Indeed, even if all of the previous consents were granted on the basis of an avoidance rate of 99% this would still be nearly double the current cumulative prediction.

316. The Examining Authorities Recommendation Report for the Rampion Offshore Windfarm (Planning Inspectorate 2014a) presents a cumulative mortality for lesser black-backed gull of between 1,873 (applicant's estimate) and 2,072 (Natural England's estimate), against a lower PBR threshold of 6,318. The current annual cumulative total of 522 is considerably below these levels. Therefore, the cumulative collision mortality for lesser black-backed gull is not considered to be at a level likely to result in adverse effects on the population.

317. A review of nocturnal activity in seabirds (*Appendix 13.1*) has indicated that the value currently used for this parameter (50%) to estimate collision risk at night for lesser black-backed gull is almost certainly an overestimate, possibly by as much as a factor of 2 (i.e. study data suggest that 25% is more appropriate). Reducing the nocturnal activity factor to 25% reduces collision estimates at the East Anglia THREE site by around 15% (*Appendix 13.2*). A correction along these lines would reduce the overall collision estimate for all windfarms by a significant amount (e.g. between 7% and 25%; note the magnitude of reduction varies depending on the time of year and windfarm latitude due to the variation in day and night length, see *Appendix 13.1* for details). Incorporating the *minimum* mortality reduction which could be applied to all windfarm estimates on this basis (7%), the cumulative annual mortality figure decreases by 36 birds, from 522 to 486 birds. This further emphasises the precautionary nature of the current assessment.

318. Furthermore, with the recently applied update to the East Anglia ONE collision assessment (with the removal of birds on the water from the calculation the annual East Anglia ONE mortality decreased from 98 to 61 at an avoidance rate of 99.5%) the cumulative annual total decreases by 37 which is 3.4 times bigger than the contribution from the proposed East Anglia THREE project.

319. In conclusion, the cumulative impact on the lesser black-backed gull population due to collisions both year round and during the nonbreeding season is considered to be

of low magnitude, and the relative contribution of the proposed East Anglia THREE project to this cumulative total is very small. The impact significance is **minor** adverse**.**

Herring Gull

320. The cumulative herring gull collision risk prediction is set out in the form of a ‘tiered approach’ in *Table 13.48.* This collates collision predictions from other windfarms which may contribute to the cumulative total. This table includes revised estimates for East Anglia ONE following a revision to the analysis (*Appendix 13.1*).

321. Using the Band Option 2 (at 99.5% avoidance) or Band Option 3 (at 99% avoidance) the nonbreeding season estimates were 26 and 25 respectively. The collision values presented in *Table 13.48* include both annual and nonbreeding season collisions with values taken from windfarm assessments and recent cumulative assessments in other windfarm submissions. However, as very few projects provide a seasonal breakdown of collision impacts it is not possible to extract data from this period for cumulative assessment. Natural England has previously noted that an 80:20 split between the nonbreeding and breeding seasons is appropriate for lesser black-backed gull in terms of collision estimates (Natural England (2013)). This ratio is considered to also be appropriate for herring gull (which remains in UK waters in winter to a greater extent than does lesser black-backed gull), therefore the annual numbers in *Table 13.48* have been multiplied by 0.8 to estimate the nonbreeding component.

322. Collision values have been extracted from windfarm assessments. These assessments were conducted using a range of avoidance rates and alternative collision model Options. In order to simplify interpretation of the data across sites and also to bring these assessments up to date with the current Natural England advice, the values in *Table 13.48* are those estimated using the Band model Option 1 (or 2, if that was the one presented) at an avoidance rate of 99.5%. (Note that estimates for the Dogger Bank projects have only been presented using Band model Option 3. Therefore, these values in *Table 13.48* have been converted to the Natural England advised rate for this model of 98.9%).

Table 13.48. Cumulative Collision Risk Assessment for herring gull. Shaded cells indicate all projects up to Tier 3.

	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 99.5% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Nonbreeding	Nonbreeding Cumulative total
1	Beatrice Demonstrator	0.0	0.0	0.0	0.0
1	Greater Gabbard	0.0	0.0	0.0	0.0
1	Gunfleet Sands	0.0	0.0	0.0	0.0
1	Kentish Flats	2.2	2.2	1.7	1.7
1	Lincs	0.0	2.2	0.0	1.7
1	London Array (Phase 1)	0.0	2.2	0.0	1.7
1	Lynn and Inner Dowsing	0.0	2.2	0.0	1.7
1	Scroby Sands	0.0	2.2	0.0	1.7
1	Sheringham Shoal	0.0	2.2	0.0	1.7
1	Teesside	43.2	45.3	34.5	36.3
1	Thanet	24.5	69.8	19.6	55.9
1	Humber Gateway	1.3	71.2	1.1	56.9
1	Westermost Rough	0.1	71.2	0.1	57.0
3	Beatrice	246.8	318.0	197.4	254.4
3	Blyth (NaREC Demonstration)	2.7	320.7	2.2	256.5
3	Dogger Bank Creyke Beck A & B	0.0	320.7	0.0	256.5
3	Dudgeon	0.0	320.7	0.0	256.5
3	East Anglia ONE	41.0	361.7	38.0	294.5
3	EOWDC (Aberdeen OWF)	4.8	366.4	3.8	298.3
3	Firth of Forth Alpha and Bravo	31.0	397.4	24.8	323.1
3	Galloper	27.2	424.7	21.8	344.9
3	Hornsea Project 1	14.5	439.2	11.6	356.5
3	Inch Cape	13.5	452.7	10.8	367.3
3	Moray Firth (EDA) [C]	52.0	504.7	41.6	408.9
3	Neart na Goithe	17.8	522.4	14.2	423.1
3	Race Bank	0.0	522.4	0.0	423.1

	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 99.5% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Nonbreeding	Nonbreeding Cumulative total
3	Rampion	155.0	677.4	124.0	547.1
3	Dogger Bank Teesside A & B	0.0	677.4	0.0	547.1
4	Triton Knoll	0.0	677.4	0.0	547.1
4	Hornsea Project 2	23.8	701.2	19.0	566.1
4	East Anglia THREE	25.0	726.2	25.0	591.1
	Total	726.2		591.1	

323. On the basis of the values in *Table 13.48*, the cumulative herring gull annual mortality is 726, of which the proposed East Anglia THREE project contributes 25 (CRM Option 2). Note, however that many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. Therefore, this value is an overestimate of the total risk. All but three of the windfarms in *Table 13.48* are either operational, under construction or fully consented. The cumulative annual mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 677. The two tier 4 projects (excluding Triton Knoll) contribute an additional 49 to this, of which approximately 51% is attributable to the proposed East Anglia THREE project.

324. Previous herring gull collision assessments were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC et al. 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 4 times that presented in *Table 13.48*. The only projects consented after November 2014 were Hornsea Project 1 (14 annual collisions at 99.5%), Dogger Bank Creyke Beck A&B (0 annual collisions at 98.9% Option 3) and Dogger Bank Teesside A&B (0 annual collisions at 98.9% Option 3). Therefore, the previous cumulative collision total (at 98%) excluding these three projects would have been 2,652 (677 - (14) x 4; note this includes the Triton Knoll estimate as the windfarm was consented in July 2013). The current cumulative total of 726, including all consented and still to be consented projects, is therefore much lower than the previously accepted cumulative total. Indeed, even if all of the

previous consents had been granted on the basis of an avoidance rate of 99% this would still be nearly double the current cumulative prediction.

325. Furthermore, with the recently applied update to the East Anglia ONE collision assessment (with the removal of birds on the water from the calculation the annual East Anglia ONE mortality decreased from 57 to 41 at an avoidance rate of 99.5%) the cumulative annual total decreased by 16 which is more than half the contribution from the proposed East Anglia THREE project.

326. On the basis of the nonbreeding season values in *Table 13.48*, the cumulative herring gull nonbreeding mortality is 591, of which the proposed East Anglia THREE project contributes 25. Note, however that many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. All but three of the windfarms in *Table 13.48* are either operational, under construction or fully consented. The cumulative nonbreeding mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 547. The two tier 4 projects (excluding Triton Knoll) contribute an additional 44 to this, of which approximately 57% is attributable to the proposed East Anglia THREE project.

327. Previous herring gull collision assessments were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC et al. 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 4 times that presented in *Table 13.48*. The only projects consented after November 2014 were Hornsea Project 1 (12 nonbreeding collisions at 99.5%), Dogger Bank Creyke Beck A&B (0 nonbreeding collisions at 98.9% Option 3) and Dogger Bank Teesside A&B (0 nonbreeding collisions at 98.9% Option 3). Therefore, the previous cumulative nonbreeding collision total (at 98%) excluding these two projects would have been 2,140 (547 - (12) x 4; note this includes the Triton Knoll estimate as the windfarm was consented in July 2013). The cumulative total of 591, including all consented and still to be consented projects, is therefore much lower than the previously accepted cumulative total. Indeed, even if all of the previous consents had been granted on the basis of an avoidance rate of 99% this would still be nearly double the current cumulative prediction.

328. A review of nocturnal activity in seabirds (*Appendix 13.1*) has indicated that the value currently used for this parameter (50%) to estimate collision risk at night for herring gull is almost certainly an overestimate, possibly by as much as a factor of 2

(i.e. study data suggest that 25% is more appropriate). Reducing the nocturnal activity factor to 25% reduces collision estimates at the East Anglia THREE site by around 24% (*Appendix 13.2*). A correction along these lines would reduce the overall collision estimate for all windfarms by a significant amount (e.g. between 7% and 25%; note the magnitude of reduction varies depending on the time of year and windfarm latitude due to the variation in day and night length, see *Appendix 13.1* for details). Incorporating the *minimum* mortality reduction which could be applied to all windfarm estimates on this basis (7%), the cumulative annual mortality figure decreases by 51 birds, from 726 to 675 birds. This further emphasises the precautionary nature of the current assessment.

329. The Examining Authority's Recommendation Report for the Hornsea Project One windfarm (Planning Inspectorate 2014b) presents cumulative collision mortality for herring gull of 1,890 to 2,247 (applicant, building block and all projects respectively) and 1,993 (RSPB), while Natural England presented a value of 2,236 (Natural England 2014b). All of these cumulative totals were assessed as being not significant on the grounds they were considerably lower than precautionary PBR thresholds (5,083 to 15,248 for f values of 0.1 to 0.3). The BDMPS on which this was based has since been updated to a lower estimate (from 1,086,140 to 466,511, Furness 2015). It is straightforward to adjust the PBR values for this population estimate (by multiplying by the ratio of the two population estimates: 0.429) which gives a revised PBR range of 2,183 to 6,549. As the current cumulative herring gull mortality is 726 it is clear that the conclusion of no risk of a significant effect, reached by Natural England (2014b) and the Planning Inspectorate (2014) in relation to the cumulative total presented for the Hornsea Project One windfarm, remains applicable.

330. In conclusion, the cumulative impact on the herring gull population due to collisions both year round and during the nonbreeding season is considered to be of low magnitude, and the relative contribution of the proposed East Anglia THREE project to this cumulative total is very small indeed. The impact significance is **minor** adverse**.**

Great black-backed Gull

331. The cumulative great black-backed gull collision risk prediction is set out in the form of a 'tiered approach' in *Table 13.49.* This collates collision predictions from other windfarms which may contribute to the cumulative total. This table includes revised estimates for East Anglia ONE following a revision to the analysis (*Appendix 13.1*).

332. Using the Band Option 2 CRM, the total annual mortality at the East Anglia THREE site was 42 (at 99.5% avoidance)(breeding season 7, nonbreeding season 48), while the equivalent annual estimate was 46 using Band Option 3 (at 98.9% avoidance). The collision values presented in *Table 13.49* include both annual and nonbreeding season collisions with values taken from windfarm assessments and recent cumulative assessments in other windfarm submissions. However, as very few projects provide a seasonal breakdown of collision impacts it is not possible to extract data from this period for cumulative assessment. Natural England has previously noted that an 80:20 split between the nonbreeding and breeding seasons is appropriate for lesser black-backed gull in terms of collision estimates (Natural England (2013)). This ratio is considered to also be appropriate for great black-backed gull, therefore the annual numbers in *Table 13.49* have been multiplied by 0.8 to estimate the nonbreeding component.

333. Collision values have been extracted from windfarm assessments. These assessments were conducted using a range of avoidance rates and alternative collision model Options. In order to simplify interpretation of the data across sites and also to bring these assessments up to date with the current Natural England advice, the values in *Table 13.49* are those estimated using the Band model Option 1 (or 2, if that was the one presented) at an avoidance rate of 99.5%. (Note that estimates for the Dogger Bank projects have only been presented using Band model Option 3. Therefore these values in *Table 13.49* have been converted to the Natural England advised rate for this model of 98.9%).

Table 13.49. Cumulative Collision Risk Assessment for great black-backed gull. Shaded cells indicate all projects up to Tier 3.

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 99.5% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Nonbreeding	Nonbreeding Cumulative total
1	Beatrice Demonstrator	0.0	0.0	0.0	0.0
1	Greater Gabbard	75.0	75.0	60.0	60.0
1	Gunfleet Sands	0.0	75.0	0.0	60.0
1	Kentish Flats	0.3	75.3	0.2	60.2
1	Lincs	0.0	75.3	0.0	60.2
1	London Array (Phase 1)	0.0	75.3	0.0	60.2
1	Lynn and Inner Dowsing	0.0	75.3	0.0	60.2
1	Scroby Sands	0.0	75.3	0.0	60.2
1	Sheringham Shoal	0.0	75.3	0.0	60.2
1	Teesside	43.6	118.8	34.8	95.1
1	Thanet	0.5	119.3	0.4	95.5
1	Humber Gateway	6.3	125.7	5.1	100.5
1	Westermost Rough	0.2	125.8	0.1	100.7
3	Beatrice	151.0	276.8	120.8	221.5
3	Blyth (NaREC Demonstration)	6.3	283.2	5.1	226.5
3	Dogger Bank Creyke Beck A & B	29.1	312.3	23.3	249.9
3	Dudgeon	0.0	312.3	0.0	249.9
3	East Anglia ONE	71.0	383.3	70.0	319.9
3	EOWDC (Aberdeen OWF)	3.0	386.3	2.4	322.3
3	Firth of Forth Alpha and Bravo	66.8	453.1	53.4	375.7
3	Galloper	26.0	479.1	20.8	396.5
3	Hornsea Project 1	85.8	564.8	68.6	465.1
3	Inch Cape	36.8	601.6	36.8	501.8
3	Moray Firth (EDA)	139.0	740.6	25.5	527.3
3	Neart na Goithe	4.5	745.1	3.6	530.9
3	Race Bank	0.0	745.1	0.0	530.9

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 99.5% avoidance rate, Band Model Option 1 or 2)			
		Annual	Annual Cumulative total	Nonbreeding	Nonbreeding Cumulative total
3	Rampion	26.0	771.1	20.8	551.7
3	Dogger Bank Teesside A & B	31.9	803.0	25.5	577.2
4	Triton Knoll	140.8	943.8	112.6	689.8
4	Hornsea Project 2	62.7	1006.5	50.2	740.0
4	East Anglia THREE	42.0	1048.5	37.0	777.0
	Total	1048.5		777.0	

334. On the basis of the values in *Table 13.49*, the cumulative great black-backed gull annual mortality is 1,048, of which the proposed East Anglia THREE project contributes 42. Note, however that many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. Therefore, this value is an overestimate of the total risk. All but three of the windfarms in *Table 13.45* are either operational, under construction or fully consented. The cumulative annual mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 944. The two tier 4 projects (excluding Triton Knoll) contribute an additional 105 to this, of which approximately 40% is attributable to the proposed East Anglia THREE project.

335. Previous great black-backed gull collision assessments were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC et al. 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 4 times that presented in *Table 13.49*. The only projects consented after November 2014 were Hornsea Project 1 (86 annual collisions at 99.5%), Dogger Bank Creyke Beck A&B (29 annual collisions at 98.9% Option 3) and Dogger Bank Teesside A&B (32 annual collisions at 98.9% Option 3). Therefore, the previous cumulative collision total (at 98%) excluding these three projects would have been 3,188 (944 - (86 + 29 + 32) x 4; note this includes the Triton Knoll estimate as the windfarm was consented in July 2013). The current cumulative total of 1,048, including all consented and still to be consented projects, is therefore much lower than the previously accepted cumulative total. Indeed, even if all of the previous consents had been granted on

the basis of an avoidance rate of 99% this would still be nearly 1.5 times the current cumulative prediction.

336. Furthermore, with the recently applied update to the East Anglia ONE collision assessment (with the removal of birds on the water from the calculation the annual East Anglia ONE mortality decreased from 124 to 71 at an avoidance rate of 99.5%) the cumulative annual total decreased by 53 which is higher than the number estimated for the proposed East Anglia THREE project.

337. On the basis of the nonbreeding season values in *Table 13.49*, the cumulative great black-backed gull nonbreeding mortality is 777, of which the proposed East Anglia THREE project contributes 37. Note, however that many of the collision estimates were calculated for larger windfarms than have been built or are planned to be built. All but three of the windfarms in *Table 13.49* are either operational, under construction or fully consented. The cumulative autumn mortality for these windfarms (up to tier 3, but including Triton Knoll as the windfarm was consented in 2013) is 690. The two tier 4 projects contribute an additional 87 to this, of which approximately 42% is attributable to the proposed East Anglia THREE project.

338. Previous great black-backed gull collision assessments were made on the basis of Band model Option 1 and an avoidance rate of 98%, with the change to 99.5% dating from November 2014 (JNCC et al. 2014). Therefore, projects consented prior to this date were on the basis of a cumulative collision mortality 4 times that presented in *Table 13.49*. The only projects consented after November 2014 were Hornsea Project 1 (69 nonbreeding collisions at 99.5%), Dogger Bank Creyke Beck A&B (23 nonbreeding collisions at 98.9% Option 3) and Dogger Bank Teesside A&B (25 nonbreeding collisions at 98.9% Option 3). Therefore, the previous cumulative nonbreeding collision total (at 98%) excluding these three projects would have been 2,292 (690 - (69 + 23 +25) x 4; note this includes the Triton Knoll estimate as the windfarm was consented in July 2013). The cumulative total of 777, including all consented and still to be consented projects, is therefore much lower than the previously accepted cumulative total. Indeed, even if all of the previous consents were granted on the basis of an avoidance rate of 99% this would still be nearly double the current cumulative prediction.

339. A review of nocturnal activity in seabirds (*Appendix 13.1*) has indicated that the value currently used for this parameter (50%) to estimate collision risk at night for great black-backed gull is almost certainly an overestimate, possibly by as much as a

factor of 2 (i.e. study data suggest that 25% is more appropriate). Reducing the nocturnal activity factor to 25% reduces collision estimates at the East Anglia THREE site by around 22% (*Appendix 13.2*). A correction along these lines would reduce the overall collision estimate for all windfarms by a significant amount (e.g. between 7% and 25%; note the magnitude of reduction varies depending on the time of year and windfarm latitude due to the variation in day and night length, see *Appendix 13.1* for details). Incorporating the *minimum* mortality reduction which could be applied to all windfarm estimates on this basis (7%), the cumulative annual mortality figure decreases by 73 birds, from 1,048 to 975 birds. This further emphasises the precautionary nature of the current assessment.

340. In the decision for the Rampion windfarm (Planning Inspectorate 2014a, DECC 2014), the cumulative collision mortality for great black-backed gull was considered. In their recommendations to the Secretary of State (Planning Inspectorate 2014a), the Examining Authority (ExA) reported the cumulative mortality for this species as either 1,803 individuals per year (Applicant's estimate) or 3,025 (Natural England's estimate). The difference in these two values remained unresolved between the applicant and Natural England, however the ExA (Planning Inspectorate 2014a) concluded:

'that the addition of Rampion OWF does not tip the balance in terms of exceeding a threshold that would not otherwise be exceeded.'

341. The threshold referred to in the above quote was the PBR value for this species, estimated as between 832 and 2,495 for recovery factor (f) values of 0.1 and 0.3. The current cumulative mortality of 1,065 (*Table 13.49*) is lower than either of the cumulative totals reported for Rampion (1,803 and 3,025), is much lower than the realistic PBR threshold estimated using an f value of 0.3 (2,495) and is not much higher than the PBR threshold estimated using a highly precautionary f value of 0.1 (832).

342. Overall, therefore the increase in the avoidance rate for this species has resulted in a large reduction in the cumulative total to the extent that the current estimate is much lower than those on which it has been concluded there will be no effect on the population in the long term (DECC 2014).

343. In conclusion, the cumulative impact on the great black-backed gull population due to collisions both year round and during the nonbreeding season is considered to be

of low magnitude, and the relative contribution of the proposed East Anglia THREE project to this cumulative total is very small. The impact significance is **minor** adverse**.**

13.9 Transboundary Impacts

344. Consultation with other EU Member States surrounding the North Sea basin resulted in only one response that raised a potential concern over transboundary impacts on ornithology receptors. This was the response from Rijkswaterstaat (RWS) in the Netherlands. They expressed concern over the potential for impact on the non-breeding seabirds that are the interest feature of the Bruine Bank (Brown Ridge) pSPA due to its relative proximity to the East Anglia THREE site. Their view was that they did not expect a direct effect of the construction, operation or decommissioning of the East Anglia THREE site on the birds in the Bruine Bank (Brown Ridge) pSPA but that these issues should be included in the EIA (comments received in a letter dated 7th July 2014).

345. The non-breeding seabirds that are the interest feature of the Bruine Bank (Brown Ridge) pSPA are primarily auks. An assessment of potential impacts on auks has been conducted as part of this EIA, specifically in *sections 13.7.1.1* and *13.7.2.1* in relation to construction and operational disturbance and displacement. In all cases impacts were found to be **minor** adverse or **negligible** (based on BDMPS populations in UK North Sea waters). Assessment of impacts over the whole North Sea would greatly increase the estimated seabird population sizes and only slightly increase cumulative impacts (because most offshore windfarms are in UK waters). Accordingly a significant effect on the Bruine Bank (Brown Ridge) pSPA is not predicted.

346. The only seabirds for which breeding populations in other Member States may fall within the maximum foraging range to the East Anglia THREE site are gannet, fulmar and lesser black-backed gull.

347. Gannets at Helgoland are within the 590km maximum foraging range (Thaxter et al. 2012), but Helgoland is not an SPA for breeding gannets. More importantly, this is a relatively small gannet colony, and tracking studies suggest that breeding gannets from Helgoland do not normally commute into UK waters while breeding but tend to remain within the German Bight (S. Garthe, pers. comm.). Gannets at colonies in the Channel Islands are also within 590km of the East Anglia THREE site. The

Channel Islands colonies are not SPA populations, but more importantly the adults from these colonies do not normally commute into the North Sea while breeding (Warwick-Evans et al. 2015; J.A. Green, pers. comm.) and therefore show no connectivity with the proposed development.

348. The maximum foraging range of fulmars is 580km (Thaxter et al. 2012), which means that fulmar colonies in Germany (principally Helgoland), and northern France are theoretically within potential range from the East Anglia THREE site. However, fulmar breeding numbers in Germany (tens of pairs) and northern France (tens of pairs) are very small, are not designated breeding features of any SPAs, and in practice are very unlikely to show connectivity with the East Anglia THREE site.

349. Lesser black-backed gulls breed in large numbers in The Netherlands (between 32,000 and 57,000 pairs were estimated to breed in The Netherlands in 1992-97 (Mitchell et al. 2004) and the numbers subsequently increased to a peak of over 90,000 pairs in 2005 (Camphuysen 2013)). With a maximum foraging range of 181km from breeding colonies (Thaxter et al. 2012), some colonies in The Netherlands lie within a 181km radius from the East Anglia THREE site so could theoretically show connectivity. However, extensive colour ringing and tracking of breeding lesser black-backed gulls from multiple colonies in The Netherlands has shown that there is no connectivity during the breeding season between birds breeding in those colonies and the UK, and indeed that there is remarkably little migration of birds from the colonies in The Netherlands through UK waters even after the breeding season in autumn, winter or spring (Camphuysen 2013). Not only do breeding adult lesser black-backed gulls from colonies in The Netherlands normally remain on the continental side of the North Sea while breeding, but 95% of their foraging trips are less than 135km from those colonies (Camphuysen 1995, 2013), so could not reach the East Anglia THREE site. These studies therefore rule out any transboundary impacts of the proposed East Anglia THREE project on any of these breeding lesser black-backed gull populations.

13.10 Inter-relationships

350. The construction, operation and decommissioning phases of the proposed East Anglia THREE project would cause a range of effects on offshore ornithological interests. The magnitude of these effects has been assessed individually above in section 13.7 using expert judgement, drawing from a wide science base that includes

project-specific surveys and previously acquired knowledge of the bird ecology of the North Sea.

351. These effects have the potential to form an inter-relationship and directly impact the terrestrial and seabird receptors and have the potential to manifest as sources for impacts upon receptors other than those considered within the context of offshore ornithology.

352. As none of the offshore impacts to birds were assessed individually to have any greater than a minor adverse impact it is considered unlikely that they would inter-relate to form an overall significant impact on Offshore Ornithology.

353. In terms of how impacts to offshore ornithological interests may form inter-relationships with other receptor groups, assessments of significance are provided in the chapters listed in the third column of *Table 13.50*. In addition, the table shows where other chapters have been used to inform the offshore ornithology inter-relationships assessment.

Table 13.50 Chapter topic inter-relationships

Topic and description	Related Chapter (informing this chapter)	Related Chapter (Chapters informed by this chapter)	Where addressed in this Chapter
Indirect impacts through effects on habitats and prey during construction	10 – Benthic ecology 11 – Fish and shellfish ecology		Section 13.7.1
Indirect impacts through effects on habitats and prey during operation	10 – Benthic ecology 11 – Fish and shellfish ecology		Section 13.7.2
Indirect impacts through effects on habitats and prey during decommissioning	10 – Benthic ecology 11 – Fish and shellfish ecology		Section 13.7.3

13.11 Summary

354. This chapter describes the offshore components of the proposed project; the consultation that has been held with stakeholders; the scope and methodology of

the assessment; the avoidance and mitigation measures that have been embedded through project design; the baseline data on birds and important sites and habitats for birds acquired through desk study and survey (*Appendix 13.2. East Anglia THREE Offshore Ornithology Baseline Technical Report*); and assesses the potential impacts on birds.

355. Detailed consultation and iteration of the overall approach to the impact assessment on ornithology receptors was conducted through the Evidence Plan process for the proposed East Anglia THREE project. An Ornithology Expert Technical Group was convened which involved Natural England and the Royal Society for the Protection of Birds (RSPB) for the offshore ornithology discussions. The Schedule of Agreement and Non-agreement produced as part of the minutes to the Ornithology Expert Technical Group of the Evidence Plan is provided in *Appendix 13.1* and is summarised in the consultation section of this chapter (*section 13.2*).

356. A study area was defined that was relevant to the consideration of potential impacts on offshore ornithological receptors. The study area was agreed as adequate for the purpose of an environmental impact assessment with Natural England and the RSPB in EPM1 (*Appendix 13.1*). This study area includes the East Anglia THREE site and a 4km buffer placed around it within which a series of high resolution aerial surveys were conducted over two years (24 consecutive months) to define the abundance and assemblage of birds using or passing across the area. In addition to the area subject to aerial survey, the offshore cable corridor to the Mean Low Water Spring (MLWS) at its landfall location at Bawdsey has been included within this assessment.

357. Birds were screened in for assessment taking into account their abundance on the windfarm site and their potential sensitivity to windfarm development.

358. The impacts that could potentially arise during the construction, operation and decommissioning of the proposed East Anglia THREE project were discussed with Natural England and the RSPB as part of the Evidence Plan process (*Appendix 13.1*). As a result of those discussions it was agreed that the potential impacts that required detailed assessment were:

In the Construction Phase

- Impact 1: Disturbance / displacement; and
- Impact 2: Indirect impacts through effects on habitats and prey species.

In the Operational Phase

- Impact 3: Disturbance / displacement;
- Impact 4: Indirect impacts through effects on habitats and prey species;
- Impact 5: Collision risk; and
- Impact 6: Barrier effect.

In the Decommissioning Phase

- Impact 7: Disturbance / displacement; and
- Impact 8: Indirect impacts through effects on habitats and prey species.

359. During the construction phase of the proposed project no impacts have been assessed to be greater than of minor adverse significance for any bird species. Similarly, no species is subject to an impact of greater than minor adverse significance from the potential effects of the proposed project during the 25 year operational lifetime.

360. Displacement effects on red-throated divers, gannets, guillemots, razorbills and puffins would not create impacts of more than minor adverse significance during any biological season.

361. The risk to birds from collisions with wind turbines from the proposed East Anglia THREE project alone is assessed as no greater than minor adverse significance for all species when considered for all biological seasons against the most appropriate population scale.

362. Potential plans and projects have been considered for how they might act cumulatively with the proposed project and a screening process carried out.

363. The cumulative assessment identified that most impacts would be temporary, small scale and localised. Given the distances to other activities in the region (e.g. other offshore windfarms and aggregate extraction) and the highly localised nature of the impacts above it concluded that there is no pathway for interaction between most impacts cumulatively, which were screened out.

364. In the offshore environment only other windfarms that were operational, under construction, consented but not constructed, subject to current applications, subject to consultation or listed in the future plans by developers were screened in. This list of windfarms with their status is provided in *Table 13.38*.

365. The cumulative collision risk impact and displacement impact assessment follows the tiered approach in its presentation of mortality predictions for the identified projects. The risk to birds from cumulative collisions with wind turbines across all windfarms considered is assessed as no greater than minor adverse significance for all species with the exception of kittiwake, for which a minor to moderate adverse significant impact is predicted.

366. The identified potential impacts are summarised in *Table 13.51*.

Table 13.51 Potential Impacts Identified for Offshore Ornithology Receptors

Potential Impact	Receptor	Value / Sensitivity	Magnitude	Significance
Construction				
Impact 1: Disturbance and Displacement	Red-throated diver	Regional / Very High	Negligible	Minor
	Guillemot	Regional / Low to Medium	Negligible	Negligible
	Razorbill	Regional / Low to Medium	Negligible	Negligible
	Puffin	Regional / Low to Medium	Negligible	Negligible
Impact 2: Indirect impacts through effects on habitats and prey species	Gannets and auks	Regional / Low	Negligible	Negligible to Minor
Operation				
Impact 3: Disturbance and Displacement	Red-throated diver	Regional / Very High	Negligible	Minor
	Gannet	Regional / Low	Negligible	Negligible
	Guillemot (Breeding)	Regional / Low to Medium	Negligible	Negligible
	Guillemot (Nonbreeding)	Local / Low to Medium	Negligible	Negligible
	Guillemot (Annual)	Local / Low to Medium	Negligible	Negligible
	Razorbill (Breeding)	Regional / Low to Medium	Negligible	Negligible
	Razorbill (Autumn migration)	Regional / Low to Medium	Negligible	Negligible
	Razorbill (Midwinter)	Regional / Low to Medium	Negligible	Negligible

Potential Impact	Receptor	Value / Sensitivity	Magnitude	Significance
	Razorbill (Spring migration)	Regional / Low to Medium	Negligible	Negligible
	Razorbill (Annual)	Regional / Low to Medium	Negligible	Negligible
	Puffin (Breeding)	Regional / Low to Medium	Negligible	No Impact
	Puffin (Nonbreeding)	Regional / Low to Medium	Negligible	No Impact
Impact 4: Indirect impacts through effects on habitats and prey species	Seabirds	Regional / Low	Negligible	Negligible to Minor
Impact 5: Collision Risk	Fulmar	Local / Negligible	Negligible	No Impact
	Gannet (Spring Migration / Breeding)	Regional / Medium	Negligible	Negligible
	Gannet (Autumn Migration)	Regional / Medium	Negligible	Negligible
	Kittiwake (Spring Migration)	Regional / Medium	Negligible	Negligible
	Kittiwake (Breeding)	Regional / Medium	Negligible	Negligible
	Kittiwake (Autumn Migration)	Regional / Medium	Negligible	Minor
	Lesser black-backed gull (Spring Migration)	Local / Medium	Negligible	No Impact
	Lesser black-backed gull (Breeding)	Local / Medium	Negligible	Negligible
	Lesser black-backed gull (Autumn Migration)	Local / Medium	Negligible	Minor
	Lesser black-backed gull (Wintering)	Local / Medium	Negligible	Negligible
	Herring gull (Breeding)	Local / Medium	Negligible	No Impact

Potential Impact	Receptor	Value / Sensitivity	Magnitude	Significance
	Herring gull (nonbreeding)	Local / Medium	Negligible	Negligible
	Great black-backed gull (Breeding)	Local / Medium	Negligible	Negligible
	Great black-backed gull (nonbreeding)	Local / Medium	Negligible	Minor
	Migrant seabirds	International / Low to High	No Change	No Impact
	Migrant non-seabirds	International / Low to High	No Change	No Impact
Impact 6: Barrier Effect	All birds	Local to Regional	No Change	Negligible
Decommissioning				
Impact 7: Disturbance and Displacement	All birds	n/a	No Changes	Negligible to Minor
Impact 8: Indirect impacts through effects on prey species	Gannets and auks	Regional / Low	Negligible	Negligible to Minor
Cumulative				
Cumulative Impact 1: Operational Disturbance and Displacement	Red-throated diver	Regional / Very High	Negligible	Minor
	Gannet	Regional / Medium	Negligible	Negligible
	Guillemot	Regional / Low to Medium	Negligible	Negligible
	Razorbill	Regional / Low to Medium	Negligible	Negligible
	Puffin	Regional / Low to Medium	Negligible	Negligible
Cumulative Impact 2: Collision Risk	Gannet (annual / autumn migration)	Regional / Medium	Negligible	Minor

Potential Impact	Receptor	Value / Sensitivity	Magnitude	Significance
	Kittiwake (annual / Spring / Autumn)	Regional / Medium	Low to Medium	Minor to Moderate
	Lesser black-backed gull (annual / nonbreeding)	Local / Medium	Negligible	Minor
	Herring gull (annual / nonbreeding)	Local / Medium	Negligible	Minor
	Great black-backed gull (annual / nonbreeding)	Local / Medium	Negligible	Minor

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Chapter 13 Ends Here