East Anglia ONE

Offshore Windfarm

Environmental Statement

Volume 2 Offshore

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Chapter 12

Ornithology (Marine and Coastal)

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12 Ornithology (Marine and Coastal)

12.1 Introduction

1 This chapter was compiled by APEM Ltd. and assesses the impacts of the East Anglia ONE offshore windfarm (referenced as the East Anglia ONE site) and offshore cable corridor on marine and coastal ornithology.

2 This chapter is supported by the following appendices:

- *Volume 5, Appendix 12.1 – Ornithology Baseline Technical Report;*
- *Volume 5, Appendix 12.2 – Migration Modelling Report;*
- *Volume 5, Appendix 12.3 – East Anglia ONE Boat v Aerial Species List;*
- *Volume 5, Appendix 12.4 – Collision risk modelling outputs by season; and*
- *Volume 5, Appendix 12.5 – Collision Risk Models for all Bird Species.*

3 Along with the following figures:

- *Volume 6, Figure 12.1* – Special Protection Areas (SPAs) on the east coast;
- *Volume 6, Figure 12.2* – Special Protection Areas on the south and west coast;
- *Volume 6, Figure 12.3* – RSPB tagging data for lesser black-backed gulls at the Alde-Ore Estuary;
- *Volume 6, Figure 12.4* – RSPB tagging data for kittiwakes at the Flamborough Head and Bempton Cliffs SPA;
- *Volume 6, Figure 12.5* – Outer Thames Estuary SPA, East Anglia ONE and Cable Corridor;
- *Volume 6, Figure 12.6* – Lesser black-backed gull foraging range;
- *Volume 6, Figure 12.7* – Gannet foraging range;
- *Volume 6, Figure 12.8* – Little tern foraging range;
- *Volume 6, Figure 12.9* – Common tern foraging range;

- *Volume 6, Figure 12.10* – Sandwich tern foraging range;
- *Volume 6, Figure 12.11* – Bird distribution November 2009 – October 2010; and
- *Volume 6, Figure 12.12* – Bird distribution November 2010 – October 2011.

4 Further baseline and assessment of impacts on onshore ornithology is contained in *Volume 3, Chapter 24 Ecology and Ornithology*.

12.2 Consultation

5 *Table 12-1* presents consultee responses to the East Anglia ONE Offshore Windfarm Scoping Report, June 2011, the East Anglia ONE Offshore Windfarm PEIR, February 2012.

Consultation Responses		
Consultee	**Comment**	**Response to Consultation**
Scoping Responses – Windfarm		
JNCC/NE	The requirement for baseline data collection is to conduct surveys over 24 months at present the plan will result in only 22 or 23 months. We strongly urge that the survey plan is extended to ensure that there is 24 months of both aerial and boat surveys (i.e. both the Aerial Bird Surveys and Boat Based survey outlines (p. 102) state 18 months of survey, this should be revised to ensure that a data set of 24 months is available for both methods). This may mean negotiating with The Crown Estate to extend a "Golden Milestone".	24 months of aerial survey data collected overall between November 2009 and October 2011. This consists of 5 months of aerial video surveys conducted as part of TCE enabling actions and 19 months of aerial digital stills surveys. Boat-based surveys undertaken from May 2010 to April 2011 and then additional monthly 2 cm Ground Sampling Distance (GSD) aerial digital stills surveys undertaken in addition to the monthly 3 cm GSD surveys for use in identification and proportioning out of birds identified to group level.
JNCC/NE	The compatibility of the HiDef data with the digital stills data is still to be validated, whilst the assumption is that data sets can be calibrated to use as a continuous data set, this may not prove to be the case. As such, a contingency plan might need to be considered to allow for this eventuality.	See *Volume 5, Appendix 12.1 Annex IV* for calibration report and population estimates resulting from calibration exercise for the two different survey methods.
JNCC/NE	In terms of informing an AA, some consideration should be given to methods for establishing (or not) connectivity between birds in the zone, and breeding colony SPAs on the coast	Data from tagging studies of lesser black-backed gulls breeding at the Alde-Ore Estuary SPA, kittiwakes breeding at the Flamborough Head and Bempton Cliffs SPA and gannets breeding at the Flamborough Head and Bempton Cliffs SPA have been used to assess connectivity between birds at these colonies and the East Anglia ONE site.
JNCC/NE	A1.6 It should be noted that the methods listed, may not be adequate to reliably inform an impact assessment for certain species (eg passage species) and as noted in the report we welcome early engagement to	A migration model has been constructed to account for migratory wildfowl and waders – see *Volume 5, Appendix 12.2* for full details on methodology and *Section 12.5.2.5* of this chapter for the population outputs. The snap shot nature of surveys with regard to

Consultation Responses		
Consultee	**Comment**	**Response to Consultation**
	discuss complimentary methodologies.	the migratory nature of great skua through the East Anglia ONE site has been addressed in *Section 12.5.2.4.5* of this chapter.
IPC	Attention is drawn to the comments from JNCC/NE relating to extending baseline survey data to ensure it covers 24 months.	See above – data set now consists of 24 months of survey data.
Scoping Responses – Offshore Cable Corridor		
JNCC/NE	In defining the boundaries between categories of sensitivity, the appropriate use and comparison of pre-determined threshold percentage values, such as 1% national population size, with field derived estimates of bird abundance within the onshore and offshore areas of search should be carefully considered.	Importance of the East Anglia ONE site is assessed against regional, national and international 1% thresholds for both the wintering and breeding seasons. It is considered highly unlikely that thresholds of importance will be reached for the offshore cable corridor area, owing to the long, narrow shape and small area of sea affected.
JNCC/NE	We agree that the species of principal interest in the context of EIA of the offshore cable are breeding birds on SPAs with foraging ranges overlapping the area of search and offshore overwintering birds. However, any breeding birds or wintering birds originating from SSSIs not also notified as SPA/Ramsar should be given equal consideration in the EIA.	Birds have been assessed that against regional, national and international importance. Those species that occur in these numbers or considered in the assessment, as well as those that are connected to SPAs.
JNCC/NE	In addition, JNCC and NE agree that laying of the cable and its operation is unlikely to pose a significant collision risk or barrier to passage migrants. However, depending upon the location, timing and nature of cable installation, maintenance and decommissioning activity impacts upon passage birds, such as passage waders in autumn and spring on coastal sites may arise through disturbance	Acknowledged. Passage migrants have only been assessed in terms of collision risk with the windfarm itself and barrier effects are not considered, as the impacts of one off migration movements are not conidered to be significant. Any disturbance from cable installation and maintenance will be temporary and decommissioning will be short-term and therefore there is

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Consultee	**Comment**	**Response to Consultation**
	and displacement and should be considered.	anticipated to be little or no impact.
JNCC/NE	Further clarity is required as to the area of survey and the survey methodology used to assess intertidal habitat. The information presented here is not sufficient to understand the survey that has taken place and to form an opinion as to whether further work is required this winter.	Two cable landfall sectors (FF001 and Cable Landfall) were surveyed using WeBS core count and low tide methodology during winter 2011/12 (methodology is summarised in *Section 12.5.2.6* of this chapter), along with three exisitng WeBS core count sectors and six exisiting WeBS low tide sectors on the Deben Estuary in connection with the onshore cable route (covered in *Volume 3, Chapter 24 onshore ornithology section*). The impact assessments for the intertidal species are also included within *Volume 3, Chapter 24 Ecology and Ornithology*.
JNCC/NE	Recent tagging and tracking studies of lesser black-backed gull on the coast of mainland Europe have yielded evidence of considerable movements of birds during the breeding season to the English coast. Further information is required as to whether the tagged birds were breeding, failed or non-breeders. However, such evidence should be considered before scoping out transboundary impacts. We acknowledge that the significance of any transboundary impacts relating directly to the cabling works of EA ONE is likely to be low.	Acknowledged. However, the data obtained from the BTO/RSPB tagging studies of lesser black-backed gulls do not provide evidence to suggest that the tagged birds were successful breeders or not. No transboundary impacts are anticipated as a result of the cabling laying activities.
JNCC/NE	Noise disturbance should be amended to include both noise and visual disturbance to birds and both should be assessed during all phases except operation. If scour protection, rock dump material or concrete mattressing is likely to be required along the cable route (as indicated in 3.4.2) then a potential loss of foraging habitat (for red-throated diver) may be incurred throughout the operational phase. For completeness we recommend that this table should include those potential impacts that have been scoped out i.e. collision and barrier	Disturbance during both construction and decomissioning phases have been considered in terms of noise through piling etc and in terms of visual distrubance through vessel presence (see *Sections 12.6.2.2 and 12.6.3.2* of this chapter). The offshore cable corridor has been included in the calculations for loss of habitat in *Sections 12.6.2.3 and 12.6.3.5* of this chapter.

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	impacts. The potential impacts on intertidal habitats, benthic communities and terrestrial habitats along the cable route should be included in this table and fully assessed for all stages of the project.	The potential impacts of the development on the benthic and epibenthic communities (*Volume 2, Chapter 9: Benthic and Epibenthic Environment*) and the fish ecology (*Volume 2, Chapter 10 Fish Ecology)* are fully considered within the indirect impacts on ornithology during both the construction and operational phases and within the cumulative indirect imapcts (*Sections 12.6.2.4, 0 and 12.6.6.2.3* of this chapter).
IPC	The second Scoping Report states that it is anticipated that birds that are displaced as a result of the cable laying activity (and later maintenance) are likely to return once the cable laying has been completed, and that the impact will be short-term. Such conclusions must be fully explained and justified in the ES.	Acknowledged, see Section 12.6.3.2
Section 42 Responses		
JNCC/NE	V2, Section 2.5.2 - Data sources - 312: We look forward to reviewing an updated analysis such as that presented in Chapter 2.5 when the full data for the as collected is available.	Data have been updated to include 24 months of data and the migration modelled species, see *Volume 5, Appendix 12.1*
JNCC/NE	V2, Section 2.5.2 - Approach to Surveys / Survey Methods - 317: Identification of species. We request further details regarding the sample sizes informing the ratios of identified species from the digital aerial techniques (both stills at 2cm GSD and video)	Information has been collated and presented in *Volume 5, Appendix 12.1 Annex V*
JNCC/NE	V2, Section 2.5.2 - Approach to Surveys / Survey Methods - 321: We advise that biologically relevant periods will be species specific, and in some cases the identified seasons may need to be altered (eg	Biological preiods have been revised on a species specific basis and data have been analysed based on these. The biologically relevant periods have been based on information presented in

Consultation Responses		
Consultee	**Comment**	**Response to Consultation**
	breeding season for gannets). We advise reference to a suitable text (eg Cramp & Perrins 1977-94) to inform this.	Wernham *et al*. (2002) – The Migration Atlas. Reasoning behind this and the breakdown of the calendar year into species specific periods can be found in *Volume 5, Appendix 12.1 Section 2.1*.
JNCC/NE	V2, Section 2.5.2 - Data Analysis/Abundance - 327: We would welcome a comparison of the results of proportioning unidentified birds according to relative abundance from positively identified species during boat surveys and according to 2 cm digital aerial surveys.	More detail has been added for robust response, emphasising the differences in surveys methods and difficulty in direct comparisons.
JNCC/NE	V2, Section 2.5.2 - Abundance - 334: We welcome the derivation of a correction factor to account for unavailability of diving birds, and look forward to a further explanation of this approach.	See *Volume 5, Appendix 12.1 Annex VI* for correction factor methodology. Mean peak estimates for divers and auks presented in the baseline report, *Volume 5, Appendix 12.1 Section 3.4*, both with and without the application of correction factors. However, for the purpose of the assessment process, only auks' corrected values have used for the EIA. All monthly estimates for these species/groups are presented with and without correction factors in *Volume 5, Appendix 12.1 Section 3.4.*
JNCC/NE	V2, Section 2.5.2 - Important thresholds - We recommend taking into account the latest publication on over winter population estimates of British water birds (Musgrove et al. 2011) providing estimates for several gull species, seaducks and diver species relevant in context of EA ONE.	The qualifying levels presented in Holt *et al.* (2011) represent the most up-to-date figures following recent reviews and include figures presented in Musgrove *et al.* (2011) for wildfowl and waders in Britain and in Banks *et al.* (2007) for gulls in Britain. *Section 12.1.1.1* of this chapter amended to make this clear.

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Consultee	**Comment**	**Response to Consultation**
JNCC/NE	V2, Section 2.5.2 - Important thresholds - We query how birds on migration are being assessed within this framework. For species that display a definite passage movement, (eg skuas, terns) there will be a need to consider a) the turnover at the site and b) which the relevant population is to define a threshold. For example, during a period of sustained passage (say 4 weeks), if 50 birds transited the site per day, the "population" would be approx 1500 birds, this may result in a species being deemed sensitive.	A full section has been completed on migration modelling for non-seabirds in *Section 12.5.2.6* of this chapter and the snap shot nature of surveys with regard to the migratory nature of great skua through the East Anglia ONE site has been addressed in *Section 12.5.2.4.5* of this chapter.
JNCC/NE	V2, Section 2.5.2 - Important thresholds - 337: We would suggest using 1% of bio-geographic population as threshold to compare with peak estimates of EAONE rather than international population (if there is a difference). Using a minimum 50 threshold is sensible.	The international qualifying levels in Holt *et al.* (2011) present figures based on biogeographic populations, following WPEP4 (Delany & Scott 2006). *Section 12.5.2.4* of this chapter amended to make this clear.
JNCC/NE	V2, Section 2.5.2 - Important thresholds - 338. We query how the geographical extent of „regional breeding populations" has been defined. Is it informed by foraging radii?	Regional breeding thresholds were based on colony counts in Mitchell *et al.* (2004) that are within the maximum foraging ranges for each species given in Thaxter *et al.* (2012b) from the East Anglia ONE site. *Section 12.1.1.1* of this chapter amended to make this clear.
JNCC/NE	V2, Section 2.5.2 - Important thresholds - 339: We generally support the derivation of national and international 1% thresholds from breeding estimates in BirdLife International (2004) as presented, noting that the 1% threshold applied might underestimate the population as it misses all sub-adult birds not part of the breeding pool, yet contributing to the overall population size. In terms of applying a precautionary approach these numbers are supported.	*Section 12.1.1.1* of this chapter amended to acknowledge this.

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JNCC/NE	V2, Section 2.5.2 - Collision Risk - 349: Site specific flight height and behavioural data will also be available from the year of boat-based survey work, it would be useful if this could be presented/utilised.	A stepwise approach was applied to the use of flight height data in CRM. Where sufficient data from flying birds were available, flight height data from digital surveys were used in the first instance. Where there were insufficient encounters with flying birds in the digital imagery, data from the site specific boat based surveys were utilised. In the event that neither of the site specific survey data sets provided sufficient data, the bird flight altitude data published in the SOSS-02 report (Cook *et al.* 2011) were used. Numbers of birds recorded flying and sitting and the percentages of those in flight recorded at heights that would be within and below the likely rotor swept areas are presented in the *Section 12.5.2.4* (seabird species accounts) of this chapter.
JNCC/NE	V2, Section 2.5.2 - Collision Risk - It would appear that the sample sizes used to inform flight height using digital stills are very low – this may be improved with a second year of data, however, sampling artefacts caused by small sample sizes may cause erroneous results.	This is acknowledged and more data has been collected and analysed since the PEIR, though actual numbers have not risen massively. As a result of this a stepwise approach was applied to the use of flight height data in CRM (see above).
JNCC/NE	V2, Section 2.5.2 - Environmental Baseline - 353: We recommend using peak estimates for the assessment of importance within the final ES to secure a precautionary approach.	Acknowledged. However, mean peak estimates over the two years of surveys were continued to be used for assessment of the importance of the site. This was because most long-term data sets (eg Wetland Bird Survey, WeBS) use peak mean estimates (eg five-year peak means) for assessment of the importance of sites and the data used in calculating the national and international/biogeographic populations are based the data from such surveys. Using peak values for the wintering and breeding periods may create an overly precautionary scenario. Two years of site-specific survey data have been collected in order to remove

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Consultee	**Comment**	**Response to Consultation**
		fluctuations to create a site-specific mean.
JNCC/NE	V2, Section 2.5.2 - Environmental Baseline - Table 2.18 should include references for the presented thresholds for clarity. Where the minimum threshold has been used it would be useful to present the actual numbers estimated (eg for a number of breeding birds a 50 threshold has been used, however the actual numbers of breeding birds in a region will be available from Mitchell 2004).	References for thresholds added to *Table 12-14* and *Table 12-15* of this chapter. Where the 1% threshold is listed as the nominal 50 birds, the value of the actual 1% threshold has been added in brackets to *Table 12-14* and *Table 12-15*.
JNCC/NE	V2, Section 2.5.2 - Environmental Baseline - Table 2.19 – see previous comments regarding turnover rate of passage individuals.	A full section has been completed on migration modelling for non-seabirds in Section 12.5.2.6 of this chapter and the snap shot nature of surveys has been with regard to the migratory nature of great skua through the East Anglia ONE site has been addressed in Section 12.5.2.4.5 of this chapter. *Table 12-13* and *Table 12-15* have been updated to include the revised autumn and spring migration estimates for great skua following the caluclations made in Section 12.5.2.4.5.
JNCC/NE	V2, Section 2.5.2 - Environmental Baseline - Table 2.18 should include references for the presented thresholds for clarity. Where the minimum threshold has been used it would be useful to present the actual numbers estimated (eg for a number of breeding birds a 50 threshold has been used, however the actual numbers of breeding birds in a region will be available from Mitchell 2004).	Biologically relevant periods have been revised in this chapter. Following this, the mean peak in spring was assessed against the regional 1% threshold for migration, which is based on the estimated maximal numbers migrating through the Strait of Dover presented in Stienen et al. (2007). This was considered the most appropriate threshold to use as it takes account of both British and Norwegian breeding birds that pass through the area at this time. The national threshold accounts only for British breeding birds. Birds on migration may have overwintered not only in the Outer Thames Estuary SPA, but also in areas further south.

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JNCC/NE	V2, Section 2.5.2 - Environmental Baseline - 389 (and others): It is usual to describe the percentage of birds flying at rotor height (compared to the total number of birds in flight). The presentation approach used here is to define the total proportion of birds in flight vs birds on the water, may lead to some confusion.	A stepwise approach was applied to the use of flight height data in CRM (see above). Numbers of birds recorded flying and sitting and the percentages of those in flight recorded at heights that would be within and below the likely rotor swept areas are presented in the Section 12.5.2.4 (seabird species accounts) of this chapter.
JNCC/NE	V2, Section 2.5.2 - Environmental Baseline - 442: We are concerned about a reported secondary peak (389 Ind. estimates for EAONE plus a 4km buffer) in auk numbers observed at the end of the breeding season in August within the EAONE buffer. This is likely to reflect post-fledgling dispersal of immature first summer auks (as stated within the PEI with reference to (Wernham et al. 2002) – it can be expected that a proportion of those birds should be recruited from the Flamborough Head and Bempton Cliffs SPA, as the next breeding site (Farne Islands) is more than 400 km north of the Flamborough Head and Bempton Cliffs SPA. As auks avoid the vicinity of OWFs (decreased abundance reported for up to 4km around Horns Rev OWF (Petersen et al. 2004) – Dierschke & Garthe (2006) suggest -100% within OWF, -14.1% OWF + 0-2km buffer, and -49,0% OWF + 2-4 km buffer based on those data) there is the potential of displacement from the EA ONE buffer. Moulting auks cannot fly and are restricted in their foraging range. Due to this EA ONE might affect the auk breeding population of Flamborough Head and Bempton Cliffs SPA. This issue should be considered in frame of the PEI (Volume 2) as well as the Screening & Scoping Report (p. 38) as it could lead to not screening out auks and investigating LSEs, especially taking into account potential in combination effects with further OWFs.	This has been explained in the context of other assessments. Of particular note are more recent papers suggesting no displacement of auks from windfarms. This has been addressed in Section 12.6.3.2.7 of this chapter, backed up with site-specific data and other references.
JNCC/NE	V2, Section 2.5.2 - Migratory routes through East Anglia ONE - 464:	Acknowledged. However, the migration model only addresses

Consultation Responses		
Consultee	**Comment**	**Response to Consultation**
	JNCC and NE welcome the application of a migration model to identify potential impacts on species migrating through the EAONE site and are also of the opinion that waders and wildfowl associated with non-breeding SPAs should be assessed in terms of potential impact. We would welcome more detailed information on how the model will address potential barrier effects.	CRM and was not designed to assess barrier effect. Full details of the migration model can be found in *Volume 5,* Appendix 12.2, whilst the outputs of the model are discussed in Section 12.5.2.5 of this chapter and the results of the CRM for the migrant species are discussed in this chapter.
JNCC/NE	V2, Section 2.5.2 - Migratory routes through East Anglia ONE - We advise that use is made of population estimates for the modelling of migratory seabirds due to only frequent detection during surveys. We recommend that seabird tagging studies (eg FAME project) are used to inform movements of different populations across the EAONE area. If field data is to be applied it would be useful to provide clarification on how the flux of species (eg great skuas, terns etc.) across the site will be considered.	Acknowledged. However, migratory seabirds were not modelled (with the exception of great skua: Section 12.5.2.4.5 of this chapter). Migration modelling was selected for birds not captured during survey effort. Tagging data were used where available in this chapter. Only great skua have been taken through the impact assessment process further, as there is evidence to suggest that they do migrate through the site. Other seabirds not already included within the assessment were not found to use the area of sea to fly through on migration and so have been omitted from further assessment, such as terns.
JNCC/NE	V2, Section 2.5.2 - EIA Assessment Methods - 484: While the PEI Report states a worst case 100% post-construction displacement has been assumed, no information is provided on how displacement of seabird from a buffer around the OWF is addressed. The displacement of seabirds from the wider vicinity of OWFs differs in a species specific way. Commonly displacement buffers of 2 km are eg used for RTD (Dierschke & Garthe 2006). JNCC and NE would welcome further clarification on this issue. It is stated (PEI Vol. 2, 517) that the ES will present a range of displacement proportions informed by previous studies, we would welcome more information on this topic so that appropriate advice may be offered.	This has been addressed in Section 12.6.3.2 of this chapter, for certain species where this is relevant (particularly red-throated divers).

Consultation Responses		
Consultee	**Comment**	**Response to Consultation**
JNCC/NE	V2, Section 2.5.2 - Possible Impacts - 503: RTD are estimated to occur in nationally important numbers during spring (March 2010, 414 Ind. within the EA ONE site and 689 Ind. within EA ONE site plus 4km buffer) and might be significantly affected. We stress that the operation of EA ONE is likely to displace all birds reported from the site and a considerable amount of those reported from the buffer. Those birds will redistribute leading to increased density depended competition within the remaining habitat.	All known data and reports that provide information on diver migration times have been assessed, particularly in reference to peaks occurring in March within the East Anglia ONE site, which have now been confirmed as spring movements of divers (see Section 12.5.2.5.2 of this chapter). As mentioned above, a range of displacement proportions from the windfarm footprint and surrounding buffer have been considered for the disturbance and displacement of red-throated divers during the operation of the East Anglia ONE site (Section 12.6.3.2.2 of this chapter).
JNCC/NE	V2, Section 2.5.2 - Possible Impacts - 514 The increased level of vessel activity throughout the lifetime of the operational windfarm, eg. for maintenance, should be fully considered.	Levels of vessel activity during considered for the assessments during the operational phase are detailed in the worst case scenario detailed in Section 12.3.3.2 of this chapter.
JNCC/NE	V2, Section 2.5.2 - Possible Impacts - 524: Great black-backed gulls were estimated in nationally important numbers during winter and are expected to be most likely impacted by collision risk. We recognise the increased importance of this species in terms of the upcoming collision risk modelling.	Acknowledged. See Section 12.6.3.3.7.9 of this chapter for collision risk impact assessment for great black-backed gulls.
JNCC/NE	V2, Section 2.5.2 - Possible Impacts - 525: The current population of lesser black backed gull is significantly lower than the designated size. Impacts needs to be considered in terms of the current population size, trend and sensitivity (i.e. an SPA population considerably lower than that at designation will be extremely sensitive to adverse effects that may influence its ability to return to higher population levels). In addition, the cumulative effects from other windfarms may be significant to this population.	The impacts on lesser black-backed gulls have been considered in terms of the current Alde-Ore Estuary SPA population size (approximately 1,500 breeding pairs) and to the regional population as a whole that have foraging ranges within reach of the East Anglia ONE site. Cumulative impacts are also considered within Section 12.6.6.3.2 of this chapter.

Consultation Responses		
Consultee	**Comment**	**Response to Consultation**
JNCC/NE	V2, Section 2.5.2 - Cumulative Impacts - 555: see point above regarding the sensitivity to cumulative collision risk of lesser black backed gull from the Alde Ore Estuary SPA.	Acknowledged as above. See Section 12.6.6.3.2 of this chapter for cumulative collision risk assessment for lesser black-backed gulls.
JNCC/NE	V2, Section 2.5.2 - Cumulative Impacts - 565: In terms of aggregate dredging it is important to take into account that eg the Humber and Greater Wash MAREA expects a 100% increase in dredging activities during the coming years, doubling all associated impacts on seabirds. Increased turbidity due to dredging activities might displace visual feeders like divers and auks from areas larger than the avoidance distance associated with dredging vessels.	This has been included within the cumulative impacts of dredging and aggregate extraction section of this chapter (Section 12.6.6.4.3).
JNCC/NE	V2, Section 2.5.2 - Offshore cable corridor (PEI) - 470: NE agrees that species of principal interest in terms of the cable corridor identified within the PEI are those associated with nearby SPAs which encompass the offshore cable corridor or are designated for species with foraging ranges encompassing the cable corridor.	Acknowledged
JNCC/NE	V2, Section 2.5.2 - Offshore cable corridor (PEI) - 497: In terms of the method applied for installation of the offshore cable, we would recommend not to be restricted to one method, but better consider a combination of techniques that are best suited for the situation and having least environmental impact. The need for scour protection should be fully assessed upfront in the application process so that mitigation measure can be applied where appropriate and feasible.	Methods for installation of the offshore cable and scour protection that are to be assessed during the impact assessment are discussed in the worst case scenario section of this chapter.

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JNCC/NE	V2, Section 2.5.2 - Offshore cable corridor (PEI) - 499: EAOW state that cable installation could trigger permanent changes of sea bed habitat within the cable corridor, if scour protection is likely to be required along the cable route this has the potential to change the feeding habitat suitability which could impose changes to the at sea distribution of seabirds within the area. This might cause impacts on RTD foraging habitat within the Outer Thames SPA throughout the operational phase.	The offshore cable corridor and associated works have been captured within the worst case detailed in this chapter. The impacts associated with this are not anticipated to be significant due to the temporary nature and are thus considered to be negligible.
JNCC/NE	V2, Section 2.5.2 - Offshore cable corridor (PEI) - We suggest that potential impacts on intertidal habitat associated with a potential landfall of the offshore cable will need to be assessed in more detail. Works on the intertidal landfall is expected to cause temporary / permanent disturbance to / alteration of intertidal habitats and benthic communities and associated waterbird species.	Two cable landfall sectors (FF001 and Cable Landfall) were surveyed using WeBS core count and low tide methodology during winter 2011/12 (methodology is summarised in Section 12.5.2.6 of this chapter), along with three existing WeBS core count sectors and six existing WeBS low tide sectors on the Deben Estuary in connection with the onshore cable route (covered in *Volume 3, Chapter 24 Ecology and Ornithology*). The impact assessments for the intertidal species are also included within *Volume 3, Chapter 24 Ecology and Ornithology*.
JNCC/NE	V2, Section 2.5.2 - Offshore cable corridor (PEI) - 478-482 provides results of the APEM survey of the potential landfall. The surveys undertaken during February 2011 report high bird diversity (20 species) and high abundance (2005 individuals reported during 2 survey days) with the majority of individuals (1562) roosting. Findings suggest disturbance of a large and diverse assemblage of roosting birds in terms of cable installation during winter. We look forward to the provision of summer survey results for comparison and potential indication of mitigation based on those findings.	Landfall site has altered and the February 2011 surveys are no longer relevant. Further surveys were undertaken during winter 2011/12 of the relevant sites. Two cable landfall sectors (FF001 and Cable Landfall) were surveyed using WeBS core count and low tide methodology during winter 2011/12 (methodology is summarised in Section 12.5.2.6 of this chapter), along with three exisitng WeBS core count sectors and six exisiting WeBS low tide sectors on the Deben Estuary in connection with the onshore cable route (covered in *Volume3, Chapter 24 Ecology and*

Consultation Responses		
Consultee	**Comment**	**Response to Consultation**
		Ornithology section). The impact assessments for the intertidal species are also included within *Volume 3, Chapter 24 Ecology and Ornithology*.
JNCC/NE	V2, Section 2.5.2 - Red-throated diver - The cable corridor passes through the Outer Thames Estuary SPA designated for wintering red-throated divers (RTD) which are known to be sensitive to vessel presence (Dierschke & Garthe 2006).	The impacts of the installation of the offshore cable on red-throated diver in terms of disturbance due to vessel presence is assessed in Section 12.6.2.2.2 and is not considered to be of major concern.
JNCC/NE	V2, Section 2.5.2 - Red-throated diver - 373: The PEI Report states: "The numbers of divers using the offshore cable corridor are not expected to be of international importance as this area has not been included in the Outer Thames Estuary SPA designation." This statement is incorrect, while the number of RTD might not be adversely affected by the cable corridor, approx. 1/3 of the cable corridor lies within the Outer Thames SPA.	Acknowledged and sentance amended accordingly.
JNCC/NE	V2, Section 2.5.2 - Red-throated diver - RTD are likely to be displaced by cable laying vessels operating within the SPA, we would suggest mitigating displacement effects by considering cable laying works during summer, when RTD do not occur within the SPA.	The impacts of the installation of the offshore cable on red-throated diver in terms of disturbance due to vessel presence is assessed in Section 12.6.2.2.2 and is not considered to be of major concern as any impacts are anticipated to be low and temporary in nature. Therefore no mitigation proposed.
JNCC/NE	V2, Section 2.5.2 - Gulls - 431: We welcome the consideration that foraging ranges of both herring gulls and black-headed gulls from the Alde-Ore colonies could potentially overlap with parts of the offshore cable corridor.	Acknowledged
JNCC/NE	V2, Section 2.5.2 - Gulls - Foraging ranges of lesser black-backed	All foraging ranges throughout this chapter now refer to those

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	gulls breeding within the Alde-Ore SPA overlap with the entire cable corridor (SPA lies within 135 km of the cable corridor – max. mean foraging range during breeding season 141 km (Thaxter et al. 2012)).	presented in Thaxter et al. (2012b) where available.
JNCC/NE	V2, Section 2.5.2 - Gulls - 426: We welcome and share EAOW"s concern being raised in accordance to breeding lesser black-backed gulls from the Alde-Ore SPA foraging within the offshore cable corridor.	Acknowledged
JNCC/NE	V2, Section 2.5.2 - Terns - 454: We welcome the consideration that the foraging ranges of little terns from Alde-Ore and Hamford Water SPAs overlap with the offshore cable corridor. Moreover little terns from Minsmere – Walberswick and the Colne Estuary (13 and 16 km from the cable corridor) may potentially forage within the area.	Acknowledged
JNCC/NE	V2, Section 2.5.2 - Terns - 456: We welcome the consideration of common and sandwich terns from the Foulness SPA (minimum of 30 km from offshore cable corridor) potentially foraging within the offshore cable corridor.	Acknowledged
JNCC/NE	V2, Section 2.5.2 - Terns - 449: Patchy distribution of terns recorded for the cable corridor in summers 2005 and 2006 confirms the overlap of foraging ranges of terns associated with the close by SPAs.	Acknowledged
JNCC/NE	V2, Section 2.5.2 - Auks - Flamborough Head and Bempton Cliffs SPA is located a minimum of 252 km and a maximum of 275 km from the offshore cable corridor.	Distances checked. Flamborough Head and Bempton Cliffs SPA is located a minimum of approximately 252 km from the offshore cable corridor area and a minimum of approximately 275 km from the East Anglia ONE site.

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JNCC/NE	V2, Section 2.5.2 - Auks - 447: Densities up to 10-25 auks per km2 were recorded in the offshore cable corridor approximately 18-20 km off the coast during the first mid-winter survey period.	Acknowledged. However, the data referred to for the offshore cable corridor (*Section 12.5.2.4.17* of this chapter) is for the Thames Strategic Area survey blocks that are most relevant to the cable corridor (blocks TH3 had TH4) surveyed by WWT (DTI 2006; DBERR 2007) and therefore cover a wider area of sea than just the offshore cable corridor. As the offshore cable corridor is considered to have only temporary and minor impacts, numbers and densities have not been detailed. Additionally, surrounding areas are considered suitable for foraging.
Galloper & Greater Gabbard (GWFL & GGOWL)	GWFL note that an avoidance rate of 98% is advocated. GWFL have undertaken extensive investigations into avoidance rates for key species as part of their Environmental Impact Assessment studies and would welcome further discussion with EAOW on this matter (Section 2.2.2 Para 484).	Acknowledged. It was noted that GWFL had used different avoidance rates to the 98%. However, the SNH standard 98% avoidance rate has been used in *Section 12.6.3.3* of this chapter with some discussions in the individual species assessments on this being precautionary.
Galloper & Greater Gabbard (GWFL & GGOWL)	GWFL note that displacement effects will be assessed based on a range of different displacement percentages, but the same approach is not being adopted for collision risk. GWFL would again welcome further dialogue with EAOW on this matter (Section 2.2.2 Para 517).	Acknowledged. Displacement ranges have been used for species that have evidence to support specific differences. CRM also has a range within it, not for displacement but for avoidance rates.
RSPB	Overall, the RSPB welcomes the general approach proposed for Environmental Impact Assessment (EIA) and HRA. Namely, to take a systematic, evidence-based and precautionary approach to judging potential significance of impacts on sensitive ecological receptors. However, at this stage we have concerns about conclusions being drawn regarding the potential impact of EAONE on ornithological interest features, in advance of completion of the relevant assessments. This said, we recognise that additional work is ongoing	Acknowledged

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	and, as stated in the report, await the outcome of detailed Collision Risk Modelling and other ongoing work.	
RSPB	V2, p. 2-92 (Section 2.5.2, data sources). Construction of a detailed migration model to inform impact assessment for passage migrants is welcomed. However, we remain concerned that this will be restricted to waterfowl and waders only and will not include passage seabirds. We maintain that this group would benefit from different treatment for collision risk assessment (CRA) in particular, given the shortfalls of boat and aerial methods to adequately detect passage seabirds and other groups.	Acknowledged. However, migratory seabirds were not modelled (with the exception of great skua: *Section 12.5.2.4.5* of this chapter). Migration modelling was selected for birds not captured during survey effort. Tagging data were used where available in this chapter.
RSPB	V2, p. 2-92 (Section 2.5.2, data sources). We also remain concerned that the boat based surveys (BBS) recorded several migratory seabirds (eg c.100 records of great skua) that have not been detected by aerial surveys but this information is not presented upfront in the PEIR and the issue is not discussed beyond a statement at para. 459. We appreciate EAOW's position on the matter as outlined in the email of 22.12.11. However we maintain the following points: we do not consider the fact that BBS were originally intended to only provide contextual information offers just reason to disregard BBS data for species not recorded by aerial surveys. While an industry wide issue, individual developers will need to ensure their assessments are adequate and based on all reasonably available data, which we consider includes the BBS data in this instance. Further, it may be the case that the assumption of the Band (offshore) model of constant flux ensures precautionary CRA but the extent to which this can address the issue of low detection in the first place is questionable. In relation to this, we would suggest the potential shortfalls of aerial are listed alongside the advantages of this method given at para. 315, for	Aerial data has remained the primary data source, with a stepwise approach applied to the use of flight height data in CRM (aerial first, followed by boat-based, followed by SOSS-02 (Cook et al. 2011) depending on sample sizes). A full section has been completed on migration modelling for non-seabirds in this chapter, which covers those species not captured during survey effort. Additionally, the snap shot nature of surveys with regard to the migratory nature of great skua through the East Anglia ONE site has been addressed in *Section 12.5.2.4.5* of this chapter. A full account of the methodology, including the need for additional migration modelling can be found in *Section 12.5.1.1*.

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	balance. (Eg potential reduced detection of low frequency high volume movements due to comparatively shorter length of time on survey, i.e. cf BBS.)	
RSPB	V2, p. 2-92 (Section 2.5.2, data sources) We are pleased to note that further data from tracking studies of kittiwakes and lesser black-backed gulls will be used in the final ES. We recommend that in addition to RSPB studies, those of lesser black-backed gulls by the BTO (Natural England funded) and University of Amsterdam are as well. Likewise the RSPB (DECC funded) studies of gannets from Bempton Cliffs. We would be happy to provide further details for acquiring data where relevant. We also strongly recommend that necessary caution is applied in consideration of data from such studies given the small sample sizes involved and in some cases lack of coverage of certain periods within the breeding season.	Assessments have been complied on all available information from tagging studies to date, which include the RSPB gannet study from Bempton Cliffs, RSPB and BTO lesser black-backed gull studies from the Alde-Ore Estuary, University of Amsterdam lesser black-backed gull study and the RSPB study of kittiwakes at Flamborough and Bempton. These also include an explanation of the merits and limitations of these studies. See the relevant seabird species accounts within *Section 12.5.2.4* of this chapter.
RSPB	V2, p. 2-94 (section 2.5.2, survey methods). We recommend that the divisions of the calendar year into biologically relevant periods, while useful, may require further interpretation/clarification in the final ES on a species by species basis given there is likely to be overlap between some months and seasons. Eg breeding season for lesser black-backed gulls is described in the literature as March-August, with birds returning to colonies either side of these months.	Biological preiods have been revised on a species specific basis and data have been analysed based on these. The biologically relevant periods have been based on information presented in Wernham et al. (2002) – The Migration Atlas. Reasoning behind this and the breakdown of the calendar year into species specific periods can be found in *Volume 5, Appendix 12.1 Section 2.1*.
RSPB	V2, p. 2-97 (section 2.5.2, data analysis). We are pleased to note that a correction factor to account for diving species possibly not detected whilst underwater will be applied to relevant species totals for the final ES and would welcome further information on this when available.	See *Volume 5, Appendix 12.1 Annex VI* for correction factor methodology. Mean peak estimates for auks presented in the baseline section of this chapter, *Section 12.5.2.4*, both with and without the application of correction factors. All monthly estimates for these species/groups are presented with and without correction factors in *Volume 5, Appendix 12.1 Section 3.4*. Diver

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		correction factors are presented within *Volume 5, Appendix 12.1 Annex VI* Baseline Report, but not used in this chapter for the assessment process.
RSPB	V2, p. 2-97 (section 2.5.2, importance thresholds). We agree Stienen et al. (2007) provides suitable published values to inform importance thresholds. Whilst the issues identified are acknowledged, we query whether use of national and international breeding population estimates are appropriate to assess importance of wintering populations against. Other UK offshore wind farm ESs have used eg Baker et al. (2006) and other sources more specific to the wintering season.	Acknowledged. The GB wintering populations presented in Baker et al. (2006) was used for species where no national wintering 1% thresholds were given in Holt et al. (2011). However, no wintering population estimates were given in this reference for these species either. Text in *Section 12.1.1.1* of this chapter amended to state that Baker et al. (2006) was consulted.
RSPB	V2, p. 2-97 (section 2.5.2, importance thresholds). The caveats outlined in Holt (2011) (eg for great black-backed gull) should also be taken into account if figures from this source are to be used in the final ES.	Acknowledged
RSPB	V2, p. 2-101, Tbl. 2.17; p. 2-104, Tbl 2.18. We note the large number of auks (razorbill and guillemot) not identified to species. We recommend that further discussion is included in the ES as to why it is considered unlikely that a large proportion may have been razorbill, which may therefore have been recorded in nationally/near nationally important wintering numbers given these records.	All unidentified auks have now been proportioned out into species using boat-based and 2cm GSD aerial data. Information has been regarding the sample sizes and ratios have been collated and presented in *Volume 5, Appendix 12.1 Annex V.*
RSPB	V2, Tbl. 2.17; Tbl 2.18. In line with our above comments (No. 3), we suggest that the BBS data are presented upfront alongside the aerial data in the final ES.	Acknowledged. However, aerial data is the primary source of data and has been used to generate population estimates. No population estimates from the boat-based surveys have been presented within this chapter. However, all seabird species

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		accounts within *Section 12.5.2.4* of this chapter have a behaviour section which includes a table of the total numbers of birds recorded flying and sitting and the total numbers recorded across all the boat-based surveys. Additionally, the sample sizes and ratios of the positively identified species (gulls and auks) recorded from the boat-based data and used to proportion out aerial group level data to species has been collated and presented in *Volume 5, Appendix 12.1 Annex V*.
RSPB	V2, Tbl.s 2.18-19. We consider that where species were recorded in any numbers in the relevant season that the site is of at least some importance to them rather than “none” as described in these tables.	*Table 12-14* and *Table 12-15* in this chapter amended to have a “-“ where a species has been recorded in numbers of less than Regional importance
RSPB	V2, p. 2-107 (section 2.5.2, environmental baseline - divers). We recommend the proportion of the Outer Thames Estuary (OTE) SPA population potentially represented should also be considered at this stage alongside national and international thresholds.	Acknowledged. Outer Thames Estuary SPA red-throated diver population will be considered in the HRA. However, for migration it is considered too precautionary to all of the birds passing through on migration are from the SPA.
RSPB	V2, p. 2-107 (section 2.5.2, environmental baseline - divers). It is stated here that the offshore cable corridor is not included in the OTE SPA but elsewhere it is described that the corridor passes through a part of the SPA. This should be corrected.	Acknowledged. Text amended as the offshore cable corridor does pass through part of the Outer Thames Estuary SPA.
RSPB	V2, p. 2-109 (section 2.5.2, environmental baseline - gannets). We note the description that distances gannets may travel from colonies are considered to be positively correlated with colony size. It may be pertinent to consider population trends for specific colonies (particularly the expanding Flamborough Head and Bempton Cliffs SPA colony) and assess whether this may be a possibility that could	Acknowledged. However, this was not considered to be necessary, as accounting for additional numbers for this species in the future is very subjective. Likewise, falls in other populations in line with current trends have not been modelled. The assessments have been based on the current information to hand

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	affect future risks from EA ONE, in the final ES.	and this has been updated where appropriate with up to date colony data.
RSPB	V2, p. 2-113 (section 2.5.2, environmental baseline - gulls) & p. 2-126 (section 2.5.2, environmental baseline - migratory routes). In line with our above comment (No. 3), we strongly recommend that where the final ES is informed by tracking studies clear descriptions of the necessary caveats to interpretation of the results for the purposes of impact assessment are included. For example, regarding the gannet tracking study cited here, the conclusions that can be drawn at this stage are limited as the data relate to a small sample from part of one breeding season only and in one year, which was also a very successful season at Bempton Cliffs. There is a clear need to account for inter-annual variation which is not possible with reference to one year of data only. (However, results of the 2011 season will be available in time to inform the final ES to aid in this.) The description at para. 384 that gannet do not forage in the vicinity of EA ONE risks over-generalising these results.	*Section 12.5.2.4.4.2* of this chapter has been updated to include 2011 results that are available from the RSPB website along with the addition of caveats to account for small sample sizes and relating to two years covering partial chick-rearing periods in each year.
RSPB	V2, p. 2-112 (section 2.5.2, environmental baseline - skuas). The reference to Wernham et al (2002) concerning great skuas tending to remain at least 2-5km from coasts on migration (in the context of recording the species from shore) should be balanced with reference to other sources that describe this species as a predominately offshore migrant (eg Steinen et al. 2007).	Acknowledged. Reference that this species is considered by Stienen et al. (2007) to be an offshore species, rarely observed within 20km of the shoreline has been added to *Section 12.5.2.4.5.1* of this chapter.
RSPB	V2, p. 2-112 (section 2.5.2, environmental baseline - gulls). This section discusses potential reasons for the decline in the lesser black-backed gull population on the Alde-Ore Estuary SPA. Whilst changes	*Section 12.5.2.4.9* of this chapter amended to account for this.

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	in pig farm abundance may have had some influence, the key reasons for decline relate to predation, habitat deterioration, and recreational disturbance. Periodic outbreaks of botulism have also affected this population. The detail presented on this issue should therefore be improved. The RSPB, as managers of Havergate Island within the SPA, would be happy to provide further information on this if needed.	
RSPB	V2, p. 2-117 (section 2.5.2, environmental baseline - gulls). We recommend Thaxter et al. (in press) is also referred to with respect to herring gull foraging ranges.	Text in *Section 12.5.2.4.10.2* of this chapter updated to detail herring gull foraging ranges presented in Thaxter et al. (2012b).
RSPB	V2, p. 2-119 (section 2.5.2, environmental baseline - auks). Comparison with densities for the wider area to provide some gauge of the importance of the offshore cable corridor for auks would be useful here.	Acknowledged. However, the data refered to for the offshore cable corridor area (*Section 12.5.2.4.17* of this chapter) is for the Thames Strategic Area survey blocks that are most relevant to the cable corridor (blocks TH3 nad TH4) surveyed by WWT (DTI 2006; DBERR 2007) and therefore covers a wider area of sea than just the offshore cable corridor.
RSPB	V2, p. 2-122 (section 2.5.2, environmental baseline - other birds). It is not clear whether these summaries are for the EA ONE site or EA ONE + buffer?	This covers all the surveys that were used to inform the baseline – WWT surveys of the relevant blocks that include the offshore cable corridor, East Anglia zone aerial survey that cover the East Anglia ONE site plus buffer plus part of the offshore cable corridor and the boat-based surveys covering the East Anglia ONE site plus buffer. *Section 12.5.2.4.18* of this chapter amended to clarify this.
RSPB	V2, tbl. 2.20, It is not clear why lesser black-backed gull is missing from the flight heights table?	No lesser black-backed gulls were recorded in flight in the aerial survey data from the period covered by the PEIR

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RSPB	V2, p. 2-126 (section 2.5.2, environmental baseline - migratory routes). The RSPB seeks further information concerning the description here that “Migratory seabirds were frequently detected on surveys and therefore, assessments will be based on field data, allowing for passage through the site on a relevant number of days”. We reiterate that the BBS data should be used to inform further CRA of migratory seabirds.	A simple, but robust model has been developed to take into account the snap shot nature of surveys with regard to the migratory nature of great skua through the East Anglia ONE site in *Section 12.5.2.4.5* of this chapter.
RSPB	V2, p. 2-136 (section 2.5.4, impacts during construction). We note the statement that there is tentative evidence that red-throated divers habituate to sources of disturbance/displacement over time. We consider there is too much uncertainty at the present time to reliably confirm this and recommend that a much fuller consideration of the available evidence is presented alongside any such statements in the final ES.	The most recent research on displacement of red-throated divers has been used to model displacement from the East Anglia ONE site and its 4km buffer in *Section 12.6.3.2.2* of this chapter
RSPB	V2, p. 2-146 (section 2.5.4, cumulative impacts). In relation to our above comment about RTD and disturbance; particular attention should be given to proposals for new aggregates extraction and dredging activity, such as that at area 507.	Acknowledged. See cumulative impact section of this chapter (*Section 12.6.6.4*)
RSPB	V2, p. 2-136 (section 2.5.4, impacts during construction). We also recommend that the description that responses to cable laying vessels will not be significantly more than currently observed with existing vessels is revisited. This is given that existing activity can be considered part of the baseline level of disturbance red-throated divers are already influenced by, whereas new activity may introduce additional pressures. Similarly, the description at para. 570 that high	Acknowledged. Other shipping must be considered part of the baseline shipping level. Only additional vessel movements have been incorporated into the impact assessment, as other shipping is already a factor affecting the populations and distributions of birds in the region.

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	shipping activity in the Thames Strategic Area does not seem to affect the overwintering population of red-throated divers of the SPA. Shipping activity was an influence on the population at the time of designation and it is probable that in its absence numbers would be greater. However, this question could not be answered with certainty without a shipping-free baseline for comparison, which does not exist.	
RSPB	V2, p. 2-136 (section 2.5.4, impacts during construction). This section states that gulls have associated with vessels used in the construction of the Greater Gabbard Offshore Wind Farm. This raises the possibility that gulls will be attracted to construction and maintenance vessels for the EA ONE Offshore Wind Farm. It is important to understand the risk that attraction to maintenance vessels within the operational site would pose for lesser black-backed gulls and other seabirds that associate with vessels. The RSPB is of the view that there is not yet sufficient evidence to support the theory that gulls will habituate to presence of vessels that do not present feeding opportunities.	Acknowledged. Comment is made on gulls and vessel movements, but not referenced GGOWF.
RSPB	V2, p. 2-139 (section 2.5.4, impacts during operation). We question the interpretation of Thaxter et al. (2011) to suggest that it does not appear that EA ONE is within core foraging range of lesser black-backed gulls from the Alde Ore Estuary SPA and recommend a fuller consideration of the information in this report (and relevant cautions) for the final ES.	Data from BTO and RSPB tagging studies of lesser black-backed gulls breeding at the Alde-Ore colonies have been fully considered in *Section 12.5.2.4.9* of this chapter and have been used to assess the possible impacts of the operation of the East Anglia ONE site within *Section 12.1.1* of this chapter.
RSPB	V2, p. 2-142 (section 2.5.4, cumulative impacts). We note that data presented in ESs for other developments will be used to inform CIA – we recommend consideration is given to requesting raw data in respect of some other developments (i.e. other OWFs for purposes of	Acknowledged. However, it is not possible to secure confidential data until it is made publically available at the time of application. And this will be outside of East Anglia ONE Project development

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	CRA) as compatible methods may not have been used in some instances.	timelines.
RSPB	V2, p. 2-145 (section 2.5.4, cumulative collision risk). It would have been useful for a list of other OWFs to potentially be included in CIA to be listed in this section (as per preceding sections). We consider the other OWFs for inclusion will need to be informed by the available evidence from eg tracking studies and we are therefore pleased to note from other sections of the PEIR that this is the intention. We would suggest the list could potentially be greater (than that given at para. 542 in respect of cumulative disturbance/displacement impacts), for wider ranging species such as great black-backed gull, for which we note a considerable collision risk has been predicted for the recently submitted Triton Knoll proposal.	*Section 12.6.6.3.2* of this chapter lists the other offshore windfarms considered in the cumulative collision risk.
RSPB	V2, p. 2-145 (section 2.5.4, cumulative collision risk). Whether cumulative collision risk to low flying spp. is likely to be minimal will clearly need to be determined in the final ES. The cumulative impact from multiple OWFs may be of greater than negligible/minor significance even if collision risk at each is relatively small, and will also need to be considered in relation to the sensitivity of species to increases in background mortality rates and other factors.	CRM modelling has been undertaken for all species where sufficient numbers were recorded in flight in *Section 12.6.3.3* of this chapter. Such low numbers of divers and auks were recorded in flight that these species could not be modelled through a CRM. With respect to cumulative impacts, it is acknowledged that multiple **negligible/minor significant** impacts may warrant further consideration.
RSPB	V2, p. 2-146 (section 2.5.4, cumulative impacts). We would welcome further information on the reasons behind the suggestion that any increase in cumulative displacement effects would only be potentially significant if there was a concentration of activity in a single year within the main foraging areas for each species. This may not	Justification behind this is given in *Section 12.6.6.4.3* of this chapter.

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	necessarily be the case for some species, namely red-throated divers in relation to the OTE SPA.	
RSPB	V2, p. 2-146 (section 2.5.4, mitigation measures). The RSPB considers the question of whether any project specific mitigation is required will need to be answered by the assessment of all final information (eg final CRA using 24 months of survey data). It would seem premature at this stage to assert that mitigation will not be required in the absence of this. It is also unclear as to why this statement is made in this section when the summary of the PEIR chapter suggests (para. 587) that a number of techniques and methods can be implemented to reduce potentially significant impacts during the project inception and development stages, such as timing of construction and maintenance works.	A more robust mitigation section (*Section 12.7*) is included within this chapter, along with a residual impacts section (*Section 12.8*).

Table 12-1 Marine and Coastal Ornithology Consultation Responses

12.3 Scope

6 This chapter describes the ornithological interests within the East Anglia ONE site and the offshore cable corridor and evaluates the effects of the proposed offshore windfarm on this ornithological resource. Data relating to the 4km buffer surrounding the East Anglia ONE site are presented in *Volume 5, Appendix 12.1*.

7 The baseline includes information relating to the distribution and abundance of ornithological interests, key species characteristics such as flight height, direction of movement through the site, ecology and behaviour. The sensitivity of key species to particular types of disturbance and the implications for Special Protection Areas are also crucial aspects of the impact assessment (refer to HRA report).

8 The baseline information, worst case development scenario and embedded mitigation are considered so that possible impacts of construction, operation and decommissioning can be identified and their levels of significance can be assessed. Measures to prevent or reduce possible significant effects are discussed where appropriate. Cumulative impacts are considered when other offshore operations may overlap temporally with the East Anglia ONE site and offshore cable corridor.

12.3.1 Definition of the Study Area

12.3.1.1 The East Anglia ONE Project (offshore)

9 The study area includes the East Anglia ONE site and offshore cable corridor, along with the intertidal (cable landfall) area. The East Anglia ONE site lies within the North Sea, which as a whole is an important area for seabirds at all times of year. Many species nest on coastal sites during the spring / summer months; offshore areas can be important during this time as foraging grounds for non-breeding as well as breeding adults of some species. During migration periods, large numbers of migrants are present as they move from northerly breeding grounds to wintering areas in the UK, southern Europe and north-west Africa. In the non-breeding season, several species of seabirds are typically dispersed throughout the North Sea.

10 The ornithological interests of the East Anglia ONE site and its surrounding 4km buffer have been surveyed by both aerial survey and boat-based survey methods over 24 months between November 2009 and October 2011. The wider East Anglia zone has also been surveyed by aerial survey methods over 23 months of this period, between November 2009 and September 2011. In addition, intertidal surveys of the cable landfall area have been conducted over five winter months. These surveys and their timings are summarised in *Table 12-2*.

	2009		2010												2011												2012	
Summary of Site Specific Surveys and Timings																												
	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December	January	February
TCE enabling actions High Definition (HD) aerial video surveys																												
High Resolution (HR) aerial surveys – 3cm resolution																												
Boat-based surveys																												
High Resolution (HR) aerial surveys – 2cm resolution																												
Cable landfall (intertidal surveys)																												

Table 12-2 Summary of Site Specific Surveys and Timings

12.3.2 Embedded Mitigation

11 Embedded mitigation measures to reduce the impacts to ornithology are the careful site selection of the offshore windfarm to avoid European designated sites.

12.3.3 Worst Case

12.3.3.1 Construction

12 The worst case scenarios with respect to ornithology during the construction period of the East Anglia ONE project are discussed in *Table 12-3.*

12.3.3.2 Operation

13 The worst case scenarios with respect to ornithology during the operational lifetime of the East Anglia ONE project are discussed in *Table 12-4*.

12.3.3.3 Decommissioning

14 The worst case scenarios with respect to ornithology during the decommissioning phase of the East Anglia ONE project are discussed in *Table 12-5*

Worst Case Parameters for Ornithology during the Construction of the East Anglia ONE project				
Parameter During Construction	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
Disturbance and Displacement (D&D)	D&D from an increase in human-related activities, for example - vessel presence during construction works	Indicative vessel numbers considered in displacement to birds on site	**Foundation Installation - 12 vessels**	It must be noted that the total construction period is 2.5 years and is proposed to take place over 24 hours a day, 7 days a week.
			1x dredging vessel; 2x jack-up vessel, 2 x dynamic position heavy lift vessel; 4x support vessels; 3x tugs and barges for foundation delivery / gravity base spoil	Vessel numbers and types estimated as likely requirements in absence of detailed construction plan to be developed post consent and required to complete the project. An important note for consideration of impacts from vessels is that two different approaches to the development programme are proposed, one that involves a 3 phase approach to construction and one that involves a single phase for construction. In addition to this it must be noted that piling activities, for instance, would not be taking place across the entire construction period, so any worst case may not involve all vessels for all activities being on site and in operation at the same time.
			Turbine Installation - 14 vessels	
			2x jack-up vessel; 2x dynamic position heavy lift vessel; 2x accommodation / support vessels; 4x windfarm service vessels for transfer and logistics support; 4x support vessels	
			Collector/Converter Station Install - 7 vessels	
			1x installation vessel, 1x tug and accommodation barge; 1x supply vessel; 4x support vessels.	
			Cable Installation - 6 vessels	
			1x inter-array cable laying vessel; 1x	

Worst Case Parameters for Ornithology during the Construction of the East Anglia ONE project				
Parameter During Construction	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
			accommodation / support vessel; 1x export cable laying vessel; 2x export cable support vessels; 1x cable jetting and survey vessel.	
	D&D from both airborne and underwater noise associated with the installation of turbine (and met mast) foundations.	Maximum estimated airborne noise (airborne noise considered worse than underwater noise on birds) is from pile driving operations for turbine, met mast and other ancillary structures foundations.	**Wind Turbine Foundation Installation**	
			The maximum number of wind turbines is 325, so the worst case would be if this array design is taken forward and two turbines were to be installed with jacket foundations simultaneously until all 325 were completed. 325 Jacket foundations with four 2.5m diameter pin piles each, installed with a 900kj hammer	The worst case is based on a maximum of foundations being constructed at any one point in time, for which two jacket foundations would create most noise. It is considered that noise is a greater and more influential factor than that of increased suspended sediments associated with gravity base bed preparation or from suction bucket foundations.
			Met Mast, Collector Station and Converter Station Foundation installation	
			one met mast, three collector stations and two convertor stations on jacket foundations with four 2.5m diameter pin piles installed with a 900kj hammer.	The worst case includes the maximum number of ancillary structures required, as this allows for the maximum number of structures to be accounted for in the assessment.
	Indirect displacement	Prey species for	**Wind turbine and associated**	

Worst Case Parameters for Ornithology during the Construction of the East Anglia ONE project				
Parameter During Construction	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
	of birds due to a reduction in prey availability. Impacts caused by noise/suspended sediments may result in mobile species being displaced or an increase in turbidity levels hindering foraging by sight.	foraging birds are repelled from the site due to increased levels of turbidity. Birds unable to forage and hunt for prey due to decreased levels of visibility in water surrounding construction activities.	**ancillary structures installation**	
			240 gravity base foundations with 50m diameter base, including 120x120m seabed preparation (seabed preparation of 14,400m^2 per foundation) area plus an additional suction caisson foundation for the installation of one operational meteorological mast (seabed preparation 9,025m^2). Rock armour layer across the entire seabed preparation area of each foundation an area of 120m x 120m (14,400m^2), 1m in thickness. This area includes 50m diameter gravity base structure; plus 95 x 95m for the met mast foundation).	See *Volume 2, Chapter 6: Physical Processes and Volume 2, Chapter 9 Benthic and Epibenthic Environment*.
			Cable Laying	
			The proposed plans are for the cables to be buried. The worst case scenario for laying the full length of offshore export cable would involve jetting (80% of cables) and trenching (20% of cables) techniques,	It is understood that EAOW will bury the cables, except where there is a need to cross existing cables, pipelines and hard ground. It is anticipated that cable burying would by jetting would directly affect an area 5m wide, and trenching up to 50m wide, with some limited dredging required. Further information is provided in *Volume 2, Chapter 6 Physical Processes* and *Volume 2,*

Worst Case Parameters for Ornithology during the Construction of the East Anglia ONE project				
Parameter During Construction	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
			550km AC inter-array cables. *13x 10km HVAC interconnector three-core cables.* *4x 100km of HVDC offshore export cables* Limited "pre sweeping" of sandwaves (dredging) may be required in advance of laying the offshore export, interconnector and inter-array cables due to the prevalence of sandwaves across the East Anglia ONE site and offshore extent of the offshore cable corridor.	*Chapter 9 Benthic and Epibenthic Environment*. Worst case due to sediment disrupting effects that repel the benthic invertebrate and fish prey of some bird species, which in turn leads to there being an indirect displacement effect on birds. Recognising the ability of the seabed to recover from such stress, it is expected that this task would be of low significance and a locally temporary factor (*Volume 2, Chapter 9:Benthic and Epibenthic Environment*).
Habitat Loss/Change	The effect of increased loss of sea bed from the installation of foundations across the windfarm over the construction period. In the affected habitat this would have a direct impact on the benthic communities that are the prey of some seabirds, and would	The worst case scenario for habitat loss during construction is that associated with the techniques that remove or cover a greater area of sea bed eg gravity base foundations.	**Turbine and other ancillary structure foundations**	
			240 gravity base foundations with 50m diameter base, including 120x120m seabed preparation (seabed preparation of 14,400m^2 per foundation) area plus an additional suction caisson foundation for the installation of one operational meteorological mast (seabed preparation 9,025m^2). Rock armour layer across the entire seabed preparation area of each foundation an area of 120m x 120m	Based on maximum seabed area.

Worst Case Parameters for Ornithology during the Construction of the East Anglia ONE project				
Parameter During Construction	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
	result in the partial loss of a food resource for the birds.		(14,400m^2), 1m in thickness. This area includes 50m diameter gravity base structure; plus 95 x 95m for the met mast foundation). Total worst case loss of seabed: approximately 3.47km^2.	
			Cable	
			The worst case is based on the technique of burying the export cable using the 80% jetting and 20% trenching technique Some dredging of sandwaves may be required. *45 cable crossings, 100m lengths, 6m wide. (total area of 0.03km^2)*	Although a range of options are presented in *Volume 1, Chapter 4: Project Description*, the worst case is based on assumptions reported in *Volume 2, Chapter 6 Physical Processes* outlining jetting as the worst case in terms of suspended sediment concentrations and also discusses trenching and dredging. Rock dumping, mattressing or alternative techniques would only occur where cables are required to overlay other existing cables, pipelines or hard ground. This would impact most on the current seabed environment.

Table 12-3 Worst Case Parameters for Ornithology during the Construction of the East Anglia ONE site

Worst Case Parameters for Ornithology during the Operation of the East Anglia ONE site				
Parameter During Operation	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
Collision Risk	Mortality of birds from colliding with wind turbines and other ancillary structures.	The worst case is represented by the wind turbine array design that causes the highest collision risk for birds flying through the windfarm.	The worst case scenario would be for 325x 150m to tip height wind turbines with a rotor diameter of 120m, and a minimum air draft of 22m Mean High Water Spring (MHWS), spread across the site.	The worst case was based on a high-level modeling exercise that sought to examine the rotor swept area for various array designs, which showed 150 x 200m tip height wind turbines to be worse than 325 x 150m tip height wind turbines with respect to actual total swept area, but when other factors were considered, such as the speed of rotation, the 325 x 150m tip height wind turbine layout led to the highest predicted number of total collisions. Varying just the number of turbines and swept area showed that 325 turbines would lead in theory to more bird collisions per year, as birds have to avoid more turbines. The predicted impacts are an artifact of a mathematical model and may not reflect the biological environment therefore a range of worst case collision impacts has been modeled in parallel for comparison. Air draft = distance between lowest point of vertical blade and sea surface.
Barrier Effect	The presence of the East Anglia ONE site potentially creates a barrier to bird migratory and	It has been shown that some species (eg divers and seaducks) avoid windfarms and	The worst case scenario would be 325 150m tip height wind turbines with a 120m rotor diameter spread across the East Anglia ONE site. This would create the densest congregation of	As with CRM, the barrier effect has potential to be of concern to certain species.

Worst Case Parameters for Ornithology during the Operation of the East Anglia ONE site				
Parameter During Operation	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
	foraging routes that would depend upon the extent of the array design. This has the potential to result in long-term changes in bird movements.	take evasive detours, thereby increasing energy expenditure (Petersen & Fox 2007). Worst case will be the option with the maximum number of structures (turbines / substations / met masts) spread out evenly across the windfarm to the boundary edge.	turbines across the area of sea to be covered by the wind farm, maximising the potential barrier to foraging grounds and migration routes.	
Disturbance and Displacement (D&D)	The presence of wind turbines could cause birds to no longer utilise the sea both within the area of sea that is covered by the windfarm and to varying degrees away from the site in a buffer zone. This can alter feeding behaviour, particularly for more sensitive species.	It is known that certain species have been found to show avoidance of operational windfarms. The worst case scenario is that which will displace the most birds.	The worst case scenario would result in all birds being displaced from the windfarm site and a 4km buffer around the site.	The general approach to displacement is one that relies on the latest research carried out at operational UK and European OWFs that has led to differences in bird distribution and abundance prior to and after construction being published.

Worst Case Parameters for Ornithology during the Operation of the East Anglia ONE site				
Parameter During Operation	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
	Disturbance and attraction of birds away from or into the windfarm may result from the presence of maintenance vessels and operations on turbines, cables and other infrastructure over the 25-year life of the windfarm. Vessel activity may change the numbers of certain species present in the East Anglia ONE site as some species are attracted to boats (Kubetzki & Garthe 2003) while others are repelled (Garthe & Hüppop 2004).	The worst case scenario would involve the almost daily activity of vessels throughout the windfarm and export cable areas, and large vessel movements to and from the shore.	The worst case is associated with the windfarm design incorporating 325 wind turbines. Worst case calculations would involve up to 10 annual trips per wind turbine (so 3,250 visits for 325 turbines) and weekly visits to substations (262 visits for up to three collector stations and two converter stations).	A more calculated approach has been taken rather than a generic one based on estimates from 'windfarms', as the number of vessels to be used has been taken into account.
Habitat Loss/Change	Alteration of habitats post construction may alter the assemblage of species and prey availability within the footprint due to the presence of turbines	The worst case would be that no new species take up residence on the new foundations or bases leading to the loss of fish	The elimination of fish and benthic fauna from the footprint of the foundations and associated scour protection.	It is known that new benthic communities grow on and around new structures in offshore environments, which in turn provide new opportunities for both benthic and fish communities. This will have a net positive impact on benthic and fish communities, so therefore providing birds with additional prey to feed on within and around the footprint of

Worst Case Parameters for Ornithology during the Operation of the East Anglia ONE site				
Parameter During Operation	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
	and their associated bases and foundations. In the affected habitat this will have a direct impact on the benthic communities that are the prey of some seabirds, and will result in the partial loss of a food resource for the birds.	and benthic food sources for the 25-year life of the windfarm.		individual turbines and surrounding areas where the communities will spread in to.
Indirect Impacts	Attraction to illuminated structures - (turbines / platforms / met masts / sub stations) may attract / repel birds.	Birds may become disorientated or more susceptible to collision risk, particularly at night and during low light conditions (eg fog).	The worst case scenario is the option with the maximum number of structures with full lighting options;325 wind turbines, as this may increase the CRM if birds are attracted to the turbines, or increase collision with any other structures associated with the windfarm.	This provides for a maximum number of structures and associated lighting to be accounted for.

Table 12-4 Worst Case Parameters for Ornithology during the Operation of the East Anglia ONE site

Worst Case Parameters for Ornithology during the Decommissioning of the East Anglia ONE site				
Parameter During Decommissioning	**Impact Type**	**Worst Case Criteria**	**Worst Case Definition**	**Notes / Justification**
Disturbance and Displacement (D&D)	Acoustic impacts associated with removing foundations and scour protection.	Birds are repelled from areas around associated activities.	Removal of piled foundations by cutting or abrasive techniques to below the seabed surface As with construction efforts, any works are likely to be limited to being carried out on no more than two structures simultaneously. No impacts associated with cable decommissioning, as cables are likely to be de-rated, 'snipped' and left *in situ*, rather than actually removed from the sea bed. A further element of D&D will derive from vessel presence associated with decommisioning activities, considered to be similar to construction numbers	Any decommissioning works will be subject to change; particularly as and when new guidance and best practice develops from other offshore windfarms in other locations being decommissioned.
Habitat Loss/Change	Removal of foundations from windfarm will alter the benthic and fish communities that have established themselves on these structures.	Benthic communities will be removed and fish communities/habitat associated with all windfarm structures removed.	Foundations to be removed, but cables are likely to be 'snipped' and left *in situ*, rather than actually removed from the sea bed, which will reduce the impacts on both benthic, fish and birds in comparison to construction impacts.	Any decommissioning works will be subject to change; particularly as and when new guidance and best practice develops from other offshore windfarms in other locations being decommissioned.

Table 12-5 Worst Case Parameters for Ornithology during the Decommissioning of the East Anglia ONE site

12.4 Assessment Methodology

12.4.1 Guidance Documents

15 The impact assessment methodology adopted is based on the methodology proposed by Maclean et al. (2009) and the good practice guidance developed by the IEMA (2004) and the IEEM (2010). The IEEM guidance defines a significant effect as “an impact on the integrity of a defined site or ecosystem and/or the conservation habitats and species within a defined geographic area” (IEEM 2006).

16 The integrity of a site is defined as “the coherence of its ecological structure and function, across its whole area that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified” (IEEM 2006).

17 A number of steps are required as part of the impact assessment methodology to confidently assess the potential impacts the proposed development may have on ornithological interests using the proposed development area. These steps are discussed separately in the following sections and include:

- Definition and categorisation of generic sensitivity to disturbance;
- Definition and categorisation of sensitivity to windfarm specific disturbances;
- Definition and categorisation of magnitude of impact;
- Consideration of likelihood and application of professional judgement;
- Consideration of uncertainty and confidence in predictions;
- Definition of significance categories; and
- Assessment of significance of impacts using a matrix approach.

18 Species specific sensitivity is determined in the context of generic sensitivity to disturbance and likely specific disturbance due to the development of an offshore windfarm. Generic sensitivity categories and the process of assigning bird species to a category has been undertaken in accordance with the guidelines provided by Percival et al. (1999). Windfarm specific sensitivity categories and the process of assigning bird species to a category has been drawn from the methodology presented by Maclean et al. (2009) and based on the classification presented by Garthe & Hüppop (2004).

19 The main categories of windfarm specific impacts include; disturbance and displacement, direct and indirect habitat loss (including prey distribution), barrier effects and collision risk. In considering the sensitivity of a particular species to a disturbance, knowledge of the flexibility of a species in terms of habitat preference, behavioural habits and ecology, such as flight height and adult survivability, is used to determine sensitivity categorisation. Experience from post-construction monitoring and test studies is also informative.

20 Species specific ratings for generic sensitivity and impact specific sensitivity are combined in a sensitivity matrix as presented in Maclean et al. (2009) to determine overall sensitivity. This methodology follows a standard semantic scale, including negligible, low, medium and high, plus an additional 'very high' category, which is in line with the sensitivities and matrices in Maclean et al. (2009) and with the five point sensitivity scales in Garthe & Hüppop (2004).

12.4.2 Prediction Methods

21 In order to assess the potential impacts of the East Anglia ONE project on existing baseline ornithological conditions, and the significance of those impacts, a complete assessment has been undertaken on the key species and species groups known to be within the proposed East Anglia ONE site and a 4km buffer around it. Those species identified as of importance during migration periods, that may not have been regularly observed during the surveys, but are known to move through the site in potentially considerable numbers, have been modelled separately. A combination of impacts are predicted for these bird species, based on them being assessed through a collision risk model (CRM), alongside a qualitative assessment and using professional judgement to assess the significance of those impacts.

12.4.3 Significance Criteria

22 It is important to gauge the sensitivity of an ecosystem's components both on a broad scale, a site specific scale and a species specific scale to predict impacts. A development may have multiple impacts on the facets within its ecosystem so it is essential to quantify the sensitivity of its receptors to enable a more robust approach to assigning levels of magnitude to the predicted impacts. Once these levels have been established a reliable assessment can be made of the significance of these impacts to a species level as well as to the wider community (or ecosystem).

23 The quantification and assessment of significance of impacts on birds for the East Anglia ONE project has approached this matter by following a six stage process of assigning levels of sensitivity, including:

- Identification of the key species within the site;

- Assigning a non-impact specific value to each species, which is based upon both the legislative status of the species concerned and the importance of the site to that species in terms of international, national and regional populations;

- Using agreed and well documented species specific sensitivities (general sensitivity) to windfarm developments to apply a consistent approach to impact assessments;

- Producing a site-specific sensitivity based on the values of both the non-impact specific sensitivity and the general sensitivity;

- Calculating the magnitude of effects. The magnitude of effects upon these receptors is determined by reference to the extent to which key elements and / or features of the baseline conditions would be altered by the development; and

- Finally, once the first five stages have been completed the prediction of the significance of the developments impacts on the receptors can be made from applying the site specific sensitivity with the magnitude.

24 Where suitable references differ in opinion during each of the above stages a degree of expert opinion has been incorporated into the matrices and assessment process in order to achieve as robust an EIA as is possible.

12.4.3.1 Value and Sensitivity of the Resource or Receptor

25 The non impact-specific value of each of the ornithological interests identified by the baseline surveys is assessed in relation to its conservation status (Peterson *et al.* 2006) and the importance of the population in question with respect to international (biogeographic population and not entire world population), national and regional importance. It can then be assigned a value of very high, high, medium, low or negligible based on the information in *Table 12-6* in recognition of its status.

Definition of Terms Relating to the Non Impact-specific Value of Ornithological Receptors (Peterson et al. 2006).	
Non Impact-Specific Value	**Examples**
Very high	Bird species that form part of a cited interest of an SPA or Ramsar site that may potentially interact with the study area at some stage of their life cycle or A bird species which is present within the site in numbers of greater than 1% of the international (biogeographic) population
High	Bird species that form part of an assemblage qualification of an SPA that may potentially interact with the study area at some stage of their life cycle or A bird species which is present within the site in numbers of greater than 1% of the national population
Medium	Bird species that are listed on Annex I of the EU Birds Directive or on Schedule 1 of the Wildlife & Countryside Act 1981, requiring increased legal protection from disturbance during the breeding season or Species listed on the Birds of Conservation Concern (BoCC) Red list or Species that are the subject of a specific action plan within the UK Biodiversity Action Plan or A bird species which is present within the site in numbers of greater than 1% of the regional population
Low	Any other species of conservation interest, eg species listed on the BoCC Amber list
Negligible	All other species of low conservation concern

Table 12-6 Definition of Terms Relating to the Non Impact-specific Value of Ornithological Receptors (Peterson et al. 2006).

26 The general sensitivities of each species to each potential impact from the East Anglia ONE project are assigned to categories of very high, high, medium and low. This categorisation is based upon published material subjecting species vulnerabilities to a range of impacts associated with windfarms. This is discussed in detail in *Section 12.5.2.7*.

27 The general species sensitivities to each specific impact have then been cross-tabulated with the non impact-specific species values to produce an overall site-specific (East Anglia ONE site) sensitivity score (*Table 12-7*, based on Maclean *et*

al. 2009 and combined with expert judgement, where appropriate). It should be noted that these values appear over precautionary in relation to Maclean *et al* (2009), as no 'very low' level has been included, therefore an application of expert judgement will be applied within the assessment process to account for this.

Determination of Overall Site-specific (East Anglia ONE site) Sensitivities of Ornithological Features to Windfarm Specific Impacts (this is a generic variant of Tables 6.2.2.2, 6.2.3.2, 6.2.4.4 and 6.2.5.3 in Maclean et al. 2009)				
Non Impact-specific Value	**General Sensitivity to Windfarm Specific Impact**			
	Very high	**High**	**Medium**	**Low**
Very high	Very high	Very high	Very high	Medium
High	Very high	High	High	Medium
Medium	Very high	High	Medium	Low
Low	High	Medium	Low	Low

Table 12-7 Determination of Overall Site-specific (East Anglia ONE site) Sensitivities of Ornithological Features to Windfarm Specific Impacts (this is a generic variant of Tables 6.2.2.2, 6.2.3.2, 6.2.4.4 and 6.2.5.3 in Maclean et al. 2009)

12.4.3.2 Magnitude of Effect

28 Assessing and defining the magnitude of impacts requires consideration of a range of elements related to the nature of the impact including:

- Receptor exposure, i.e. likelihood of impact occurring;
- Nature of the impact, i.e. beneficial / adverse; indirect / direct;
- Extent of the impact (geographical area and the size of the population);
- Persistence of the impact and / or recoverability – short term (1 year), medium (2 to 10 years) or long term (>10 years);
- Reversibility, i.e. permanent / temporary;
- Timing and frequency of the impacts in relation to key sensitivities;

- Likelihood of impact occurring; and
- Potential for impact to be cumulative.

29 Magnitude therefore describes the extent or degree of change that is predicted to occur to the receptor. The magnitude of effects on each species has been based on the guidance in IEEM (2010), which offers a standardised ecological impact assessment approach, and is combined with expert judgement and is defined in *Table 12-8*.

Defining the Magnitude of Effect on Ornithological Receptors	
Magnitude	**Description**
Very high	Would cause the total loss or major alteration of a whole feature / population, or cause sufficient damage to a feature to immediately affect its viability. Irreversible. Guide: >80% population loss
High	Major effects on the feature / population, which would have a sufficient effect to irreversibly alter the nature of the feature in the short-to-long term and affect its long-term viability. Recovery expected to be long term i.e. 10 years following cessation of activity. Guide: >20-80% population loss
Medium	Effects that are detectable in short and long-term, but which should not alter the long-term viability of the feature / population. Recovery expected to be medium term i.e. five years following cessation of activity. Guide: >5-20% population loss
Low	Minor effects from baseline, either of sufficiently small-scale or of short duration to cause no long-term harm to the feature / population. Recovery expected to be short-term i.e. one year following cessation of activity. Guide: 1-5% population loss
Negligible	A potential impact that is not expected to affect the feature / population in any way. Very slight or no change from baseline. Therefore no effects are predicted. Recovery expected to be relatively rapid ~ six months following cessation of activity. Guide: <1% population loss

Table 12-8 Defining the Magnitude of Effect on Ornithological Receptors

12.4.3.3 Evaluation of Significance

30 The overall significance of an impact is a function of the magnitude of the impact and the sensitivity of the receptor. The sensitivity of the receptor species and the magnitude of the impact will be determined based on a combination of previously published evidence and professional judgement taking account of the specific factors associated with the East Anglia ONE project. It will also be based on survey data available at the time of the assessment. Post-construction data / studies where available for other offshore windfarm sites (eg Kentish Flats, Horns Rev) will be used to inform a range of impact scenarios (eg 100% displacement, 90%, 80%, etc). Published mean, mean maximum and maximum foraging ranges for relevant species will be used and plotted in GIS to assess overlap with the East Anglia ONE site and offshore cable corridor (see *Volume 6, Figures 12.6 to 12.10*) to investigate potential use of these areas by foraging birds and hence make an assessment of the likely significance of any identified impacts.

31 The significance of impact matrix in *Table 12-9* illustrates how the magnitude of impact and value / sensitivity is combined to assign the impact significance. Significance is described as Major, Moderate, Minor, Negligible or within a range (e.g. Moderate to Minor) for each species or species group within this impact assessment. However, if there is no evidence of impacts occurring then a significance level of no impact may be considered.

Defining the Significance of Impacts				
Impact Magnitude	**Site-specific (East Anglia ONE site) Sensitivity (calculated from *Table 12-7*)**			
	Very high	**High**	**Medium**	**Low**
Very high	Major	Major	Moderate	Moderate
High	Major	Moderate	Moderate	Minor
Medium	Moderate	Moderate	Minor	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Table 12-9 Defining the Significance of Impacts

32 The following definitions for the levels of significance explain the extent of the impacts being predicted, though the significance rating for impacts on each species within this ES does not solely rely upon these definitions:

- Major – A large change in site conditions, causing potentially serious concern for receptor, which is likely to be an important consideration at the national level or could result in exceedence of statutory objectives and or breeches of legislation;
- Moderate – Intermediate change in site conditions causing some concern for receptor, which is likely to be an important consideration at the regional level;
- Minor – A small change in site conditions, which may be raised as a local issue on receptor, but is of limited concern and unlikely to be important in the decision-making process. Considered not significant in EIA terms;
- Negligible – A very slight reduction in site conditions, which will not be of concern and is not significant in EIA terms; and
- No Impact – There is an absence of impacts of any significance on any source, pathway or receptor.

33 Using the above criteria and with rationale to explain the reasoning (based on expert judgement and scientific evidence), the predicted level of significance may be altered either upwards (eg from Minor to Moderate) or downwards (eg from Moderate to Minor) to enable the assessment process to provide the best estimate of the potential impacts of developing the East Anglia ONE project on the ornithological interests within the East Anglia ONE site and surrounding area. Furthermore, expert judgement has been used to provide additional commentary to describe the results of the significance of an impact to determine whether this is, for example, tolerable or not.

12.5 Description of Environmental Baseline

12.5.1 Data Sources

12.5.1.1 Site Specific Surveys

34 To assess the temporal and spatial ornithological abundance and distribution within the East Anglia ONE site, data were collected from high resolution digital aerial surveys. Boat based survey data were collected to inform proportioning of aerial survey data to species level where necessary.

35 The data collected by the site specific surveys listed below have been used to inform the baseline description and will be used to inform the impact assessment:

- Monthly aerial video surveys commissioned by The Crown Estate (TCE) as part of the enabling actions from November 2009 to March 2010;
- Monthly April 2010 to October 2011 High Resolution (HR) digital aerial surveys collected at 3 cm GSD resolution of the East Anglia ONE site commissioned by EAOW and undertaken by APEM Ltd from April 2010 to October 2011;
- Monthly boat-based surveys undertaken by the Institute of Estuarine Coastal Studies (IECS) and informing proportioning of aerial survey data from May 2010 to April 2011;
- Monthly May 2011 to October 2011 High Resolution (HR) digital aerial surveys collected at 2 cm GSD resolution undertaken by APEM Ltd and informing proportioning of aerial 3 cm GSD survey data from May 2011 to October 2011;
- Data from aerial video surveys (monthly surveys from November 2009 to March 2010) and HR digital aerial surveys (monthly surveys from April 2010 to October 2011) of the wider East Anglia zone, which covers approximately 30% of the offshore cable corridor area; and
- Data from intertidal surveys of the proposed cable landfall conducted by APEM between November 2011 and February 2012 at both low and high tide.

36 The methodologies adopted and the nature of the resulting data are detailed in *Volume 5, Appendix 12.1 Ornithology Baseline Technical Report (Section 2)*. In summary, the data were analysed to produce the following:

- Population estimates were generated for each species / group for every survey month for both the East Anglia ONE site alone and the East Anglia ONE site plus surrounding 4km buffer (see *Volume 5, Appendix 12.1, Section 2.3.1* for detailed methodology on how these estimates were generated). Where birds were only identified to group level (gulls and auks), data were proportioned out using the data on positively identified species of that group from the boat-based surveys and higher resolution digital images (see *Volume 5, Appendix 12.1 Section 2.3.1* and *Annex V* for methods and ratios used).

- A calculation for correction factors to account for the numbers of diving birds (divers and auks) under the water at the time of the aerial surveys has been completed on the counts and population estimates (see *Volume 5, Appendix 12.1 Annex VI* for details of the correction factor methodology). However, these corrected values have only been applied within the assessment process for auks (as the figures are compared to census data from colonies, therefore no birds are missed due to being out of sight, due to being underwater). Uncorrected data are assessed against for red-throated divers, as the primary data sources for populations are also based on uncorrected figures for comparison.

- The calendar year was divided up into biologically relevant periods/seasons (wintering, spring migration, breeding and autumn migration) specific to each species and from this mean peak population estimates for each season were calculated.

- Summed seasonal and monthly distribution maps for each species / group were produced in ArcGIS.

- The flight height and direction of birds in flight was recorded and analysed (see *Volume 5, Appendix 12.1 Section 2.3.2* for methodologies and *Volume 5, Appendix 12.1 Section 3.5* for an overview of the flight heights recorded using the HR digital still aerial survey data).

37 A stepwise approach was applied to the use of flight height data in collision risk modelling (CRM). Where sufficient data from flying birds were available, flight height data from digital surveys were used in the first instance. Where there were insufficient encounters with flying birds in the digital imagery, data from the site specific boat based surveys were utilised. In the event that neither of the site specific survey data sets provided sufficient data, the bird flight altitude data published in Cook *et al.* (2011) were used.

38 In addition, a detailed migration model has been constructed by APEM / BTO (under guidance from the Strategic Ornithological Support Services (SOSS)) to provide information on passage migrants, predominantly those waders and wildfowl associated with non-breeding SPAs in the UK. Passerines were not modelled owing to their extreme broad front migration, disparate UK distribution, difficulty in quantifying and r-selected ecology (highly productive, short generation time, early

sexual maturity). See *Volume 5, Appendix 12.2* for full details of the methodology used.

39 The species covered by the migration modelling were identified as those potentially at risk from the development of an offshore windfarm in the southern North Sea, based on a number of factors. This modelling exercise is recognised as the first of its kind used within an offshore windfarm application, so offers a genuine assessment of potential collision risk for the migrants to be identified within this EIA. For the purpose of this assessment three test species (dark-bellied brent goose, shelduck and knot) were chosen to run through the model. These species were chosen due to each being found in significant numbers, all making flights across the southern North Sea during migration periods and displaying different migration fronts.

40 A further set of ten species were identified as potentially at risk of collision and therefore most suitable to include in the modelling and subsequent collision risk modelling and impact assessment. This was based on species ranked as highest concern (from collision risk) identified by Langston (2010) in relation to offshore windfarms. This was coupled with additional information with regards to bird species, or sub-species, having one or more of the following attributes; a large population in East Anglia, (e.g. avocet), a large proportion of the UK population in East Anglia (e.g. Bewick's swan), a migration route predominantly across the southern North Sea (e.g. dark-bellied brent goose), and/or a large proportion of the UK population of a sub-species in East Anglia (e.g. Taiga bean goose). This assessment has identified those species considered most at risk to assess the potential impact from collision risk on migrating waders and wildfowl through the East Anglia ONE site. The species covered in this assessment were:

- Bewick's swan (*Cygnus columbianus bewickii*);
- Taiga bean goose (*Anser fabalis fabalis*);
- European white-fronted goose (*Anser albifrons albifrons);*
- Dark-bellied brent goose (*Branta bernicla bernicla);*
- Shelduck (*Tadorna tadorna);*
- Common scoter (*Melanitta nigra);*
- Avocet (*Recurvirostra avosetta);*
- Golden plover (*Pluvialis apricaria);*

- Knot (*Calidris canutus);*
- Dunlin (*Calidris alpine);*
- Black-tailed godwit (*Limosa limosa); and*
- Bar-tailed godwit (*Limosa lapponica);*

12.5.1.2 Other Information Sources

41 In addition to the site specific surveys, a range of other published data sources have been consulted:

- Published reports on all the Round 3 Zones including the East Anglia zone (Zone 5) (Langston 2010);
- Information where relevant and available for other offshore windfarm developments on the East Coast;
- Other published material covering atlases of seabirds, seabird populations, and migration movements (Stone et al. 1995; Mitchell et al. 2004; Wernham et al. 2002; Flegg 2004; Griffin et al. 2010; Kober et al. 2010);
- Information from tagging studies undertaken by statutory and non-statutory nature conservation organisations (RSPB and BTO), including at designated sites, for example gannets and kittiwakes at Flamborough Head and Bempton Cliffs and lesser black-backed gulls at the Alde-Ore Estuary;
- Offshore data from winter aerial surveys from 2003/04 and 2004/05 undertaken by WWT Consulting of Round 2 windfarm strategic areas (TH3 and TH4 most relevant to the offshore cable corridor area, covering up to 95% of the area); and
- Additional data from breeding colonies, local bird reports and wider reports.

12.5.2 Environmental Baseline

12.5.2.1 General Ornithological Context and Designated Sites

42 The East Anglia ONE site lies approximately 45km from the eastern shore of the UK at its nearest boundary, and approximately 64km at its furthest. Bird distribution and therefore importance of areas within the site for birds will depend on factors such as proximity to coasts (and thus breeding colonies), bathymetry (and thus access to benthic prey), suitability for prey including fish, location in relation to migratory

routes, range of dispersal of pelagic species and level of anthropogenic disturbance (eg from shipping and trawling).

43 The IPC Scoping Opinion lists 40 Special Protection Areas (SPAs) of potential relevance to the East Anglia ONE project (*Table 12-10*).

Relevant SPAs from IPC Scoping Opinion. Minimum distance refers to straight line distance from approximate centre of SPA to nearest edge of East Anglia ONE site.		
Name and Designation	**Species the site has been designated for either as Annex 1 species or regularly occurring migratory species not listed in Annex I**	**Minimum distance from East Anglia ONE (km)**
Outer Thames Estuary SPA (UK)	Wintering red-throated diver.	
Minsmere-Walberswick SPA / Ramsar Site (UK)	Wintering shoveler, gadwall, greater white-fronted goose, avocet, bittern and hen harrier. Breeding shoveler, teal, gadwall, little tern, avocet, bittern, marsh harrier, nightjar and woodlark.	
Alde-Ore Estuary SPA /Ramsar Site (UK)	Breeding avocet, sandwich and little terns, marsh harrier and lesser black-backed gull, Wintering avocet and redshank. Assemblages of breeding seabirds and wintering waterbirds.	
Breydon Water SPA / Ramsar Site (UK)	Breeding common tern, wintering avocet, Bewick's swan and golden plover and wintering waterbird assemblage.	
Broadland SPA / Ramsar Site (UK)	Breeding bittern and marsh harrier. Wintering marsh harrier, shoveler, wigeon, hen harrier, ruff, Bewick's swan, whooper swan and gadwall.	
Deben Estuary SPA / Ramsar Site (UK)	Wintering avocet and dark-bellied brent geese.	
Stour & Orwell Estuaries SPA / Ramsar Site (UK)	Wintering hen harrier, dark-bellied brent goose, black-tailed godwit, grey plover, dunlin, pintail, redshank, ringed plover, shelduck and turnstone. Wintering waterbird assemblage.	

Relevant SPAs from IPC Scoping Opinion. Minimum distance refers to straight line distance from approximate centre of SPA to nearest edge of East Anglia ONE site.		
Name and Designation	**Species the site has been designated for either as Annex 1 species or regularly occurring migratory species not listed in Annex I**	**Minimum distance from East Anglia ONE (km)**
Hamford Water SPA / Ramsar Site (UK)	Wintering avocet, golden plover ruff, black-tailed godwit, dark-bellied brent goose, grey plover, ringed plover and teal. Wintering waterbird assemblage. On passage ringed plover. Breeding little tern.	
Colne Estuary SPA / Ramsar Site (Mid Essex Coast Phase 2)	Breeding little tern and overwintering dark-bellied brent goose, avocet, golden plover, redshank and hen harrier. Wintering waterbird assemblage.	
Foulness (Mid-Essex Coast Phase 5) SPA / Ramsar site (UK)	Wintering dark-bellied brent goose, avocet, bar-tailed godwit, grey plover, knot, oystercatcher, redshank, and breeding sandwich tern, little tern common tern, ringed plover and avocet.	
Dengie (Mid-Essex Coast Phase 1) SPA / Ramsar Site (UK)	Wintering bar-tailed godwit, dark-bellied brent goose, grey plover, knot and hen harrier. Wintering waterbird assemblage.	
Blackwater Estuary (Mid-Essex Coast Phase 4) SPA / Ramsar Site (UK)	Wintering avocet, golden plover, hen harrier, ruff, dark-bellied brent goose, black-tailed godwit, dunlin, grey plover, redshank, ringed plover and shelduck. Wintering waterbird assemblage. On passage, ringed plover. Breeding little tern.	
Crouch & Roach Estuary (Mid-Essex Coast Phase 3) SPA / Ramsar (UK)	Wintering dark-bellied brent goose, bar-tailed godwit, grey plover and knot. Wintering waterbird assemblage.	
North Norfolk Coast SPA / Ramsar Site (UK)	Breeding bittern, marsh harrier, avocet, little tern, common tern and sandwich tern. Wintering wigeon, pink-footed goose, dark-bellied brent goose, knot, and avocet. Wintering waterbird assemblage.	
Benfleet & Southend Marshes SPA / Ramsar Site (UK)	Wintering dark-bellied brent goose, grey plover and knot. Wintering waterbird assemblage. On passage ringed plover.	

Relevant SPAs from IPC Scoping Opinion. Minimum distance refers to straight line distance from approximate centre of SPA to nearest edge of East Anglia ONE site.		
Name and Designation	**Species the site has been designated for either as Annex 1 species or regularly occurring migratory species not listed in Annex I**	**Minimum distance from East Anglia ONE (km)**
The Swale SPA / Ramsar Site (UK)	Wintering dark-bellied brent goose, dunlin and redshank. Breeding bird assemblage and wintering waterbird assemblage.	
Medway Estuary and Marshes SPA / Ramsar Site (UK)	Breeding avocet, little tern and common tern. Wintering pintail, shoveler, teal, wigeon, turnstone, dark-bellied brent goose, dunlin, knot, ringed plover, Bewick's swan, oystercatcher, black-tailed godwit, curlew, grey plover, great crested grebe, avocet, shelduck, greenshank and redshank. Breeding bird and wintering waterbird assemblages.	
Thames Estuary and Marshes SPA / Ramsar Site (UK)	Wintering hen harrier, avocet, dunlin, knot, black-tailed godwit, grey plover and redshank. On passage ringed plover. Wintering waterbird assemblage.	
Ouse Washes SPA / Ramsar Site (UK)	Breeding shoveler, mallard, garganey, gadwall and black-tailed godwit. Wintering hen harrier, Bewick's swan, whooper swan, ruff, pintail, shoveler, common teal, wigeon, gadwall, pochard, tufted duck, mute swan, coot and cormorant. Breeding bird and wintering waterbird assemblages.	
The Wash SPA / Ramsar Site (UK)	Breeding little tern and common tern. Wintering Bewick's swan, bar-tailed godwit, northern pintail, wigeon, gadwall, pink-footed goose, turnstone, dark-bellied brent goose, goldeneye, sanderling, dunlin, knot, oystercatcher, black-tailed godwit, common scoter, curlew, grey plover, shelduck and redshank. Wintering waterbird assemblage.	
Nene Washes SPA / Ramsar Site (UK)	Breeding shoveler, garganey, gadwall and black-tailed godwit. Wintering pintail, shoveler, teal, wigeon, gadwall and Bewick's swan.	
Dungeness to Pett Level SPA / Ramsar Site (UK)	Breeding Mediterranean gull, little tern, common tern. Wintering shoveler and Bewick's swan.	

Relevant SPAs from IPC Scoping Opinion. Minimum distance refers to straight line distance from approximate centre of SPA to nearest edge of East Anglia ONE site.		
Name and Designation	**Species the site has been designated for either as Annex 1 species or regularly occurring migratory species not listed in Annex I**	**Minimum distance from East Anglia ONE (km)**
Humber Estuary SPA / Ramsar Site (UK)	Breeding bittern, marsh harrier, avocet and little tern. Wintering teal, wigeon, mallard, turnstone, pochard, scaup, bittern, dark-bellied brent goose, goldeneye, sanderling, dunlin, knot, ringed plover, hen harrier, oystercatcher, bar-tailed godwit, black-tailed godwit, curlew, golden plover, grey plover, avocet, shelduck, redshank and lapwing. On passage, sanderling, dunlin, red knot, ringed plover, black-tailed godwit, whimbrel, ruff, grey plover, greenshank and redshank. Wintering waterbird assemblage.	
Arun Valley SPA /Ramsar Site (UK)	Wintering Bewick's swan and assemblages of wintering waterbirds.	
Flamborough Head & Bempton Cliffs SPA (UK)	Breeding kittiwake. Breeding gannet, herring gull, puffin, guillemot and razorbill are assemblage species.	
Chichester and Langstone Harbour SPA / Ramsar Site (UK)	Breeding little tern, sandwich tern and common tern. Wintering pintail, shoveler, teal, wigeon, turnstone, dark-bellied brent goose, sanderling, dunlin, ringed plover, bar-tailed godwit, red-breasted merganser, curlew, grey plover, shelduck, and redshank. Wintering waterbird assemblage.	
Lower Derwent Valley SPA / Ramsar Site (UK)	Breeding shoveler. Wintering teal, wigeon, Bewick's swan, ruff and golden plover. Wintering waterbird assemblage.	
Portsmouth Harbour SPA / Ramsar Site (UK)	Wintering dark-bellied brent goose, dunlin, black-tailed godwit and red-breasted merganser.	
Solent and Southampton Water SPA / Ramsar Site (UK)	Breeding Mediterranean gull, little tern, common tern, sandwich tern and roseate tern. Wintering teal, dark-bellied brent goose, ringed plover and black-tailed godwit. Wintering waterbird	

Relevant SPAs from IPC Scoping Opinion. Minimum distance refers to straight line distance from approximate centre of SPA to nearest edge of East Anglia ONE site.		
Name and Designation	**Species the site has been designated for either as Annex 1 species or regularly occurring migratory species not listed in Annex I**	**Minimum distance from East Anglia ONE (km)**
	assemblage.	
Avon Valley SPA / Ramsar Site (UK)	Wintering Bewick's swan and gadwall.	
Walmore Common SPA / Ramsar Site (UK)	Wintering Bewick's swan.	
Poole Harbour SPA / Ramsar Site (UK)	Breeding Mediterranean gull and common tern. Wintering black-tailed godwit, avocet and shelduck. Wintering waterbird assemblage.	
Severn Estuary SPA / Ramsar Site (UK)	Wintering gadwall, European white-fronted goose, dunlin, Bewick's swan, shelduck and redshank. Wintering waterbird assemblage.	
Martin Mere SPA / Ramsar Site (UK)	Wintering pintail, wigeon, pink-footed goose, Bewick's swan and whooper swan.	
Somerset Levels and Moors SPA / Ramsar Site (UK)	Wintering teal, Bewick's swan, golden plover and lapwing. Wintering waterbird assemblage.	
Chesil Beach and the Fleet SPA / Ramsar Site (UK)	Wintering dark-bellied brent goose.	
Ribble and Alt Estuaries SPA / Ramsar Site (UK)	Breeding lesser black-backed gull, black-headed gull, ruff and common tern. Wintering pintail, teal, wigeon, pink-footed goose, scaup, sanderling, dunlin, knot, Bewick's swan, whooper swan, oystercatcher, bar-tailed godwit, black-tailed godwit, common scoter, curlew, cormorant, golden plover, grey plover, shelduck, redshank and lapwing. On passage sanderling, ringed plover, whimbrel and redshank. Wintering waterbird and breeding	

Relevant SPAs from IPC Scoping Opinion. Minimum distance refers to straight line distance from approximate centre of SPA to nearest edge of East Anglia ONE site.		
Name and Designation	**Species the site has been designated for either as Annex 1 species or regularly occurring migratory species not listed in Annex I**	**Minimum distance from East Anglia ONE (km)**
	seabird assemblages.	
Exe Estuary SPA / Ramsar Site (UK)	Wintering dark-bellied brent goose, dunlin, oystercatcher, black-tailed godwit, grey plover, slavonian grebe, and avocet. Wintering waterbird assemblage.	
Lough Foyle SPA	Wintering whooper swan, bar-tailed godwit and pale-bellied brent goose. Wintering waterbird assemblage.	
Lough Neagh and Lough Beg SPA	Breeding common tern. Wintering Bewick's swan, whooper swan and pale-bellied brent goose. Wintering waterbird assemblage.	

Table 12-10 Relevant SPAs from IPC Scoping Opinion. Minimum distance refers to straight line distance from approximate centre of SPA to nearest edge of East Anglia ONE site.

44 Fifteen SPAs are designated for species for which have not been recorded during any of the site-specific surveys. However, many of these are designated for overwintering migratory wildfowl and wader species (including Bewick's swans, European white-fronted geese, shelduck, golden plover, avocet), which have been included in the migration modelling (see *Section 12.5.2.5* and *Volume 5, Appendix 12.2*).

45 Of the remaining 25 SPAs, dark-bellied brent goose is the sole designated species detected within the East Anglia ONE site for 12 of the SPAs (ranging geographically from the Exe Estuary SPA in Devon to the Humber Flats & Marshes SPA in Yorkshire / Lincolnshire) (*Volume 6, Figures 12.1 and 12.2*).

46 Six of the 25 remaining SPAs are designated for dark-bellied brent geese and breeding terns (either common or sandwich), with a further three of the 25 SPAs included for breeding terns and one (the Ribble and Alt Estuaries) designated for breeding lesser back-backed and black-headed gulls and common terns.

47 Three remaining SPAs are primarily designated for individual species of interest; the Outer Thames Estuary (wintering red-throated divers), Alde-Ore Estuary (breeding lesser black-backed gulls; with herring and black-headed gulls forming an important part of the wider breeding seabird assemblage qualification) and Flamborough Head and Bempton Cliffs (breeding kittiwakes; with gannets, guillemots, razorbills and herring gulls also forming part of the wider breeding seabird assemblage qualification).

48 Species of principal interest to the offshore cable corridor area will be those associated with nearby SPAs which encompass the offshore cable corridor area or are designated for species with foraging ranges encompassing the offshore cable corridor (*Volume 6, Figures 12.5* to *12.10*). There are several designated for both breeding and wintering birds, which would be of relevance. For example, part of the Outer Thames Estuary SPA (designated for wintering red-throated divers) overlaps the offshore cable corridor area (*Volume 6, Figures 12.1 & 12.5)*, whilst the Alde-Ore Estuary (designated for breeding lesser black-backed gulls) lies well within 181 km of the offshore cable corridor area (the maximum foraging range of lesser black-backed gulls recorded during the breeding season; Thaxter *et al.* 2012b) (*Volume 6, Figure 12.6*). Therefore, such species could potentially forage within this area. It is assumed that species associated with SPAs lying beyond known precautionary maximum foraging ranges are unlikely to forage within the offshore cable corridor area.

49 During the breeding season, the main species of interest are terns (little, common and sandwich terns) and gulls (lesser black-backed, herring and black-headed gulls) breeding along the Norfolk / Suffolk coasts, whilst during the winter season red-throated divers are present offshore. As the offshore cable corridor crosses near-shore and offshore marine areas, there is potential for interaction with all of these species.

50 Summed seabird distribution across the East Anglia ONE site and surrounding 4km buffer for the first year of aerial surveys (November 2009 to October 2010) is shown in *Volume 6, Figure 12.11*, whilst the distribution across the second year of surveys (November 2010 to October 2011) is shown in *Volume 6, Figure 12.12*. Detailed distribution per species / group by season is displayed in the relevant species accounts within *Volume 5, Appendix 12.1 Section 3.4*.

51 During the first year of surveys (November 2009 to October 2010), birds were generally distributed at densities up to 10 birds/km^2 across much of the East Anglia ONE site and 4km buffer. Higher densities of up to 41 to 50 birds/km^2 were recorded in the north-east of the buffer and up to 101 to 120 birds/km^2 were recorded in the south-west of the buffer (*Volume 6, Figure 12.11*).

52 In the second year of surveys (November 2010 to October 2011), birds were distributed across much of the East Anglia ONE site and buffer at densities of 1 to 5 birds/km^2. Densities of up to 11 to 20 birds/km^2 were recorded towards the west of the East Anglia ONE site and in the west, north-west and towards the north of the buffer. A high concentration of 81 to 100 birds/km2 was recorded to the north-west of the centre of the East Anglia ONE site (*Volume 6, Figure 12.12*).

12.5.2.2 Seabird Abundance within the East Anglia ONE Site

53 The division of the calendar year into biologically relevant periods for each species has been based largely on the information detailed in Wernham et al. (2002) on the definitions of seasons for each species. The rationale behind choosing this information is detailed in *Volume 5, Appendix 12.1 Section 2.1*. The exception to this is common scoter, as little information was available on timings of movements of this species in Wernham et al. (2002) or Kober et al. (2010) and therefore information in BWP (Cramp & Perrins 1997-1994) was used for this species. The division of the calendar year into the biologically relevant period for each species recorded within the East Anglia ONE site and surrounding 4km buffer used in the assessment is shown in *Table 12-11.*

Division of the calendar year into biologically relevant periods for all species recorded												
Species	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Common scoter												
Red-throated diver												
Fulmar												
Gannet												
Great skua												
Kittiwake												
Black-headed gull												
Common gull												
Lesser black-backed gull												
Herring gull												
Great black-backed gull												

Division of the calendar year into biologically relevant periods for all species recorded												
Species	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Guillemot	Wintering	Spring Migration	Spring Migration	Spring Migration	Breeding	Breeding	Breeding	Autumn Migration *	Autumn Migration *	Autumn Migration *	Wintering	Wintering
Razorbill	Wintering	Spring Migration	Spring Migration	Breeding	Breeding	Breeding	Breeding	Autumn Migration *	Autumn Migration *	Autumn Migration *	Wintering	Wintering
Puffin	Wintering	Spring Migration	Spring Migration	Breeding	Breeding	Breeding	Breeding	Breeding	Autumn Migration *	Autumn Migration *	Wintering	Wintering

Key:

(blue)	Wintering	(green)	Spring Migration	(yellow)	Breeding	(red)	Autumn Migration

Table 12-11 Division of the calendar year into biologically relevant periods for all species recorded

Note.The months that make up the biological period assigned to all three auk species for autumn migration is also considered to be a dispersal period from their breeding colonies during which they undergo their annual moult

54 Mean peak estimates for each season were calculated by taking an average of the peak estimate from the months making up the first year of a season (eg the peak estimate from spring migration 2010) and the peak estimate from the months making up the second year of the same season (eg the peak estimate from spring migration 2011). Mean peak estimates over the two years were used for assessment purposes in line with most long-term data sets (eg Wetland Bird Survey, WeBS). The use of mean peak estimates for assessment of the importance of sites and the data used in calculating national and international / biogeographic populations are based on data from such surveys. However, due to the snap shot nature of both aerial and boat-based surveys it was recognised that great sua numbers recorded passing through the East Anglia ONE site may not be a true reflection of the actual number migrating through during the spring and autumn passage periods, due to the nature of their migration and East Anglia ONE's location offshore. Therefore APEM have devised a simple method to calculate the movements (numbers) of great skuas through the East Anglia ONE site, which is outlined in Section 12.5.2.4.5.

55 Due to the timings of the surveys (November 2009 to October 2011) and the divisions of the calendar year into biologically relevant periods for each species, this has meant that for many of the species recorded (red-throated diver, fulmar, gannet, great skua, kittiwake, common gull, lesser black-backed gull, herring gull and great black-backed gull) the autumn migration period is complete for 2010, but incomplete

for 2009 and 2011. The data collected cover the end of the 2009 autumn migration period and the start of the 2011 autumn migration period. Due to this, the assessment of mean peak estimates for the autumn migration period for the species concerned has not used the mean of the peak counts from three autumn migration periods, as the timing of peak migration period in 2009 or 2011 may have occurred during the months when surveys were not conducted. Therefore, the mean of the peak estimate from the complete period (autumn 2010) and the peak estimate from either autumn 2009 or autumn 2011 has been calculated. This is demonstrated by using the data collected for gannets as an example (*Table 12-12*).

Gannet population estimates for each month surveyed that fall within the autumn migration period for this species (September – October). The two peaks used to calculate the mean peak estimates for gannet were those recorded in November 2009 (1,471) and November 2010 (2,187).		
Season	**Relevant Months**	**Gannet Population Estimate**
Autumn migration 2009	September 2009 October 2009 November 2009	No surveys No surveys 1,471
Autumn Migration 2010	September 2010 October 2010 November 2010	33 323 2,187
Autumn Migration 2011	September 2011 October 2011 November 2011	19 97 No surveys

Table 12-12 Gannet population estimates for each month surveyed that fall within the autumn migration period for this species (September – October). The two peaks used to calculate the mean peak estimates for gannet were those recorded in November 2009 (1,471) and November 2010 (2,187).

56 Densities, useful for comparison with published literature (eg Stone et al. 1995), were calculated by dividing the estimated abundance by the total East Anglia ONE site area, thus providing a density value in birds per km^2.

57 Mean peak estimates and densities of birds in the East Anglia ONE site recorded in aerial surveys for the relevant periods of the year are shown in *Table 12-13*.

58 Red-throated divers during the wintering period are considered to have fairly specific habitat requirements in terms of water depth requirements, being associated with shallow (between 0 to 20 m in depth, less frequently in depths of around 30 m) inshore waters (Natural England 2010). However, geophysical surveys undertaken

in 2010/11 recorded the average water depth within the East Anglia ONE site to be around 40m, meaning divers present within the East Anglia ONE site during the wintering period were generally found in deeper waters than might normally be expected. This suggests that these birds are observed in sub-optimal habitat. Too few published data are available to account for such variation in foraging effort (see *Volume 5, Appendix 12.1 Annex VI* for more detail on correction factor methodology). Due to the uncertainty of these correction factors, the mean peak population estimates presented within this environmental statement for divers have been calculated without the application of the correction factors.

59 The mean peak estimate for red-throated divers during the spring migration period in *Table 12-13* includes the peak of 414 birds recorded in March 2010. It is known that most British pairs return to breeding grounds in late March and April, with the first birds arriving on territories in the last few days of February in some years (Wernham et al. 2002). The March 2010 surveys were undertaken mid-month, so it is considered likely that this March peak in numbers represents birds on spring migration. Additionally, survey data collected in conjunction with other offshore wind developments within the Outer Thames Strategic Area (eg Galloper) have recorded peaks in numbers at a similar time and considered this to be an influx of birds on spring migration that had not necessarily overwintered in the Outer Thames Estuary SPA (Royal Haskoning 2011).

60 Overall estimates of bird abundance and densities are generally low in the East Anglia ONE site (*Table 12-13*) in comparison to areas closer inshore, with respect to few species being recorded in regionally important numbers and in comparison to data reported within document associated with other offshore windfarm sites and proposed sites in the southern North Sea.

Mean Peak Estimates and Densities of Birds								
Species	Winter		Spring Migration		Breeding		Autumn* Migration	
	Mean peak estimate	Mean peak density (birds/km^2)	Mean peak estimate	Mean peak density (birds/km^2)	Mean peak estimate	Mean peak density (birds/km^2)	Mean peak estimate	Mean peak density (birds/km^2)
Red-throated diver (excl correction factor)	79	0.26	207	0.69	0	0.00	65	0.22
Fulmar	53	0.18	66	0.22	33	0.11	253	0.84
Gannet	66	0.22	33	0.11	39	0.13	1,829	6.10
Great skua	0	0.00	0	0.00	0	0.00	6,112	20.37
Kittiwake	758	2.53	221	0.74	171	0.57	1,158	3.86
Black-headed gull	0	0.00	0	0.00	53	0.18	1	0.003
Common gull	0	0.00	79	0.26	17	0.06	65	0.22
Lesser black-backed gull	312	1.04	17	0.06	162	0.54	356	1.19
Herring gull	72	0.24	79	0.26	17	0.06	132	0.44
Great black-backed gull	17	0.06	50	0.17	15	0.05	857	2.86
Guillemot (incl. correction factor)	1,585	5.28	951	3.17	46	0.15	57	0.19

Mean Peak Estimates and Densities of Birds								
Species	Winter		Spring Migration		Breeding		Autumn* Migration	
	Mean peak estimate	Mean peak density (birds/km^2)	Mean peak estimate	Mean peak density (birds/km^2)	Mean peak estimate	Mean peak density (birds/km^2)	Mean peak estimate	Mean peak density (birds/km^2)
Guillemot (excl. correction factor)	*1,427*	*4.76*	*856*	*2.85*	*41*	*0.14*	*51*	*0.17*
Razorbill (incl. correction factor)	360	1.20	253	0.84	22	0.07	31	0.10
Razorbill (excl. correction factor)	*346*	*1.15*	*243*	*0.81*	*21*	*0.07*	*31*	*0.10*
Puffin	32	0.11	9	0.03	0	0.00	7	0.02

Table 12-13 Mean Peak Estimates and Densities of Birds

**Autumn migration also considered to be dispersal period for auks from colonies during which time they will undertake their annual moult*

12.5.2.3 Importance of the East Anglia ONE Site for Seabirds

61 The 1% population threshold is used to identify both nationally and internationally important concentrations of Annex I and regularly occurring migratory species. In the UK, holding such regularly occurring concentrations of a species can be enough to qualify an area for SPA status (Stroud et al. 2001).

62 The mean peak estimates for the East Anglia ONE site across both the winter and breeding periods have been compared to regional, national and international (relevant biogeographic or migratory flyway) 1% thresholds, to ascertain relative importance of the East Anglia ONE site for each species / group. A minimum threshold of 50 was used, which is consistent with, for example, Holt et al. (2011).

63 Regional 1% wintering thresholds were based on Stienen et al. (2007). This estimated the maximal resident population of seabirds within 51 to 52°N (approximately the southernmost part of the North Sea between Orford on the Suffolk coast and Dover to the south), and thus abuts the south of the East Anglia ONE site and encompasses much of the offshore cable corridor. These estimates are the most suitable published values for comparison.

64 *Table 12-14* shows that the East Anglia ONE site supports regionally important wintering numbers of red-throated divers, fulmars, kittiwakes, lesser black-backed gulls, guillemots (both with and without the application of the correction factor) and razorbills (both with and without the application of the correction factor).

65 Regional breeding thresholds were based on colony counts in Mitchell et al. (2004) that are within the maximum foraging ranges for each species given in Thaxter *et al.* (2012b) from the East Anglia ONE site. Although it is recognised that most birds will not fly to their maximum foraging range during each foraging journey, this approach was taken to ensure that all of the seabirds from designated sites that could reach East Anglia ONE were considered.

66 The East Anglia ONE site appears to support regionally important numbers of kittiwakes and lesser black-backed gulls during the breeding season, but none of the other species recorded reached numbers that exceed the regional 1% breeding thresholds (*Table 12-14*).

67 National and international 1% breeding thresholds were derived from breeding estimates in BirdLife International (2004) and WPEP4 (Delany & Scott 2006). International 1% thresholds were based on European breeding populations. Where these thresholds were originally given in pairs, the 1% threshold was calculated by doubling the figure to estimate the number of individuals, and then dividing this figure by 100. It should be noted that the 1% threshold applied might underestimate

the population as the breeding population does not include all the sub-adult birds that are not part of the breeding pool, but do contribute to the overall breeding population size. Therefore, where there are no breeding colonies of a species located within the maximum foraging range given in Thaxter *et al.* (2012b) from the East Anglia ONE site, the regional importance is assessed against the nominal 50 individuals or a 1% threshold.

68 During the breeding season the East Anglia ONE site does not support numbers of national or international importance of any of the species recorded *(Table 12-14*).

69 Winter national and international importance thresholds were derived from Holt et al. (2011) where possible. The qualifying levels presented in Holt et al. (2011) represent the most up-to-date figures following recent reviews and includes figures presented in Musgrove et al. (2011) for wildfowl and waders overwintering in Britain and in Banks et al. (2007) for gulls in Britain and the international criteria follow WPEP4 (Delany & Scott 2006).

70 However, as the Wetland Bird Survey does not systematically cover seabirds, such thresholds do not exist for all species. For these species, national importance was determined using 1% of the GB wintering population estimates in Baker et al. (2006) where available. However, seabirds such as fulmars and kittiwakes adopt a nomadic, pelagic distribution outside of the breeding season, and quantifying the numbers associated with marine areas bordering a country is futile. In the absence of such information in Holt et al. (2011) and Baker et al. (2006), national and international thresholds have been carefully considered and are based on 1% of the relevant breeding (rather than non-breeding) population. Although winter 1% thresholds from on land are available for great black-backed gull (Holt et al. 2011), comparing offshore winter peak estimates with these thresholds is somewhat meaningless, as this species is also pelagic and such thresholds do not account for those birds restricted to the marine environment.

71 The East Anglia ONE site does not support numbers of national or international importance of any of the species recorded during the wintering period (*Table 12-14*).

72 Regional importance thresholds during migration have been based on the estimated maximal numbers migrating through the Strait of Dover presented in Stienen et al. (2007). Estimates for fulmar, kittiwake or herring gull are not given as the populations of these species are large making it difficult populations to estimate their dispersing movements (Stienen et al. 2007). Therefore, Stienen et al. (2007) suggests that conservative percentages of 1 to 3% of the flyway population are used to estimate the numbers of these species migrating through the Strait of Dover.

73 Regionally important numbers of birds passing through the East Anglia ONE site included red-throated divers during spring migration only, gannets and kittiwakes during autumn migration only and guillemots and razorbills (both with and without the application of correction factors) during spring migration only (*Table 12-15*).

74 In the absence of suitable estimates of offshore migration at a large scale, thresholds for breeding populations were used to examine levels of national and international importance at times of spring and autumn migration.

75 This has resulted in a higher regional 1% threshold for common scoter, red-throated diver, great skua and black-headed gull than the national 1% threshold. This has occurred because the estimates presented in Stienen et al. (2007) for the estimated maximal numbers migrating through the Strait of Dover include birds passing through the area to breeding grounds in both Great Britain, Scandinavia, Iceland and northern and eastern Europe. Whilst the national estimates presented in BirdLife International (2004) relate only to birds breeding in Great Britain.

76 The peak spring estimates of red-throated divers exceed both the regional and national 1% thresholds (*Table 12-15*). However, as stated above (paragraph 77), as the numbers presented in Stienen et al. (2007) for the estimated maximal numbers migrating through the Strait of Dover (used for regional estimates) include red-throated divers passing through the area to breeding grounds in both Great Britain and Norway, and the national 1% threshold is based on the British breeding population, the regional threshold is considered the most appropriate to use for assessing the importance of the site at this time. Peak estimates of red-throated divers during the autumn migration period do not exceed the regional 1% threshold, but do exceed the national 1% threshold. Such movements perhaps reflect movements north or south away from or towards wintering grounds such as the Outer Thames Estuary SPA or areas further south off the Dutch and German coasts.

77 The survey data suggest that nationally important numbers of great black-backed gulls pass through the East Anglia ONE site during autumn migration. However, in the November 2010 survey, high aggregations of gulls were associated with a fishing vessel located in the north-west of the East Anglia ONE site. Great black-backed gulls are typically pelagic, commonly forage out at sea and are known to take discards from fishing trawlers (Camphuysen 1995; Hüppop & Wurm 2000). Therefore, the presence of a trawler may have caused the population estimate for this month to be inflated, which contravenes the basic assumption tha only birds naturally present within the study area are used to calculate population estimates and not those from more distant locations.

78 Within the offshore cable corridor, it is highly unlikely that thresholds of importance will be reached, owing to the long, narrow shape and the small area of sea affected.

Species Populations and Regional, National and International Importance Thresholds (Wintering / Breeding)										
Species	**Regional 1% Threshold[1]**		**National (GB) 1% Threshold[2]**		**International 1% Threshold[3]**		**Mean Peak Estimate in East Anglia ONE Site**		**Importance of Site****	
	Winter	**Breeding**	**Winter**	**Breeding**	**Winter**	**Breeding**	**Winter**	**Breeding**	**Winter**	**Breeding**
Common scoter	400	N/A	1,000	50* (2)	16,000	2,000	0	0	None	None
Red-throated diver (excl. correction factor)	50* (42)	N/A	170	50* (19)	3,000	640	79	0	R	None
Fulmar	50* (41)	50* (42)	10,120	10,120	56,000	56,000	53	33	R	-
Gannet	100	157	4,532	4,532	6,000	6,000	66	39	-	-
Great skua	50* (5)	N/A	192	192	320	320	0	0	None	None
Kittiwake	305	50* (0)	7,600	7,600	20,000	42,000	758	171	R	R
Black-headed gull	65	154	22,000	2,760	20,000	30,000	0	53	None	-
Common gull	205	50* (0)	7,000	974	20,000	11,800	0	17	None	-
Lesser black-backed gull	288	102	1,200	2,280	5,500	6,000	312	162	R	R
Herring gull	642	55	7,300	2,880	5,900	15,200	72	17	-	-
Great black-backed gull	251	50* (0)	760	350	4,406	2,200	17	15	-	-

Species Populations and Regional, National and International Importance Thresholds (Wintering / Breeding)										
Species	**Regional 1% Threshold[1]**		**National (GB) 1% Threshold[2]**		**International 1% Threshold[3]**		**Mean Peak Estimate in East Anglia ONE Site**		**Importance of Site****	
	Winter	**Breeding**	**Winter**	**Breeding**	**Winter**	**Breeding**	**Winter**	**Breeding**	**Winter**	**Breeding**
Guillemot (incl. correction factor)	293	50* (0)	19,040	19,040	40,000	40,000	1,585	46	R	-
Guillemot (excl. correction factor)	*293*	*50* (0)*	*19,040*	*19,040*	*40,000*	*40,000*	*1,427*	*41*	*R*	-
Razorbill (incl. correction factor)	62	50* (0)	2,520	2,520	8,600	8,600	360	22	R	-
Razorbill (excl. correction factor)	*62*	*50* (0)*	*2,520*	*2,520*	*8,600*	*8,600*	*346*	*21*	*R*	-
Puffin	50* (0)	50* (0)	12,420	12,420	106,000	106,000	32	0	None	None

* A minimum threshold of 50 has been applied (Holt *et al.* 2011), figures in brackets relate to the actual number of the 1% threshold

** A "-" is used wherever a species is present in less than Regionally Important numbers

[1]Breeding threshold from colony counts in Mitchell et al. (2004). Wintering threshold from data in Stienen *et al*. (2007) or Baker *et al.* (2006) where available and on breeding threshold if no wintering values available.

[2]Breeding threshold based on data in BirdLife (2004) – where numbers of breeding pairs are given as being between a range of two values, the lower value of the range has been used, consistent with the precautionary approach. Wintering threshold based on values in Holt *et al.* (2011) and breeding threshold if no wintering values available

[3]Breeding threshold based on data in BirdLife (2004) and Delany & Scott (2006) - where numbers of breeding pairs are given as being between a range of two values, the lower value of the range has been used, consistent with the precautionary approach. Wintering threshold based on values in Holt *et al.* (2011) and breeding threshold if no wintering values available

Table 12-14 Species Populations and Regional, National and International Importance Thresholds (Wintering / Breeding)

Species Populations and Regional, National and International Importance Thresholds (Migration)					
Species	**Regional 1% Threshold[1]**	**National (GB) 1% Threshold[2]**	**International 1% Threshold[3]**	**Mean Peak Migration Estimate in East Anglia ONE Site**	**Importance of Site during Migration****
Common scoter	600	50* (2)	2,000	0	None
Red-throated diver (excl. correction factor)	100	50* (19)	640	207 (spr)	R & N***
Fulmar	1,000	10,120	56,000	253 (aut)	-
Gannet	400	4,532	6,000	1,829 (aut)	R
Great skua	272	192	320	6,112[4] (aut & spr)	I
Kittiwake	840	7,600	42,000	1,158 (aut)	R
Black-headed gull	3,700	2,760	30,000	1 (aut)	-
Common gull	450	974	11,800	79 (spr)	-
Lesser black-backed gull	1,250	2,280	6,000	356 (aut)	-
Herring gull	140	2,880	15,200	132 (aut)	-

Species Populations and Regional, National and International Importance Thresholds (Migration)					
Species	**Regional 1% Threshold[1]**	**National (GB) 1% Threshold[2]**	**International 1% Threshold[3]**	**Mean Peak Migration Estimate in East Anglia ONE Site**	**Importance of Site during Migration****
Great black-backed gull	60	350	2,200	857 (aut)	R & N***
Guillemot (incl. correction factor)	200	19,040	40,000	951 (spr)	R
Guillemot (excl. correction factor)	*200*	*19,040*	*40,000*	*856 (spr)*	*R*
Razorbill (incl. correction factor)	50* (40)	2,520	8,600	253 (spr)	R
Razorbill (excl. correction factor)	*50* (40)*	*2,520*	*8,600*	*243 (spr)*	*R*
Puffin	50* (0)	12,420	106,000	9 (spr)	None

* A minimum threshold of 50 has been applied (Holt *et al.* 2011), figures in brackets relate to the actual number of the 1% threshold

** A "-" is used wherever a species is present in less than Regionally Important numbers

*** The regional threshold is greater than the national threshold as the regional threshold accounts for birds passing through the area to breeding grounds in both Great Britain, Scandinavia, Iceland and northern and eastern Europe, whilst the national estimates relate only to birds breeding in Great Britain

[1] Based on estimated maximal numbers migrating through the Strait of Dover (Stienen *et al.* 2007) – where numbers are given as being between a range of two values, the lower value of the range has been used, consistent with the precautionary approach

[2] Based on national breeding thresholds, derived from breeding estimates in BirdLife International (2004) and Delany & Scott (2006) – where numbers of breeding pairs are given as being between a range of two values, the lower value of the range has been used, consistent with the precautionary approach

[3] Based on international breeding thresholds, derived from breeding estimates in BirdLife International (2004) and Delany & Scott (2006) – where numbers of breeding pairs are given as being between a range of two values, the lower value of the range has been used, consistent with the precautionary approach

[4]Based on a precautionary approach to account for the snap shot nature of surveys and the nature of great skua migration

Table 12-15 Species Populations and Regional, National and International Importance Thresholds (Migration)

12.5.2.4 Seabird Species Accounts

12.5.2.4.1 Seaducks

12.5.2.4.1.1 Abundance and Distribution

79 Large numbers of common scoters *Melanitta nigra* have historically occurred in the Thames off several sites along the Essex coast. In recent years, the area around Foulness has been the most consistently used site, although the exact location and number of birds appears to be rather variable (Hall et al. 2003).

80 No scoters or seaducks were recorded within the East Anglia ONE site during any of the aerial surveys. However, an estimated 419 seaduck species were present within the East Anglia ONE site buffer in November 2010 and a single seaduck was recorded in the November 2010 survey of the East Anglia zone. These birds could not be identified to species level, but were considered to most likely be common scoters as this was the only seaduck species recorded during the temporally corresponding boat-based surveys. These records indicate the likelihood that small numbers of this group will use or pass through the East Anglia ONE site at certain times of the year.

81 Common scoters were found at very low density (0.001 to 25 birds per $4km^2$ or 0.00025 to 6.25 birds per km^2) in the area just north and south of the offshore cable corridor area during winter 2004/05, whilst no common scoters were recorded within this area during winter 2005/06 (DTI 2006; DBERR 2007). It is therefore considered possible that common scoters may utilise the offshore cable corridor area, but the numbers are likely to be too low to be of any regional, national or international importance.

82 Common scoters were also included on the list of species run through the migration model. The outputs of this are discussed in *Section 12.5.2.5.7*.

12.5.2.4.1.2 Ecology

83 Common scoters are migratory diving ducks which are coastally distributed in winter in the UK. Common scoter occur in shallow, inshore waters and are usually associated with sandy coasts where they prey upon common mussels *Mytilus edulis*, crustaceans and small fish (Kirby *et al*. 1993).

12.5.2.4.1.3 Behaviour

84 A total of 31 common scoters were recorded across all the boat-based surveys. Of these, all 31 birds were recorded in flight, which may be as a result of disturbance from the survey boat.

85 All of the common scoters were flying at heights of below 22m, meaning they were flying below the likely reach of the turbines (*Table 12-16*).

Summary of the number of common scoters recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
0	31	22 – 150 m	100	0.00

Table 12-16 Summary of the number of common scoters recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

86 Of the seaduck species recorded in flight during the aerial surveys, the four birds recorded within the 4km buffer area were flying in directions between south and south-south-west. As detailed above, these birds were considered to most likely be common scoter, as no other seaduck species were recorded during the temporally corresponding boat-based surveys.

12.5.2.4.2 Divers

12.5.2.4.2.1 Abundance and Distribution

87 Divers in the East Anglia ONE site are considered to be likely, almost exclusively, to be red-throated divers *Gavia stellata* owing to species distribution and abundance. Only one black-throated diver *Gavia arctica* was recorded during all of the boat surveys. The mean peak estimates of divers (assumed to all be red-throated divers) for each season is shown in *Table 12-17*.

88 Red-throated divers breed on lochs, lakes and small waterbodies, being largely confined as a UK breeding species to Shetland, Orkney and northern and western Scotland, reflecting the lack of records of this species during the surveys conducted in the breeding season *(Table 12-17*).

89 During winter, the species assumes an offshore distribution, concentrating in large aggregations in shallow (<20 m) waters. The Outer Thames Estuary SPA is one example of this. The mean peak winter estimate of 79 red-throated divers in the East Anglia ONE site reflects numbers below any national (170 individuals; O'Brien *et al.* 2008) or international threshold (3,000 individuals; Wetlands International 2006). However, this estimate does exceed the nominal 50 individuals required for regional importance (Stienen *et al.* 2007).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for red-throated divers.				
Season		**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site****
Wintering	Excl. correction factor	79*	0.26	Regional[1.9]
Spring Migration	Excl. correction factor	207	0.69	Regional[2.1] / National[10.9]
Breeding	Excl. correction factor	0	0	None
Autumn	Excl. correction factor	65	0.22	National[3.4]

* Peak in March 2010 is considered to be birds on early spring migration and hence included in the spring migration mean peak. Therefore, the peak estimate for the wintering period was based on peak estimates from December to February.
** Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.

Table 12-17 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for red-throated divers.

90 A marked change in the number and distribution of divers in the area has been known to occur between months (Hall *et al.* 2003). In some winters, a large influx has been noted, whilst in others, a more gradual build-up of numbers has occurred, with the precise timing of peak numbers varying between years. Large movements of birds have even been noted during the course of an individual survey (Hall *et al.* 2003).

91 Red-throated divers are widespread at coastal sites in the winter throughout the UK when numbers are boosted by arrivals from further north in Europe. The wintering mean peak estimate of 79 birds exceeds the regional wintering threshold, representing 1.9% of the regional population. The Outer Thames Estuary SPA is

designated solely for wintering red-throated divers and this estimate represents approximately 1.2% of the designated SPA population of 6,466 individuals.

92 It is known that most British pairs return to breeding grounds in late March and April, with the first birds arriving on territories at the earliest in the last few days of February in some years (Wernham *et al.* 2002). Red-throated divers from various sites have been seen in flocks of hundreds off the coast of East Anglia (Taylor *et al.* 1999), and there is substantial eastward passage along the south coast of England between March and May, the latter of which probably involve mainly Scandinavian birds since most British breeders are then already on territory (Okill 2002 in Wernham *et al.* 2002). It must also be noted that birds wintering along the south coast have greatly reduced in numbers by March, with peaks in January and February recorded off Dorset (Lane 2011), Hampshire (Cox 2011) and the Isle of Wight (Hunnybun & Hart 2011). Therefore it is considered likely that the peak of 414 birds represents birds on spring migration, as the March 2010 surveys were undertaken in mid-March. Therefore, this peak has been included in the calculation of the spring migration mean peak estimate of 207 birds presented in *Table 12-17* above. This mean peak estimate exceeds both the regional 1% migration threshold (representing 2.1% of the regional population) and also exceeds the lower national 1% threshold (representing 10.9% of the national population). However, the regional 1% migration threshold is higher than the national 1% migration threshold as the regional numbers account for both British and Norwegian breeding birds that pass through the Strait of Dover, whilst the national 1% threshold is based on the numbers of British breeding birds. Therefore, the regional 1% threshold is considered the most appropriate value to assess the importance of the site at this time.

93 A mean peak estimate of 65 birds was calculated for the autumn passage period. Therefore, it is possible that the birds recorded in spring and autumn were departing from or returning to wintering areas, including the Outer Thames Estuary SPA, heading to or from northerly breeding grounds. However, the provenance of birds recorded during these periods is unknown.

94 During all periods, there was no clear distribution pattern and divers appeared patchily spread across the East Anglia ONE site.

95 The numbers of divers using the offshore cable corridor area are not expected to be of international importance. Visual aerial surveys in 2004/05 revealed medium densities of red-throated divers in near-shore areas immediately off the Suffolk / Norfolk coast, in comparison to the wider Outer Thames (DTI 2006), where birds tended to be associated with the channels and sand banks. Densities were typically around 5 to 10 birds per $4km^2$, (i.e. 1.25 to 2.5 birds per km^2) lower than the highest densities recorded in the south of the SPA. The densities recorded during the

2004/05 visual surveys are comparable to the mean peak spring migration density of 0.69 birds per km^2 estimated from the aerial survey data collected during spring 2010 and 2011. Relatively low densities in the offshore cable corridor area were recorded in the following winter (rarely above 0 to 1 birds per $4km^2$, or 0 to 0.25 birds per km^2 in 2005/06: DBERR 2007).

12.5.2.4.2.2 Ecology

96 Red-throated divers are migratory, pursuit-diving, piscivorous predators, considered to be opportunistic feeders (Guse *et al.* 2009). Pursuit dives range from 2m to 9m in depth and birds can remain under water for up to one and a half minutes when hunting small fish (Cramp & Simmons 1977). During winter, when this species occurs almost exclusively in the marine environment, red-throated divers feed mainly on small pelagic fish species, including herring *Clupea harengus*, sprat *Sprattus sprattus* and lesser sandeels *Ammodytes marinus* (Durinck *et al.* 1994).

97 As divers feed largely on fish, a widespread and mobile distribution may be expected due to the mobility of their prey. Therefore, the numbers and timing of diver arrival to an area might be expected to be related to the seasonal occurrence of fish species, particularly if spawning (DTI 2006; DBERR 2007).

12.5.2.4.2.3 Behaviour

98 Across all the boat-based surveys, only five red-throated divers were recorded. Of these, four (80%) were in flight, which may be as a result of disturbance from the survey boat.

99 Of the four red-throated diver recorded in flight, 50% were estimated to be flying at heights of over 22m at heights where they may interact with the likely turbine sweep (*Table 12-18*).

Summary of the number of red-throated divers recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
1	4	22 - 150 m	50	50

Table 12-18 Summary of the number of red-throated divers recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

12.5.2.4.3 Fulmars

12.5.2.4.3.1 Abundance and Distribution

100 The mean peak estimates of fulmars *Fulmarus glacialis* for each season are shown in *Table 12-19*. Fulmars were recorded within the East Anglia ONE site, but were estimated to be low in abundance during the wintering period (mean peak winter estimate of 53) and spring months (mean peak spring estimate of 66). Higher numbers were estimated during the autumn, with a mean peak of 253 birds estimated for the autumn migration period.

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for fulmars.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	53	0.18	Regional[1.3]
Spring migration	66	0.22	-
Breeding	33	0.11	-
Autumn migration	253	0.84	-

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4]indicates that the East Anglia ONE site holds 2.4% of the national population. A “-“ indicates where the species was recorded in numbers below Regional Importance.

Table 12-19 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for fulmars.

101 Fulmars range widely when feeding and have been observed hundreds of kilometres from their colonies. They feed on a variety of planktonic organisms including crustaceans, cephalopods and small fish (Skov *et al.* 1995). Densities of fulmar in the southern North Sea are however typically low during the egg-laying and chick-rearing period (Stone *et al.* 1995) and this was demonstrated by the low numbers of this species recorded during the breeding period. The highest densities of these birds are commonly found around the shelf edge in north and west Scotland.

102 During the non-breeding season, fulmars adopt a pelagic distribution (Wernham *et al.* 2002) and gradually disperse southwards throughout the North Sea where they exist at relatively low densities in southern areas during the winter months (Stone *et al.* 1995). The mean peak wintering estimate of 53 just exceeds the 50 individuals

required for regional importance (Stienen *et al.* 2007), and is well below the 10,120 individuals required for national importance (based on breeding pairs, BirdLife 2004). At this time, densities were also low in the offshore cable corridor according to low level visual aerial surveys (DTI 2006; DBERR 2007). The spring peak of 66 birds is well below the 1,000 birds required for regional importance during migration and well below the breeding period national and international thresholds used for migration importance assessment at these levels.

12.5.2.4.3.2 Ecology

103 Fulmars are primarily surface-feeding polyphagous predators, ranging widely and feeding upon a variety of fish (including sandeels *Ammodytes* spp., sprats and small gadoids), large zooplankton (particularly amphipods and copepods) and squid (Skov *et al*. 1995). In addition, jellyfish are known to be an important food source during the breeding season in parts of the northeast Atlantic (Camphuysen & van Franeker 1996). Fulmars also scavenge discards from fishing vessels and trawlers (Camphuysen & Garthe 1997).

12.5.2.4.3.3 Behaviour

104 Of the 1,332 fulmars recorded across all the boat-based surveys a total of 795 birds 59.7%) were recorded in flight.

105 From these 795 fulmars, the vast majority were flying at heights that would put them below the reach of the rotors: 99.5% were at heights below 22m (*Table 12-20*).

Summary of the number of fulmars recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
537	795	22 – 150 m	99.50	0.50

Table 12-20 Summary of the number of fulmars recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

12.5.2.4.4 Gannets

12.5.2.4.4.1 Abundance and Distribution

106 The mean peak estimates of gannets *Morus bassanus* for each season are shown in *Table 12-21*. Gannetries are restricted to the north of the UK (although there is a large island colony at Grassholm in south Wales), with a general movement of birds south in autumn and north in spring. Gannets tend to winter along the coasts of West Africa, the Bay of Biscay and the Mediterranean Sea (Kubetzki *et al.* 2009; Wernham *et al.* 2002); there is therefore a passage movement south in autumn, with the reverse in spring as birds return to colonies.

107 Gannet numbers are highest in the East Anglia ONE site during the autumn migration period, with a mean peak autumn migration estimate of 1,829 birds. This estimate is below the threshold for national importance, but does exceed the 400 individuals required for regional importance (Stienen *et al.* 2007). The peak numbers during the autumn period were recorded in November, with numbers rapidly decreasing in winter. This short-lived increase in gannet numbers in late autumn with much lower numbers in winter likely represents the general movement of birds away from breeding colonies to a more dispersed pelagic distribution and to their southern wintering grounds (Stone *et al.* 1995).

108 Although abundance was highest during the autumn migration periods, abundance was relatively low during the spring migration periods, with a mean peak estimate of 33 birds. Estimates derived from surveys undertaken by Tasker *et al.* (1987) indicate that gannet numbers typically peak in the North Sea during these periods. The data suggest that the East Anglia ONE site could regularly experience relatively high numbers of gannets on passage in the autumn, but not on return passage in the spring. In both November 2009 and November 2010 greater than 1,000 gannets were estimated to be present within the East Anglia ONE site from the aerial surveys (*see Volume 5, Appendix 12.1 Section 3.4.6.1*), therefore indicating that the surveys were sufficient to pick up gannet migration.

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for gannets.			
Season	**Mean peak population estimate**	**Density (birds/km²)**	**Importance of East Anglia ONE site***
Wintering	66	0.22	-
Spring migration	33	0.11	-
Breeding	39	0.13	-
Autumn migration	1,829	6.10	Regional[4.6]

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.

Table 12-21 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for gannets.

109 During the breeding season, large numbers of gannets in the North Sea form breeding colonies, for example at Bass Rock and Bempton Cliffs. During this time adults may regularly forage 450km from the colony (Schreiber & Burger 2002), with the distances birds will travel from the colony positively correlated with colony size. Densities of foraging birds will however decline with increased distance away from the breeding colony (Dunnet *et al.* 1990; Camphuysen 2011), which would explain the very low densities recorded within the East Anglia ONE site during the summer months, as the East Anglia ONE site is approximately 300km from the nearest breeding colony.

110 Gannets were almost entirely absent from the East Anglia ONE site during the breeding season, except for an estimated 65 birds in August 2010 and an estimated 13 birds in June 2011, giving a mean peak breeding season estimate of 39 birds. These estimates are below the thresholds for regional, national or international importance.

111 Throughout all seasons gannets were distributed evenly throughout the area, although at differing densities. Gannets feed on a wide range of pelagic species including sandeel, mackerel and herring. Observations of gannet feeding behaviour at sea have shown that birds will often take advantage of discards from whitefish boats when sandeels are unavailable (Tasker *et al.* 1985).

112 In relation to the offshore cable corridor, in 2004/05 the distribution of gannets across the wider Thames Strategic Area tended to be patchy and the numbers of birds recorded in the survey blocks were too low for density maps to be produced. In the most relevant survey blocks to the offshore cable corridor (TH3 and TH4), numbers peaked in the early winter survey period with peak counts of 39 gannets recorded in this period, whilst in TH4 a single gannet recorded in the early winter period was the only bird recorded in this block through winter 2004/05 (DTI 2006). In 2005/06 gannet distribution was highly concentrated in the south-east limits of the survey area in the survey blocks located south of the offshore cable corridor area and very low densities (0.001 to 0.25 birds per $4km^2$ or 0.00025 to 0.0625 birds per km^2) were present within the offshore cable corridor area (DBERR 2007). Numbers were very low through the summer, although a small increase was noticed during the post fledging/moult period in both TH3 and TH4 in the 2004/05 surveys (DTI 2006). Such low densities are unlikely to be of any regional, national or international importance. In the aerial surveys of the East Anglia zone between November 2009 and March 2011, gannets were most abundant in winter with very little variation in numbers between years (APEM 2011a).

12.5.2.4.4.2 Ecology

113 Gannets are piscivorous predators, taking a wide variety of prey sizes and species including mackerel *Scomber scombrus*, herring, sprats and sandeels (Hamer *et al*. 2001). Gannets are also among the dominant scavengers for discards from trawlers (Tasker *et al*. 1985; Camphuysen & Garthe 1997). Furthermore, gannets often feed in multi-species assemblages or in association with cetaceans (Camphuysen *et al.* 2007).

114 Thaxter *et al.* (2012b) lists the maximum foraging range of breeding gannets as 590 km, with a mean maximum range of 229.4 ± 124.3km and a mean range of 92.5 ±59.9km. The nearest breeding colony at the Flamborough Head and Bempton Cliffs SPA is approximately 275km from the East Anglia ONE site. Therefore, although the East Anglia ONE site falls within the maximum foraging range for this species, the mean range and mean maximum range do not reach as far as the East Anglia ONE site (*Volume 6, Figure 12.7*), which may suggest that it is outside of the core foraging area for birds from this colony.

115 An RSPB tagging study (funded by DECC) of gannets breeding at the colony at Bempton Cliffs tagged 14 adult birds in July 2010 and a further 13 adults in July 2011. Data from this study indicate that gannets from the breeding colony at Bempton Cliffs do not forage in the vicinity of East Anglia ONE. In both years a small number of locations were recorded within the wider East Anglia zone, but all were to the north of the zone and outside of the East Anglia ONE site (Langston & Boggio 2011; RSPB 2012). In the 2010 breeding season most locations fell within

100km of Bempton Cliffs and in 2011 fell within 150km of the colony, with the highest density of locations in both years within 50km. The average foraging range in 2010 (straight-line distance from Bempton) was 63.6 ± 8.9km, which is lower than that given by Birdlife 2010, and the maximum range recorded was 308km (Langston & Boggio 2011). This helps explain the low numbers estimated in the East Anglia ONE site in summer. However, these results are for a relatively small sample of adult gannets from just two partial chick-rearing periods. Therefore, it is unclear whether these data are representative of year to year foraging activity by breeding gannets from the Bempton Cliffs colony (RSPB 2012).

116 Several of the tags from the RSPB study continued to transmit data into the post breeding period. Post breeding adult gannets from the Bempton colony showed different dispersal strategies and more activity was noticed in the East Anglia zone area. Locations of tagged birds during September and October 2011 (early post breeding dispersal) show activity throughout much of the East Anglia zone, including the East Anglia ONE site (RSPB 2012).

12.5.2.4.4.3 Behaviour

117 Of the 1,318 gannets recorded across all the boat-based surveys a total of 1,005 birds (76.3%) were recorded in flight.

118 From these 1,005 gannets, the majority were flying at heights that would put them below the rotors: 74.83% were below 22m (*Table 12-22*).

Summary of the number of gannets recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
313	1,005	22 – 150 m	74.83	25.17

Table 12-22 Summary of the number of gannets recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

119 Gannet orientation from birds captured in the HR digital images was not significant during any season in which they were recorded. This may be due to the small sample sizes in all seasons except autumn migration 2010. In November (autumn) 2010 surveys, high aggregations of gulls and gannets were associated with a fishing vessel present in the area, which is likely to have affected gannet abundance and

orientation, with birds flying towards and away from the boat that was located in the north-west of the East Anglia ONE site.

12.5.2.4.5 Skuas

12.5.2.4.5.1 Abundance and Distribution

120 Great skuas *Stercorarius skua* were only recorded within the East Anglia ONE site during the autumn migration period, when a mean peak estimate of 16 birds were present. Additionally, an estimated 32 skuas (considered most likely to have been great skuas) were present within the buffer area around the East Anglia ONE site in September 2010, which is consistent with the peak month in the North Sea from previous surveys (Tasker *et al.* 1987). These estimates do not exceed the 272 birds required for regional importance during the migration period, which is based on the estimated maximal numbers migrating through the Strait of Dover in Stienen *et al.* (2007).

121 However, due to the snap shot nature of both aerial and boat-based surveys no surveys are able to capture the complete movements of great skuas through a area such as the East Anglia ONE site due to the nature of their migration and East Anglia ONE’s location offshore. Therefore, APEM have devised a simple method to calculate the movements (numbers) of great skuas through the East Anglia ONE site. The method is based on a highly precautionary approach and the basic calculation is as follows:

- The total flyway population of great skuas is estimated at 27,200 birds (Stienen *et al.* 2007;
- All of these birds pass through the Strait of Dover during the autumn migration period;
- The East Anglia ONE site’s eastern boundary is approximately 60 km from the coast at its furthest point;
- It is assumed, as a precautionary approach, that 90% of birds (24,480) will fly between 0-60km off the Norfolk coast, with the remaining 10% flying further out between eastern boundary of the East Anglia ONE site and the continental European coastline;
- The East Anglia ONE site is 14.98km in width at its widest point and therefore the East Anglia ONE site accounts for 24.96% of the 0 to 60 km flyway corridor width;

- Based on the above, a total of 6,112 great skuas could potentially fly through the East Anglia ONE site during the autumn migration period (*Table 12-23*); and

- Although no great skuas were recorded during the spring migration period the same number have been been modelled during this period for this assessment, as a precautionary measure.

122 This estimate of 6,112 birds exceeds the international 1% migration threshold, accounting for 1.1% of the international population, based on the breeding population in BirdLife (2004).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for great skuas.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia site***
Wintering	0	0.00	None
Spring migration	6,112**	20.37	International[1.1]
Breeding	0	0.00	None
Autumn migration	6,112**	20.37	International[1.1]

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4]indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.
** Based on a precautionary approach to account for the snap shot nature of surveys and the nature of great skua migration

Table 12-23 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for great skuas.

123 Skuas do not breed or winter in the vicinity of the East Anglia ONE project, being confined largely to Orkney and Shetland in summer and wintering mainly in southern Europe (Wernham *et al.* 2002). Small numbers of skuas (both arctic and great), were recorded during the winter periods from visual aerial surveys covering the offshore cable corridor area (DTI 2006; DBERR 2007).

124 A single skua was recorded in the East Anglia zone during the October 2010 survey. Additionally, slightly elevated concentrations of Pomarine skua *Stercorarius pomarinus*, Arctic skua *Stercorarius parasiticus*) and great skua have been modelled during the breeding and passage season for the south of the East Anglia zone (Kober *et al.* 2010).

125 Migratory routes relevant to the offshore cable corridor area are considered to be similar to those associated with the East Anglia ONE site, although there may be greater or lesser activity closer to the coast, dependent on species behaviour. For example, great skuas on migration tend to remain at least 2 to 5km from the coast (Wernham *et al.* 2002) and are considered by Stienen *et al.* (2007) to be offshore species that are rarely observed within 20km from the coast. Therefore, fewer birds may pass through the offshore cable corridor area closer to the coast. Great skuas feed primarily on fish discarded from trawlers, and food pirated from other species, but due to diminishing fish stocks in the North Sea, they will seek alternative prey including other seabirds (Mitchell *et al.* 2004).

12.5.2.4.5.2 Ecology

126 Great skuas are migratory species, typically wintering off Iberia. This species predates primarily upon fish species including sandeels, whiting *Merlangius merlangus*, herring and mackerel (BirdLife International 2012). Prey is obtained directly via surface-feeding or indirectly from trawler discards (Camphuysen & Garthe 1997) or through kleptoparasitising prey from other seabird species (including auks, gannets, gulls and terns; Hamer 2001). However, due to diminishing fish stocks within the North Sea, great skuas also predate upon alternative food sources, including other seabird species (Mitchell *et al*. 2004).

12.5.2.4.5.3 Behaviour

127 A total of 95 great skuas were recorded across all the boat-based surveys. Of these, 75 (78.9%) were recorded in flight.

128 Of the 75 great skuas in flight, the majority were flying at heights that would put them below the reach of the rotors: 85.33% were at heights below 22m (*Table 12-24)*.

Summary of the number of great skuas recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
20	75	22 – 150 m	85.33	14.67

Table 12-24 Summary of the number of great skuas recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

129 In addition to the great skuas, a total of four Arctic skuas were recorded across all the boat-based surveys. Three of these four birds (75%) were recorded in flight, all at heights of below 22m and below the reach of the turbine rotors.

12.5.2.4.6 Kittiwakes

12.5.2.4.6.1 Abundance and Distribution

130 The mean peak estimates of kittiwakes *Rissa tridactyla* for each season are shown in *Table 12-25.* Kittiwake numbers are highest in the East Anglia ONE site during the autumn migration period, with a mean peak autumn migration estimate of 1,158 birds. This estimate is below the threshold for national importance, but does exceed the 840 individuals required for regional importance (Stienen *et al.* 2007). The peak numbers during the autumn period were recorded in November.

131 Relatively high numbers of kittiwakes were recorded during the wintering period, with a mean peak wintering estimate of 758 birds recorded. During the wintering period high densities of kittiwakes are known to occur throughout the North Sea, reflecting a preference for pelagic habitats (Stone *et al.* 1995).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for kittiwakes.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	758	2.53	Regional[2.5]
Spring migration	221	0.74	-
Breeding	171	0.57	Regional[3.4]
Autumn migration	1,158	3.86	Regional[1.4]

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance. Note: as there are no kittiwake breeding colonies within the maximum foraging range for kittiwakes (given in Thaxter *et al.* 2012b) from the East Anglia ONE site, the percentage of regional importance is assessed against the nominal 50 1% threshold (5,000 individuals).

Table 12-25 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for kittiwakes.

132 During the breeding period, kittiwakes congregate around breeding colonies on islands and at coastal sites (Cramp & Simmons 1977). Low densities are commonly found offshore during this period (Stone *et al.* 1995). The numbers of kittiwakes

recorded during the breeding season were relatively low with a mean peak estimate of 171 birds. This estimate is well below the threshold for national importance (7,600 birds), but does exceed the nominal 50 required for regional importance. However, there are no kittiwake breeding colonies within the maximum foraging range of 120km detailed in Thaxter *et al.* (2012b) as the nearest breeding colony at Flamborough Head and Bempton Cliffs SPA is located a minimum of 275km from the East Anglia ONE site. Therefore, it is likely that the birds recorded within the East Anglia ONE site during the breeding season are non breeding birds.

12.5.2.4.6.2 Ecology

133 Kittiwakes tend to forage at sea and adopt a pelagic distribution in the non-breeding season. Localised distribution patterns may be heavily influenced by trawler activity (Kubetzki & Garthe 2003). During the breeding season the vast majority of kittiwakes tend to be congregated near coastal breeding sites, with fewer birds found in offshore areas (Cramp & Simmons 1977).

134 Kittiwakes are pelagic surface-feeding predators, taking fish by shallow plunge-diving (BirdLife International 2012). Prey species include small, pelagic shoaling fish such as sandeels, sprats and young herring. Planktonic invertebrates and fishery discards are also known to feature in the diet of kittiwakes (del Hoyo *et al*. 1996).

135 Breeding kittiwakes are a designated feature of the Flamborough Head and Bempton Cliffs SPA. This is the largest colony for this species in England, though it has recently declined from an estimated 83,370 pairs (Stroud *et al.* 2001) to 37,617 (JNCC, 2009). However, other east coast colonies have increased over that period with an increase from 1,564 to 2,031 pairs at Scarborough Castle Headland and South Bay (Hopper, 2012) between 1987 and 2011. Thaxter *et al.* (2012b) lists the maximum foraging range of breeding kittiwakes as 120km, with a mean maximum range of 60.0 ± 23.3km and a mean range of 24.8 ± 12.1km (*Volume 6, Figure 12.7*). The breeding colony at the Flamborough Head and Bempton Cliffs SPA is approximately 275km from the East Anglia ONE site. Therefore, the East Anglia ONE site is located further than the maximum foraging range for this species from this colony.

136 Preliminary GPS-tagging data obtained from RSPB for 2009 to 2011 from the RSPB study of kittiwakes at the Flamborough Head and Bempton Cliffs SPA suggest that birds from this colony do not travel as far as the East Anglia ONE site, offshore cable corridor area or the East Anglia zone (*Volume 6, Figure 12.4*). A single bird was successfully tracked in June 2009 (during the chick-rearing phase), a total of 22 birds were tracked during June and July 2010 (during the incubation and chick-rearing phases) and 17 birds were tracked during June 2011 (also during the incubation and chick-rearing phases). As with the lesser black-backed gull study,

the small numbers of birds and short periods of time involved mean that the extent of the area used by the colony as a whole during the course of the entire breeding season is likely to be underestimated. Additionally, as tracking has only been conducted for a few years, there is no information on how widely foraging areas may differ over longer timescales (Mark Bolton *pers. comm*.). This reinforces the low numbers estimated in the East Anglia ONE site in summer.

12.5.2.4.6.3 Behaviour

137 Gulls vary in their feeding patterns dependent on their size. Kittiwakes forage close to the surface, but also exhibit a tendency to dive (Dunnet *et al.* 1990), which may influence flight altitudes and potentially collision risk.

138 Of the 1,434 kittiwakes recorded across all the boat-based surveys a total of 456 birds (31.8%) were recorded in flight.

139 From these 456 kittiwakes, the majority were flying at heights that would put them below the reach of the rotors: 78.73% were at heights below 22m (*Table 12-26*).

Summary of the number of kittiwakes recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
978	456	22 – 150 m	78.73	21.27

Table 12-26 Summary of the number of kittiwakes recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

140 Of the positively identified kittiwakes recorded as being in flight during the HR digital still aerial surveys conducted between April 2010 and October 2011, a significant orientation was recorded in the 2010 autumn migration period ($\mu = 320.72°$, $r = 0.97$, $P = 0.000$, see *Volume 5*, *Appendix 12.1 Section 3.4.9.6* for further details). A fishing vessel present in the area in November 2010 (autumn migration 2010) is likely to have affected kittiwake orientation, with birds flying towards and away from the boat. Due to the small sample sizes of positively identified kittiwakes, it was not possible to meaningfully measure the orientation of flying birds in the other seasons in which they were recorded (breeding season and autumn migration period of 2011).

12.5.2.4.7 Black-headed gulls

12.5.2.4.7.1 Abundance and Distribution

141 The mean peak estimates of black-headed gulls *Chroicocephalus ridibundus* for each season are shown in *Table 12-27*. Black-headed gulls were recorded within the East Anglia ONE site during the breeding season when a mean peak estimate of 53 birds was recorded and during the autumn migration period when a mean peak estimate of a single bird was recorded. The birds present during these periods are considered likely to be individuals breeding at coastal estuaries such as the Alde-Ore Estuary SPA. However, black-headed gulls were absent from aerial surveys during the autumn (September to October) and wintering (November to February) periods, reflecting a general movement inland (Wernham *et al*. 2002).

142 The mean peak estimates for both periods (breeding and autumn migration) are well below the thresholds (154 birds for breeding and 3,700 birds for migration) required for regional importance (Mitchell *et al.* 2004; Stienen *et al.* 2007).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for black-headed gulls.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	0	0.00	None
Spring migration	0	0.00	None
Breeding	53	0.18	-
Autumn migration	1	0.003	-

* Numbers following the level of importance represent the actual percentage of importance, eg National indicates that the East Anglia ONE site holds 2.4% of the national population. A “-“ indicates where the species was recorded in numbers below Regional Importance.

Table 12-27 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for black-headed gulls.

12.5.2.4.7.2 Ecology

143 Black-headed are opportunistic predators, reflecting their diverse range of inland, coastal and offshore habitats (Kubetzki & Garthe 2003). Prey items consumed include worms, insects, marine invertebrates (including gastropods and crustaceans), fish and amphibians (Vernon 1972). During winter in particular, black-headed gulls rely heavily on artificial food sources provided by man.

144 Black-headed gulls form part of the breeding seabird assemblage qualification for the Alde-Ore Estuary SPA: 1,582 pairs of black-headed gulls (Stroud *et al.* 2001). Thaxter *et al.* (2012b) report the mean foraging range of breeding black-headed gulls to be 11.4 ± 6.7km, the mean maximum foraging range to be 25.5 ± 20.5km and the maximum foraging range to be 40km. Therefore, as the minimum distance of the Alde-Ore SPA from the offshore cable corridor area overlaps the potentially affected area and the maximum distance is approximately 54km, the foraging range of black-headed gulls from the Alde-Ore colony could potentially overlap with parts of the offshore cable corridor.

12.5.2.4.7.3 Behaviour

145 As with kittiwakes, black-headed gulls also forage close to the surface, but also exhibit a tendency to dive (Dunnet *et al.* 1990), which may influence flight altitudes and potentially collision risk.

146 A total of 24 black-headed gulls were recorded across all the boat-based surveys, all of which were recorded in flight.

147 Of the 24 black-headed gulls in flight, approximately two thirds (66.67%) of birds were flying at heights of below 22m, which would put them below the reach of the rotors (*Table 12-28*).

Summary of the number of black-headed gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
0	24	22 – 150 m	66.67	33.33

Table 12-28 Summary of the number of black-headed gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

12.5.2.4.8 Common gulls

12.5.2.4.8.1 Abundance and Distribution

148 The mean peak estimates of common gulls *Larus canus* for each season are shown in *Table 12-29*. Common gull numbers are highest in the East Anglia ONE site during the spring migration period, with a mean peak spring migration estimate of 79 birds. A similar number was recorded during the return autumn migration period, with a mean peak autumn migration estimate of 65 birds. The occurrence of this species during the migration periods may be due to the movement of breeding birds to and from their wintering areas in the southern North Sea (Stone *et al.* 1995).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for common gulls.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	0	0.00	None
Spring migration	79	0.26	-
Breeding	17	0.06	-
Autumn migration	65	0.22	-

* Numbers following the level of importance represent the actual percentage of importance, eg National$^{2.4}$ indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.

Table 12-29 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for common gulls.

149 Very few common gulls were present during the breeding season (mean peak breeding estimate of 17 birds). This is probably due to movement of common gulls away from offshore areas during this time to their northern and eastern breeding grounds at coastal sites (Stone *et al.* 1995).

12.5.2.4.8.2 Ecology

150 As with black-headed gulls, common gulls are opportunistic predators, reflecting their diverse range of inland, coastal and offshore habitats (Kubetzki & Garthe 2003). Prey items consumed include worms, insects, marine invertebrates (including gastropods and crustaceans), fish and amphibians (Vernon 1972). During winter in particular, common gulls rely heavily on artificial food sources provided by man.

12.5.2.4.8.3 Behaviour

151 As with kittiwakes and black-headed gulls, common gulls forage close to the surface, but also exhibit a tendency to dive (Dunnet *et al.* 1990), which may influence flight altitudes and potentially collision risk.

152 A total of 23 common gulls were recorded across all the boat-based surveys. Of these, 21 birds (91.3%) were recorded in flight.

153 All of the 21 common gulls recorded in flight were flying at heights of below 22m, meaning they were flying below the likely reach of the turbines (*Table 12-30*).

Summary of the number of common gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area for the two different rotor swept areas to be considered				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
2	21	22 – 150 m	100	0.00

Table 12-30 Summary of the number of common gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area for the two different rotor swept areas to be considered

12.5.2.4.9 Lesser black-backed gulls

12.5.2.4.9.1 Abundance and Distribution

154 The mean peak estimates of lesser black-backed gulls *Larus fuscus* for each season are shown in *Table 12-31.* Lesser black-backed gull numbers are highest in the East Anglia ONE site during the autumn migration period, with a mean peak autumn migration estimate of 356 birds. This estimate is below the 1,250 birds required for regional importance (Stienen *et al.* 2007).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for lesser black-backed gulls.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	312	1.04	Regional[1.1]
Spring migration	17	0.06	-
Breeding	162	0.54	Regional[1.6]
Autumn migration	356	1.19	-

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.

Table 12-31 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for lesser black-backed gulls.

155 Recent data from the DECC GPS tagging study of lesser black-backed gulls breeding at Orford Ness conducted by the BTO found that five of the six tagged birds migrated to Spain and Morocco to winter (Thaxter *et al.* 2011). Additionally, the southern North Sea represents the northern-most extent of the wintering range and beyond this point densities are commonly low and more dispersed (Stone *et al.* 1995). Therefore, the autumn peak in numbers is most likely due to an influx of foreign birds (from Scandinavia and the Continent) en route to more southerly wintering grounds in south-west Europe and north-west Africa (Wernham *et al.* 2002).

156 Tagging studies suggest that some lesser black-backed gulls breeding in The Netherlands may cross to the UK before migrating south, but most position fixes of birds exhibiting this behaviour were north of the East Anglia ONE site (Ens *et al*. 2009; Klaassen *et al*. 2011).

157 Relatively high numbers were also present within the East Anglia ONE site during the wintering period, with a mean peak wintering estimate of 312 birds. This estimate is below the threshold for national importance, but does exceed the 288 individuals required for regional importance (Stienen *et al.* 2007).

158 Estimates of lesser black-backed gulls in the East Anglia ONE site were relatively low during the breeding season with a mean peak estimate of 162 birds. This estimate does exceed the 102 birds required for regional importance (Mitchell *et al*. 2004), but is well below the 2,280 required for national importance (BirdLife 2004).

This is perhaps not surprising as the numbers of lesser black-backed gulls at the nearest breeding colony, the Alde-Ore Estuary SPA have declined dramatically since the site was designated in 1996. The key reasons for this decline relate to predation, habitat deterioration and recreational disturbance (RSPB *pers. comm*.; Mason 2010). Periodic outbreaks of botulism have also affected this population and changes to pig farming abundance on surrounding farmland may also have had some influence (RSPB *pers. comm*.; National Trust 2010).

12.5.2.4.9.2 Ecology

159 The diet of the lesser black-backed gull is more varied than that of other gulls (Bustnes *et al.* 2010). The lesser black-backed gull is omnivorous and the diet includes vertebrates (eg small mammals, birds) and invertebrates of suitable size (eg beetles, flies, ants), plant material (eg seaweed, berries), and rubbish (Cramp & Simmons 1983). Birds can be seen feeding in flocks of hundreds on rubbish dumps or over shoals of fish at sea. A wide variety of fish species are predated upon, including sandeels, spats, herring and gadoids. Molluscs, crustaceans and annelid worms also form part of the diet. Lesser black-backed gulls are also known to forage on trawler discards (Camphuysen & Garthe 1997; Bustnes *et al.* 2010). This variability is the main cause of their recent strong population growth in the North Sea (Schwemmer & Garthe 2005). However, numbers of lesser black-backed gulls have declined massively at the Alde-Ore Estuary SPA since the site was designated (National Trust 2010; Mason 2010).

160 Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA (21,700 pairs, Stroud *et al.* 2001).

161 Lesser black-backed gulls observed within the East Anglia ONE site plus buffer were recorded foraging on average 60km from the Alde-Ore SPA colony. This is well within the mean foraging range of 71.9 ± 10.2km and mean maximum foraging range of 141 ± 50.8km reported by Thaxter *et al.* (2012b) for lesser black-backed gull during the breeding season and the 135km feeding range reported by Camphuysen (1995).

162 Initial tagging data from a BTO study for DECC of lesser black-backed gulls breeding at the Alde-Ore Estuary SPA in 2010 suggest that whilst there is use of the East Anglia zone by birds in the breeding season, it does not appear that the East Anglia ONE site is contained within the core foraging range of most birds examined (Thaxter *et al.* 2011; *Volume 6, Figure 12.6*). The 19 birds GPS-tagged by the BTO in 2010 and 2011 made 3,404 trips, of which 87% were solely inshore or coastal (very near coast), 6% were offshore, 4% straddled inshore and offshore habitat, and 2% were to float on the sea just offshore (Thaxter *et al*. 2011).

163 Preliminary data obtained from RSPB of all offshore and coastal trips recorded from two lesser black-backed gulls tracked in June 2010 (during incubation phase) and 10 birds tracked in May and June 2011 (during the incubation phase) from the RSPB study of lesser black-backed gulls at the Alde-Ore also suggest that there is use of the East Anglia zone by the birds at this time, but no tracks passed through the East Anglia ONE site (*Volume 6, Figure 12.3*). Additionally, a single bird tracked in 2010 and three birds tracked in 2011 foraged entirely inland for the duration of the time the birds were tracked (*Volume 6, Figure 12.3*). Given the small numbers of birds tracked and the short periods of time involved, the limits of the area accessed are therefore likely to underestimate the extent of the area used by the colony as a whole during the course of the entire breeding season. This is particularly likely during the chick rearing period when food demands are higher and foraging behaviour may differ (Mark Bolton *pers. comm*.). Tracks that appear to indicate birds moving in relatively straight lines outside of the normal pattern may be due to birds following boats (particularly fishing vessels) in and out of the areas usually utilised. However, it is unlikely that all of the birds recorded within the site are breeding birds from the Orfordness SPA, as it is likely that some of the birds will be non-breeding immature birds or even birds from other breeding colonies. An attempt has been made in the assessment process to split the birds recorded within the East Anglia ONE site into those from the regional and SPA populations and also to separate those that may be non-breeding individuals.

164 As the minimum distance of the Alde-Ore Estuary SPA from the offshore cable corridor area overlaps the potentially affected area and the maximum distance is 54km, it is possible given the 71.9km mean foraging range during the breeding season listed in Thaxter *et al.* (2012b), that lesser black-backed gulls from this colony could potentially forage within the offshore cable corridor area (*Volume 6, Figure 12.6*). The tracks of birds tagged by the RSPB study (*Volume 6, Figure 12.3*) shows that tagged birds were present along the cable route, however, despite this tagging data illustrating where birds have been, there is no indication from these studies that birds were foraging, resting or flying at any given point.

12.5.2.4.9.3 Behaviour

165 Large gull species, including lesser black-backed gulls generally feed close to the surface (Dunnet et al. 1990), which may influence flight altitudes and potentially collision risk.

166 A total of 1,118 lesser black-backed gulls were recorded across all the boat-based surveys. Of these, 754 birds (67.4%) were recorded in flight.

167 Of the 754 lesser black-backed gulls recorded in flight, the majority were flying at heights that would put them below the reach of the rotors: 73.74% were at heights below 22m (*Table 12-32*).

Summary of the number of lesser black-backed gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
364	754	22 – 150 m	73.74	26.26

Table 12-32 Summary of the number of lesser black-backed gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

12.5.2.4.10 Herring gulls

12.5.2.4.10.1 Abundance and Distribution

168 The mean peak estimates of herring gulls *Larus argentatus* for each season are shown in *Table 12-33*. Herring gull numbers are highest in the East Anglia ONE site during the autumn migration period, with a mean peak autumn migration estimate of 132 birds. This estimate is just below the 140 birds required for regional importance (Stienen *et al.* 2007).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for lesser herring gulls.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	72	0.24	-
Spring migration	79	0.26	-
Breeding	17	0.06	-
Autumn migration	132	0.44	-

* Numbers following the level of importance represent the actual percentage of importance, eg National$^{2.4}$ indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.

Table 12-33 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for lesser herring gulls.

169 The peak in numbers during the autumn migration period is thought, in part, to be due to an influx of birds from northern colonies into their offshore wintering areas (Stone *et al.* 1995), as following the end of the breeding season, herring gulls are known to increase throughout the North Sea and English Channel as their range extends further out to sea (Stone *et al.* 1995). However, in the November 2010 survey, high aggregations of gulls, including herring gulls, were associated with a fishing vesse located in the north-west of the East Anglia ONE site that is also likely to have contributed to higher numbers during thi period.

170 Lower numbers were recorded during the return spring migration period, when a mean peak estimate of 79 birds was recorded. This estimate does not reach the numbers required for regional importance. These birds may be birds heading back to their breeding areas to the north and to the Netherlands coast and the German Bight where they are known to exist at very high densities in coastal areas (Stone *et al.* 1995).

171 Herring gull numbers during the wintering period were relatively low with a mean peak estimate of 72 birds recorded. This did not reach the 642 birds required for regional importance and perhaps reflects the widespread and dispersed distribution of this species recorded throughout the area during the winter by previous studies (Olsen & Larsson 2004; Stone *et al.* 1995).

12.5.2.4.10.2 Ecology

172 Gull species, including herring gulls, tend to forage at sea and adopt a pelagic distribution in the non-breeding season. Localised distribution patterns may be heavily influenced by trawler activity (Kubetzki & Garthe 2003).

173 Herring gulls are considered generalist predators and forage in a variety of habitats including the low tidal and shallow subtidal zones, offshore, mudflats, landfills and within seabird colonies (Rome & Ellis 2004). The species is considered a klepto-parasite, meaning birds steal from other gulls (Dunnet *et al.* 1990). In coastal areas of Europe, the species feeds on discarded fish products (Camphuysen 1995; Hüppop & Wurm 2000).

174 Herring gulls form part of the breeding seabird assemblage qualifications for both the Alde-Ore Estuary and the Flamborough Head and Bempton Cliffs SPAs: 6,050 pairs at the Alde-Ore Estuary SPA and 1,110 pairs at the Flamborough Head and Bempton Cliffs SPA (Stroud *et al.* 2001). However, as with lesser black-backed gulls, numbers of herring gulls at the Alde-Ore Estuary have declined, partly due to predation (Mason 2010).

175 Thaxter *et al.* (2012b) report the mean foraging range of breeding herring gulls to be 10.5km, the mean maximum foraging range to be 61.1 ± 44km and the maximum foraging range to be 92km. Therefore, East Anglia ONE is within the maximum foraging range of Alde-Ore SPA herring gulls, as is the offshore cable corridor area.

176 The Flamborough Head and Bempton Cliffs SPA is located a minimum of 252km and from the offshore cable corridor and a minimum of 275km from the East Anglia ONE site, making the East Anglia ONE site and the offshore cable corridor outside of the maximum foraging range of herring gulls.

12.5.2.4.10.3 Behaviour

177 Herring gulls generally feed close to the surface (Dunnet *et al.* 1990), which may influence flight altitudes and potentially collision risk.

178 Of the 326 herring gulls recorded across all the boat-based surveys a total of 177 birds (54.3%) were recorded in flight.

179 From these 326 herring gulls, the majority were flying at heights that would put them below the reach of the rotors: 70.62% were at heights below 22m (*Table 12-34*).

Summary of the number of herring gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
149	177	22 – 150 m	70.62	29.38

Table 12-34 Summary of the number of herring gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

12.5.2.4.11 Great black-backed gulls

12.5.2.4.11.1 Abundance and Distribution

180 The mean peak estimates of great black-backed gulls *Larus marinus* for each season are shown in *Table 12-35.* Great black-backed gull numbers are highest in the East Anglia ONE site during the autumn migration period, with a mean peak autumn migration estimate of 857 birds. This estimate exceeds both the 60 and 350 birds required for regional and national importance respectively (Stienen *et al.* 2007; BirdLife 2004).

181 Great black-backed gulls are numerous in the North Sea on passage to their wintering grounds (Coulson *et al.* 1984). During autumn migration, great black-backed gulls are very abundant in the North Sea with up to 45% of the world's population present at this time (Stone *et al.* 1995). Many of these birds are likely to be birds of British and Norwegian descent which over winter on the east coast of England (Coulson *et al.* 1984; Wernham *et al.* 2002).

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for lesser great black-backed gulls.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	17	0.06	-
Spring migration	50	0.17	-
Breeding	15	0.05	-
Autumn migration	857	2.86	Regional[14.3]/National[2.4]

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.

Table 12-35 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for lesser great black-backed gulls.

182 The low wintering numbers (mean peak estimate of 17 birds) perhaps reflect the widespread and dispersed distribution of this species recorded throughout the area during the winter by previous studies (Olsen & Larsson 2004; Stone *et al.* 1995).

12.5.2.4.11.2 Ecology

183 Great black-backed gulls tend to forage at sea and adopt a pelagic distribution in the non-breeding season. Localised distribution patterns may be heavily influenced by trawler activity (Kubetzki & Garthe 2003). During the breeding season the vast majority of birds tend to congregate at coastal breeding sites, with fewer birds found in offshore areas.

184 Great black-backed gulls are considered generalist predators that forage in a variety of habitats including the low tidal and shallow subtidal zones, offshore, mudflats, landfills and within seabird colonies (Rome & Ellis 2004). As with the herring gull, great black-backed gulls are considered kleptoparasites, meaning they steal from other gulls (Dunnet *et al.* 1990), including herring gulls at landfills and intertidal habitats (Verbeek 1979; Rome & Ellis 2004). In coastal areas of Europe, both species feed on discarded fish products (Camphuysen 1995; Hüppop & Wurm 2000), but great black-backed gulls out-compete herring gulls for this resource (Furness *et al.* 1992).

12.5.2.4.11.3 Behaviour

185 As with lesser black-backed and herring gulls, great black-backed gulls generally feed close to the surface (Dunnet *et al.* 1990), which may influence flight altitudes and potentially collision risk.

186 A total of 52 great black-backed gulls were recorded across all the boat-based surveys. Of these, 24 birds (46.2%) were recorded in flight.

187 Of the 24 great black-backed gulls in flight, two thirds (66.67%) were flying at heights of below 22m, which would put them below the reach of the rotors (*Table 12-36*).

Summary of the number of great black-backed gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
28	24	22 – 150 m	66.67	33.33

Table 12-36 Summary of the number of great black-backed gulls recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

188 Of the positively identified great black-backed gulls recorded as being in flight during the HR digital still aerial surveys conducted between April 2010 and October 2011, a significant orientation was recorded in the 2010 autumn migration period (μ = 295.69°, r = 0.62, *P* = 0.000, see *Volume 5, Appendix 12.1 Section 3.415.6* for further details). A fishing vessel present in the area in November 2010 (autumn migration 2010) is likely to have affected great black-backed gull orientation, with birds flying towards and away from the boat. Due to the small sample sizes of positively identified great black-backed gulls, it was not possible to meaningfully measure the orientation of flying birds in the other seasons in which they were recorded (2010 and 2011 breeding seasons, 2010/11 wintering and 2011 spring migration periods).

12.5.2.4.12 Gull species

189 In general, gulls were not identified to species level in the surveys of the Thames offshore windfarm strategic area (DTI 2006; DBERR 2007). Therefore, abundance and distribution of gulls with respect to the offshore cable corridor area are presented to group level only.

190 Gulls are likely to be the most numerous species present within the offshore cable corridor, owing to their widespread distribution across a range of marine habitats (although periodic influxes of auks have been recorded; DTI 2006). Large numbers of gulls were recorded in the 2004/05 and 2005/06 surveys in the Thames offshore windfarm strategic area (DTI 2006; DBERR 2007). In the offshore cable corridor gull numbers peaked in both winter 2004/05 and winter 2005/06, in the mid-winter period between January and February. In both winters, there was an inverse relationship between distance and density; highest densities of gulls (up to 50 to 100 birds per $4km^2$, or 12.5 to 25 birds per km^2) were recorded in the areas of the offshore cable corridor nearest to the coast, with much lower densities (typically 0.001 to 5 birds per $4km^2$, or 0.00025 to 1.25 birds per km^2) recorded in the area further offshore (DTI 2006; DBERR 2007). In both surveys, numbers declined greatly by the late winter survey period (early February to early March) and then remained relatively low during the summer.

12.5.2.4.13 Terns

12.5.2.4.13.1 Abundance and Distribution

191 Terns were not recorded within the East Anglia ONE site during the aerial surveys. However, one individual that could not be identified to species level was observed in the surrounding buffer area during autumn migration in 2011, leading to a population estimate of 18.

192 Terns were recorded during the temporally corresponding boat-based surveys, when a total of three sandwich terns *Sterna sandvicensis*, eight common terns *Sterna hirundo* and one Arctic tern *Sterna paradisaea* was recorded across all the monthly boat-based surveys.

193 Terns had a patchy distribution with low densities in the offshore cable corridor area in both summer 2005 and 2006. A large proportion of the individuals recorded could not be identified to species, though most were believed to be sandwich terns and common terns, the predominant species breeding in these areas. The majority of the birds recorded in both summers were located near the coast, with densities up to 0.5 to 2 birds per $4km^2$ in summer 2005 and lower densities of up to 0.125 to 0.25 birds per $4km^2$ in summer 2006 (DTI 2006; DBERR 2007). Such densities are

unlikely to be of any regional, national or international importance (for all species regional 1% threshold is a nominal 50 (Holt *et al.* 2011); for sandwich tern, national 1% threshold (NT) = 250, international 1% threshold (IT) = 2,000; for common tern, NT = 240, IT = 5,400; for little tern, NT = 50, IT = 1,000). No terns have been recorded in the aerial surveys of the East Anglia zone between November 2009 and March 2011 (APEM 2011a).

194 Many of the tern species breeding in the UK return to their breeding colonies largely in April and May (Wernham *et al.* 2002). In 2009, little terns, common terns and sandwich terns were all observed arriving along the Suffolk coast from early-mid April with steady passage in numbers following through the rest of April and May (Mason 2010).

195 Some tern species, such as sandwich tern, undergo post-fledging dispersal in late summer (July and August), and there is redistribution around the North Sea (Møller 1981). In 2009, sandwich terns were still found off the Suffolk coast until early August, after which a prolonged and steady passage continued throughout the rest of the month, through September and into early October. The final record of the year for this species was in mid-October (Mason 2010).

196 Most little terns had departed from the Suffolk coast by mid-August 2009 and southbound common tern migrants were on the move from mid-July at least with a peak in migration numbers occurring in early August. Numbers dropped off soon after this, but a steady passage continued into September and small numbers continued to pass along the coast until the final records were made in mid-October (Mason 2010). By late October all but a few stragglers will have left British waters to head back to their wintering grounds (Wernham *et al.* 2002).

197 Therefore, it is possible that birds heading to or from their breeding territories on the east coast could use the offshore cable corridor area during these migration periods, as well as foraging birds from nearby breeding colonies.

12.5.2.4.13.2 Ecology

198 Terns feed predominantly on small fish by plunge-diving from the air, but also on crustaceans, annelid worms, insects and occasionally squid (del Hoyo *et al.* 1996). Terns are gregarious throughout the year (Snow & Perrins 1998), often forming feeding flocks where prey is abundant or concentrated (although they may also feed solitarily) (Burgess & Hirons 1992; del Hoyo *et al.* 1996). Little terns *Sternula albifrons* in the UK have been found to generally feed on small (30-40 mm) clupeids and sandeel *Ammodytes* sp. (Ratcliffe *et al.* 2008). There is evidence from some colonies of sandwich terns on the east coast of the UK that sandeels predominate in

the diet in April and May, and clupeids become more important in late July, as clupeids move further inshore and sandeels further offshore (Cramp 1985).

199 For little tern, both the Alde-Ore Estuary and Hamford Water SPAs overlap with the offshore cable corridor area. Little terns have a relatively small foraging range: Thaxter *et al.* (2012b) lists the mean foraging range of breeding little terns to be 2.1km, the mean maximum range as 6.3 ± 2.4km and the maximum range as 11km. Such figures could put little tern foraging ranges from these sites within the offshore cable corridor area (*Volume 6, Figure 12.8*). However, as home spans of up to 17.5km have been recorded for little terns (Perrow *et al.* 2006) birds from more distant sites (Minsmere – Walberswick and the Colne Estuary, located a minimum of 13km and 16km respectively from the offshore cable corridor) may also potentially forage within the area.

200 Common and sandwich terns have larger foraging ranges, with breeding common terns having a mean foraging range of 4.5 ± 3.2km and breeding sandwich terns having a mean foraging range of 11.5 ± 4.7km (Thaxter *et al.* 2012b).

201 However, maximum values can exceed these distances: for common terns, Thaxter *et al.* (2012b) gives a maximum foraging distance from the breeding colony of 30km and a mean maximum of 15.2 ± 11.2km. Whilst for sandwich terns, Thaxter *et al.* (2012b) gives a maximum foraging distance from the breeding colony of 54km and a mean maximum of 49 ± 7.1km. Therefore, there is a possibility that common and sandwich terns from the Foulness SPA (located minimum of 30km from offshore cable corridor area) could forage within the offshore cable corridor area (*Volume 6, Figures 12.9 and 12.10*).

12.5.2.4.13.3 Behaviour

202 The boat-based surveys recorded common terns, sandwich terns and Arctic terns. Across all of the boat-based surveys, a total of eight common terns, three sandwich terns and one Arctic tern were recorded. All of these birds were recorded in flight and all were flying at heights of below 22m and below the likely reach of the turbines (*Table 12-37*).

Summary of the number of terns recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area					
Species	**Total number of birds recorded sitting on seas surface**	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
Arctic tern	0	1	22 – 150 m	100	0.00
Sandwich tern	0	3	22 – 150 m	100	0.00
Common tern	0	8	22 – 150 m	100	0.00

Table 12-37 Summary of the number of terns recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

12.5.2.4.14 Guillemots

12.5.2.4.14.1 Abundance and Distribution

203 The mean peak estimates of guillemots *Uria aalge* for each season are shown in *Table 12-38*. In order to account for the snap shot nature of aerial surveys and birds that may have been diving under the water at the time of the survey, published dive profile data has been used to inform correction factors for guillemots (see *Volume 5, Appendix 12.1 Annex VI* for full methodology on correction factors).

204 Guillemot numbers peaked in the East Anglia ONE site during the wintering period, with a mean peak wintering estimate of 1,585 birds (1,427 without correction factor). This estimate is below the threshold for national importance, but does exceed the 293 individuals required for regional importance (Stienen *et al.* 2007). During the winter, guillemots are dispersed widely and thinly across the North Sea, with concentrations further offshore (Kober *et al.* 2010). The size of the non-breeding population of guillemots is largely unknown given the widespread distribution of the species concerned, which makes quantitative comparisons difficult.

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for guillemots. Values are presented with and without a correction factor for the amount of time that guillemots spend under water diving for prey.				
Season		**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site****
Wintering	Incl. correction factor	1,585	5.28	Regional[5.4]
	Excl. correction factor	1,427	4.76	Regional[4.9]
Spring migration	Incl. correction factor	951	3.17	Regional[4.8]
	Excl. correction factor	856	2.85	Regional[4.3]
Breeding	Incl. correction factor	46	0.15	-
	Excl. correction factor	41	0.14	-
Autumn** migration	Incl. correction factor	57	0.19	-
	Excl. correction factor	51	0.17	-

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.
**Autumn migration also considered to be dispersal period for auks from colonies during which time they will undertake their annual moult

Table 12-38 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for guillemots. Values are presented with and without a correction factor for the amount of time that guillemots spend under water diving for prey.

205 Low numbers of guillemots were recorded within the East Anglia ONE site during the breeding season, when a mean peak estimate of 46 birds (41 without correction factor) was recorded. Those individuals present are likely to be non-breeding birds given the distance to the nearest breeding colony at Flamborough Head and Bempton is a minimum of 275km from the windfarm area and guillemot density is thought to decline sharply beyond 100km from the coast (Camphuysen *et al.* 2006).

206 Relatively high numbers of guillemots were recorded during the spring migration period. The mean peak estimate of 951 birds (856 without correction factor) exceeds the 200 birds required for regional importance during migration (Stienen *et al.* 2007). However, this estimate is well below the 19,040 individuals required for

national importance (BirdLife 2004). These birds are likely to be returning to their breeding grounds further north.

207 After the breeding season and post-breeding moult there is a gradual movement of guillemots southwards during the autumn, with a return of birds from more northern breeding colonies in the spring (Wernham *et al.* 2002). Relatively low abundances of guillemots were recorded during both the breeding season and the autumn migration period, with mean peak estimates both with and without the correction factors during these periods being below the numbers required for regional importance.

208 A secondary peak in guillemot numbers was observed in August 2010 in the East Anglia ONE site buffer, which may reflect post-fledgling dispersal of juvenile birds (Wernham *et al.* 2002). The main post-breeding moult period for guillemots is between early August and the end of September when birds may be flightless for periods (Wernham *et al.* 2002). However no guillemots were recorded in August 2011 in either the East Anglia ONE site or the buffer area. Post-breeding, guillemots are known to become increasingly dispersed throughout the North Sea (Stone *et al*. 1995). Therefore, such inter-annual fluctuations in abundance between are to be expected.

12.5.2.4.14.2 Ecology

209 Guillemots are wing-propelled diving birds which hunt by tracking their prey. Guillemots dive for longer periods than razorbills or puffins, but with an extended time above water between dives (Wanless *et al.* 1988). Guillemots are piscivorous predators, feeding predominately on small shoaling fish including sandeels and sprats. Birds often feed in small, short-lived, multi-species foraging assemblages. The lesser sandeel is the subject of the largest single-species fishery in the North Sea and over-fishing of sandeel populations may have a direct effect on guillemot abundance (Wright & Begg 1997).

210 Thaxter *et al.* (2012b) reported the mean foraging range of breeding guillemots to be 37.8 ± 32.3km, the mean maximum foraging range as 84.2 ± 50.1km and the maximum foraging range as 135km. The East Anglia ONE site is considered unlikely to be of importance for feeding guillemots during the breeding season, given the distance to the nearest breeding colony at Flamborough Head and Bempton Cliffs is a minimum of 275km and guillemot density is thought to decline sharply beyond 100km from the coast (Camphuysen *et al.* 2006).

12.5.2.4.14.3 Behaviour

211 As guillemots are pursuit divers they therefore spend most of their time on or under the water rather than on the wing and may therefore be at less risk of collision with wind turbines.

212 A total of 849 guillemots were recorded across all the boat-based surveys. Of these, only 134 birds (15.8%) were recorded in flight.

Summary of the number of guillemots recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
715	134	22 – 150 m	100	0.00

Table 12-39 Summary of the number of guillemots recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area

213 All of the 134 guillemots recorded in flight were flying at heights of below 22m, meaning they were flying below the likely reach of the turbines (*Table 12-39*).

12.5.2.4.15 Razorbills

12.5.2.4.15.1 Abundance and Distribution

214 The mean peak estimates of razorbills *Alca torda* for each season are shown in *Table 12-40*. In order to account for the snap shot nature of aerial surveys and birds that may have been diving under the water at the time of the survey, published dive profile data has been used to inform correction factors for razorbills (see *Volume 5, Appendix 12.1 Annex VI* for full methodology on correction factors).

215 Razorbills numbers peaked in the East Anglia ONE site during the wintering period, with a mean peak wintering estimate of 360 birds (346 without correction factor). This estimate is below the threshold for national importance, but does exceed the 62 individuals required for regional importance (Stienen *et al.* 2007). During the winter, razorbills are dispersed widely and thinly across the North Sea, and razorbill density in winter is expected to be lower than guillemot density due to their more northerly winter distribution (eg Kober *et al.* 2010). The size of the non-breeding population of

razorbills is largely unknown given the widespread distribution of the species concerned, which makes quantitative comparisons difficult.

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for razorbills. Values are presented with and without a correction factor for the amount of time that guillemots spend under water diving for prey				
Season		**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site****
Wintering	Incl. correction factor	360	1.20	Regional[5.8]
	Excl. correction factor	346	1.15	Regional[5.6]
Spring migration	Incl. correction factor	253	0.84	Regional[6.3]
	Excl. correction factor	243	0.81	Regional[6.1]
Breeding	Incl. correction factor	22	0.07	-
	Excl. correction factor	21	0.07	-
Autumn** migration	Incl. correction factor	31	0.10	-
	Excl. correction factor	31	0.10	-

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.
**Autumn migration also considered to be dispersal period for auks from colonies during which time they will undertake their annual moult

Table 12-40 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for razorbills. Values are presented with and without a correction factor for the amount of time that guillemots spend under water diving for prey.

216 Low numbers of razorbills were recorded within the East Anglia ONE site during the breeding season, when a mean peak estimate of 22 birds (21 without correction factor) was recorded. Those individuals present are likely to be non-breeding birds given the distance to the nearest breeding colony at Flamborough Head and Bempton is a minimum of 275km from the East Anglia ONE site.

217 Relatively high numbers of razorbills were recorded during the spring migration period. The mean peak estimate of 253 birds (243 without correction factor) exceeds the nominal 50 birds required for regional importance during migration (Stienen *et al.* 2007). However, this estimate is well below the 2,520 individuals

required for national importance (BirdLife 2004). These birds are likely to be returning to their breeding grounds further north.

218 After the breeding season and post-breeding moult there is a gradual movement of razorbills southwards during the autumn, with a return of birds from more northern breeding colonies in the spring (Wernham *et al.* 2002). Relatively low abundances of razorbills were recorded during both the breeding season and the autumn migration period, with mean peak estimates both with and without the correction factors during these periods being below the numbers required for regional importance.

219 As with guillemots, a secondary peak in razorbill numbers was observed in August 2010 in the East Anglia ONE site buffer, which may reflect post-fledgling dispersal of immature first-summer birds (Wernham *et al.* 2002). The main post-breeding moult period of razorbills is from early August to the end of September when birds are flightless (Wernham *et al.* 2002). However no razorbills were recorded in August 2011 in either the East Anglia ONE site or the buffer area. Post-breeding, razorbills are known to become increasingly dispersed throughout the North Sea (Stone *et al*. 1995), with a more northerly distribution than guillemots (Kober *et al.* 2010). Therefore, such inter-annual fluctuations in abundance between years are to be expected, as are lower abundance estimates in comparison to guillemots.

12.5.2.4.15.2 Ecology

220 Razorbills, like guillemots, are wing-propelled diving birds which hunt by tracking their prey. Razorbills are piscivorous predators, feeding predominately on small shoaling fish, mainly sandeels. Birds often feed in small, short-lived, multi-species foraging assemblages. The lesser sandeel is the subject of the largest single-species fishery in the North Sea and over-fishing of sandeel populations may have a direct effect on razorbill abundance (Wright & Begg 1997).

221 Thaxter *et al.* (2012b) reported the mean foraging range of breeding razorbills to be 23.7 ± 7.5km, the mean maximum foraging range as 48.5 ± 35.0km and the maximum foraging range as 95km. Therefore, the East Anglia ONE site is considered unlikely to be of importance for feeding razorbills during the breeding season, given the distance to the nearest breeding colony at Flamborough Head and Bempton Cliffs is a minimum of 275km.

12.5.2.4.15.3 Behaviour

222 As razorbills are pursuit divers they therefore spend most of their time on or under the water rather than on the wing and may therefore be at less risk of collision with wind turbines.

223 A total of 131 razorbills were recorded across all the boat-based surveys. Of these, 55 birds (42%) were recorded in flight.

224 All of the 55 razorbills recorded in flight were flying at heights of below 22m, meaning they were flying below the likely reach of the wind turbines (*Table 12-41*).

Summary of the number of razorbills recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area for the two different rotor swept areas to be considered				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
76	55	22 – 150 m	100	0.00

Table 12-41 Summary of the number of razorbills recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area for the two different rotor swept areas to be considered

12.5.2.4.16 Puffins

12.5.2.4.16.1 Abundance and Distribution

225 The mean peak estimates of puffins *Fratercula arctica* for each season are shown in *Table 12-42.* Puffins were found in the East Anglia ONE site during the wintering, spring migration and autumn migration periods, when mean peak estimates of 32, nine and seven birds were estimated, respectively. All of these estimates are below the numbers required for regional importance.

Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for puffins.			
Season	**Mean peak population estimate**	**Density (birds/km^2)**	**Importance of East Anglia ONE site***
Wintering	32	0.11	-
Spring migration	9	0.03	-
Breeding	0	0.00	None
Autumn** migration	7	0.02	-

* Numbers following the level of importance represent the actual percentage of importance, eg National[2.4] indicates that the East Anglia ONE site holds 2.4% of the national population. A "-" indicates where the species was recorded in numbers below Regional Importance.
**Autumn migration also considered to be dispersal period for auks from colonies during which time they will undertake their annual moult

Table 12-42 Summary of seasonal mean peak estimates and importance of the East Anglia ONE site for puffins.

12.5.2.4.16.2 Ecology

226 Like guillemots and razorbills, puffins are wing-propelled diving birds which hunt by tracking their prey. Puffins dive for shorter periods, but more frequently than guillemots or razorbills (Wanless *et al.* 1988). Puffins are piscivorous predators, feeding predominately on small shoaling fish including sandeels, herring and other species. Birds often feed in small, short-lived, multi-species foraging assemblages. The lesser sandeel is the subject of the largest single-species fishery in the North Sea and over-fishing of sandeel populations may have a direct effect on puffin abundance (Wright & Begg 1997).

227 Thaxter *et al.* (2012b) reported the mean foraging range of breeding puffins to be 4km, the mean maximum foraging range as 105.4 ± 46.0km and the maximum foraging range as 200km. Therefore, the East Anglia ONE site is considered unlikely to be of importance for feeding puffins during the breeding season, given the distance to the nearest breeding colony at Flamborough Head and Bempton Cliffs is a minimum of 275km.

12.5.2.4.16.3 Behaviour

228 As puffins are pursuit divers they therefore spend most of their time on or under the water rather than on the wing and may, therefore be at less risk of collision with turbines.

229 Across all the boat-based surveys, only five puffins were recorded. Of these, four (80%) were in flight, which may be as a result of disturbance from the survey boat.

230 Of the four puffins recorded in flight, 100% were flying at heights of below 22m, meaning they were flying below the likely reach of the wind turbines (*Table 12-43*).

Summary of the number of puffins recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area for the two different rotor swept areas to be considered				
Total number of birds recorded sitting on sea surface	**Total number of birds recorded in flight**	**Rotor sweep height**	**Percentage of birds flying below turbine sweep**	**Percentage of birds flying within rotor sweep**
1	4	22-150 m	100	0.0

Table 12-43 Summary of the number of puffins recorded flying and sitting during the boat-based surveys and the proportions recorded at heights below and within the rotor swept area for the two different rotor swept areas to be considered

12.5.2.4.17 Auk species

231 In general, auks were not identified to species level in the surveys of the Thames offshore windfarm strategic area (DTI 2006; DBERR 2007). Therefore, abundance and distribution of auks with respect to the offshore cable corridor area are presented to group level only.

232 Counts of auks peaked during the winter in both the 2004/05 and 2005/06 aerial surveys incorporating the offshore cable corridor. In winter 2004/05, numbers peaked during the first mid-winter survey period (mid-November to end of December) and densities of up to 10 to 25 auks per 4km^2 or 2.5 to 6.25km^2, were recorded in the offshore cable corridor approximately 18 to 20km off the coast. Densities then declined with increasing distance offshore (DTI 2006). The area was not surveyed during the early winter and first mid-winter survey periods in winter 2005/06 and winter auk densities found during the surveyed periods in winter 2005/06 were much lower in the offshore cable corridor area at 0.001 to 1 bird per 4km^2 (0.00025 to 0.25 birds per km^2), with very few birds present near to the coast (DBERR 2007). As with gulls, the number of auks recorded in the summer periods

was relatively low, with densities of up to 2 to 5 birds per $4km^2$ (0.5 to $1.25km^2$) in summer 2005 and 0.001 to 1 bird per $2km^2$ (0.00025 to 0.25 birds per km^2) in summer 2006 (DTI 2006; DBERR 2007).

12.5.2.4.18 Other Birds

233 Other species / groups recorded in the 2004/05 and 2005/06 visual aerial surveys of blocks TH3 and TH4 (most relevant to the offshore cable corridor, covering up to 95% of the area) were:

- Small numbers of several species of wildfowl and waders, including geese and waders such as oystercatchers Haematopus ostralegus associated with sand banks, recorded during the winter periods;
- Phalacrocorax species (i.e. cormorant or shag), recorded in all periods during 2004/05, with highest numbers recorded in the first mid-winter period (late November to late December), but not recorded in the 2005/06 surveys; and
- A single storm petrel, recorded in the first mid-winter period (late November to late December) in 2004/05.

234 Other species identified in the surveys of the East Anglia zone (which covers both the East Anglia ONE site and surrounding 4km buffer along with approximately 30% of the offshore cable corridor) included one skua species in October 2010 and one *Phalacrocorax* species in April 2010 and September 2011 (APEM 2011a).

235 The boat-based surveys of the East Anglia ONE site and surrounding 4km buffer recorded small numbers of additional species that were not recorded in the aerial surveys, including wader and passerine species. The species lists for both boat and aerial surveys can be found in *Volume 5, Appendix 12.3.*

12.5.2.5 Migratory Waterbird Species

12.5.2.5.1 Background

236 Whilst field data can inform passage movements through East Anglia ONE for some species, field surveys alone may not be able to identify the full extent of migration movements.

237 To help determine connectivity between SPAs and the operational windfarm site, together with potential mortality rates, APEM have developed a theoretical modelling tool to derive estimates of migrating birds passing through the East Anglia ONE site, with a measure of confidence. The species focused upon are those

associated with non-breeding SPAs; i.e. waders and wildfowl migrating into the UK for the winter, with a point to point broad front migration between continental Europe and the UK. The SNCBs were involved in developing the scope of these works and the model was further refined following their input. Details of the methodology used in the migration modelling can be found in *Volume 5, Appendix 12.2*. This method has subsequently been expanded to incorporate the major staging area in the Wadden Sea for species where relevant. Details of the percentage of the population that stages at the Wadden Sea are shown in *Table 12-44*. The numbers staging at the Wadden Sea vary with spring and autumn migration, and this will therefore alter the numbers passing through the area with each season. Migratory seabirds were frequently detected on surveys and therefore, assessments will be based on field data, allowing for passage through the site on a relevant number of days. Furthermore turnover of these species is accounted for in the collision risk model, which uses snap-shot monthly bird density to calculate total bird movements through the windfarm site per month. As most seabird species exhibited an increase during the autumn migration period it is reasonable to assume that migratory birds (whether associated with a fishing vessel or not) are recorded to some degree. As with all estimates the numbers should not be considered absolute, but indicative of a trend, as there is considerable variability in the natural environment.

238 Twelve wildfowl and wader species were selected for this purpose. Wildfowl and waders, unlike passerines, typically migrate along narrow corridors known as flyways (Davidson *et al*. 1995; Wernham *et al*. 2002; Newton 2010) meaning that any windfarm situated within these routes is likely to pose a threat at both the individual and species levels. Species were selected which were at potential risk of collision with wind turbines situated in the East Anglia ONE site. These included wildfowl and waders migrating between continental breeding areas (Scandinavia, north-west Europe, Baltic areas) and their designated non-breeding SPAs along the east coast of England, as outlined in Wright *et al*. (2012). These twelve species were selected from a combination of the SOSS 05 report (Wright *et al,* 2011), known SPAs along the southern North Sea and expert judgement on those species that are potentially at most risk from the East Anglia ONE project.

239 The outputs of the migration model are summarised in *Table 12-44*.

Migration Model Outputs for Migrating Wildfowl and Waders									
Species	**Flyway population[1]**	**GB and Ireland Population**	**Percentage of flyway population staging at the Wadden Sea[2]**	**Migration season[1]**	**Migrant estimate**	**Lower confidence limit**	**Upper confidence limit**	**Percentage of flyway population within East Anglia ONE**	**Percentage of GB and Ireland Population within East Anglia ONE**
Bewick's swan	20,000	7,380	-	Spring/Autumn	993	978	1,009	4.97	13.46
Taiga bean goose	70,000-90,000	410	-	Spring/Autumn	20	18	21	0.02-0.03	4.88
European white-fronted goose	1,000,000	2,400	-	Spring/Autumn	518	505	529	0.05	21.58
Dark bellied brent goose	200,000	91,000	99.8	Spring	44,257	43,923	44,539	22.13	48.63
			41.6	Autumn	22,344	22,160	22,517	11.17	24.55
Shelduck	300,000	75,610	43.8	Spring	7,808	7,730	7,884	2.60	10.33
			81.9	Autumn	13,653	13,534	13,774	4.55	18.06
Common scoter	1,600,000	123,190	-	Spring/Autumn	1,703	1,632	1,765	0.11	1.38
Avocet	73,000	7,500	-	Spring/Autumn	2,593	2,569	2,617	3.55	34.57

Migration Model Outputs for Migrating Wildfowl and Waders									
Species	**Flyway population[1]**	**GB and Ireland Population**	**Percentage of flyway population staging at the Wadden Sea[2]**	**Migration season[1]**	**Migrant estimate**	**Lower confidence limit**	**Upper confidence limit**	**Percentage of flyway population within East Anglia ONE**	**Percentage of GB and Ireland Population within East Anglia ONE**
Golden plover	1,070,000-1,140,000	566,700	-	Spring/Autumn	118,717	117,194	120,233	10.41-11.10	20.95
Knot	450,000	338,970	75.0	Spring	39,538	39,070	40,031	8.79	11.66
			79.7	Autumn	41,659	41,119	42,193	9.26	12.29
Dunlin	1,330,000	438,480	71.2	Spring	91,364	90,754	92,007	6.87	20.84
			86.8	Autumn	98,694	97,957	99,546	7.42	22.51
Black-tailed godwit	57,000	56,880	-	Spring/Autumn	7,844	7,770	7,910	13.76	13.79
Bar-tailed godwit	120,000	54,280	58.0	Spring	3,776	3,719	3,843	3.15	6.96
			25.3	Autumn	2,252	2,215	2,286	1.88	4.15

[1] From Wright *et al.* (2012). [2] From: Laursen *et al.* (2010)

Table 12-44 Migration Model Outputs for Migrating Wildfowl and Waders

12.5.2.5.2 Bewick's swan

240 Bewick's swans *Cygnus columbianus bewickii* breed on the Russian tundra and migrate to a relatively small number of wintering sites in the Netherlands, Britain and Ireland (Wernham *et al.* 2002). Individuals are extremely site-faithful, returning to the same wintering sites every year.

241 An estimated 7,000 individuals winter in Britain and 380 individuals winter in Ireland (Crowe *et al*. 2008). In total, these Bewick's swans represent 37% of the international population.

242 Bewick's Swans migrate to Britain across the North Sea from staging sites in the Netherlands, arriving in autumn from mid to late October, but with arrivals continuing through November and into midwinter (December-January; Wernham *et al.* 2002). Return migration during February and March is again across the North Sea, to staging sites in the Netherlands and northern Germany (Wernham *et al*. 2002). The distribution of staging and wintering sites suggests that all Bewick's swans wintering in Britain and Ireland probably cross the southern part of the North Sea in both autumn and spring, with some continuing across the Irish Sea.

243 The migration model estimates that 993 Bewick's swans will pass through the East Anglia ONE site during both the spring and autumn migration periods (*Table 12-44*). This accounts for 13.5% of the Great Britain and Ireland population and 5% of the flyway population.

12.5.2.5.3 Taiga bean goose

244 Taiga bean geese *Anser fabalis fabalis* breed at high latitudes to the east of Fennoscandia, wintering largely in southern Sweden and Denmark (Hearn 2004). In Britain, Taiga been geese occur regularly during the winter but in relatively small numbers (410 individuals representing 0.5% of the north-west European population; Stroud *et al*. 2001).

245 The Taiga been goose is a designated SPA feature in the UK as its British populations occur at the south-western edge of the species' wintering range (Stroud *et al.* 2001).

246 Individuals are thought to migrate to Britain from November across the central or southern North Sea, with arrivals continuing through the winter months and then returning between mid-February and early March (Wernham *et al.* 2002).

247 The migration model estimates that 20 Taiga bean geese will pass through the East Anglia ONE site during both the spring and autumn migration periods (*Table 12-44*).

This accounts for 4.9% of the Great Britain and Ireland population and 0.02 to 0.03% of the flyway population.

12.5.2.5.4 European white-fronted goose

248 Britain forms the western edge of the wintering range of the European white-fronted goose *Anser albifrons albifrons*, which breeds in arctic Russia (Wernham *et al.* 2002). Approximately 2,400 individuals overwinter in the UK forming 0.24% of the international population (Stroud *et al*. 2001).

249 Like Bewick's swans, white-fronted geese are site-faithful, annually returning to winter in the same area. Their migration route to Britain crosses the southern North Sea in a well-defined flyway between the Netherlands and eastern England, arriving between late November and early February. Individuals return to staging sites in the Netherlands in March (Wernham *et al*. 2002).

250 The migration model estimates that 518 European white-fronted geese will pass through the East Anglia ONE site during both the spring and autumn migration periods (*Table 12-44*). This accounts for 21.6% of the Great Britain and Ireland population and 0.05% of the flyway population.

12.5.2.5.5 Dark-bellied brent goose

251 Dark-bellied brent geese *Branta bernicla bernicla*, migrate from breeding sites in arctic Russia via staging sites in the Wadden Sea to spend the winter in southern and south-eastern parts of Britain (Wernham *et al.* 2002).

252 The same route is used during both autumn and spring migrations. The majority of migrants visiting Britain are therefore likely to pass across central and/or southern parts of the North Sea. British wintering birds account for almost half of the entire flyway population (n=91,000; 46%). Autumn migration occurs between late September and November, with return migration in spring occurring from late February into May (Wernham e*t al*. 2002).

253 The migration model estimates that 44,257 dark-bellied brent geese will pass through the East Anglia ONE site during the spring migration period and 22,344 will pass through during the autumn migration period (*Table 12-44*). This accounts for 48.6% of the Great Britain and Ireland population and 22.1% of the flyway population during spring and 24.6% of the Great Britain and Ireland population and 11.2% of the flyway population during autumn.

12.5.2.5.6 Shelduck

254 Many British and Irish breeding shelducks *Tadorna tadorna* undertake a moult migration across the North Sea to moulting sites in the Helgoland Bight in the Wadden Sea (Wernham *et al*. 2002). The majority of these individuals complete their journey to moulting sites between mid-June and July, with some individuals migrating in August.

255 The timing of return migration is less well defined, but it appears that birds gradually return to Britain during the first half of winter; many individuals arrive first in the south-east and then gradually disperse around the coast back to breeding sites. These shelducks are known to stop at several large estuaries en route, often leading to large concentrations of individuals as they move through the area (Wernham et al. 2002).

256 These individuals are also joined in winter by migrants from breeding populations in Scandinavia and the Baltic, but the timing and routes of their migration across the North Sea in not known (Wernham *et al.* 2002). The migration routes of shelducks across UK waters must therefore be concentrated in the North Sea with some individuals also crossing the Irish Sea. Other concentrations of migrating shelducks occur close to British moulting sites, notably around the Bristol Channel and the Forth, Humber and Wash on the east coast (Wernham *et al*. 2002).

257 The migration model estimates that 7,808 shelducks will pass through the East Anglia ONE site during the spring migration period and 13,653 will pass through during the autumn migration period (*Table 12-44*). This accounts for 10.3% of the Great Britain and Ireland population and 2.6% of the flyway population during spring and 18.1% of the Great Britain and Ireland population and 4.6% of the flyway population during autumn.

12.5.2.5.7 Common scoter

258 Approximately 37,500 common scoters *Melanitta nigra* are known to winter off British shores (Stone *et al.* 1997), comprising both British breeders and those that breed elsewhere.

259 It is thought that many of these birds may migrate across the North Sea from moulting sites in the Baltic or the eastern North Sea (Wernham *et al.* 2002). Birds from these populations are also known to migrate south-west through the English Channel in autumn after moulting, returning in spring.

260 The migration model estimates that 1,703 common scoters will pass through the East Anglia ONE site during both the spring and autumn migration periods (*Table*

12-44). This accounts for 1.4% of the Great Britain and Ireland population and 0.1% of the flyway population.

12.5.2.5.8 Avocet

261 Avocets *Recurvirostra avosetta* in the UK are concentrated on the south and east coasts of England throughout the year (Wernham *et al*. 2002). Indeed, avocets are a designated feature of six coastal SPAs in the south-east of England (Stroud *et al.* 2001).

262 In winter, there is an influx of birds from the Low Countries in addition to resident breeders, with the total wintering population representing 10% (n=7,500) of the international avocet population (Holt *et al*. 2011). Some birds from the UK migrate south to sites in France, Iberia or North Africa. Key migration times are July-November and March-April (Wernham *et al*. 2002).

263 The migration model estimates that 2,593 avocets will pass through the East Anglia ONE site during both the spring and autumn migration periods (*Table 12-44*). This accounts for 34.6% of the Great Britain and Ireland population and 3.6% of the flyway population.

12.5.2.5.9 Golden plover

264 Three populations of golden plover *Pluvialis apricaria* occur during the winter. Individuals from Iceland and the Faeroes winter in Ireland and western Britain, individuals from northern mainland Europe winter in eastern Britain (via the Netherlands on passage) and some British breeders migrate southwards to France, Iberia and North Africa (Wernham *et al*. 2000). This combination of three different populations moving in different directions mean that golden plovers are likely to be moving across most offshore areas around Britain.

265 Individuals migrating from Ireland to Iceland are likely to pass across the Irish Sea and to the west and north of Scotland, those migrating from mainland Europe migrate across the North Sea (most likely the southern North Sea and the south-east coast of Britain), and those breeding in the UK probably migrate across the English Channel.

266 Autumn migration occurs soon after chicks fledging, from late June until September, and most birds return to breeding grounds in the UK by February. However, birds may move long distances, potentially crossing the sea, at any time during the winter in response to harsh weather (Wernham *et al*. 2002).

267 The migration model estimates that 118,717 golden plovers will pass through the East Anglia ONE site during both the spring and autumn migration periods (*Table 12-44*). This accounts for 20.9% of the Great Britain and Ireland population and 10 to 11% of the flyway population.

12.5.2.5.10 Knot

268 Most knots *Calidris canutus* wintering in Britain breed in the high Arctic (northern Greenland and Canadian islands) and migrate via staging sites in Iceland and/or Norway in autumn to wintering sites on large estuaries in western Europe, returning north to breeding grounds via Iceland or northern Norway in spring, with some birds also staging at sites in the Wadden Sea in autumn or spring (Wernham *et al*. 2002).

269 The UK is internationally important both as a wintering site and as a staging site in spring and autumn, supporting more than 70% of the population, and with 25 estuaries designated as SPAs for this species.

270 Large concentrations of moulting birds occur in autumn on the Wash, Dee, Ribble and in Morecambe Bay. Autumn passage migration and arrivals of wintering birds across UK waters occurs from mid-July to September, but with the majority of arrivals in August (adults) or September (juveniles).

271 Birds migrating between the UK and breeding grounds may travel across UK waters to either the west, east and/or north of mainland Britain depending on the route they take (via Iceland, Norway and/or the Wadden Sea), and the English Channel is also likely to be crossed by many birds that winter in France or further south. Further movements of birds between passage or moulting sites and wintering sites occurs between October and December, with many birds moving across the North Sea between the Wadden Sea and the UK, or across the English Channel between the UK and France (Wernham *et al*. 2002). There are also considerable movements between estuaries within the UK at this time, with birds tending to move towards the north and west.

272 In March, many birds (more than half of the British wintering population) move eastwards across the North Sea to staging sites in the Wadden Sea. The majority of spring departures northwards for the breeding grounds occur in the first two weeks of May, and birds may pass over the sea almost anywhere around the UK at this time, though probably with concentrations in particular areas where birds have departed from large estuaries (Wernham *et al.* 2002).

273 The migration model estimates that 39,538 knots will pass through the East Anglia ONE site during the spring migration period and 41,659 will pass through during the autumn migration period (*Table 12-44*). This accounts for 11.7% of the Great Britain

and Ireland population and 8.8% of the flyway population during spring and 12.3% of the Great Britain and Ireland population and 9.3% of the flyway population during autumn.

12.5.2.5.11 Dunlin

274 Dunlins *Calidris alpina* wintering in the UK breed in northern Scandinavia and Russia (Wernham *et al*. 2002).

275 Autumn migration occurs over a relatively long period as birds migrate first to moulting sites then on to wintering sites once they have completed their moult. Substantial numbers cross the North Sea during July and August to moult on the Wash, Thames and Morecambe Bay (Boere 1976, Wernham *et al*. 2002), but the majority of the British and Irish wintering population (c. 438,480 individuals; Stroud *et al.* 2001) moult on the Wadden Sea before moving across the southern and central North Sea to the UK in October and November, with some (n=88,480) continuing across the Irish Sea to Ireland (Wernham *et al*. 2002). Birds from moulting sites on UK estuaries also disperse at this time.

276 Juvenile dunlin migrate on a broader front than adults and most arrive in the UK and Ireland in September and October, most likely crossing the North Sea or far-eastern parts of the English Channel, with Irish-wintering birds also crossing the Irish Sea.

277 In spring, birds congregate on a few sites such as the Wash and Wadden Sea before returning to breeding grounds, with the majority of the wintering population crossing the North Sea during April and May.

278 The migration model estimates that 91,364 dunlins will pass through the East Anglia ONE site during the spring migration period and 98,694 will pass through during the autumn migration period (*Table 12-44*). This accounts for 20.8% of the Great Britain and Ireland population and 6.9% of the flyway population during spring and 22.5% of the Great Britain and Ireland population and 7.4% of the flyway population during autumn.

12.5.2.5.12 Black-tailed godwit

279 The British breeding population of black-tailed godwits *Limosa limosa* is very small (44-52 pairs) and concentrated at two main breeding sites in the east of England which are designated as SPAs. These individuals migrate to sub-Saharan Africa and/or Iberia during the non-breeding season. Spring migration occurs during late March and April, and autumn migration during July (Wernham *et al.* 2002).

280 The vast majority of the Icelandic population of black-tailed godwits either winters in or migrates across the British Isles. Spring migration occurs from mid-April to early May (Gunnarsson *et al*. 2006) and autumn migration sees birds returning to the UK in July and August where they congregate in large moulting flocks before dispersing to wintering sites elsewhere in Britain, Ireland or continental Europe (Wernham *et al*. 2002). These post-moult movements see individuals crossing the southern North Sea, Irish Sea and English Channel in autumn and early winter, returning in early spring.

281 The migration model estimates that 7,844 black-tailed godwits will pass through the East Anglia ONE site during both the spring and autumn migration periods (*Table 12-44*). This accounts for 13.8% of the Great Britain and Ireland population and 13.7% of the flyway population.

12.5.2.5.13 Bar-tailed godwit

282 Bar-tailed godwits *Limosa lapponica* wintering in the UK migrate from breeding populations in Scandinavia and Russia (Wernham *et al*. 2002). Large numbers of bar-tailed godwits cross the North Sea from the continent to Britain (n=38,000) and on to Ireland (n=16,280), constituting 45% of the international population.

283 Migration occurs mainly between July and September and with individuals returning to breeding grounds in February and March. Large numbers stage at sites in the Wadden Sea suggesting that migration routes are probably concentrated on paths to this area from key wintering sites.

284 The migration model estimates that 3,776 bar-tailed godwits will pass through the East Anglia ONE site during the spring migration period and 2,252 will pass through during the autumn migration period (*Table 12-44*). This accounts for 7% of the Great Britain and Ireland population and 3.1% of the flyway population during spring and 4.1% of the Great Britain and Ireland population and 1.9% of the flyway population during autumn.

12.5.2.6 Cable Landfall (Intertidal)

285 Ground based surveys of two sectors (‘Cable landfall’ and FF001) which were designed to encompass the cable landfall areas were undertaken on a monthly basis between November 2011 and February 2012 (Diagram 12-1). These surveys were undertaken along with surveys of several sectors along the Deben Estuary, which were conducted to assess the ornithological interests of the onshore cable route. Therefore, the Deben Estuary surveys are discussed in *Volume 3, Chapter 24 Ecology and Ornithology*.

286 Although not covered by WeBS, the cable landfall sector and sector FF001 were surveyed using WeBS core count (high tide) and low tide survey methods. Each sector was surveyed both at high tide and at low tide in each month from November 2011 to February 2012. Surveys were conducted from vantage points with a wide view, allowing the observer to count the entire sector (or most of it) while remaining relatively concealed from feeding and roosting birds. In line with WeBS methods, counts were performed using binoculars (10 x 42) and a high powered (25 to 50x) telescope. Each full survey was performed within a maximum four hour period to ensure minimum movement of birds between sectors. This minimised the probability of double-counting individual birds and provided a “snap-shot” of bird abundance and distribution within the study site (see *Volume 5, Appendix 24.11* for full methodology).

287 A total of 16 species were recorded over eight surveys of the cable landfall sector FF001 between November 2011 and February 2012. Bird numbers at this sector were generally low across all the surveys. Of these maximum counts for high tide and low tide were as follows:

- Shelduck: four birds at high tide, none were recorded during any low tide surveys;
- Teal: two birds at high tide, none were recorded during any low tide surveys;
- Red-breasted merganser: two birds at high tide, none were recorded during any low tide surveys;
- Grey heron: one bird at high tide, none were recorded during any low tide surveys;
- Ringed plover: 28 birds at high tide, none were recorded during any low tide surveys;
- Golden plover: 11 birds at high tide, 10 birds at low tide;
- Lapwing: 18 birds at high tide, seven birds at low tide;
- Dunlin: 75 birds at high tide, four birds at low tide;
- Woodcock: one bird at high tide, none were recorded during any low tide surveys;
- Curlew: two birds at high tide, none were recorded during any low tide surveys;
- Redshank: four birds at high tide, one bird at low tide;

- Black-headed gull: 115 birds at high tide, 300 birds at low tide;
- Common gull: two birds at high tide, two birds at low tide;
- Lesser black-backed gull: one bird at high tide, none were recorded during any low tide surveys;
- Herring gull: seven birds at high tide, four birds at low tide; and
- Great black-backed gull: two birds at high tide, four birds at low tide (*see Volume 5, Appendix 24.11*).

288 A total of eight species were recorded over eight surveys of the Cable Landfall Sector between November 2011 and February 2012. Bird numbers at this sector were generally low across all the surveys. Of these maximum counts for high tide and low tide were as follows:

- Mute swan: 25 birds at high tide, 29 birds low tide;
- Dark-bellied brent goose: none were recorded during any high tide surveys, five birds at low tide;
- Cormorant: three birds at high tide, two birds at low tide;
- Great crested grebe: one bird at high tide, none were recorded during any low tide surveys;
- Black-headed gull: 60 (incomplete count) birds at high tide, 43 birds at low tide surveys;
- Common gull: three birds at high tide, six birds at low tide surveys;
- Herring gull: 20 birds at high tide, 25 birds at low tide; and
- Great black-backed gull: six birds at high tide, 10 birds at low tide (see *Volume 5, Appendix 24.11*).

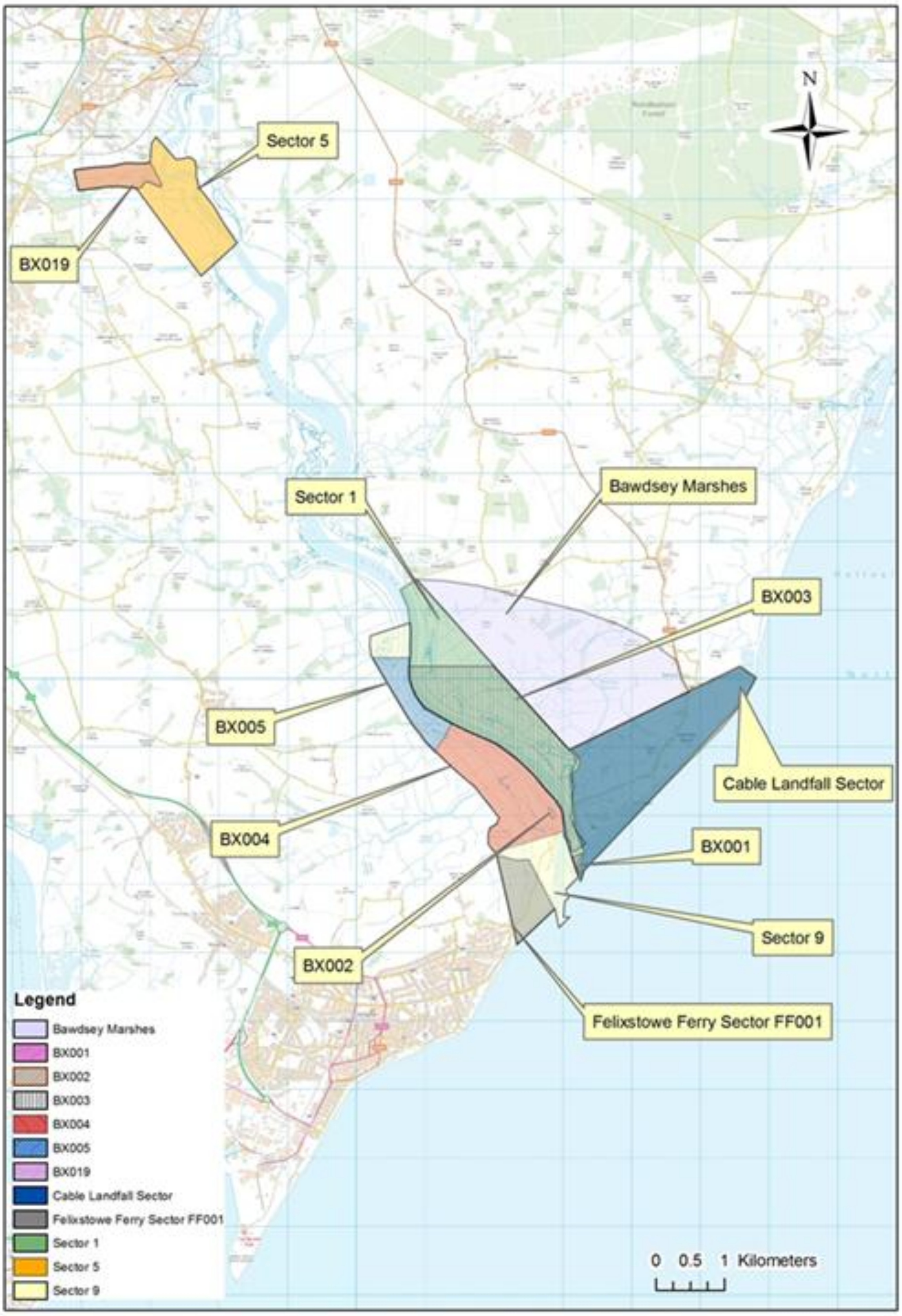

Diagram 12-1 Location of Intertidal Survey Sectors 'Cable landfall' sector and sector FF001. Note: Diagram also shows the Deben Estuary survey sectors, which are covered in Volume 3, Chapter 24 Ecology and Ornithology (Onshore).

12.5.2.7 Sensitivity / Vulnerability of each Species to Different Types of Impact

289 The general sensitivities of each species to each potential East Anglia ONE project related impact (eg disturbance / displacement, habitat loss, collision risk, barrier effects) are assigned to categories of high, medium, low or negligible. These are assessed by considering the vulnerability of the species to that impact based on the classifications in Garthe & Hüppop (2004), interpretations by Maclean *et al.* (2009) and collision risks and rankings in Langston (2010) and SOSS rankings (SOSS 03 2012) (*Table 12-45*).

290 The migrant species covered by the migration modelled are considered with respect to collision risk only. The general sensitivity of each of these species to this impact have been assessed by considering the vulnerability of each species to collision risk based on the classifications in King *et al.* (2009) (*Table 12-46*).

291 Sensitivities of species in the offshore cable corridor will be as per those presented for the East Anglia ONE site. However, it should be noted that assessment of sensitivity should not include estimated collision risk for the offshore cable corridor.

General Species Sensitivity to Specific Windfarm Impacts				
Species	**General Species Sensitivity to Specific Impacts**			
	Disturbance / displacement[1]	**Habitat loss[2]**	**Collision risk[3]**	**Barrier effect[4]**
Common scoter	Very high	High	Low	Medium
Red-throated diver	Very high	High	Medium	High
Fulmar	Low	Low	Low	Low
Gannet	Low	Low	Medium	Medium
Great skua	Low	Low	Medium	Low
Kittiwake	Low	Low	Medium	Low
Black-headed gull	Low	Low	Low	Low
Common gull	Low	Low	Low	Low
Lesser black-backed gull	Low	Low	Medium	Low
Herring gull	Low	Low	Medium	Low
Great black-backed gull	Low	Low	Medium	Low
Guillemot	Medium	Medium	Low	Low
Razorbill	Medium	Medium	Low	Low
Puffin	Low	Medium	Low	Low

[1] Based on sensitivity to ship and helicopter traffic scores in Garthe & Hüppop (2004).
[2] Based on habitat flexibility scores in Garthe & Hüppop (2004) and flexibility in habitat use in Maclean *et al.* (2009)
[3] Based on flight manoeuvrability, flight altitude, percentage flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010)
[4] Based on sensitivities to barrier effects in Maclean *et al.* (2009)

Table 12-45 General Species Sensitivity to Specific Windfarm Impacts

General Migrant Species Sensitivity to Collision Risk Impacts	
Species	**General Species Sensitivity to Collision Risk[1]**
Bewick's swan	High
Taiga bean goose	Medium
European white-fronted goose	Medium
Dark-bellied brent goose	Medium
Shelduck	Medium
Avocet	High
Golden plover	Low
Knot	Low
Dunlin	Low
Black-tailed godwit	High
Bar-tailed godwit	High

[1] Based on flight manoeuvrability, flight altitude, percentage flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012)

Table 12-46 General Migrant Species Sensitivity to Collision Risk Impacts

12.5.2.8 Baseline Summary

292 A list of all seabird species recorded during the baseline aerial surveys of the East Anglia ONE site is given below (*Table 12-47*), together with information on conservation status according to the following: EC Birds Directive Annex 1; Wildlife and Countryside Act 1981 (WCA) Schedule 1 (breeding only); designated features of nearby Special Protection Areas (SPAs), with assemblage features in brackets; Natural Environment & Rural Communities Act 2006 (NERC) Section 41; and Birds of Conservation Concern (BoCC) listing (Eaton *et al.* 2009).

Seabird Species Recorded within the East Anglia ONE site during 2009/10 and 2010/11 Aerial Surveys and their Conservation Status						
Species	**Birds Directive Annex I Species**	**Birds Directive Migratory Species**	**WCA S1**	**SPA feature***	**NERC S41**	**BoCC**
Common scoter **		✓	✓		✓	**Red**
Red-throated diver	✓	✓	✓	✓		**Amber**
Fulmar		✓				**Amber**
Gannet		✓		(✓)		**Amber**
Great skua **		✓				**Amber**
Kittiwake		✓		✓		**Amber**
Black-headed gull ***		✓		(✓)		**Amber**
Common gull		✓				**Amber**
Lesser black-backed gull		✓		✓		**Amber**
Herring gull		✓		(✓)	✓	**Red**
Great black-backed gull		✓				**Amber**
Guillemot		✓		(✓)		**Amber**
Razorbill		✓		(✓)		**Amber**
Puffin ***		✓		(✓)		**Amber**

* SPA features include those of UK SPAs. SPA features in brackets indicate assemblage features
** These species were not recorded in numbers of at least regional importance during the aerial surveys, but have been included in the migration modelling (*Appendix 12.2*) and are thus included in the impact assessment
*** These species were not recorded in numbers of at least regional importance, so are omitted from the impact assessment.

Table 12-47 Seabird Species Recorded within the East Anglia ONE site during 2009/10 and 2010/11 Aerial Surveys and their Conservation Status

12.5.2.8.1 Non Impact-specific Species Values / Sensitivities

293 The sensitivity values for each of the species recorded within the East Anglia ONE site given below have been based on the definitions of non impact-specific species values / sensitivities given in *Section 12.5.2.8.1* above and summarised in *Table 12-48* below for clarity.

Definition of Terms Relating to the Non Impact-specific Value of Ornithological Receptors (Peterson et al. 2006)	
Non Impact-specific Value	**Examples**
Very high	Bird species that form part of a cited interest of an SPA or Ramsar site that may potentially interact with the study area at some stage of their life cycle Or A bird species which is present within the site in numbers of greater than 1% of the international population
High	Bird species that form part of an assemblage qualification of an SPA that may potentially interact with the study area at some stage of their life cycle Or A bird species which is present within the site in numbers of greater than 1% of the national population
Medium	Bird species that are listed on Annex I of the EU Birds Directive or on Schedule 1 of the Wildlife & Countryside Act 1981, requiring increased legal protection from disturbance during the breeding season Or Species listed on the Birds of Conservation Concern (BoCC) Red list Or Species that are the subject of a specific action plan within the UK Biodiversity Action Plan Or A bird species which is present within the site in numbers of greater than 1% of the regional population
Low	Any other species of conservation interest, eg species listed on the BoCC Amber list
Negligible	All other species of low conservation concern

Table 12-48 Definition of Terms Relating to the Non Impact-specific Value of Ornithological Receptors (Peterson et al. 2006)

294 The non impact-specific sensitivities of each species are detailed in *Table 12-49* below.

Summary of Non Impact-Specific Sensitivities for the Species Included in the Impact Assessments		
Species	**Non Impact-specific Value**	**Justification**
Seabird Species		
Common scoter	Very high	This species migrates into the UK for the winter and is associated with non-breeding SPAs around The Wash and the North Norfolk coast. Although not recorded within the East Anglia ONE site in regional numbers it was included within migration modelling for this EIA.
Red-throated diver	Very high	Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.
Fulmar	Medium	Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.
Gannet	High	Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during the breeding season it can be assumed that the area of sea within the East Anglia ONE site is not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.
Great skua	Very high	Recorded in low numbers during both boat-based and aerial surveys, but it is recognised that during migration periods birds may fly through East Anglia ONE site. This species is on the BoCC amber list and through a precautionary modelling exercise it has been estimated that potentially internationally important numbers fly through the East Anglia ONE site during autumn and spring migration.
Kittiwake	Very high	Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods throughout the East Anglia ONE site.
Common gull	Low	The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally

Summary of Non Impact-Specific Sensitivities for the Species Included in the Impact Assessments		
Species	**Non Impact-specific Value**	**Justification**
		important numbers during the aerial surveys during any biologically relevant period.
Lesser black-backed gull	Very high	Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.
Herring gull	High	Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC red list.
Great black-backed gull	High	The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.
Guillemot	High	Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider number of colonies and not exclusively from the Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.
Razorbill	High	
Migratory Species		
Bewick's swan	Very high	These species all migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.
Taiga bean goose	Very high	
European white-fronted goose	Very high	
Dark-bellied brent goose	Very high	

Summary of Non Impact-Specific Sensitivities for the Species Included in the Impact Assessments		
Species	**Non Impact-specific Value**	**Justification**
Shelduck	Very high	
Avocet	Very high	
Golden plover	Very high	
Knot	Very high	
Dunlin	Very high	
Black-tailed godwit	Very high	
Bar-tailed godwit	Very high	

Table 12-49 Summary of Non Impact-Specific Sensitivities for the Species Included in the Impact Assessments

12.6 Potential Impacts

12.6.1 Introduction

295 This section assesses the potential effects of the development on the bird species recorded within the East Anglia ONE site or from the species- specific migration modelling exercise. Focus is on the main species of concern that are more commonly found within the East Anglia ONE site or are predicted to migrate through it during spring or autumn passage. For the purpose of identifying and assessing all potential impacts that may occur from the development of the East Anglia ONE project and associated structures across its lifetime this section focuses on the three stages of the proposed development, which will be accounted for in separate sub-sections:

- Potential impacts during the construction of the East Anglia ONE project;
- Potential impacts during the 25 year operational lifetime; and
- Potential impacts during the decommissioning of the wind turbines and associated infrastructure after the 25 year licence.

296 All potential impacts will be assessed in accordance with the assessment methodology guidelines described in *Section 12.4* and also in conjunction with the worst case outlined within *Section 12.3.3*. The magnitude of effects upon each receptor is determined by reference to the extent to which key elements and / or features of the baseline conditions would be altered by the development and the significance of the magnitude of impacts will be drawn from this process.

12.6.2 Potential Impacts during Construction

12.6.2.1 Identification of Effects

297 The offshore construction components of the East Anglia ONE project would take approximately two and a half years to construct, with at least two breeding, two wintering and five migration periods potentially being affected.

298 The construction phase of the East Anglia ONE site and offshore cable corridor would require mobilisation of vessels and equipment to the site and the installation of foundations and cables to the sea bed. These activities have the potential to directly disturb and displace birds from within the proposed development area and habitat loss as bird access to the development site for the purposes of feeding, loafing and moulting could be reduced. Vessel activity and the installation of lighting could also attract (or repel) migrating birds and therefore affect migratory routes on a local scale.

299 Birds could also be indirectly affected by construction activities through sediment dispersal, altering feeding behaviour for benthic species and distributions of fish species.

300 Apart from localised habitat change due to turbines themselves, in general, any effects from construction activity are considered to be short-term, lasting only for the duration of construction activity. Therefore they will be direct, but are temporary, reversible and short-term in nature. Although a 4km buffer from the construction site is recommended by Maclean *et al.* (2009) for disturbance, the spatial extent of construction related disturbance is likely to be less than this for the majority of species, although the exact level may differ per species or construction activity.

12.6.2.2 Direct Disturbance and Displacement

12.6.2.2.1 Overview

301 Direct disturbance of birds during the construction of a windfarm may occur due to vessel movements, noise from foundation installation and cable laying and the physical presence of vessels, installation equipment and their crews. Any

disturbance and displacement effects resulting from these activities are considered to be short-term, temporary and reversible in nature. Birds may return to areas once construction activities have ceased.

302 The worst case scenario (see *Table 12-3, Section 12.3.3.1*) considers the developments impacts on birds from a variety of different perspectives. For the purpose of a thorough investigation into the worst case during the construction period as described in *Section 12.3.3.1* . This scenario assumes that one met mast, three collector stations and two converter stations would also be constructed within the East Anglia ONE site.

303 Construction is programmed to occur over a period of two and a half years, 24 hours a day, seven days a week. The worst case scenario has assumed that piling would be simultaneously taking place on two separate foundations at the same time, which are not in close proximity to each other, to give the maximum footprint for vessel movements and underwater noise, though works of a different nature may be taking place simultaneously on other turbines.

304 Disturbance and displacement of birds both directly and indirectly (through disturbance of prey species or feeding conditions) will occur from the installation of foundations and associated scour protection that may be required. *Volume 1, Chapter 4 Project Description* identifies jacket foundations in particular require pin piles to secure foundations to seabed which provides the worst case scenario since this has the greatest potential for noise impacts on both birds and prey species. The largest pile options (2.5m in diameter) installed using a 900kJ hammer are likely to be associated with the loudest noise. Noise would travel furthest in deeper water (45-55 m). Piling may also create disturbance to the sea bed and water clarity due to increased suspended sediment, leading to changes in feeding habitat suitability and bird distribution.

305 Pursuit diving species, such as divers and auks, spend most of their time on or in the water. Therefore, the greatest effects of disturbance and displacement during construction operations are most likely to be seen on these species groups (as well as similar effects affecting prey, and, indirectly, these birds). Within the East Anglia ONE site, populations of red-throated divers, guillemots and razorbills are thus at greatest risk of impact.

306 The main impact as a result of the offshore export cables, interconnector cables and inter-array cables installation on ornithological interests is likely to be disturbance and potential short-term displacement of individual birds or groups of birds during the laying of the cables. However, displacement would not occur throughout the whole project area, but would be limited to the area around installation vessels during construction. The worst case assumes that offshore export cables would be

laid by 80% by jetting and 20% trenching, which is assessed as the worst case. Additional, limited “pre-sweeping” by dredging may be required in areas of large sandwaves (see *Volume 2, Chapter 6 Physical Processes*).

307 The offshore cable corridor passes through part of the Outer Thames Estuary SPA, designated solely for wintering red-throated divers. Red-throated divers are prone to disturbance, and possibly displacement (Garthe & Hüppop 2004), though there is some tentative evidence of habituation (eg to windfarm turbines) over time (Percival 2009). Wintering and passage (spring / autumn) red-throated divers may show avoidance of cable laying vessels. This could potentially lead to an alteration of spring and autumn migration routes on a local scale, and short-term loss of feeding habitat availability. However, as the area is currently a busy shipping area a reduction in vessel movement due to construction activities are likely to offset any effect of the cable laying on the divers.

308 There are a number of nearby SPAs designated for breeding terns (little tern, common tern and sandwich tern) and one designated for lesser black-backed gulls, with herring gulls and black-headed gulls forming part of the breeding seabird assemblage qualification. Many of these birds are known to feed outside of these SPAs in nearby coastal waters (Stroud *et al.* 2001).

309 Several of these SPAs have been identified in the baseline as being of relevance as the maximum foraging ranges of the species for which they are designated could put foraging birds from these sites within the area proposed for the offshore cable corridor. This may lead to displacement during periods of cable laying activity through avoidance of operations, leading to changes in foraging activity and energy budgets. However, there is no evidence to suggest the cable route is an important area in itself and (in the absence of any other information to the contrary) assuming homogenous density across the offshore foraging radius it would be approximately 1% of the available area, so any affect is likely to be on a very small proportion of the suitable habitat within foraging range.

310 Any disturbance, and associated displacement of the birds to unaffected similar habitat close by, caused by cable installation may lead to a short-term avoidance impact that is likely to occur at a local scale. It is anticipated that any birds using the affected area are likely to start using the area again shortly after cable installation is complete, with at worst only a small loss of carrying capacity due to the possible very localised loss of benthos resulting from the works.

12.6.2.2.2 Red-throated divers

311 Red-throated divers are considered to have a *very high* general sensitivity to disturbance and displacement *(Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to disturbance and displacement is considered to be *very high*.

312 As they have fairly specific habitat requirements in terms of water depth preferences, they are also considered to have a low level of habitat adaptability. However, construction activity is expected to be fairly concentrated in small areas of the East Anglia ONE site and over a relatively short time period, as wind turbines would be installed in sequence and not all suitable habitat will be affected simultaneously.

313 Red-throated divers were present in the East Anglia ONE site in regionally important numbers during the winter and in regionally and nationally important numbers during the spring migration period. These birds are considered likely to be most sensitive to disturbance in early winter or midwinter when they are in moult and become flightless for some days (Wernham *et al.* 2002). Therefore, during this time birds would find it difficult to quickly escape from vessels or find alternative areas away from disturbance. Even when considering the worst case construction scenario works not take place simultaneously across the entire East Anglia ONE site. With respect to disturbance associated with piling in particular, this activity would only take place at a maximum of two locations at any one time. Construction activity would be relatively localised. .At worst birds may be displaced 4km from areas of construction activities associated with foundation installation, though it is assumed that an abundance of alternative habitat is available within the East Anglia ONE site for birds to utilise, so any effect will be minor and temporary in nature.

314 The installation of the offshore cable also has the potential to disturb and displace red-throated divers. However, any disturbance would likely be localised around the actual area of activity due to the presence of the vessel and cable laying activities. Cable laying vessels are static for large periods of time moving only short distances as laying operations take place. Cable laying activities also create less noise than pile driving and other foundation/scour protection construction activities, so it is likely that displacement would be substantially less than that from the foundation laying operations. It is quite possible that all of the displaced birds could be assimilated in surrounding waters if the carrying capacity is sufficient.

315 The density of red-throated divers across the East Anglia ONE site is low (0.5 birds / km^2) in comparison to the Outer Thames Estuary SPA (1.7 birds / km^2), which supports the assumption that the habitat is sub-optimal for foraging during the winter and spring periods. Any potential impact is not expected to affect the population of

red-throated divers within the East Anglia ONE project, so no effects are predicted from the construction activities, other than short-term ones. Therefore, any disturbance and displacement due to construction activities can be considered to be of *negligible magnitude*.

316 Therefore, the combination of activities associated with construction disturbance associated with wind turbines, ancillary structures, vessel movements and cable laying activities within the East Anglia ONE project will create at worst a **minor adverse impact** on red-throated divers. This is in recognition that only a small change will be experienced by red-throated divers in site conditions, as birds may move within the site itself during the construction period, as areas will still be devoid of construction activity and therefore disturbance.

12.6.2.2.3 Fulmars

317 Fulmars are wide-ranging, aerial foragers that spend much of their time on the wing. Fulmars are considered to have a *low* general sensitivity to disturbance and displacement (*Table 12-45*). From *Table 12-49*, the species is considered to be a *medium* value species. Therefore their site-specific sensitivity to disturbance and displacement is considered to be *low*.

318 As a result of their relatively low sensitivities, their general ecology and given that any effects of disturbance as a result of construction activities are considered to be short-term and restricted to a localised subset of the population (i.e. that present within 4km of a turbine foundation installation area), any impacts from disturbance and displacement due to construction are anticipated to be of *negligible magnitude*. Therefore, it is considered that construction disturbance associated with wind turbines, ancillary structures, vessel movements and cable laying activities within the East Anglia ONE project would create at worst a impact of **negligible significance** on fulmars due to any reduction in site conditions being only slight and not anticipated to be of concern.

12.6.2.2.4 Gannets

319 Gannets are considered to have a low general sensitivity to disturbance and displacement (*Table 12-45*). From *Table 12-49*, the species is considered to be a *high* value species. As gannets are only found in the East Anglia ONE site in regionally important numbers during the migration periods there is no reason to believe that these passage birds are uniquely from the Bempton SPA colony. However their site-specific sensitivity to disturbance and displacement is considered to be at most a precautionary *medium*. Gannets are also wide-ranging, aerial foragers that spend much of their time on the wing. They forage on mobile food sources and localised distribution patterns are known to be heavily influenced by

trawler activity, as the species is known to feed on the fish products discarded by these boats (Camphuysen *et al*. 1995).

320 As a result of their low level sensitivities, general ecology and given that any effects of disturbance as a result of construction activities are considered to be short-term and restricted to a localised subset of the population, any impacts from disturbance and displacement due to construction are anticipated to be of negligible magnitude. Therefore, it is considered that construction disturbance associated with wind turbines, ancillary structures, vessel movements and cable laying activities within the East Anglia ONE project will create at worst an impact of **negligible significance** on gannets.

12.6.2.2.5 Gulls

321 Most gull species have been found to remain undisturbed by the presence of boats even when in close proximity. Survey data from Greater Gabbard offshore windfarm in December 2010 observed lesser black-backed gulls in association with a construction vessel (GGOWL 2011). This is likely reflected in gulls' foraging strategy of taking discards close to fishing vessels: lesser black-backed gull (Camphuysen 1995); herring gull (Camphuysen 1995; Hüppop & Wurm 2000); great black-backed gull (Hüppop & Wurm 2000; Buckley 2009).

322 Gulls might be expected to tolerate pile-driving and other installation activities as birds have rapidly colonised industrial sites across the UK despite the high intensity use of machinery on them eg landfill sites (Royal Haskoning 2011). Visual observations before and during three pile driving sessions at the Egmond aan Zee (OWEZ) Wind Farm in the Netherlands did not detect any noticeable reactions of gulls to construction activities (Leopold & Camphuysen 2007). All of the gull species considered for the East Anglia ONE assessment are considered to have *low* general sensitivities to disturbance and displacement (*Table 12-45*).

323 Gull species recorded within the East Anglia ONE site were recorded in numbers of varying importance levels during different times of the year. From *Table 12-49*, kittiwakes and lesser black-backed gulls are considered to be *very high* value species, herring gulls and great black-backed gulls are considered to be *high* value species and the common gull is considered to be a *low* value species.

324 This leads to site specific sensitivities to disturbance and displacement being considered to be *medium* for kittiwakes, lesser black-backed gulls, herring gulls, great black-backed gulls and black-headed gulls, whilst it is considered *low* for common gulls.

325 As a result of the sensitivities of the birds, their general ecology and given that any effects of disturbance as a result of construction activities are considered to be short-term, local to the installation of foundations and restricted to a localised subset of the population, any impacts on gull species from disturbance and displacement due to construction are anticipated to be of *negligible magnitude*. Therefore, it is considered that construction disturbance associated with wind turbines, ancillary structures, vessel movements and cable laying activities within the East Anglia ONE project will create at worst a **negligible impact** on all gull species, including kittiwakes, common gulls, black-headed gulls, lesser black-backed gulls, herring gulls and great black-backed gulls as the localised changes will be of a temporary nature that will not be of concern to all gulls.

12.6.2.2.6 Auks

326 Both guillemots and razorbills are considered to have *medium* general sensitivities to disturbance and displacement (*Table 12-45*). However, they are considered to be fairly flexible in habitat use (Garthe & Hüppop 2004; Maclean *et al.* 2009), as they are very mobile (except when flightless during moult or first year birds that have not yet grown full flight feathers) and widely distributed (Stone *et al.* 1995; Wernham *et al.* 2002) and are therefore likely to be able to exploit areas outside the area of impact.

327 From *Table 12-49* both species are considered to be *high* value species. This equates to both guillemot and razorbill being assigned site specific sensitivities to disturbance and displacement of *high*.

328 It is anticipated that the population level effect will be much smaller and localised, with birds displaced to a maximum of 4km around the foundation installation area, although there is likely to be abundant alternative habitat available within the East Anglia ONE site for birds to utilise. It is recognised that the risk to auks may be greater during moulting times (mostly between early August to end of September) when the birds are flightless and unable to escape by flight. Birds would be most at risk during the period they are flightless from multiple movements of fast vessels. However, even if the worst case vessel movements is applied as an impact during this period, vessels would be assigned to particular routes to, from and between wind turbines and moving to and from the site each day for construction activities, which registers at most as a *low* impact, but more likely of **negligible impact**.

329 The installation of the offshore export cable also has the potential to disturb and displace guillemots and razorbills. However, any disturbance will likely be localised around the actual area of activity due to the presence of the vessel and cable laying activities, so both temporary and minimal in its area of impact.

330 As construction activities are considered to be both short-term and restricted to small areas within the East Anglia ONE project, any disturbance and displacement due to construction activities can be considered to be of *negligible* magnitude. Therefore, it is considered that construction disturbance associated with wind turbines, ancillary structures, vessel movements and cable laying activities within the East Anglia ONE project will create at worst an impact of **negligible significance** on both guillemots and razorbills.

Summary of Potential Direct Disturbance Effects during Construction					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Construction**
Red-throated diver	Very high - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	Very high - Based on the known sensitivity to ship and helicopter traffic given in Garthe & Hüppop (2004).	Very high – A combination of both a very high non impact-specific value and a very high general sensitivity to disturbance and displacement.	Negligible – Effects are considered to be short-term and restricted to a localised subset of the population.	**Minor adverse** – A combination of both a very high site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.
Fulmar	Medium - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	Low – Based on their sensitivity to ship and helicopter traffic given in Garthe & Hüppop (2004).	Low – A combination of both a medium non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Wide ranging species and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population.	**Negligible** – A combination of both a low site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.
Gannet	High - Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during the breeding season it can be	Low – Based on their low level of sensitivity to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Wide ranging species and effects are considered to be short-term and restricted to a localised subset of the population. Present in	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.

Summary of Potential Direct Disturbance Effects during Construction					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Construction**
	assumed that the area of sea within the East Anglia ONE is not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.			low abundance in the East Anglia ONE site.	
Kittiwake	Very high - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods throughout the East Anglia ONE site.	Low – Based on their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Wide ranging species and fairly tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.

Summary of Potential Direct Disturbance Effects during Construction					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Construction**
Common gull	Low - The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally important numbers during the aerial surveys during any biologically relevant period.	Low – Based on their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Low – A combination of both a low non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Wide ranging species and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population. Present in low abundance in the East Anglia ONE site.	**Negligible** – A combination of both a low site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.
Lesser black-backed gull	Very high - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	Low – Based on their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004) and observations from other offshore windfarms.	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Wide ranging species and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.
Herring gull	High - Herring gulls have been recorded in regionally important numbers within the East	Low – Based on their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a	Negligible – Wide ranging species and tolerant of human activities. Effects are	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance

Summary of Potential Direct Disturbance Effects during Construction					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Construction**
	Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC red list.		low general sensitivity to disturbance and displacement.	considered to be short-term and restricted to a localised subset of the population. Present in low abundance in the East Anglia ONE site.	and displacement and a negligible magnitude of impact.
Great black-backed gull	High - The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	Low – Based on their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Wide ranging and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.
Guillemot Razorbill	High - Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and	Medium – Based on their individual sensitivities to ship and helicopter traffic in Garthe & Hüppop (2004)	High – A combination of both a high non impact-specific value and a medium general sensitivity to	Negligible – Both species are wide ranging during the winter months when numbers peaked.	**Negligible** – A combination of both a high site-specific sensitivity to disturbance and displacement and a

Summary of Potential Direct Disturbance Effects during Construction					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Construction**
	migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider number of colonies and not exclusively from the Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.		disturbance and displacement for both species.	Effects of disturbance to prey are considered to be short-term and localised.	negligible magnitude of impact.

* Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Disturbance / Displacement Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

** Predicted Impact Significance is a product of combining the Site-specific Sensitivity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-50 Summary of Direct Disturbance Effects during Construction

12.6.2.3 Direct Habitat Loss / Change

12.6.2.3.1 Overview

332 Installation and anchoring of equipment and vessels to the seabed has the potential to result in both temporary and permanent displacement and habitat loss. The presence of the wind turbine, collector station and converter station foundations is likely to result in the permanent loss of the current sea bed habitat, creating an impact on those organisms that currently rely on this to survive. The habitat generally lost due to windfarm developments involves areas of seabed lost to wind turbine bases and ancillary structures, which typically equates to a small area of <1% of the total development footprint area (Drewitt & Langston 2006).

333 During the construction of each foundation a considerable amount of disturbance would occur to the sea bed, causing increased turbidity in surrounding waters before the foundation is in place. The effects of increased turbidity are addressed within the indirect impacts of construction (*Section 12.6.2.4*). Habitat loss will be gradual over the course of the two and half years that it will take to build all of the foundations across the windfarm. Eventually, approximately 1% of the original seabed would have been removed and been replaced with foundations, that will initially be largely void of both benthic and fish communities, thus removing a potential food resource for birds foraging in the sea within and around the foundation laying activities. Some of the habitat used by the benthic invertebrate prey of fish and birds would remain lost as long as the foundations are in place which will potentially lead to a temporary minor net loss of carrying capacity for the birds such as diving ducks that feed on the benthos, or the divers and auks that feed on the fish that feed on the benthos. However, in due course loss of seabed due to the foundations may be partially or fully compensated by the development of new communities of benthic and fish species that would take advantage of the new structures that offer a new foraging resource for the birds, as is described in more detail in *Section 12.6.3.5* (habitat change during operational phase) and more detailed information in *Section 9.5.2* (*Potential Impacts During Operation*) of *Volume 2, Chapter 9 (Benthic and Epibenthic Environment)* and *Section 10.6.3* (*Potential Impacts During Operation*) of *Volume 2, Chapter 10 (Fish Ecology)*.

334 Available habitat which may be affected by offshore export cable installation includes the seabed, the sea itself and intertidal habitat at the offshore export cable landfall location. Few benthic feeding birds (eg common scoter) have been recorded in the offshore cable corridor. Areas of the sea, possibly including bird foraging habitat, may be temporarily lost during the cable installation and may lead to a displacement of birds to other areas. Disturbance and displacement is, however, likely to be limited in spatial extent and is likely to be short term.

With respect to habitat loss the worst case scenario would be for 240 50m diameter gravity base foundations (GBFs) to be installed with scour protection around the extent of the maxmimum seabed preparation area to protect against currents and waves that may cause erosion of the seabed.

335 Cables installed by jetting are assumed to each result in a 5m wide area of seabed disturbance, and trenching 50m wide, with direct habitat loss only associated with cable protection installed at cable and pipeline crossings or where cables are required to cross hard ground.

336 It is likely that there will be some changes in sediment and habitat types immediately adjacent to the foundation structures, which may affect local benthic and fish prey species temporarily during the construction period. However, the disturbance and displacement to the sea bed around the foundations and cable route will not be permanent. As the total area affected from construction activities would be approximately 1% of the total East Anglia ONE site and that construction would be carried out in stages over a two and half year period, the impact of construction activities on habitats within the East Anglia ONE project is expected to be of negligible magnitude on all bird species.

12.6.2.3.2 Red-throated divers

337 Red-throated divers have fairly specific habitat requirements in terms of water depth requirements, being associated with shallow (between 0 to 20m in depth, less frequently in depths of around 30m) inshore waters (Natural England 2010), which partly explains the low densities of birds found within the East Anglia ONE site, as much of the area is between 30 to 40m depth. Red-throated divers are considered to have a *high* general sensitivity to habitat loss (*Table 12-45*). From *Table 12-49,* the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to habitat loss is considered to be *very high.*

338 Red-throated divers are sensitive to changes in habitat, as they have very specific requirements for their chosen areas for foraging. However, although they have a *very high* value and *very high* site specific sensitivity, red-throated divers will only be impacted by a temporary habitat loss from the cable laying activities and little habitat loss from the construction activities laying foundations, as the total area of sea bed covered by foundations is little in comparison to the entire East Anglia ONE site, being approximately 1% in total area and these waters are too deep to be important for foraging, resulting in an impact of *negligible* magnitude and of a **minor adverse significance**, particularly on the wintering population.

12.6.2.3.3 Fulmars and Gannets

339 Fulmars and gannets are both considered to have *low* general sensitivities to habitat loss (*Table 12-45*). From *Table 12-49*, fulmars are considered to be a *medium* value species and therefore the site specific sensitivity of fulmars to habitat loss is considered to be *low*.

340 From *Table 12-49* gannets are considered to be a *high* value species. As birds are not found in regionally important numbers during the breeding season it can be assumed that the area of sea within the East Anglia ONE site is not an important one for the species with respect to foraging from the Bempton SPA. Therefore, the site-specific sensitivity to habitat loss is considered to be *medium* for gannets.

341 The effects of temporary habitat loss during the construction stage of this development on fulmar and gannet will have a *negligible* magnitude impact, as only minimal direct habitat loss will occur on the water surface during this period and the removal of approximately 1% of the seabed surface will have only a temporary and minimal impact on their food resources. Therefore with a *low* site specific sensitivity for fulmars and *medium* value for gannets the effect of a *negligible* magnitude impact is not considered to be of more than **negligible significance** from habitat lost during construction period.

12.6.2.3.4 Gulls

342 All of the gull species considered in the East Anglia ONE assessment are considered to have *low* general sensitivities to habitat loss (*Table 12-45*).

343 Gull species recorded within the East Anglia ONE site were recorded in numbers of varying importance levels during different times of the year. From *Table 12-49,* kittiwakes and lesser black-backed gulls are considered to be *very high* value species, herring gulls and great black-backed gulls are considered to be *high value* species and the common gull is considered to be a *low* value species.

344 Therefore, the site-specific sensitivities to habitat loss are considered to be *low* for common gulls and *medium* for black-headed gulls, kittiwakes, lesser black-backed gulls, herring gulls and great black-backed gulls.

345 Although a *medium* value may be applicable for site specific sensitivities for some gull species, none will be affected by the limited habitat loss during the construction period, so the magnitude of the impact will be of *negligible* value. With no species being assigned anything more than a *medium* site specific sensitivity and all having a *negligible* magnitude of impact the significance for all gull species is no more than **negligible** for habitat loss during the construction period.

12.6.2.3.5 *Auks*

346 Both guillemots and razorbills are considered to have *medium* general sensitivities to habitat loss (*Table 12-45*). From *Table 12-49* both species are considered to be *high* value species, although they only occur in the East Anglia ONE site outside of the breeding season (during winter and migration periods) in numbers of regional importance. Therefore, the site-specific sensitivities for both species to habitat loss are considered to be *high*.

347 As a result the predicted magnitude of effect from construction activities on both species is considered to be *negligible*, meaning that the impact of habitat loss during the construction phase of the development is of **negligible significance** for auks.

Summary of Potential Direct Habitat Loss / Change Effects during Construction					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Habitat Loss / Change Effects during Construction**
Red-throated diver	Very high - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	High – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Very high – A combination of both a very high non impact-specific value and a high general sensitivity to habitat loss.	Negligible – Approximately 1% of habitat within East Anglia ONE will be lost.	**Minor adverse** – A combination of both a very high site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Fulmar	Medium - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Low – A combination of both a medium non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Approximately1% of habitat within East Anglia ONE will be lost.	**Negligible** – A combination of both a low site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Gannet	High - Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during the breeding season it can be assumed that the area of sea within the East Anglia ONE is	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Approximately1% of habitat within East Anglia ONE will be lost.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Direct Habitat Loss / Change Effects during Construction					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Habitat Loss / Change Effects during Construction**
	not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.				
Kittiwake	Very high - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods throughout the East Anglia ONE site.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Approximately1% of habitat within East Anglia ONE will be lost.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Common gull	Low - The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Low – A combination of both a low non impact-specific value and a low general	Negligible – Approximately 1% of habitat within East Anglia ONE will be	**Negligible** – A combination of both a low site-specific sensitivity to habitat loss

Summary of Potential Direct Habitat Loss / Change Effects during Construction					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Habitat Loss / Change Effects during Construction**
	important numbers during the aerial surveys during any biologically relevant period.		sensitivity to habitat loss.	lost.	and a negligible magnitude of impact.
Lesser black-backed gull	Very high - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Approximately 1% of habitat within East Anglia ONE will be lost.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Herring gull	High - Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC red list.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Approximately 1% of habitat within East Anglia ONE will be lost.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Direct Habitat Loss / Change Effects during Construction					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Habitat Loss / Change Effects during Construction**
Great black-backed gull	High - The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Approximately 1% of habitat within East Anglia ONE will be lost.	**Negligible –** A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Guillemot Razorbill	High - Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider number of colonies and not exclusively from the Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage	Medium – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009) for both species.	High – A combination of both a high non impact-specific value and a medium general sensitivity to habitat loss for both species.	Negligible – Approximately 1% of habitat within East Anglia ONE will be lost.	**Negligible** – A combination of both a high site-specific sensitivity to habitat loss and a negligible magnitude of impact for both species.

Summary of Potential Direct Habitat Loss / Change Effects during Construction					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Habitat Loss / Change Effects during Construction**
	of the Flamborough Head and Bempton Cliffs SPA.				

* Site-specific Sensitivity is a product of combining the Non Ipact-specific Value with the General Habitat Loss Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

** Predicted Impact Significance is a product of combining the Site-specific Sensitivity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-51 Summary of Direct Habitat Loss / Change Effects during Construction

12.6.2.4 Indirect Effects

12.6.2.4.1 Overview

348 Birds may be indirectly affected by construction activities, particularly from the installation of foundations, which may cause increased suspended sediment and sediment dispersal caused by piling activities, which could potentially affect birds indirectly by smothering or affecting the feeding behaviour of some of their benthic organism prey. The noise associated with all construction activities may also impact the birds indirectly, as some of their prey is repelled from areas of water in close proximity to the activities. *Volume 2, Chapter 9 Benthic and Epibenthic Environmen)* suggests a non-significant impact on the benthic ecology as a result of increased suspended sediment. *Volume 2, Chapter 10 Fish Ecology* suggests that pile driving may cause fish dispersal away from construction areas, but that this will only be locally around areas of activity. However, both the benthic community and the fish assemblage are relatively homogenous across the East Anglia ONE site and adjacent areas. If fish species are displaced through piling noise the bird species that feed on fish should therefore be able to find suitable prey in adjacent areas, as no evidence was found to suggest that there were regularly occurring hotpots for birds within the East Anglia ONE site boundary. Birds are therefore considered to be of *low* sensitivity and in the context of birds the impact of piling noise on prey and feeding behaviour is assessed to be not significant.

349 Additional effects can be expected as a result of sediment pluming during pile driving and other construction activities disturbing the sea bed. These effects are expected to be temporary and localised but may result in disruption of feeding by filter feeding organisms and smothering when the sediment settles from the water column. As a result of this birds that rely on these food sources may be impacted by a reduction in the number of available organisms to feed upon.

350 There may be localised effects on prey loss in response to the cable laying activities. The offshore export cable installation may also lead to disturbance of some fish species within the area, which is likely to add to the displacement of birds (particularly red-throated divers during winter and breeding gulls and terns during the summer) from the area as they search for prey items.

351 The worst case scenario is for the development to construct 325 wind turbines using jacket foundations, with three collector stations, two converter stations, one met mast. In addition, a worst case of 400km of offshore export cables, 130km of interconnector cables and 550km of inter-array cables would be installed.

352 The level of sensitivity to indirect effects for each species has followed MacLean *et al.* (2009), with further additional information on species behaviour relating to

feeding behaviour from scientific literature and the survey results. In order to account for potential indirect effects on the species of interest in the East Anglia ONE site each has been evaluated at the species group level or species level where a stronger impact was identified. The indirect impacts have then been predicted from the worst case scenario and information from both *Volume 2, Chapter 9 Benthic and Epibenthic Environment* and *Volume 2 Chapter 10 Fish Ecology*.

353 The effect of increased turbidity associated with the removal of seabed habitat reduces visibility for birds foraging visually within the areas of sea within and around foundation laying activities, resulting in a decline in resource availability within the areas affected.

354 The most significant indirect effects are likely to be from the noise levels associated with pile driving on fish species present in the East Anglia ONE site. If fish are displaced from these areas in great numbers then the knock-on (indirect) effect would be an area of reduced prey for foraging birds near the piling events. However, despite the effect on local fish populations being high, it is unlikely that the effect will be felt at a regional scale, as operational activities will be localised and of short duration. Therefore it is unlikely that any significant indirect impacts will be felt by the birds during the construction period of the East Anglia ONE project.

12.6.2.4.2 Red-throated divers

355 Red-throated divers have fairly specific water depth requirements and depend mostly on a mixture of cod, herring, sprat and sandeels (BWPi) for food, that are also associated with shallow inshore waters (Natural England 2010) between 0 to 20m in depth, less frequently in depths of around 30m. Based on the scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009), red-throated divers are considered to have a *high* general sensitivity to indirect impacts associated with windfarm construction activity. From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to indirect effects is considered to be *very high.*

356 However, due to the indirect impacts associated with construction activities being of localised and temporary nature to red-throated divers the level of magnitude on the birds within the East Anglia ONE project will be *negligible*, resulting in an impact of **minor adverse significance**, particularly on the wintering population.

12.6.2.4.3 Fulmars and Gannets

357 Fulmars and gannets are both considered to have *low* general sensitivities to indirect effects from construction activities (Garthe & Hüppop 2004; Maclean *et al.* 2009). From *Table 12-49*, fulmars are considered to be a *medium* value species and

therefore the site-specific sensitivity of fulmars to indirect effects is considered to be *low*.

358 From *Table 12-49* gannets are considered to be a *high* value species. As birds are not found in regionally important numbers during the breeding season (and no RSPB-tagged gannet was tracked within the East Anglia ONE site) it can be assumed that the area of sea within the East Anglia ONE site is not an important one for the species with respect to foraging from the Bempton SPA. Therefore, the site-specific sensitivity of gannets to indirect effects is considered to be *medium*.

359 Both fulmars and gannets prey on a variety of fish that may be affected by noise associated with pile driving, but due to the localised nature of construction activities it is unlikely that these effects will be more than *negligible* in magnitude. Therefore the significance of indirect impacts on fulmar and gannet will be **negligible**, as they pose no concern.

12.6.2.4.4 Gulls

360 All of the gull species considered in the East Anglia ONE assessment are considered to have *low* general sensitivities to indirect impacts (Garthe & Hüppop 2004). From *Table 12-49*, kittiwakes and lesser black-backed gulls are considered to be *very high* value species, herring gulls and great black-backed gulls are considered to be *high* value species and the common gull is considered to be a *low* value species. Therefore, the site-specific sensitivities to indirect effects are considered to be *medium* for kittiwakes, lesser black-backed gulls, herring gulls, great black-backed gulls and black-headed gulls, but *low* for common gulls.

361 Although a *medium* value may be applicable for site specific sensitivities for some gull species, none will be affected by the limited indirect impacts of increased sediment in the water or fish being driven from the small areas around the construction activities. As a result the magnitude of any effect will be of *negligible* value resulting in all impacts associated with indirect effects being of **negligible significance**.

12.6.2.4.5 Auks

362 Both guillemots and razorbills are considered to have *medium* general sensitivities to indirect impacts (Garthe & Hüppop 2004; Maclean *et al.* 2009). From *Table 12-49* both species are considered to be *high* value species. Therefore the site-specific sensitivities to indirect effects are considered to be *high*.

363 As a consequence of any indirect effects from construction activities being localised and only temporary in nature the magnitude of effect is predicted to be *negligible,* so

the significance of the indirect impacts will also be of **negligible significance** in nature for auks.

Summary of Potential Indirect Impacts from Construction Activities					
Species	**Non Impact-specific Value**	**General Indirect Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance****
Red-throated diver	Very high - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	**High** – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	**Very high** – A combination of both a very high non impact-specific value and a high general sensitivity to habitat loss.	**Negligible** – Effects are considered to be short-term and restricted to a localised subset of the population.	**Minor adverse** – A combination of both a very high site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Fulmar	Medium - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	**Low** – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	**Low** – A combination of both a medium non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – Prey on a variety of fish species that may be affected by noise associated with pile driving. However, these effects are considered to be short-term and localised.	**Negligible** – A combination of both a low site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Gannet	High - Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during the breeding season it can be assumed that the area of sea within the East Anglia ONE is not an important	**Low –** Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	**Medium** – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – Prey on a variety of fish species that may be affected by noise associated with pile driving. However, these effects are considered to be short-term and localised.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Indirect Impacts from Construction Activities					
Species	**Non Impact-specific Value**	**General Indirect Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance****
	one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.				
Kittiwake	Very high - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods throughout the East Anglia ONE site.	**Low –** Based on the habitat flexibility scores in Garthe & Hüppop (2004).	**Medium** – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – Wide ranging species with a variety of foraging strategies to cope with prey disturbance. Effects are considered to be short-term and localised.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Common gull	Low - The species is on the BoCC amber list. Has not been recorded in the	**Low** – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	**Low** – A combination of both a low non impact-	**Negligible** – Wide ranging species with a variety of foraging	**Negligible** – A combination of both a low site-specific

Summary of Potential Indirect Impacts from Construction Activities					
Species	**Non Impact-specific Value**	**General Indirect Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance****
	East Anglia ONE site in regionally important numbers during the aerial surveys during any biologically relevant period.		specific value and a low general sensitivity to habitat loss.	strategies to cope with prey disturbance. Effects are considered to be short-term and localised.	sensitivity to habitat loss and a negligible magnitude of impact.
Lesser black-backed gull	Very high - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	**Low** – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	**Medium** – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – Wide ranging species with a variety of foraging strategies to cope with prey disturbance. Effects are considered to be short-term and localised.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Herring gull	High - Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head	**Low** – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	**Medium** – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – Wide ranging species with a variety of foraging strategies to cope with prey disturbance. Effects are considered to be short-term and localised.	**Negligible –** A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Indirect Impacts from Construction Activities					
Species	**Non Impact-specific Value**	**General Indirect Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance****
	and Bempton Cliffs SPA and the species is on the BoCC red list.				
Great black-backed gull	High - The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	**Low** – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	**Medium** – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible –** Wide ranging species with a variety of foraging strategies to cope with prey disturbance. Effects are considered to be short-term and localised.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Guillemot Razorbill	High - Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider number of colonies and not exclusively from the	**Medium** – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009) for both species.	**High** – A combination of both a high non impact-specific value and a medium general sensitivity to habitat loss for both species.	**Negligible** – Both species are wide ranging during the winter months when numbers peaked. Effects of disturbance to prey are considered to be short-term and localised.	**Negligible** – A combination of both a high site-specific sensitivity to habitat loss and a negligible magnitude of impact for both species.

Summary of Potential Indirect Impacts from Construction Activities					
Species	**Non Impact-specific Value**	**General Indirect Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance****
	Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.				

*Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Indirect Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

**Predicted Impact Significance is a product of combining Site-specific Sensitivity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-52 Summary of Indirect Impacts from Construction Activities

12.6.3 Potential Impacts during Operation

12.6.3.1 Identification of Effects

364 The East Anglia ONE project would be operational over 25 years, longer than some seabirds' life expectancies.

365 The operational phase of the East Anglia ONE site will involve a worst case scenario of 325x 150m tip height wind turbines with a 120m rotor diameter and 22m minimum air draft rotating for 25 years across the site. This will require an almost constant mobilisation of maintenance vessels to, from and within the site.

366 The main operational impacts are predicted to be due to wind turbine presence and maintenance operations likely to be required throughout the life of the East Anglia ONE site. The presence of the East Anglia ONE site has the potential to affect offshore bird populations in a number of ways including:

- Direct and indirect disturbance / displacement of birds and prey;
- Increased mortality through collision with wind turbines;
- Alteration of migratory and foraging movements (barrier effect); and
- Through the loss or alteration of habitat.

367 The presence of a windfarm has the potential to directly disturb and displace birds from within the proposed development area and cause habitat loss by reducing bird access to the development site for the purposes of feeding, loafing and moulting. Vessel activity and the lighting of wind turbines and associated ancillary structures could attract (or repel) migrating birds and therefore affect migratory routes on a local scale.

368 Birds could also be indirectly affected by the creation and / or loss of habitat from the creation of foundations, altering the densities, behaviour and distributions of benthic invertebrates and fish. There may also be impacts associated with any "artificial" reef creation around the cable laid out to the windfarm that could lead to increased prey densities thus attracting birds towards the development area.

369 The greatest impacts associated with a windfarm are those arising during its operational life, as they will last at least 25 years across the East Anglia ONE site. Therefore they will be direct and long term, although ultimately reversible.

370 Although a 4km buffer from operational windfarms is recommended by Maclean *et al.* (2009) for disturbance, more sensitive species such as divers and auks have shown avoidance of areas to a lesser distance than this: areas up to 1km at Horns Rev in Denmark (Petersen *et al.* 2004; Petersen 2005; Drewitt & Langston 2006) and within 500 m at Kentish Flats (Percival 2009). There is a growing body of knowledge that indicates a reduction in bird displacement both spatially (within and around windfarms) and in abundance may be more appropriate, within the assessment process, than is currently recognised.

12.6.3.2 Direct Disturbance and Displacement

12.6.3.2.1 Overview

371 Any birds displaced from areas due to the physical presence of the wind turbines are potentially unlikely to return to these areas during the operational life of the site, assuming worst case scenario of 100% displacement from the entire site for the full operational period of 25 years. Under EIA guidance any displacement from the East Anglia ONE site for such a period would constitute a long-term impact. In this Environmental Statement, a range of displacement proportions informed by previous studies will be presented. The impacts of disturbance and displacement are then be assessed with respect to them having a temporary or permanent effect.

372 Maintenance activities requiring the use of vessels and the presence of lighting offshore have the potential to directly disturb birds, in a similar way to construction activities, but on a greatly reduced scale. These activities could potentially reduce access for birds to important areas for feeding, moulting and loafing. Reduced access to some areas could result in changes to feeding and other behavioural activities.

373 The generation of noise or visual disturbances during normal wind farm operation could result in displacement and a loss of foraging / loafing and moulting areas. The worst case scenario (*Section 12.3.3.2*) for disturbance and displacement presents the maximum number of turbines and other structures associated within the East Anglia ONE site (325 wind turbines, three collector stations and two converter stations). This would cause the most significant impact on the more sensitive species known to inhabit the site currently, and would reduce their numbers post-development.

374 Following installation of the offshore export cable, the required maintenance activities may have short-term and localised disturbance and displacement impacts on birds using the entire East Anglia ONE site. However, disturbance effects from maintenance activities are not thought to be significant, in line with other offshore windfarm EIAs (eg Galloper: Royal Haskoning 2011 and Greater Gabbard: Banks *et*

al. 2006). The focus of this section will be on the displacement effect associated with the presence and operation of the wind turbine structures.

12.6.3.2.2 Red-throated Divers

375 Red-throated divers are considered to have a very high general sensitivity to disturbance and displacement (*Table 12-45*). In particular they are notoriously shy and prone to avoiding disturbed areas (Garthe & Hüppop 2004; Petersen 2005). 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 2009). This is consistent with a study on pre-construction and post-construction abundance and distribution of birds conducted at Horns Rev, Denmark, around one operational offshore windfarm. They found red-throated divers avoided areas of sea that were of favourable habitat, of suitable sea depth and with abundant food sources post-development within an offshore windfarm throughout a period of three years that the study, which used aerial visual survey techniques, took place over (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 (Pizzolla 2011) 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.

376 From *Table 12-49*, the species is considered to be a very high value species. Therefore their site-specific sensitivity to disturbance and displacement is considered to be *very high*.

377 Red-throated divers were present in the East Anglia ONE site in the winter period in regionally important numbers and during spring migration in regionally and nationally important numbers. Birds are considered likely to be most sensitive to disturbance in early winter or midwinter when they are in moult and become flightless for some days (Wernham *et al.* 2002). Therefore, during this time birds would find it difficult to quickly escape from vessels or find alternative areas away from disturbance.

378 If it is assumed that birds will be displaced from the East Anglia ONE project to varying degrees, within the site and a buffer around its boundary, once operational activities commence. In order to estimate an impact on red-throated divers across the East Anglia ONE site and a 4km buffer surrounding its site boundary further calculations based on displacement values from Pizzolla (2011) have been used. Pizzolla (2011) 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 12-53 and Table 12-54*). These figures may represent a conservative interpretation of the scale of the change in red-throated diver abundance, as Pizolla (2011) recorded an increase in abundance beyond the 2km buffer.

Percentage change in red-throated diver abundance between pre- and post-construction surveys of the Kentish Flats windfarm and buffer zones (Pizzolla 2011)					
Windfarm Footprint	**0.0 - 0.5 km buffer**	**0.5 – 1.0 km buffer**	**1.0 – 2.0 km buffer**	**2.0 – 3.0 km buffer**	**3.0 – 4.0 km buffer**
-94%	-83%	-77%	-59%	n/a	n/a

Table 12-53 Percentage change in red-throated diver abundance between pre- and post-construction surveys of the Kentish Flats windfarm and buffer zones (Pizzolla 2011)

379 The values from within *Table 12-53* have been used to determine potential red-throated diver displacement out of the proposed East Anglia windfarm site. First, the 4km buffer zone was divided into distance zones to match those presented by Pizolla (2011) as closely as possible (*Table 12-54*). The area of each of these zones was then calculated using ArcGIS (version 9.2). Mean peak abundance estimates from the East Anglia ONE baseline figures were used to determine the number of red-throated divers within the East Anglia ONE site footprint and for the 4km buffer. The mean peak abundance estimates for the 4km buffer were then apportioned into the new distance zones based on distance bands away from the site boundary, defining new zonal areas to establish the population estimates for each zone.

Distance zones within the 4km buffer and their corresponding areas (km^2). Percentage (%) changes in abundance taken from Pizzolla (2011)		
Zone	**Area (km^2)**	**% Change**
Footprint	305.15	-94%
0.0 – 0.5 km buffer	41.83	-83%
0.5 – 1.0 km buffer	43.39	-77%
1.0 – 2.0 km buffer	91.47	-59%
2.0 – 3.0 km buffer	97.72	None
3.0 – 4.0 km buffer	103.96	None

Table 12-54 Distance zones within the 4km buffer and their corresponding areas (km^2). Percentage (%) changes in abundance taken from Pizzolla (2011)

380 Based on the rates of displacement shown in *Table 12-54* a total of 105 wintering red-throated divers are estimated to be displaced from the site footprint and buffer together. If 105 red-throated divers were displaced from the winter population of 175 birds the total displacement equates to 60% of the population in East Anglia ONE site plus buffer. Red-throated divers moving through the site during spring migration are more likely to be affected by the windfarm acting as a barrier rather than being displaced from the site, as these birds are moving through the East Anglia ONE site and not using the site for a prolonged period of time, as described in *Sections 12.5.2.4.2* and *12.6.3.4.2*. Based on the rates of displacement in *Table 12-54*, a further 249 from 375 red-throated divers (66%) and 62 from 65 (94%) birds would be displaced during the spring and autumn migration periods, respectively. However, if must be noted that during the autumn survey no birds were recorded within the buffer, and thus the displacement value of 94% applied only to birds within the site footprint.

Displacement values from East Anglia ONE site and a 4km buffer (based on displacement values set out by Pizzolla (2011) Note that rounding errors may lead to apparent summation discrepancies								
Red-throated diver (excl. correction factor)								
Season	**Wintering**		**Spring migration**		**Breeding**		**Autumn migration**	
Area / Period	Pre-Ops	Post-Ops	Pre-Ops	Post-Ops	Pre-Ops	Post-Ops	Pre-Ops	Post-Ops
Footprint	79	5	207	12	0	0	65	3
Buffer (0-4 km)	96	65	168	114	0	0	0	0
0.0-0.5 km	11	2	19	3	0	0	0	0
0.5-1.0 km	11	3	19	4	0	0	0	0
1.0-2.0 km	23	10	41	17	0	0	0	0
2.0-3.0 km	25	25	43	43	0	0	0	0
3.0-4.0 km	26	26	46	46	0	0	0	0
Total Birds Remaining (Footprint & 4km Buffer)	175	70	375	126	0	0	65	3
Total Displacement	N/A	105	N/A	249	0	0	N/A	62

Table 12-55 Displacement values from East Anglia ONE site and a 4km buffer (based on displacement values set out by Pizzolla (2011) Note that rounding errors may lead to apparent summation discrepancies

381 These figures provide an estimate of the number of red-throated divers that are likely to be displaced from the East Anglia ONE site and its 4km buffer. The magnitude of the effects on the wintering population (regionally important numbers being displaced) will be *medium.* The magnitude of impact on the migratory populations is *high* in spring (as nationally important numbers are displaced from the area), but *low* for autumn (as the number displaced falls short of regional importance), based on the population thresholds in *Table 12-15* in *Section 12.1.1.1*.

382 January and February have previously been identified as peak months for red-throated divers wintering in the Greater Thames estuary (Webb *et al.* 2009). The large numbers of divers observed during this period may represent pre-migration aggregations of birds; pairs return to territories from the UK typically in March and April (Wernham *et al*. 2002).

383 In addition to this, previous surveys of the Greater Thames area have shown wide variation in peak population estimates, ranging from 2,460 divers in January 2002 to 10,884 individuals in January 2003 (Webb *et al.* 2009). Other peak estimates made historically from visual aerial surveys include 7,688 divers recorded in February 2004, 6,123 divers in January / February 2005, 5,291 divers in January 2006 and 3,106 divers in February / March 2007 (Webb *et al.* 2009).

384 The mean peak estimate of 207 red-throated divers in spring suggests that this species passes through the East Anglia ONE site on passage migration at this time of year. It is probable that these birds were departing from wintering areas, including areas other than the Outer Thames Estuary SPA, to return to northerly and easterly breeding grounds, including Scandinavia and Russia. Assigning a value of magnitude to this migrating population is not straight forward, but if it is assumed that birds will avoid the East Anglia ONE site then migrating birds will simply take a different route around the area. Considering that a barrier effect will reduce the number of birds choosing this route for migration in the first instance the effect will be *of low magnitude*, so the overall magnitude of effect on the wintering and migration populations is assumed to be *low-medium*. A combined *very high* site specific sensitivity with a *low-medium* magnitude impact equates to a **moderate impact significance**.

385 The operation of an offshore windfarm will displace the local (those within the East Anglia ONE site) population of red-throated divers (Peterson *et al.* 2006) and it is presumed that birds show little, if any, habituation towards offshore windfarm operations (Percival 2010) in the short term, so will suffer from a site specific sensitivity as further underlined by the displacement values calculated within this section. However, though the expected magnitude on the local population can be considered *medium* it is not assumed that the overall impact on this species in the wider region is any greater than of **moderate significance**, due to it occurring in relatively low numbers and densities and with birds being able to move in to similarly suitable surrounding areas of habitat within reach (2-4km) of the East Anglia ONE site (Percival 2010; Pizzolla 2011). Combining this evidence with the overall resident abundance and distribution data it is considered that the significance of impact on the national population will be **minor adverse** in nature from the East Anglia ONE project, though the significance of impact on the local population will be **moderate** (but tolerable). It is not envisaged that any impact will occur on the Outer

Thames SPA wintering population, which hold the majority of the southern North Sea population and is of international importance (Stienen *et al.* 2007).

12.6.3.2.3 Fulmars

386 Fulmars are considered to have a *low* general sensitivity to disturbance and displacement (*Table 12-45*). From *Table 12-49*, the species is considered to be a *medium* value species. Therefore their site-specific sensitivity to disturbance and displacement is considered to be *low.*

387 The development is therefore predicted to cause little if no displacement on the population, with no change from the baseline expected. This means that the magnitude of the effects will be at worst *low,* but most likely *negligible*, as no effects are expected. Therefore the predicted significance of any displacement impacts, associated with the operation of the East Anglia ONE project, on fulmar populations over the course of 25 years will therefore be **negligible** as any impacts will be of no concern.

12.6.3.2.4 Gannets

388 Gannets are considered to have a *low* general sensitivity to disturbance and displacement (*Table 12-45).* However, data from the Egmond aan Zee (OWEZ) offshore windfarm monitoring program showed that gannets showed a strong avoidance of offshore windfarms (Krijgsveld *et al.* 2010; Leopold *et al.* 2011), suggesting a higher level of sensitivity. A further study of post-construction data from one Horns Rev offshore windfarm in Denmark also found that gannets were found in lower than expected numbers within the offshore windfarm area, but birds were still found within the windfarm site (Petersen *et al.* 2004). Combining the sensitivities shown by gannets towards the activities associated with an operational windfarm it can be predicted that they show a *low* sensitivity towards windfarm operations, but that a level of displacement does occur from active windfarms. It has been observed that gannets show a preference to fly around offshore wind farms, but there is no evidence that suggests birds within the buffer zone are displaced (Petersen *et al.* 2004). As no studies available suggest that gannets habituate to windfarms and few actual values for displacement are available from the studies aforementioned, a precautionary approach has been applied to gannets within the East Anglia ONE site of 100% displacement from the windfarm’s footprint, in line with that suggested from Nysted and Horns Rev windfarms (Petersen *et al.* 2006).

389 From *Table 12-49,* the species is considered to be a *high* value species. Gannets were almost entirely absent from the East Anglia ONE site during the breeding season, with population estimates well below the thresholds for regional, national or

international importance. Data from tracking studies also indicate that gannets from the nearest breeding colony at Bempton Cliffs do not forage in the vicinity of the East Anglia ONE site (Langston & Boggio 2011), helping to explain the low numbers estimated to be present in summer. On the basis of this evidence and even factoring in a 100% displacement during the breeding season (which equates to 39 birds) from the East Anglia ONE site the magnitude of any impacts on gannet populations will be of *negligible* effect during the breeding season. This is based on the assumption that the addition of 39 birds into surrounding areas of the southern North Sea would not constitute a significant change in density, therefore would not exert an unreasonable increase on the resources that gannets rely upon to survive.

390 Estimates derived from surveys undertaken by Tasker *et al*. (1987) indicate that gannet numbers typically peak in the North Sea during spring and autumn migration periods. Survey data collected in the East Anglia ONE site for this ES showed a relatively low abundance during these periods, though regionally important numbers occurred in autumn, suggesting that similar peaks do not occur within the area at these times. Combining this evidence it may be concluded that the site itself does not experience regularly high numbers of gannets on passage, so an effect of *low* magnitude is considered most likely on the migratory population of gannets utilising the East Anglia ONE site, as only minor effects from the baseline are expected.

391 Gannet numbers were low in the East Anglia ONE site during winter, with the population still well below the threshold for regional and national importance, so the level of magnitude on this population, even if it is assumed that 100% are displaced from the East Anglia ONE site footprint (which equates to 66 birds), will be of *negligible* effect during the winter period. This is based on the assumption that the addition of 66 birds into surrounding areas of the southern North Sea would not constitute a significant change in density, therefore would not exert an unreasonable increase on the resources that gannets rely upon to survive.

392 Though population estimates vary within the East Anglia ONE site, dependent upon the season, gannets were generally distributed in low abundance throughout the year across the area, with the exception of higher numbers during autumn migration. As a precaution it can be predicted that any level of effect on gannet populations in the East Anglia ONE site may be of *medium* magnitude. This approach can be justified by the fact that numbers being displaced are low, even during the autumn migration period. The effect of such low numbers being displaced from East Anglia ONE will not alter the long-term viability of the population and birds will move back once operations cease. In addition, those birds that may be displaced during the autumn migration period are most likely to be moving through, so will be dealt with within the barrier effect section (*Section 12.6.3.4.4*). If this approach is taken the significance of any impacts are considered to be limited to

only a **minor adverse impact** with respect to being disturbed and displaced by the operational activities in the East Anglia ONE site.

393 In relation to the offshore cable corridor, in 2004/05 the distribution of gannets across the wider Thames Strategic Area tended to be patchy and the numbers of birds recorded in the survey blocks were too low for density maps to be produced. In addition to this there are no operational activities anticipated to cause any impact on the presence of gannets in the offshore cable corridor post-construction. With respect to disturbance and displacement no impacts related to the offshore export cable are anticipated.

12.6.3.2.5 Skuas

394 Skua species are known to suffer little displacement from offshore windfarms (Krijgsveld *et al.* 2010). Great skuas are considered to have a *low* general sensitivity to disturbance and displacement (*Table 12-45*), being tolerant to and having a *low* sensitivity to disturbance (Garthe and Hüppop, 2004 and Maclean *et al* 2009). Although there is evidence that the southern North Sea in autumn has only low numbers of great skuas migrating through and some studies suggest migration from the northern isles of Scotland is to the north from the North Sea and south along the west coast of Britain (Wernham *et al.* 2002) other references suggest that the southern North Sea flyway population is approximately 27,200 (Stienen *et al.* 2011).

395 Great skuas were only recorded in very low numbers within the East Anglia ONE site during September and October, the autumn migration period, which is consistent with the peak months in the North Sea from previous surveys (Tasker *et al.* 1987). Other skua species were either not recorded or recorded in such low numbers in the East Anglia ONE site that their abundance and distribution has not been modelled.

396 Despite low numbers being recorded throughout the survey periods it is acknowledged that great skua move through the East Anglia ONE site across the whole autumn period and also in the spring period. Through a precautionary modelling exercise it has been estimated that potentially internationally important numbers of great skua fly through the East Anglia ONE site during autumn and spring migration (see *Section12.5.2.4.5* for explanation of modelling) and from *Table 12-49*, the species is considered to be a very *high* value species. Therefore, great skuas are considered to have a *medium* site-specific sensitivity to disturbance and displacement. However, despite the presence of potentially internationally important numbers of great skuas flying through the site, they are not expected to suffer from displacement due to the presence of wind turbines, as they do not show signs of being disturbed by turbines (Krijgsveld *et al.* 2010), so the magnitude of effect is

predicted to be *low*. Therefore as a precaution, the significance of any impacts will be of a **minor adverse** nature.

12.6.3.2.6 Gulls

397 Most gull species have been found to remain undisturbed by the activities associated with operational windfarms, including vessel activity and rotating turbine blades. Data from the Egmond aan Zee (OWEZ) windfarm monitoring program showed that gulls (including kittiwakes, common gulls, lesser black-backed gulls, herring gulls and great black-backed gulls) did not show notable avoidance and were seen foraging in the windfarm on a regular basis (Leopold *et al.* 2011). Post-construction monitoring from the Horns Rev windfarm found that gulls showed a preference for the windfarm area following its construction, which may reflect habituation to the presence of turbines (Petersen *et al.* 2004). For example, monitoring surveys at operational offshore windfarms in UK waters have shown that lesser black-backed gulls show no obvious displacement effects and have often been seen perching on turbine bases. Great black-backed gulls have also been observed roosting on operation offshore windfarm structures (Royal Haskoning 2011). This is also likely reflected in gulls' foraging strategy of taking discards close to fishing vessels: lesser black-backed gull (Camphuysen 1995), herring gull (Camphuysen 1995; Hüppop & Wurm 2000) and, great black-backed gull (Hüppop & Wurm 2000; Buckley 2009).

398 Monitoring surveys at operational offshore windfarms in UK and Dutch waters have shown that lesser black-backed gulls and herring gulls show no obvious displacement effects and have often been seen perching on wind turbine bases. Great black-backed gulls have also been observed roosting on operational offshore windfarm structures (Royal Haskoning 2011; Leopold *et al.* 2011).

399 All of the gull species considered for the East Anglia ONE assessment are considered to have *low* general sensitivities to disturbance and displacement (*Table 12-45*). Gull species recorded within the East Anglia ONE site were recorded in numbers of varying importance levels at different times of the year. From *Table 12-49*, kittiwakes and lesser black-backed gulls are considered to be *very high* value species, herring gulls and great black-backed gulls are considered to be *high* value species and the common gull is considered to be a *low* value species.

400 This leads to site specific sensitivities to disturbance and displacement being considered to be *low* for common gulls and *medium* for kittiwakes, lesser black-backed gulls, herring gulls, and great black-backed gulls.

401 As a result of the sensitivities, their general ecology and given that any effects of disturbance as a result of East Anglia ONE windfarm's activities are considered to

be limited, any impacts on gull species from disturbance and displacement due to its operational activities are considered to be of *negligible* magnitude, as no effects are predicted. Therefore, it is considered that significance of any disturbance and displacement associated with wind turbines, ancillary structures, vessel movements and the offshore export cable within the East Anglia ONE project will create at worst a **negligible impact** all gulls.

12.6.3.2.7 Auks

402 Data from the Egmond aan Zee (OWEZ) windfarm monitoring program showed that the OWEZ had relatively mild displacement effects on auks. Guillemots were recorded swimming within the OWEZ site on several occasions, and razorbills were also found within the site, which underlines that if avoidance is occurring, it is not 100% (Leopold *et al.* (2011). Post-construction data from the Horns Rev windfarm found guillemot and razorbill numbers were lower than expected within the windfarm area (Petersen *et al.* 2004). However, more recent studies in UK waters comparing pre-construction and post-construction numbers of auks within offshore windfarms have found different results. Evidence from Thorntonbank and Bligh Bank (Vannerman *et al.* 2010) and North Hoyle (RWE 2008) have shown no avoidance from the windfarm footprint or buffer up to 3km, with some increases in numbers found during their studies.

403 Both guillemots and razorbills are also considered to have *medium* general sensitivities to disturbance and displacement (*Table 12-45*). However, as the more specific evidence of tolerance towards windfarms presented above is both more recent and UK and North Sea-specific it is appropriate to use it to assign a value of *low* general sensitivity for auks to disturbance and displacement during the operational lifetime of the East Anglia ONE site. This results in a *medium* site-specific sensitivity to disturbance and displacement for auks, as they have been found to tolerate operational wind turbines.

404 As both guillemot and razorbill are important components of the wider breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA, they are both considered to be *high* value species. It is also known that auks may be more at risk during moult (mostly between early August to end of September) when they are flightless and unable to escape by flight. Regionally important numbers of guillemots and razorbills were only present within the East Anglia ONE site during the winter period and spring migration, so the site is of negligible importance during the months when moulting takes place in.

405 The East Anglia ONE site is considered unlikely to be of importance for feeding guillemots or razorbills during the breeding season, given that the nearest breeding colony at Flamborough Head and Bempton is 275km away. Population estimates

put together for this EIA also support this evidence, as few auks, mostly guillemots, were recorded during the breeding season. Auks, mostly guillemots, were recorded at their highest levels in the winter and spring with an even distribution throughout the area.

406 The operation of an offshore windfarm will not displace the local population of guillemots and razorbills as it is presumed that birds show little, if any, displacement away from active wind turbines (RWE 2008; Vannerman *et al.* 2010).

407 Although both guillemot and razorbill have *medium* site-specific sensitivities, the level of magnitude assigned must reflect their low numbers within the East Anglia ONE site and the likely low level of displacement. As such it must be considered that the level of effect on the populations of guillemot and razorbill will be of *negligible* magnitude. Though there is expected to be some degree of displacement associated with the presence of vessels within the site any birds disturbed should move into surrounding areas within the East Anglia ONE site that offer less disturbed habitat. Even taking into consideration any disturbance and displacement associated with vessels moving within and into and out of the East Anglia ONE site a value of magnitude of *negligible* is predicted. Therefore any impacts are predicted to be of **negligible significance** on guillemots and razorbills respectively from the development of the East Anglia ONE project.

408 There is not anticipated to be any disturbance or displacement to auks from the cable corridor post-construction, so no level of effect or impact is registered for its operational period in relation to these birds.

Summary of Potential Direct Disturbance and Displacement Effects during Operation					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Operation**
Red-throated diver	Very high - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	Very high - Divers are notoriously shy and prone to avoiding disturbed areas (Garthe & Hüppop 2004; Petersen 2005). Their avoidance of vessels and operating wind turbines indicates a low level of tolerance to the presence of these activities and structures.	Very high – A combination of both a very high non impact-specific value and a very high general sensitivity to disturbance and displacement.	Low – East Anglia ONE site is not as important for the species compared to the Thames region and Outer Thames Estuary SPA. 100% displacement from the site and 4km buffer is considered unlikely, with suitable habitat available for birds to move into between 2-4 km.	**Minor to Moderate adverse** – A combination of both a very high site-specific sensitivity to disturbance and displacement and a low magnitude of impact. Moderate (but tolerable) impact is predicted for local population during winter only, whilst minor impact is predicted for regional population overall
Fulmar	Medium - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	Low – Birds have been found to show no signs of avoidance behaviour towards vessel activities or operational wind turbines (Maclean *et al*. 2009).	Low – A combination of both a medium non impact-specific value and a low general sensitivity to disturbance and displacement.	Low / Negligible – Species has shown no signs of avoidance towards vessel activities or operational wind turbines.	**Negligible** – A combination of both a low site-specific sensitivity to disturbance and displacement and a low / negligible magnitude of impact.

Summary of Potential Direct Disturbance and Displacement Effects during Operation					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Operation**
Gannet	High - Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during the breeding season it can be assumed that the area of sea within the East Anglia ONE is not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.	Low – Based on their low level of sensitivity to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to disturbance and displacement.	Medium – Birds show a preference to avoid flying into or through windfarm arrays.	**Minor adverse** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a medium magnitude of impact.

Summary of Potential Direct Disturbance and Displacement Effects during Operation					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Operation**
Great skua	Very high – although recorded in low numbers during surveys it is recognised that during migration periods birds may fly through East Anglia ONE. This species is on the BoCC amber list and through a precautionary modelling exercise it has been estimated that potentially internationally important numbers fly through the East Anglia ONE site during autumn migration.	Low – Based on their low level of sensitivity to ship and helicopter traffic given in Garthe & Hüppop (2004) and Maclean *et al.* (2009). Skua species are known to suffer little displacement from offshore windfarms (Krijgsfeld *et al* 2010).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to disturbance and displacement.	Low – As the species does not generally reside within the site it will not suffer from impacts of disturbance and displacement.	**Minor adverse** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a low magnitude of impact.

Summary of Potential Direct Disturbance and Displacement Effects during Operation					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Operation**
Kittiwake	Very high - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods throughout the East Anglia ONE site.	Low – Based on results from operational offshore windfarms and their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.
Common gull	Low - The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally important numbers during the aerial surveys during any biologically relevant period.	Low – Based on results from operational offshore windfarms and their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Low – A combination of both a low non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	**Negligible** – A combination of both a low site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.

Summary of Potential Direct Disturbance and Displacement Effects during Operation					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Operation**
Lesser black-backed gull	Very high - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	Low – Based on results from operational offshore windfarms and their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.
Herring gull	High - Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC red list.	Low – Based on results from operational offshore windfarms and their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.

Summary of Potential Direct Disturbance and Displacement Effects during Operation					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Operation**
Great black-backed gull	High - The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	Low – Based on results from operational offshore windfarms and their sensitivities to ship and helicopter traffic given in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to disturbance and displacement.	Negligible – Tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.

Summary of Potential Direct Disturbance and Displacement Effects during Operation					
Species	**Non Impact-specific Value**	**General Disturbance / Displacement Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Direct Disturbance and Displacement during Operation**
Guillemot Razorbill	High - Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider number of colonies and not exclusively from the Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.	Low – Based on their individual sensitivities to ship and helicopter traffic in Garthe & Hüppop (2004) and that recent studies in UK waters comparing pre-construction and post-construction numbers of auks within offshore windfarms have shown tolerance towards windfarms.	Medium – A combination of both a high non impact-specific value and a low general sensitivity to disturbance and displacement for both species.	Negligible – Neither species is known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future. However, auks are considered to be dispersive rather than truly migratory. Recent studies in UK waters comparing pre-construction and post-construction numbers of auks within offshore windfarms have shown tolerance towards windfarms.	**Negligible** – A combination of both a medium site-specific sensitivity to disturbance and displacement and a negligible magnitude of impact.

The general sensitivity of auks to disturbance/displacement has been reduced from medium (as in *Table 12-45a*) to low based on recent UK and North Sea-specific evidence of tolerance towards operational offshore windfarms

*Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Disturbance / Displacement Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

**Predicted Impact Significance is a product of combining the Site-specific Sensitivity value with the Impact Magnidtude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-56 Summary of Direct Disturbance and Displacement Effects during Operation

12.6.3.3 Collision Risk

409 The presence of the East Anglia ONE site presents a potential collision risk to birds which fly through the wind turbine array whilst foraging for food or when migrating through the site. The risk to birds is from directly colliding with the wind turbine rotors and their associated structures at sea.

410 The number of collisions with wind turbines would be influenced by the extent to which birds are disturbed and displaced from the windfarm itself. There would be a reduced level of collision risk to those species that may be deterred from entering the windfarm in the first instance. Conversely there could be an increased risk of collision for species that either habituate towards the windfarm over time or are attracted to it by factors associated with the operation of the wind turbines such as lighting, maintenance vessels and other activities. It is also possible that the potential artificial reef effect of the foundations would have an influence on prey species, which in turn could influence bird distribution.

411 The ability of birds to detect and manoeuvre around wind turbine blades is also a factor that is considered when modelling and assessing the risk. Birds that collide with a wind turbine are likely to be killed outright or be fatally injured. In response to this it is standard practice to calculate differing levels of avoidance for different species or species groups. Avoidance rates can be applied to collision risk models to more accurately predict realistic levels of impact, based on available literature written about bird behaviour and their flight response to wind turbines.

412 The significance of collision mortalities within a windfarm on any given species of bird varies in response to the size of its population, the density of the population within the windfarm site, known annual mortality rates and estimated rates of avoidance. As a general rule a single individual lost from a small population will have an increased significance in comparison to a single individual lost from a large population. The impact of losing an individual bird will also be more significant if it is lost from a species that occurs at low density, is relatively long-lived and reproduces at a low rate. The opposite is also true where birds are relatively abundant, have high densities within an area, are short lived and have high reproduction rates, where the impact of collision fatality on an individual is **insignificant**, as is expected through ecological r/K selection theory.

413 Collision risk is an impact associated with the operation of wind turbines and their associated offshore structures. As a result, the offshore cable laid on the sea bed will not contribute to any additional collision risk associated with this aspect of the development.

414 All collision risk assessments used the new ‘Band’ model (Band *et al.* 2012) designed specifically for applications for offshore windfarm developments. To be precautionary, avoidance rates of 98%, 99% and 99.5% have been modelled. Monthly projected operational data for the turbines (or cut in / out speeds) have been sourced, from four years of monitoring data from a mast in the Greater Gabbard offshore windfarm that operates similar turbines and provides a precautionary average operational time of approximately 92%. Other assumptions were similarly precautionary including a continuous flux of birds through the site at peak density in each period, each bird crossing the widest diagonal of the windfarm and encounters every turbine on its route through.

415 Data on flight behaviour and altitude were taken from aerial survey estimates of flight altitude, where available. Where data was not available or the number of birds recorded in flight was too few for a statistically robust average to be calculated, estimates from the Cook *et al*. (2011) were used.

12.6.3.3.1 Approach to CRM

416 A high level Band model was tested to compare the two different potential layouts for the proposed windfarm, which are for 325 x 150m to tip height wind turbines or 150 200m to tip height wind turbines. Despite the proposal for 150 x 200m tip height wind turbines having a larger overall rotor swept area, the 325 x 150m tip height wind turbines rotate at a higher speed of rotation and cover a larger area of sea surface. Rotor speed was increased for the 325 smaller wind turbines compared with the 150 larger turbines in line with known mechanical operations. The birds were then modelled in a simplistic manner through the respective windfarms, which resulted in 325 wind turbines causing theoretically more bird collisions per year, so being treated as the worst case scenario for collision risk for the East Anglia ONE site.

417 Collision risk should be considered to be a long-term effect lasting for the operational life of the windfarm.

418 CRMs don’t decrease in response to losses to a population, whereas in reality it may change over time according to a range of factors including: habituation, changes in fishing activities; changes in prey distribution. Therefore, it is difficult to confidently predict the long-term effects of collision risk through CRM alone.

419 In addition to the species included within this chapter it is acknowledged that other species must be accounted for that are known, or are likely, to migrate through the East Anglia ONE site. These species were identified using various publications on migrating birds across the southern North Sea, including SOSS reports and expert judgement, prior to commencing any modelling to ensure that all birds deemed to be

at risk of collision within the East Anglia ONE site were modelled separately and included within the CRM process. Great skua were the only anomaly, having also been modelled in a different manner to the non-seabirds due to very few birds being recorded during any survey efforts. It is recognised that conventional survey methods do not accurately account for the potential true number of great skuas flying through offshore environments, so a simple modelling exercise was completed to predict a precautionary figure for passage through the East Anglia ONE site. Great skua and those other species run through a more complex migration model have been included within CRM for the purpose of allowing a full assessment within the East Anglia ONE impact assessment process. Detailed migration modelling was used only for species of conservation concern wintering in large numbers in the UK that were connected with SPAs. Great skua were not modelled in this way due to the spread of breeding sites within and beyond the UK being less easily linked to SPAs and a more accurate estimate being available of the southern flyway population, which is more relevant to the East Anglia ONE site (Steinen *et al.* 2007).

12.6.3.3.2 CRM methodology

420 The CRM methodology outlined by Band *et al.* (2012) has been followed for the modelling and assessment of impacts predicted within the development of the East Anglia ONE site. This section presents the parameters used for the CRM and the outputs of the modelling process using the baseline data obtained within the East Anglia ONE survey area between 2009 and 2011.

421 The Band Model (2012) assumes an equal and additive risk of collision with each individual turbine within a windfarm development. Therefore the risk of collision is the sum of the risk from each rotor passage. As the risk of collision within large windfarms is potentially relatively high, a declining proportion of birds will theoretically survive through the early rows of wind turbines, inevitably reducing the numbers at risk of collision in later rows. Whilst the current Band Model (2012) accounts for this decline in collision risk with a Large Array Correction, this only contributes a significant decrease in collision with low avoidance rates.

422 Species vary in their susceptibility to collision with wind turbine rotors due to their general behaviour and preferred flight altitude. Therefore, a combination of information taken from the available baseline data and species ecology was used to screen which species to include in CRM.

423 Certain species that are accounted for in other impact assessment sections are not warranted in the CRM, as they may have very low input numbers or are known to have a very low risk of collision through generally low flight heights.

424 A number of species are known to pass through the North Sea area but are rarely detected on surveys. To acknowledge this APEM have designed a migration model to estimate the number of a migratory species that may pass through a particular windfarm development area. This approach incorporates significant staging areas, on the European continent, to enable species specific migratory paths to be accounted for in the routes that were modelled (see *Volume 5, Appendix 12.2* for full details of methodology). This approach has been used to estimate the number of birds potentially passing through the East Anglia ONE site with the outputs being included in CRM.

12.6.3.3.3 CRM Input Parameters

425 It is envisaged that a number of potential wind turbine types and manufacturers would be employed to supply the infrastructure for the windfarm. Therefore, the parameter envelopes enabling sufficient variation in the detailed design are being employed on this project, though the collision risk model I based on the 'worst case' scenario parameters (*Table 12-57*).

Turbine Parameters for the East Anglia ONE site	
Rotor Diameter	120m
Number of WTGs	325 units
Tip Height Range	150m (LAT)
Air Draft	22 (MHWS)
Hub Height	90m

Table 12-57 'Worst Case' Turbine Parameters for the East Anglia ONE site

426 The 'worst-case' scenario is the layout that was considered to have the greatest potential impact (*Table 12-55*). This being the proposed layout of 325 Siemens wind turbines of 3.6MW that have a 120 m rotor turbine specification, reaching 150m tip height.

427 The results of the 2009 / 2010 and 2010 / 2011 surveys were used to estimate the monthly density of birds in flight for each species within the windfarm area. Information across all survey months was collated to provide an average estimate of the proportion of those birds in flight at potential collision height PCH (*Table 12-58*).

428 The average proportion of flights at PCH across the survey period 2009 to 2011 was incorporated into the CRM. Species biometrics were obtained from Robinson (2005), and the nocturnal activity rate was based on a 1 to 5 scoring index for each species in Garthe and Hüppop (2004) with 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75%, 5 = 100% (*Table 12-19*). The number of available daylight hours is calculated within the Band *et al.* (2012) model based on the latitude of the windfarm development.

Species Input Parameters for Collision Risk Modelling in the East Anglia ONE site (PCH[1] is the percentage of birds flying within rotor swept height with a minimum air draft clearance of 22 metres).

Species	Proportion of flights at Potential Collision height (PCH)[1]	Body Length (m)	Wingspan (m)	Flight speed (ms^{-1})	Nocturnal Activity Rate (%)
Bewick's Swan	38	1.21	1.96	18.5	100
European white-fronted goose	75	0.72	1.48	16.1	100
Taiga bean goose	75	0.75	1.58	17.3	100
Dark-bellied brent goose	75	0.58	1.15	17.7	100
Shelduck	50	0.62	1.12	15.4	100
Common scoter	1	0.49	0.84	22.1	50
Fulmar	0.5	0.475	1.07	13	75
Gannet	25.2	0.94	1.72	14.9	25
Avocet	75	0.44	0.78	16.7	100
Golden plover	75	0.28	0.72	26.8	100
Knot	75	0.24	0.59	20.1	100
Dunlin	75	0.18	0.40	15.3	100
Black-tailed godwit	75	0.42	0.76	19.44	100
Bar-tailed godwit	75	0.38	0.75	18.3	100

Species Input Parameters for Collision Risk Modelling in the East Anglia ONE site (PCH[1] is the percentage of birds flying within rotor swept height with a minimum air draft clearance of 22 metres).					
Species	**Proportion of flights at Potential Collision height (PCH)[1]**	**Body Length (m)**	**Wingspan (m)**	**Flight speed (ms^{-1})**	**Nocturnal Activity Rate (%)**
Great skua	4.3	0.56	1.36	16.0	0
Black-legged kittiwake	21.3	0.39	1.08	13.1	50
Common gull	22.9	0.41	1.20	11.6	50
Lesser black-backed gull	26.3	0.58	1.42	12.3	50
Herring gull	29.4	0.6	1.44	9.9	50
Great black-backed gull	33.1	0.71	1.58	13	50

Data obtained from the following sources; Alerstam (1990); Alerstam *et al.* (2007); Bruderer & Boldt (2001); Cook *et al.* (2012); King *et al.,* (2009); Larsen & Clausen (2002); Mateos-Rodriguez & Bruderer (2012); Pennycuick (1997); Platteeuw (2005); Robinson (2005); Wright *et al.* (2012).

Table 12-58 Species Input Parameters for Collision Risk Modelling in the East Anglia ONE site (PCH[1] is the percentage of birds flying within rotor swept height with a minimum air draft clearance of 22 metres and tip height of 150 metres).

429 The strike probability for each species flying in a straight line along the longest length of the windfarm is taken from the Band *et al.* (2012) model. This model has been modified from an onshore model used for small array and have been modified for offshore wind applications and incorporates both upwind and downwind flights and the associated change in mortality risks.

430 Input parameters for the turbine specifications used within the CRM are shown in *Table 12-59*. Rotation speed is an estimated mean speed based on wind cut in and cut out speeds. Meteorological data collected from the Greater Gabbard meteorology mast (over a period of four years) have provided theoretical maximum operational times for the East Anglia ONE project wind turbines (*Table 12-60*), which have been incorporated into the CRM. These times represent a theoretical maximum, or worst case, as they do not account for any downtime that is required for wind turbines during planned and unplanned servicing or maintenance.

Collision Risk Modelling Turbine Specification for the East Anglia ONE site	
Turbine Parameter	**Worst Case Array**
Turbine Model	SWT 3.6
Number of Turbines	325
Number of Blades	3
Rotation Speed (rpm)	9.72
Rotor Radius (m)	60
Minimum Height of Rotor (m)	22
Maximum Blade Width (m)	4.20
Pitch (degrees)	10

Table 12-59 Collision Risk Modelling Turbine Specification for the East Anglia ONE site

Theoretical Monthly Operational Time Calculated from Meteorology Data and Turbine Cut In and Cut Out Speeds	
Month	**Operational Time (%)**
January	95.0
February	89.7
March	94.1
April	91.2
May	92.9
June	84.3
July	94.4
August	89.3
September	89.5
October	91.6
November	96.9
December	94.8

Table 12-60 Theoretical Monthly Operational Time Calculated from Meteorology Data and Turbine Cut In and Cut Out Speeds

12.6.3.3.4 Avoidance Rates

431 A birds' ability to avoid colliding with a wind turbines' rotating blades is a critical factor in determining mortality rates associated for different species and as such how sensitive each species is to those turbines and the windfarm in its entirety.

432 Collision risk modelling following the standard SNH model (SNH 2010), assumes a 98% avoidance of turbines by birds. Since the publication of that report data have become available from scientific papers (eg MacLean *et al* 2009) offering differing levels of avoidance that may be more appropriately assigned to different species to calculate a more accurate rate of avoidance or collision. The assumptions made within the CRM for the East Anglia ONE project takes a more calculated approach, modelling a range of avoidance rates including 98% avoidance, 99% avoidance and 99.5% avoidance. Further discussion on the latest research on species specific

avoidance rates and known behavioural traits is included in the species by species sections to allow for alternative avoidance rates to be assessed alongside the more precautionary 98%. This CRM has been calculated using the most up to date Band model (Band *et al.,* 2012).

12.6.3.3.5 Summary of annual mortality rates

433 To estimate the mortality rates for the species that have been modelled through the CRM, mean, maximum and minimum peaks have been calculated per month between the 2009/2010 and 2010/2011 survey periods. The mean, maximum and minimum CRM values represent the collision mortality rates associated with the mean peak, the maximum and minimum density for each month between survey years. These estimates have been used to calculate the predicted annual mortality rates for a range of avoidance rates *(Table 12-61*). The mortality rates for each species for each season are reported in *Volume 5, Appendix 12.4*.

Summary of Annual Mortality Rates (individuals) for 98%, 99% and 99.5% Avoidance Rates using 22metre air draft clearance for PCH

Avoidance	Annual Mortality Rate	Fulmar	Gannet	Kittiwake	Common gull	Lesser black-backed gull	Herring gull	Great black-backed gull
98% avoidance	**Mean**	2	850	1056	41	394	230	496
	Minimum	0	598	195	0	95	118	1
	Maximum	4	1102	1918	82	693	342	991
99% avoidance	**Mean**	1	425	528	21	197	115	248
	Minimum	0	299	98	0	47	59	1
	Maximum	2	551	959	41	347	171	495
99.5% avoidance	**Mean**	0	213	264	10	99	57	124
	Minimum	0	150	49	0	24	29	0
	Maximum	1	276	479	21	173	86	248

Table 12-61 Summary of Annual Mortality Rates (individuals) for 98%, 99% and 99.5% Avoidance Rates using 22metre air draft clearance for PCH

12.6.3.3.6 CRM results for East Anglia ONE

434 Full details of each species with respect to individual CRM models can be found in *Volume 5, Appendix 12.5*.

435 The predicted annual mortality rates have been assessed with respect to baseline mortality rates for each species modelled through the CRM in comparison to population estimates for each species on an international, national and regional scale for the worst case turbine array *(Table 12-62, Table 12-63, Table 12-64* respectively). All seabird species assessed or collision risk have been assessed against the breeding, wintering and annual rates of mortality against the populations at a regional, national and international level, which can be determined. However, during the migration period it is not possible to determine regional populations, therefore as a result any rates are adjusted to be compared to international (biogeographic) populations, for which no species would suffer above **minor significance** impacts. This comparison allows for a level of magnitude to be applied to each population and therefore an overall level of significance to be estimated.

East Anglia ONE Annual Mortality Rate in Comparison to Baseline International Mortality Rates (Based on Worst Case Array including 22m PCH and a 98% avoidance rate)									
Species	**Baseline Mortality Rate (%)[1]**	**Breeding**				**Wintering**			
		Mean Peak Mortality Rate (individuals)	**International Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Peak Mortality Rate (individuals)**	**International Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Red-throated diver	16.0	N/A	64,000	N/A	N/A	N/A	300,000	N/A	N/A
Fulmar	2.8	0	5,600,000	2.8	0.00	0	5,600,000	2.8	0.00
Gannet	8.1	16	600,000	8.1	0.03	23	600,000	8.1	0.05
Kittiwake	19.0	6	4,200,000	19.0	0.00	344	2,000,000	19.02	0.09
Common gull	14.0	6	1,180,000	14.0	0.00	0	2,000,000	14	0.00
Lesser black-backed gull	8.7	58	600,000	8.71	0.11	162	550,000	8.73	0.34
Herring gull	12.0	8	1,520,000	12.00	0.00	84	590,000	12.01	0.12
Great black-backed gull	7.0	9	220,000	7.00	0.06	16	440,600	7	0.05
Guillemot	5.4	N/A	4,000,000	N/A	N/A	N/A	4,000,000	N/A	N/A

East Anglia ONE Annual Mortality Rate in Comparison to Baseline International Mortality Rates (Based on Worst Case Array including 22m PCH and a 98% avoidance rate)									
Species	**Baseline Mortality Rate (%)[1]**	**Breeding**				**Wintering**			
		Mean Peak Mortality Rate (individuals)	**International Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Peak Mortality Rate (individuals)**	**International Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Razorbill	10.0	N/A	860,000	N/A	N/A	N/A	860,000	N/A	N/A

[1] Baseline mortality rates have been calculated from the adult annual survival rates given in Robinson (2005) and Garthe & Hüppop (2004)

Table 12-62 East Anglia ONE Annual Mortality Rate in Comparison to Baseline International Mortality Rates (Based on Worst Case Array including 22m PCH and a 98% avoidance rate)

East Anglia ONE Annual Mortality Rate in Comparison to Baseline National Mortality Rates (Based on the Worst Case Array including 22m PCH and a 98% avoidance rate)									
Species	**Baseline Mortality Rate (%)[1]**	**Breeding**				**Wintering**			
		Mean Peak Mortality Rate (individuals)	**National Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Peak Mortality Rate (individuals)**	**National Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Red-throated diver	16.0	N/A	1,870	N/A	N/A	N/A	17,000	N/A	N/A

East Anglia ONE Annual Mortality Rate in Comparison to Baseline National Mortality Rates (Based on the Worst Case Array including 22m PCH and a 98% avoidance rate)									
Species	**Baseline Mortality Rate (%)[1]**	**Breeding**				**Wintering**			
		Mean Peak Mortality Rate (individuals)	**National Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Peak Mortality Rate (individuals)**	**National Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Fulmar	2.8	0	1,012,000	2.8	0.00	0	1,012,000	2.8	0.00
Gannet	8.1	16	453,200	8.1	0.04	23	453,200	8.11	0.06
Kittiwake	19.0	6	760,000	19.0	0.00	344	760,000	19.05	0.24
Common gull	14.0	6	97,400	14.01	0.04	0	700,000	14	0.00
Lesser black-backed gull	8.7	58	228,000	8.73	0.29	162	120,000	8.84	1.55
Herring gull	12.0	8	288,000	12.0	0.02	84	730,000	12.01	0.10
Great black-backed gull	7.0	9	35,000	7.03	0.37	16	76,000	7.02	0.30
Guillemot	5.4	N/A	1,904,000	N/A	N/A	N/A	1,904,000	N/A	N/A
Razorbill	10.0	N/A	252,000	N/A	N/A	N/A	252,000	N/A	N/A

[1] Baseline mortality rates have been calculated from the adult annual survival rates given in Robinson (2005) and Garthe & Hüppop (2004)

Table 12-63 East Anglia ONE Annual Mortality Rate in Comparison to Baseline National Mortality Rates (Based on the Worst Case Array including 22m PCH and a 98% avoidance rate)

East Anglia ONE Annual Mortality Rate in Comparison to Baseline Regional Mortality Rates (Based on the Worst Case Array including 22m PCH and a 98% avoidance rate)									
Species	**Baseline Mortality Rate (%)[1]**	**Breeding**				**Wintering**			
		Mean Peak Mortality Rate (individuals)	**Regional Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Peak Mortality Rate (individuals)**	**Regional Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Red-throated diver	16.0	N/A	N/A	N/A	N/A	N/A	4,176	N/A	N/A
Fulmar	2.8	0	4,244	2.8	0.00	0	4,051	2.8	0.00
Gannet	8.1	16	15,718	8.2	1.26	23	10,024	8.33	2.83
Kittiwake	19.0	6	5,000	19.12	0.63	344	30,467	20.13	5.94
Common gull	14.0	6	5,000	14.12	0.86	0	20,527	14	0.00
Lesser black-backed gull	8.7	58	10,178	9.27	6.55	162	28,788	9.26	6.47
Herring gull	12.0	8	5,452	12.15	1.22	84	64,172	12.13	1.09

East Anglia ONE Annual Mortality Rate in Comparison to Baseline Regional Mortality Rates (Based on the Worst Case Array including 22m PCH and a 98% avoidance rate)									
Species	**Baseline Mortality Rate (%)[1]**	**Breeding**				**Wintering**			
		Mean Peak Mortality Rate (individuals)	**Regional Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Peak Mortality Rate (individuals)**	**Regional Population (individuals)**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Great black-backed gull	7.0	9	5,000	7.18	2.57	16	25,117	7.06	0.91
Guillemot	5.4	N/A	0	N/A	N/A	N/A	29,291	N/A	N/A
Razorbill	10.0	N/A	0	N/A	N/A	N/A	6,161	N/A	N/A

[1] Baseline mortality rates have been calculated from the adult annual survival rates given in Robinson (2005) and Garthe & Hüppop (2004)

Table 12-64 East Anglia ONE Annual Mortality Rate in Comparison to Baseline Regional Mortality Rates (Based on the Worst Case Array including 22m PCH, a 150 m tip height and a 98% avoidance rate)

436 The results of the CRM summarise the collision mortality rates for those species identified to be most at risk from the development of the East Anglia ONE project. These mortality rates, or numbers of birds that are predicted to collide with wind turbines and associated infrastructure per year, have been compiled using the best available techniques to provide precautionary collision rates for assessment in this EIA. It must be recognised though that the estimates for all species associated with collision in East Anglia ONE site are expected to be an overestimate of annual mortality rates, due to the precautionary assumptions that have been applied within the Band model (Band *et al.* 2012), such as a lack of maintenance downtime, birds encountering all turbines within the windfarm and retaining a steady bird population level despite collisions.

12.6.3.3.7 Assessment of CRM results for East Anglia ONE

12.6.3.3.7.1 Overview

437 The species most likely to be at risk from collision are those that fly at a height that places them within the PCH of the wind turbines and that are not displaced from entering a windfarm array in the first instance. Small and large gull species and fulmars are the most likely birds to continue to forage, migrate and generally fly through windfarms, due to their tolerance to mechanical infrastructure and habituation to manmade structures in general. This behaviour may put them at an increased risk of collision with wind turbines. Divers and auks tend to fly close to the sea surface and therefore below the sweep of the wind turbine blades. However, as divers and auks are less tolerant to human disturbance it is likely that fewer birds will be found within the East Anglia ONE site.

438 Seabirds are relatively long-lived species with low reproductive rates; for example the fulmar has a typical lifespan of 44 years and produces a single egg in a year (Robinson 2005). Therefore, such species are less tolerant of increases in baseline mortality than short-lived species producing many offspring (Garthe & Hüppop 2004); for example the wren, which has a typical lifespan of two years and can produce two broods of five to six eggs in a year (Robinson 2005).

439 Professional judgement has been used to assess the magnitude of impacts from collision risk based on the percentage increases relative to baseline mortality. Therefore, any increases relative to baseline mortality calculated to be less than 1% are considered to be of negligible magnitude. Where the increase relative to baseline mortality exceeds 1% then this increase is not considered to give an indication of the level of magnitude, just that it needs to be considered further at a species and population specific level.

12.6.3.3.7.2 Red-throated diver

440 Red-throated divers are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49,* the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

441 The typical flight behaviour of divers is to fly close to the sea surface and that birds fly less frequently in the non-breeding season (Cramp & Simmons 1977; Garthe & Hüppop 2004). Additionally, the results of Cook *et al.* (2012) modelled 2% (95% confidence limits: 1.5-2.6) of red-throated diver flights would be within the collision risk window for a turbine with rotor blades a minimum of 20 m asl and a diameter of 130 m. Therefore, collision risk from wind turbine rotors is not considered likely to have a significant impact on the population. The effect of displacement from the site during the operational period of the windfarm lifetime means that fewer birds will be within the East Anglia site to be impacted by collision. In addition to this the evidence from APEM's aerial survey data suggests very few (only one) birds were actually in flight within the East Anglia ONE site, meaning that they could not be modelled through a CRM due to such low numbers.

442 As a result, the magnitude of any collision impacts is considered to be *negligible.* Therefore, it is considered that collision risk with wind turbines within the East Anglia ONE site will create at worst a **minor adverse impact** on red-throated divers, but as no divers were observed during the aerial surveys in flight it highly unlikely that a **minor adverse impact** can be assumed, with it more likely to be **negligible** or even *no impact*. With this in mind the assigned value for the significance of collision mortality on red-throated divers in East Anglia ONE is **negligible**.

12.6.3.3.7.3 Fulmars

443 Fulmars are considered to have a *low* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49,* the species is considered to be a *medium* value species. Therefore their site-specific sensitivity to collision risk is considered to be *low*.

444 The PCH for fulmars used in the CRM was 0.5% of birds in flight (*Table 12-59)*, based on site specific species flight heights. The increase relative to the baseline mortality rate from this flight height is 0% at the *international, national and regional* levels (*Table 12-62 to Table 12-64*), as zero collisions are predicted, therefore a *negligible magnitude* effect will occur. However, as there is an absence of impacts of any significance a more realistic level of significance is that *no impact* will occur on fulmars.

12.6.3.3.7.4 Gannets

445 Gannets are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *high*.

446 During the breeding season, large numbers of gannets in the North Sea form breeding colonies, for example at Bass Rock and Bempton Cliffs. During this time adults may regularly forage 450km from the colony (Schreiber & Burger 2002), with the distances birds will travel from the colony positively correlated with colony size. Densities of foraging birds will however decline with increased distance away from the breeding colony (Dunnet *et al.* 1990; Camphuysen 2011). This would explain the very low densities recorded within the East Anglia ONE site during the summer months, as the East Anglia ONE site is approximately 300 km from the nearest breeding colony. Gannets were almost entirely absent from the East Anglia ONE site during the breeding season.

447 As gannets are found within the East Anglia ONE site in very low numbers during the summer, the level of magnitude on SPA populations is likely to be of *negligible* magnitude. A *negligible* magnitude is supported further by none of the tagged birds from an RSPB study on breeding birds at Bempton Cliffs SPA (Langston & Boggio 2011) being found to forage in the East Anglia ONE site.

448 Regionally important numbers of gannets are found within the East Anglia ONE site during the autumn migratory period. If the birds in autumn are assumed to come from the total east coast population of 66,128 pairs (132,256 individuals), based on three east coast SPAs of Bempton Cliffs, Bass Rock and Troup Head (data from JNCC species accounts), the mean peak estimate of 1,829 gannets within the East Anglia ONE site during autumn migration accounts for 1.38% of east coast gannet colony population. However, this only reinforces the likelihood that the magnitude of any impact on the SPA populations is reduced further, as it is considered that a proportion of those birds spending time in the East Anglia ONE site during the migratory periods will be sub-adults, non-breeders and from a variety of other colonies around the North Sea resulting in the level of impact being of **negligible significance**. It should be noted that the colony data used are from surveys undertaken between 1998 and 2000, therefore these numbers may be low and that more recent counts have been made. However, the data used are the best available published data, but it is acknowledged that this assessment will be precautionary.

449 The percentages of gannets flying at PCH within the CRM model was 25.2% for the worst case. The mortality rate was predicted to be 16 birds during the breeding season and 23 birds during the winter, which is the equivalent of an increase of 1.26% relative to the regional baseline mortality rate during the breeding season

and of 2.83% during the wintering period, based on 98% avoidance, as seen in *Table 12-62 to Table 12-64*. Such rates are considered to result in a *low magnitude* effect at the *regional* level. Such low levels of mortality at a regional level would create at worst an impact of **minor adverse significance**.

450 Data from operational windfarms, including Egmond aan Zee and Horns Rev, have shown that gannets show a strong avoidance of the windfarms as a whole (Krijgsveld *et al.* 2010; Leopold *et al.* 2011; Petersen *et al.* 2004), which may result in a high proportion of birds avoiding entering the windfarm all together. If this is factored in to the estimates of collision fatality then a much reduced number of birds can be expected to both fly through the windfarm site and hence fly in to the operational wind turbines. Therefore a reduction in the predictions is more reasonable, resulting in a **negligible impact** of any significance on the international, national and regional populations.

12.6.3.3.7.5 Kittiwake

451 Kittiwakes are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

452 The PCH for kittiwakes used in the CRM was 21.3% of birds in flight *(Table 12-58)*. This has led to a predicted mortality rate of 6 birds during the breeding season, which leads to an increase of 0.63% relative to the baseline mortality at a regional level during this period *(Table 12-64*), which is considered to be of *negligible* magnitude. However, there are no breeding colonies of kittiwakes located within the maximum foraging range of 120km (Thaxter *et al.* 2012b) from the East Anglia ONE site, with the nearest colony located at Flamborough Head and Bempton Cliffs, which is a minimum of 275km from the East Anglia ONE site. Additionally, the RSPB tagging study of birds breeding at this colony has shown that birds do not forage as far from this colony as the East Anglia ONE site. Therefore, many of the birds found within the East Anglia ONE site are likely to be non-breeders. Taking this into account it must be recognised that the population found within the East Anglia ONE site during the breeding season is unlikely to constitute birds from local breeding colonies and as such will form the part of the wider national and international populations. At a national and international level, the increase relative to the baseline breeding mortality is predicted to be 0% (*Table 12-62 to Table 12-64)*, which is considered to be of *negligible* magnitude and results in a **minor adverse impact**.

453 However, the mortality rate during winter is much higher, with 344 birds predicted to collide with wind turbines. This would register an increase of 5.94% relative to the

regional baseline wintering mortality (*Table 12-62*), which is considered to be a *medium* magnitude impact, increasing the significance of the impact to **moderate adverse***.* However, as the wintering population is more likely to contain birds from a wider population, the increase relative to the national wintering mortality is considered more appropriate to assess the significance of impact against. An increase of 0.24% relative to the national wintering baseline mortality is predicted (*Table 12-63*), which is considered to be of *negligible* magnitude, resulting in an impact of **minor adverse significance** on the national wintering population of kittiwakes.

12.6.3.3.7.6 Common gulls

454 Common gulls are considered to have a *low* general sensitivity to collision risk *(Table 12-45*). From *Table 12-49*, the species is considered to be a *medium* value species. Therefore their site-specific sensitivity to collision risk is considered to be *low*.

455 The increase relative to baseline mortality due to collision risk is predicted to be less than 1% at the *international* and *national* levels during both the breeding season and the wintering period *(Table 12-62 to Table 12-64*), which are considered to be *negligible magnitude* effects at these levels. Therefore, it is considered that the significance of any increased mortality from collision risk with wind turbines within the East Anglia ONE site will create a **negligible impact** on the *national and international* breeding and wintering populations of common gulls.

456 The predicted collision mortality for common gulls is 6 birds during the breeding season, which is an increase of 0.86% relative to the regional breeding baseline mortality (*Table 12-64*). As this species does not breed in large numbers in Norfolk or Suffolk and breeds more widely in Scotland and the north Pennines (Taylor & Marchant 2011) it means that many of the birds found within the East Anglia ONE site are likely to be non-breeders, as the East Anglia ONE site is outside of the foraging range for common gull. Taking this into account it must be recognised that the population found within the East Anglia ONE site during the breeding season is unlikely to constitute birds from local breeding colonies and as such will form the part of the wider national and international populations. This reduces the significance of any impacts further.

457 When considering the regional wintering population, there were no predicted mortalities from collision with any turbines in the East Anglia ONE site (*Table 12-64*), therefore the magnitude of impact would be **negligible** and there would be no significance rating, as no impact is predicted.

458 The combined impact of the East Anglia ONE windfarm on common gulls, when accounting for the impacts on both breeding and wintering numbers, will be of **negligible significance**.

12.6.3.3.7.7 Lesser black-backed gulls

459 Lesser black-backed gulls are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be *a very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

460 *Table 12-61* shows that the predicted annual mortality rates for lesser black-backed gulls are relatively high at 394 individuals, which equates to an increase of 0.13% relative to the baseline mortality rate at the international population level. Due to the lesser-black-backed gulls present in the East Anglia ONE site being from different geographical areas at different times of the year it is only possible to consider overall annual mortality in terms of the international population of the species (see following sections). During the breeding season 58 individuals are estimated to be affected (*Volume 5, Appendix 12.4*) leading to increases relative to the baseline mortality at the regional, national and international levels of 6.55%, 0.29% and 0.11% respectively (*Table 12-62 to Table 12-64*). During the wintering period 162 individuals are estimated to be affected (*Volume 5, Appendix 12.4*) leading to increases relative to the baseline mortality at the regional, national and international levels of 6.47%, 1.55% and 0.34% respectively (*Table 12-62 to Table 12-64*).

461 In order to assess the impact on the lesser black-back gull population recorded during the survey efforts in the East Anglia ONE site it is important to establish where the birds are from and which populations are considered to be represented within the area.

462 Lesser black-backed gulls breed in nationally important numbers along the coast of East Anglia. A total of 5,089 pairs of lesser black-backed gulls currently breed within maximum foraging range (181km) of the East Anglia ONE site (based on Mitchell *et al.* 2004 and the latest colony count at the Alde-Ore SPA from the RSPB). The Alde-Ore SPA is particularly important for this species and currently holds approximately 1,600 breeding pairs (though a large reduction from the estimated 21,700 pairs in 1998 has occurred in the population in the last 14 years). Tagging data provided by the RSPB from studies in 2010 and 2011 of birds from this breeding colony show that only two thirds of birds actually feed offshore and of those birds none flew out as far as the East Anglia ONE site during the breeding season. A BTO study published by Thaxter *et al.* (2012a) suggests that a higher percentage (upward of 60%) of birds from the Alde-Ore SPA colony forage at some point within the entire East Anglia zone, though more specific information on

whether they actually flew in to the East Anglia ONE site was not provided. It is accepted that these data sets are limited in their extent, though they suggest that the population of lesser black-backed gulls that exists within the East Anglia ONE site during the breeding season includes birds from the Alde-Ore SPA and other regional colonies.

463 Mortality due to collision with turbines in the proposed East Anglia ONE site is predicted to have a 6.55% increase relative to the baseline mortality on the regional breeding population of lesser black-backed gulls, which is considered to be a *medium* magnitude impact. However, of the 58 birds predicted to collide with the wind turbines within East Anglia ONE site only 78% (from East Anglia ONE boat-based and aerial survey data) are predicted to be adults (potential breeding birds), so it is estimated that the actual effect on the regional breeding population will be 45 individuals. This reduces the increase relative to the baseline mortality rate to 5.08%, which is still considered to be a *negligible* magnitude impact on the regional breeding population. Therefore the predicted significance of the impact from collision on the regional breeding population is of **minor adverse significance**. It is recognised that this is precautionary as there is the potential for an unknown proportion of lesser black-backed gulls breeding at colonies on the European coast located within the maximum foraging range of this species from the East Anglia ONE site to forage within the site.

464 In order to estimate the impact on the Alde-Ore SPA breeding population the proportion of birds from this SPA was calculated and the proportion of adult birds in East Anglia ONE accounted for, as these are classed as breeding birds. Within the East Anglia ONE site 78% and 22% of lesser-black-backed gulls were identified as adults or juveniles and sub-adults, respectively. As the Alde-Ore population holds 31.5% of the regional breeding population, it would be expected that 31.5% of the proportion of adult birds predicted to collide with turbines within the East Anglia ONE site during the breeding season are potentially from the Alde-Ore. Thus of the 58 individuals expected to collide with the turbines, 18 (adults, juveniles and sub-adults) are expected to be from the Alde-Ore SPA, of which 78% or 14 would be breeding adults. This leads to an increase of 5.03% relative to the baseline mortality rate for the Alde-Ore SPA population.

465 To determine the likely effect that these collisions would have on the Alde-Ore breeding colony of lesser black-backed gulls a Population Viability Analysis (PVA) was commissioned from MacArthur Green and subsequently delivered (Trinder 2012). An additional mortality of 20 adult lesser black-backed gulls, more than that predicted to occur annually as a result of the proposed construction of East Anglia ONE, has a negligible effect on the number of breeding pairs of lesser black-backed gulls expected to be present at the Alde-Ore colony after 25 years under the medium scenario presented in the PVA. Under the medium scenario a difference of

under 5% between end populations with or without additional mortality was found, which is likely to be well within the margins of error for the model and most importantly does not stop the upward trend in breeding pairs. Following the construction of East Anglia ONE, it is therefore expected that the magnitude of impact will be **negligible** on lesser black-backed gulls during the breeding season.

466 On this basis it is considered that there will not be a minor adverse effect on breeding lesser black-backed gulls due to collision mortality arising from the operation of East Anglia ONE.

467 In Britain lesser black-backed gulls are known to winter further south and birds can migrate as far as north - mid Africa and back outside of the breeding season (Wernham *et al.* 2002). Gulls ringed at British breeding colonies have been relocated in Spain, Portugal and Morocco during the winter months and the BTO study of birds at Orfordness has found that individulas wintered in Morocco and Mauritania (Thaxter pers. comm.). The southern North Sea population is thought to increase during the winter months when as many as 125,000 birds from northern Europe fly south through the bottle neck of the English Channel (Steinen *et al.* 2007). It is also known that lesser black-backed gulls from continental Europe migrate to Britain for the winter, as the population increases during the winter months. These birds may come from colonies in Norway or Sweden, but equally evident is the migration of Dutch and Belgium birds across the southern North Sea to Britain (Ens *et al.* 2009). With this in mind it is estimated that the magnitude of any effects from the East Anglia ONE windfarm on lesser black-backed gulls is likely to be more widely spread over the entire Northern European wintering population, and that any effects will occur at the level of the international population. Mortality due to collision with wind turbines in the proposed East Anglia ONE site is predicted to have a 0.34% increase relative to the baseline mortality on the international wintering population of lesser black-backed gulls, so is likely to produce *negligible* magnitude impact. Consequently the significance of any impacts on the wintering population is of **minor adverse significance** at the international population level.

468 Due to the majority of predicted collisions occurring outside of the breeding period it is reasonable to assess the annual mortality against the wider international (biogeographic) populations. The predicted annual mortality rate for lesser black-backed gulls of 394 individuals equates to an increase of 0.13% relative to the baseline mortality rate at the international population level. This is considered to be a *negligible* magnitude impact.

12.6.3.3.7.8 Herring gulls

469 Herring gulls are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *high*.

470 The increase relative to baseline mortality due to collision risk was predicted to be less than 1%, at the *international* and *national* levels, in the breeding and wintering periods respectively (*Table 12-62 and Table 12-63*), which is considered to be a *negligible magnitude* effect at these levels. Therefore, it is considered that the significance of the impact from collision risk with wind turbines within the East Anglia ONE site will be **negligible** on the *national and international* populations of herring gulls during the breeding and wintering periods.

471 The predicted winter mortality rate is predicted to be 84 individual herring gulls, resulting in a 1.09% increase relative to the regional baseline mortality (*Table 12-64*). This is considered to be an impact of *low* magnitude. The predicted collision rate during the breeding season is substantially lower in numbers, with a predicted mortality rate of eight birds, resulting in a 1.22% increase relative to the regional baseline mortality (*Table 12-64*). This is also considered to be a *low* magnitude impact. Therefore, it is considered that the significance of the impact from collision risk with wind turbines within the East Anglia ONE site will be **minor adverse** on the regional population of herring gulls during both the breeding and wintering periods.

472 When considering the impact of collision risk on the regional, national and international breeding and wintering populations, it is more likely that any impacts are to be on the regional population during the breeding season and the national population during the winter. The increase relative to baseline mortality rates is predicted to be a *low magnitude* effect regionally during the breeding season and *negligible* on the national wintering population. Therefore, it is considered that collision risk with wind turbines within the East Anglia ONE site will create an impact of **negligible significance** on national wintering population of herring gulls and an impact of **minor adverse significance** on the regional breeding population of herring gulls.

12.6.3.3.7.9 Great black-backed gulls

473 Great black-backed gulls are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *high*.

474 The increase relative to the baseline mortality rates is predicted to be less than 1% at the *international* and *national* levels during the breeding and wintering periods (*Table 12-62 and Table 12-63*), which would result in a *negligible magnitude* effect at this level. Therefore, it is considered that collision risk with wind turbines within the East Anglia ONE site will create an impact of **negligible significance** on the *international* and *national* wintering and breeding populations of great black-backed gulls.

475 The predicted number of collisions is 9 during the breeding season and 16 during the winter, representing an increase of 0.91% and 2.57% relative to the regional baseline mortality rates respectively. This is considered to be of *negligible* magnitude with regard to the regional wintering population and of *low* magnitude for the regional breeding population. This will create an impact of **minor adverse significance** at most and only on the regional breeding population, as the impact on the regional wintering population will be of **negligible significance**.

12.6.3.3.7.10 Auks

476 Both guillemots and razorbills are considered to have a *low* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, both species are considered to be of *high* value. Therefore their site-specific sensitivities to collision risk are considered to be *medium*.

477 Guillemots and razorbills are considered to have a generally low flight altitude, medium-low manoeuvrability and low proportion typically in flight: Garthe & Hüppop (2004). Given this typical flight behaviour, those auks that do fly through the East Anglia ONE site are predicted to fly below the turbine rotors, under 22m, and any impact from collision is considered unlikely.

478 Evidence from APEM's aerial survey data suggests that very few birds were actually in flight within the East Anglia ONE site, meaning that they could not be modelled through a CRM due to such low numbers. Additionally, all the birds that were recorded in flight were flying at heights below the 22m worst case scenario rotor sweep. As a result, the magnitude of any collision impacts is considered to be *negligible.* Therefore, it is considered that collision risk with wind turbines within the East Anglia ONE site will create *no impacts* of significance on both guillemots and razorbills.

Summary of Potential Collision Risk Effects during Operations					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk during Operations**
Red-throated diver	Very high - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	Medium – Based on the flight manoeuvrability, flight altitude, percentage flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	Very high – A combination of both a very high non impact-specific value and a medium general sensitivity to collision risk.	Negligible – Typical flight behaviour is to fly close to the sea surface and that birds fly less frequently in the non-breeding season. <1% of flights at collision height.	**Negligible**– A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact.
Fulmar	Medium - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	Low – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	Low – A combination of both a medium non impact-specific value and a low general sensitivity to collision risk.	Negligible – <1% of flights at collision height. The increase relative to the baseline mortality is predicted to be 0% at the regional, national and international populations.	**No impact** – A combination of both a low site-specific sensitivity to collision risk and a negligible magnitude of impact.
Gannet	High - Found in regionally important numbers during migration periods. As birds are not found in regionally important	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of	High – A combination of both a high non impact-specific value and a medium general sensitivity to collision risk.	Negligible – Additional rate of annual mortality results in a 1.26% at worst increase relative to the baseline mortality at the regional	**Negligible** – A combination of both a high site-specific sensitivity to collision risk and a negligible magnitude of impact.

Summary of Potential Collision Risk Effects during Operations					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk during Operations**
	numbers during the breeding season it can be assumed that the area of sea within the East Anglia ONE is not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.	perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).		population level, but is less than 0.1% at the national and international population levels.	
Kittiwake	Very high - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	Very high – A combination of both a very high non impact-specific value and a medium general sensitivity to collision risk.	Negligible – Additional rate of wintering mortality results in a 5.94% at worst increase relative to the baseline mortality at the regional population level. However, birds present in the East Anglia ONE	**Minor adverse** – A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact.

Summary of Potential Collision Risk Effects during Operations					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk during Operations**
	throughout the East Anglia ONE site.			site at this time are considered likely to be from the wider national population and an increase of 0.24% relative to the baseline mortality rate is predicted for the national population.	
Common gull	Low - The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally important numbers during the aerial surveys during any biologically relevant period.	Low – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	Low – A combination of both a low non impact-specific value and a low general sensitivity to collision risk.	Negligible – Additional rate of mortality is predicted to result in an increase relative to the baseline mortality rates of less than 1% at the regional, national or international population level.	**Negligible** – A combination of both a low site-specific sensitivity to collision risk and a negligible magnitude of impact.
Lesser black-backed gull	Very high - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of	Very high – A combination of both a very high non impact-specific value and a medium general sensitivity to collision	Negligible – Additional mortality of 16 adult lesser black-backed gulls has a negligible effect on lesser black-backed gulls expected	**Minor adverse** – A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact.

Summary of Potential Collision Risk Effects during Operations					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk during Operations**
		perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	risk.	to be from the Alde-Ore SPA. On this basis it is considered that there will be a minor adverse effect on breeding lesser black-backed gulls due to collision mortality arising from the operation of East Anglia ONE.	
Herring gull	High - Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC red list.	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	High – A combination of both a high non impact-specific value and a medium general sensitivity to collision risk.	Low – Additional rate of breeding mortality is predicted to result in a 1.22% increase relative to the baseline mortality rate at the regional population level.	**Minor adverse** – A combination of both a high site-specific sensitivity to collision risk and a low magnitude of impact.

Summary of Potential Collision Risk Effects during Operations					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk during Operations**
Great black-backed gull	High - The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	High – A combination of both a high non impact-specific value and a medium general sensitivity to collision risk.	Low – Additional rate of breeding mortality is predicted to result in a 2.57% increase relative to the baseline mortality rate at the regional population level.	**Minor adverse** – A combination of both a high site-specific sensitivity to collision risk and a low magnitude of impact.
Guillemot	High - Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider	Low – Based on the their individual flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012) and collision risks in Langston (2010).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to collision risk for both species.	Negligible – Typical flight behaviour of both species is to fly close to the sea surface. <0.01% of flights at collision height. No additional mortality is predicted.	**No impact** – A combination of both a medium site-specific sensitivity to collision risk and a negligible magnitude of impact for both species.

Summary of Potential Collision Risk Effects during Operations					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk during Operations**
Razorbill	number of colonies and not exclusively from the Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.				

*Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Collision Risk Sensitivity, as outlined in Section 12.4 on impact methodologies

**Predicted Impact Significance is a product of combining the Site-specific Sensitity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-65 Summary of Collision Risk Effects during Operations

12.6.3.3.8 Migrant Species Avoidance Rates

479 Few detailed assessments of collision risk have been undertaken for migrants, as such there are no standard recommended avoidance rates available. To assess the risk of collision to the waders and wildfowl predicted to pass through the East Anglia ONE site, avoidance rates as detailed in Cook *et al.* (2012) have been used. To assess the variability around these estimates, variation in the avoidance rates have been incorporated, though the assessment will be based on 98% avoidance.

12.6.3.3.9 Migrant Species Summary of Annual Mortality Rates

480 The annual mortality rates for each of the migrant species at the various avoidance rates are shown in *Table 12-66*. The mortality rates for the spring and autumn periods for each species are reported in *Volume 5, Appendix 12.4*.

12.6.3.3.10 Migrant Species CRM results for East Anglia ONE

481 The predicted annual mortality rates have been assessed with respect to baseline mortality rates for each migrant species modelled through the CRM in comparison to population estimates for each species on a national and international scale. The annual mortality rates for East Anglia ONE in comparison to national and international baseline mortality rates for the migrant species can be observed in *Table 12-67* and *Table 12-68* respectively.

482 The majority of the migrant species considered in the East Anglia ONE assessment are also relatively long-lived species with low reproductive rates. For example the dark-bellied brent goose has a typical lifespan of 11 years and produces three to five eggs in a year; the black-tailed godwit has a typical lifespan of 18 years and produces up to four eggs per year (Robinson 2005). Therefore, these species are also less tolerant of increases in baseline mortality than short-lived species producing many offspring (Garthe & Hüppop 2004). Thus, the magnitude of impacts from collision risk based on the percentage increases relative to baseline mortality has been assessed using professional judgement in the same way as for the seabird species above.

Summary of Annual Mortality Rates for 98%, 99% and 99.5% Avoidance Rates														
Avoidance	Annual Mortality Rate	Bewick's swan	Taiga bean goose	European white-fronted goose	Dark-bellied brent goose	Shelduck	Common scoter	Avocet	Golden plover	Knot	Dunlin	Black-tailed godwit	Bar-tailed godwit	Great skua
98%	Mean	1	0	1	51	11	0	4	155	51	115	11	4	0
	Minimum	1	0	1	51	11	0	4	153	50	114	11	4	-
	Maximum	1	0	1	52	11	0	4	157	52	116	11	4	-
99%	Mean	0	0	0	26	6	0	2	77	26	57	5	2	0
	Minimum	0	0	0	25	6	0	2	76	25	57	5	2	-
	Maximum	1	0	0	26	6	0	2	78	26	58	5	2	-
99.5%	Mean	0	0	0	13	3	0	1	39	13	29	3	1	0
	Minimum	0	0	0	13	3	0	1	38	13	29	3	1	-
	Maximum	0	0	0	13	3	0	1	39	13	29	3	1	-

Table 12-66 Summary of Annual Mortality Rates for 98%, 99% and 99.5% Avoidance Rates

East Anglia ONE Migrant Species Annual Mortality Rate in Comparison to Baseline International Mortality Rates (Based on a worst case array and a 98% avoidance rate)								
Species	**Baseline Mortality Rate (%)[1]**	**International Population (Individuals)**	**Spring**			**Autumn**		
			Mean Mortality Rate	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Mortality Rate**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Bewick's swan	17.8	20,000	1	17.81	0.03	0	17.80	0.00
Taiga bean goose	23	70,000	0	23.00	0.00	0	23.00	0.00
European white-fronted goose	27.6	1,000,000	0	27.60	0.00	0	27.60	0.00
Dark-bellied brent goose	10.0	200,000	34	10.02	0.17	17	10.01	0.09
Shelduck	11.4	300,000	4	11.40	0.01	7	11.40	0.02
Common scoter	21.7	1,600,000	0	21.70	0.00	0	21.70	0.00
Avocet	22	73,000	2	22.00	0.01	2	22.00	0.01
Golden plover	27	1,070,000	78	27.01	0.03	77	27.01	0.03

East Anglia ONE Migrant Species Annual Mortality Rate in Comparison to Baseline International Mortality Rates (Based on a worst case array and a 98% avoidance rate)								
Species	**Baseline Mortality Rate (%)[1]**	**International Population (Individuals)**	**Spring**			**Autumn**		
			Mean Mortality Rate	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**	**Mean Mortality Rate**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Knot	15.9	450,000	25	15.91	0.03	26	15.91	0.04
Dunlin	26	1,330,000	56	26.00	0.02	59	26.00	0.02
Black-tailed godwit	6	57,000	5	6.01	0.15	5	6.01	0.15
Bar-tailed godwit	28.5	120,000	3	28.50	0.01	2	28.50	0.01
Great skua	10.0	32,000	0	10.0	0.00	0	10.00	0.00

[1] Baseline mortality rates have been calculated from the adult annual survival rates given in Robinson (2005)

Table 12-67 East Anglia ONE Migrant Species Annual Mortality Rate in Comparison to Baseline International Mortality Rates (Based on a worst case array and a 98% avoidance rate)

East Anglia ONE Migrant Species Annual Mortality Rate in Comparison to Baseline National Mortality Rates (Based on a worst case array)								
Species	**Baseline Mortality Rate (%)**[1]	**National Population (Individuals)**	**Spring**			**Autumn**		
			Mean Mortality Rate	**Predicted Baseline Mortality including East Anglia ONE (%))**	**Increase Relative to Baseline Mortality (%)**	**Mean Mortality Rate**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Bewick's swan	17.8	7,380	1	17.81	0.08	0	17.80	0.00
Taiga bean goose	23	410	0	23.00	0.00	0	23.00	0.00
European white-fronted goose	27.6	2,400	0	27.60	0.00	0	27.60	0.00
Dark-bellied brent goose	10.0	9,100	34	10.04	0.37	17	10.02	0.19
Shelduck	11.4	75,610	4	11.41	0.05	7	11.41	0.08
Common scoter	21.7	123,190	0	21.70	0.00	0	21.70	0.00
Avocet	22	7,500	2	22.03	0.12	2	22.03	0.12
Golden plover	27	566,700	78	27.01	0.05	77	27.01	0.05

East Anglia ONE Migrant Species Annual Mortality Rate in Comparison to Baseline National Mortality Rates (Based on a worst case array)								
Species	**Baseline Mortality Rate (%)**[1]	**National Population (Individuals)**	**Spring**			**Autumn**		
			Mean Mortality Rate	**Predicted Baseline Mortality including East Anglia ONE (%))**	**Increase Relative to Baseline Mortality (%)**	**Mean Mortality Rate**	**Predicted Baseline Mortality including East Anglia ONE (%)**	**Increase Relative to Baseline Mortality (%)**
Knot	15.9	338,970	25	15.91	0.05	26	15.91	0.05
Dunlin	26	438,480	56	26.01	0.05	59	26.01	0.05
Black-tailed godwit	6	56,880	5	6.01	0.15	5	6.01	0.15
Bar-tailed godwit	28.5	54,280	3	28.51	0.02	2	28.50	0.01
Great skua	10.0	19,268	0	10.00	0.00	0	10.00	0.00

[1] Baseline mortality rates have been calculated from the adult annual survival rates given in Robinson (2005)

Table 12-68 East Anglia ONE Migrant Species Annual Mortality Rate in Comparison to Baseline National Mortality Rates (Based on a worst case array)

12.6.3.3.11 Migrant Species Assessment of CRM results for East Anglia ONE

12.6.3.3.11.1 Bewick's swan

483 Bewick's swans are considered to have a *high* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

484 The PCH used in the CRM modelling was 38% (Larsen & Clausen 2002). The predicted mean mortality rate at 98% avoidance rate is of one and zero birds during the spring and autumn migration periods respectively, which results in an increase of 0.03% and 0.08% to the baseline mortality rate at an international and national level respectively during the spring and a 0% increase at both levels in the autumn (*Table 12-67and Table 12-68*). These levels of increase are considered to be of *negligible* magnitude and will create an impact of **minor adverse significance** on Bewick's swans at both a national and international population level.

12.6.3.3.11.2 Taiga bean goose

485 Taiga bean geese are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

486 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). Taiga bean geese winter largely in southern Sweden and Denmark (Hearn 2004). Individuals are thought to migrate to and from Britain from across the central or southern North Sea (Wernham *et al.* 2002) and relatively small numbers occurring regularly in Britain during the winter. The migration model estimated 20 Taiga bean geese would pass through the East Anglia ONE site during the spring and autumn migration periods.

487 No Taiga bean geese are predicted to be killed by collision with turbines at the 98% avoidance rate during the spring or autumn migration periods (*Table 12-67 and Table 12-68*). As a result, the magnitude of any collision impacts is considered to be *negligible.* Therefore, it is considered that collision risk with wind turbines within the East Anglia ONE site will create at worst a **minor adverse impact** on Taiga bean geese. However, as no birds are predicted to be killed by the CRM, it is highly unlikely that a **minor adverse impact** can be assumed, with it more likely to be **negligible** or even *no impact*. With this in mind *no impact* is anticipated to occur on Taiga bean geese at both the national and international population levels.

12.6.3.3.11.3 *European white-fronted goose*

488 European white-fronted geese are considered to have a medium general sensitivity to collision risk (*Table 12-45)*. From *Table 12-49*, the species is considered to be a very high value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

489 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at 98% avoidance rate is zero birds during both the spring and autumn migration periods (*Table 12-67 and Table 12-68*). As a result, the magnitude of any collision impacts is considered to be *negligible* and will create at worst a **minor adverse impact***.* However, as no birds are predicted to suffer from mortality from collision with turbines in the East Anglia ONE site the level of significance is unlikely to be minor adverse and it is considered to be more likely that there will be **no impact** on European white-fronted geese at both a national and international population level.

12.6.3.3.11.4 *Dark-bellied brent goose*

490 Dark-bellied brent geese are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49* the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

491 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at 98% avoidance rate is 34 during the spring migration and 17 during the autumn migration period, which is an increase of 0.37% and 0.19% relative to the baseline mortality rate at a national level (*Table 12-68*) and an increase of 0.17% and 0.09% relative to the baseline mortality rate at the international level (*Table 12-67*).

492 These levels of increase are considered to be of *negligible magnitude* and will create at worst an impact of **minor adverse significance** on dark-bellied brent geese at both a national and international population level.

12.6.3.3.11.5 *Shelduck*

493 Shelducks are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

494 The PCH used in the CRM modelling was 50% (Wright *et al.* 2012). The predicted mean mortality rate at 98% avoidance is four birds during the spring migration and seven birds during the autumn migration, which results in an increase of 0.05% and 0.08% relative to the baseline mortality rates at a national level and an increase of 0.01% and 0.02% relative to the baseline mortality rate at the international level (*Table 12-67 and Table 12-68*).

495 These levels of increase are considered to be of *negligible magnitude* at national and international levels. This will create an impact of **minor adverse significance** on shelducks at the national and international population levels.

12.6.3.3.11.6 Common scoter

496 Common scoters are considered to have a low general sensitivity to collision risk (*Table 12-45*). From *Table 12-49* the species is considered to be a very high value species. Therefore their site-specific sensitivity to collision risk is considered to be *medium*.

497 The CRM was based on the numbers of common scoter estimated to pass through the East Anglia ONE site during spring and autumn migration by the migration model rather than on the aerial survey data.

498 The PCH used in the CRM modelling was 1% (Cook *et al.* 2012). Common scoters are considered to have a generally low flight altitude, medium-low manoeuvrability and low proportion typically in flight: Garthe & Hüppop (2004). Given this typical flight behaviour, those common scoters that do fly through the East Anglia ONE site are predicted to fly below the turbine rotors, less than 22m, and any impact from collision is considered unlikely. The results of the CRM predict that no common scoters will be killed by collision with wind turbines at 98% avoidance rate, during the spring or autumn migration periods *(Table 12-67and Table 12-68*). As a result, the magnitude of any collision impacts is considered to be **negligible***.* Although the predicted significance of impacts on common scoter is **negligible** no birds are calculated to collide with wind turbines in the East Anglia ONE site. Therefore, it is considered that collision risk with wind turbines within the East Anglia ONE site will create *no impact* on the national and international populations of common scoters.

12.6.3.3.11.7 Avocet

499 As no flight manoeuvrability, flight altitude, percentage of birds flying and nocturnal flight activity scores are available for avocet in Garthe & Hüppop (2004), King *et al.* (2009), Maclean *et al.* (2009) or Wright *et al.* (2012), in order to be precautionary avocets have been considered to have a *high* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value

species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

500 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at 98% avoidance rate is two birds during the spring and two birds during the autumn migration periods. This results in an increase of 0.12% relative to the baseline mortality rate at the national population level during both the spring and autumn migration periods and an increase of 0.01% relative to the baseline mortality rates at the international population level for both the spring and autumn migration periods (*Table 12-67 and Table 12-68*).

501 These levels of increase are considered to be of *negligible magnitude* at a national and international level. This will create an impact of **minor adverse significance** on avocets at the national and international population levels. However, it is considered more likely that the impact would be of **negligible significance** on the national population and have *no impact* at the international level from the loss of two birds during each migration period.

12.6.3.3.11.8 Golden plover

502 Golden plovers are considered to have a low general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a very high value species. Therefore their site-specific sensitivity to collision risk is considered to be *medium*.

503 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at 98% avoidance rate is 78 and 77 birds during the spring and autumn migration periods. This results in an increase of 0.05% relative to the baseline mortality rate at the national population level during both the spring and autumn migration periods and an increase of 0.03% relative to the baseline mortality rates at the international population level for both the spring and autumn migration periods (*Table 12-67 and Table 12-68*).

504 These levels of increase are considered to be of *negligible magnitude* at the national and international level. This will create an impact of **negligible significance** on golden plovers at the national and international population level.

12.6.3.3.11.9 Knot

505 Knots are considered to have a *low* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49,* the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *medium*.

506 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at a 98% avoidance rate is of 25 birds during the spring and 26 birds during the autumn migration periods. This results in an increase of 0.03% and 0.04% relative to the baseline mortality rate at an international level in spring and autumn respectively and a 0.05% increase at a national level in both spring and autumn (*Table 12-67and Table 12-68)*.

507 These levels of increase are considered to be of *negligible magnitude* at both the national and international level. This will create an impact of **negligible significance** on knots at the national and international population level.

12.6.3.3.11.10 Dunlin

508 Dunlins are considered to have a *low* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *medium*.

509 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at a 98% avoidance rate is of 56 and 59 birds during the spring and autumn migration periods. This results in an increase of 0.05% relative to the baseline mortality rate at the national population level during both the spring and autumn migration periods and an increase of 0.02% relative to the baseline mortality rates at the international population level for both the spring and autumn migration periods (*Table 12-67 and Table 12-68*).

510 These levels of increase are considered to be of *negligible magnitude* at a national and international level. This will create an impact of **negligible significance** on dunlins at the national and international population level, though more likely to be *no impact* at the international level.

12.6.3.3.11.11 Black-tailed godwit

511 Black-tailed godwits are considered to have a *high* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49,* the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

512 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at a 98% avoidance rate is of five birds during the spring and five birds during the autumn migration periods. This results in an increase of 0.15% relative to the baseline mortality rates at the national and international population level for both the spring and autumn periods (*Table 12-67 and Table 12-68*).

513 This level of increase is considered to be of *negligible* magnitude and will create an impact of **minor adverse significance** on black-tailed godwits at both a national and international population level. However, it is highly unlikely that the impact will be **minor adverse** in nature, as only ten birds are predicted to collide fatally with wind turbines within the East Anglia ONE site during both migration periods each year. Therefore it is considered more appropriate to reduce the overall significance of the impact to **negligible** for bar-tailed godwits.

12.6.3.3.11.12 Bar-tailed godwit

514 Bar-tailed godwits are considered to have a *high* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

515 The PCH used in the CRM modelling was 75% (Wright *et al.* 2012). The predicted mean mortality rate at a 98% avoidance rate is of three birds during the spring and two birds during the autumn migration periods. This results in an increase of 0.01% relative to the baseline mortality rate at an international level in both spring and autumn and an increase of 0.02% and 0.01% relative to the baseline mortality rates at a national level in spring and autumn respectively (*Tables 12-65 and 12-66*).

516 These levels of increase are considered to be of *negligible* magnitude and are predicted to create an impact of **minor adverse significance** on bar-tailed godwits at both a national and international population level. However, it is highly unlikely that the impact will be of a **minor adverse** nature, as only five birds are predicted to fatally collide with East Anglia ONE wind turbines during both migration periods per year. Therefore it is considered more appropriate to reduce the overall significance of the impact to **negligible** for bar-tailed godwits.

12.6.3.3.11.13 Great skua

517 Great skuas are considered to have a *medium* general sensitivity to collision risk (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to collision risk is considered to be *very high*.

518 Although there is evidence that the southern North Sea in autumn has low numbers of great skua migrating through and migration is thought to be north from the North Sea and south along the west coast of Britain (Wernham *et al.* 2002) other references suggest that the southern North Sea is an important flyway for this species (Steinen *et al.* 2011). Therefore, birds might be expected to pass through the East Anglia ONE site mostly during the autumn migration period and as such a

modelling exercise was completed to estimate the potential number of great skua passing through the East Anglia ONE site (see *Section 12.5.2.2.5*) during the autumn.

519 No great skuas are predicted to be killed by collision with wind turbines at the 98% avoidance rate during the autumn migration period (*Table 12-67and Table 12-68*). A similar exercise was completed assuming the numbers during the spring migration period, as a precautionary measure, with the result equalling a collision rate also of zero. As a result, the magnitude of any collision impacts in both the autumn and spring migration periods is considered to be *negligible.* Therefore, it is considered that collision risk with wind turbines within the East Anglia ONE site will create at worst a **minor adverse impact** on great skuas. However, as no birds are predicted to be killed by the CRM, it is highly unlikely that a **minor adverse impact** can be assumed, with a **negligible** or even *no impact* considered to be more likely. With this in mind the assigned value for the significance of collision mortality on the national and international populations of great skuas in the East Anglia ONE site is **negligible**.

Summary of Potential Collision Risk Effects during Operation for Migrant Species					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk duing Operations**
Bewick's swan	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	High – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Very high – A combination of both a very high non impact-specific value and a high general sensitivity to collision risk.	Negligible – Additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	Minor adverse – A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact.
Taiga bean goose	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Very high – A combination of both a very high non impact-specific value and a medium general sensitivity to collision risk.	Negligible – Due to flight behaviour, no birds are predicted to be killed by collision with turbines.	No impact – Due to no birds predicted to be killed.

Summary of Potential Collision Risk Effects during Operation for Migrant Species					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk duing Operations**
European white-fronted goose	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Very high – A combination of both a very high non impact-specific value and a medium general sensitivity to collision risk.	Negligible – No birds are predicted to be killed by collision with turbines.	No impact – Due to no birds predicted to be killed.
Dark-bellied brent goose	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Very high – A combination of both a very high non impact-specific value and a medium general sensitivity to collision risk.	Negligible – Additional rate of mortality is predicted to result in a <1%increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	Minor adverse – A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact.

Summary of Potential Collision Risk Effects during Operation for Migrant Species					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk duing Operations**
Shelduck	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	Medium – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Very high – A combination of both a very high non impact-specific value and a medium general sensitivity to collision risk.	Negligible – Additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	Minor adverse – A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact.
Common scoter	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	Low – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop (2004), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to collision risk.	Negligible – Due to flight behaviour, no birds are predicted to be killed by collision with turbines.	No impact – Due to no birds predicted to be killed.

Summary of Potential Collision Risk Effects during Operation for Migrant Species					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk during Operations**
Avocet	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	High – As no data available for avocets in King *et al.* (2009), (SOSS 03 2012), Langston (2010) or Wright *et al.* (2012), based on professional judgement and data available for other large wader species.	Very high – A combination of both a very high non impact-specific value and a high general sensitivity to collision risk.	Negligible – Additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	Negligible – A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact and the very low numbers of birds predicted to be killed.
Golden plover	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	Low – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to collision risk.	Negligible – Additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	Negligible – A combination of both a medium site-specific sensitivity to collision risk and a negligible magnitude of impact.
Knot	Very high – migrate into the UK for the winter and are	Low – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying	Medium – A combination of both a very high non impact-	Negligible – Additional rate of mortality is predicted to result in a <1% increase relative to	Negligible – A combination of both a medium site-specific

Summary of Potential Collision Risk Effects during Operation for Migrant Species					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk duing Operations**
	associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	specific value and a low general sensitivity to collision risk.	the baseline mortality rate at the national or international population level in both spring and autumn.	sensitivity to collision risk and a negligible magnitude of impact.
Dunlin	Very high – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	Low – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to collision risk.	Negligible – Additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	Negligible – A combination of both a medium site-specific sensitivity to collision risk and a negligible magnitude of impact.
Black-tailed godwit	Very high – migrate into the UK for the winter and are associated with non-	High – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity	Very high – A combination of both a very high non impact-specific value and a high	Negligible – Additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at	Negligible – A combination of both a very high site-specific sensitivity to collision

Summary of Potential Collision Risk Effects during Operation for Migrant Species					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk duing Operations**
	breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	general sensitivity to collision risk.	the national or international population level in both spring and autumn.	risk and a negligible magnitude of impact and the very low numbers of birds predicted to be killed.
Bar-tailed godwit	**Very high** – migrate into the UK for the winter and are associated with non-breeding SPAs, with a point to point broad front migration between continental Europe and the UK.	**High** – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in King *et al.* (2009), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	**Very high** – A combination of both a very high non impact-specific value and a high general sensitivity to collision risk.	**Negligible** – Additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	**Negligible** – A combination of both a very high site-specific sensitivity to collision risk and a negligible magnitude of impact and the very low numbers of birds predicted to be killed.
Great skua	**Very high** – migrate into the UK for the winter and are associated with non-breeding SPAs, with	**Medium** – Based on the flight manoeuvrability, flight altitude, the percentage of birds flying and nocturnal flight activity scores in Garthe & Hüppop	**Very high** – A combination of both a very high non impact-specific value and a medium general	**Negligible** – Due to flight behaviour, no birds are predicted to be killed by collision with turbines.	**Negligible** – A combination of both a very high site-specific sensitivity to collision risk and a negligible

Summary of Potential Collision Risk Effects during Operation for Migrant Species					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Collision Risk duing Operations**
	a point to point broad front migration between continental Europe and the UK.	(2004), SOSS rankings of perceived collision risk (SOSS 03 2012), collision risks in Langston (2010) and migratory flight heights presented in Wright *et al.* (2012).	sensitivity to collision risk.		magnitude of impact and that no birds are predicted to be killed.

*Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Collision Risk Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

**Predicted Impact Significance is a product of combining the Site-specific Sensitivity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-69 Summary of Collision Risk Effects during Operation for Migrant Species

12.6.3.4 Barrier Effects

12.6.3.4.1 Overview

520 The presence of the East Anglia ONE site potentially creates a barrier to migratory and foraging routes (dependent to some extent on array design and species of interest) and has the potential to result in long term changes in bird movements. It has been shown that some species (divers and scoters) avoid windfarms and take evasive detours, thereby potentially increasing energy expenditure (Petersen 2005; Petersen & Fox 2007). Such effects are more likely to have a greater impact on birds that regularly commute around the windfarm (eg birds heading to / from foraging grounds and roosting / nesting sites) than passage migrants that will have to negotiate the site once per migratory season (Speakman *et al*. 2009). Lesser black-backed gulls, estimated to be present in regionally important numbers during the breeding season, are therefore perhaps at greatest risk of impact, though there is evidence to suggest that this species will habituate to windfarms (Maclean *et al.* 2009).

521 During spring and autumn migrating individuals (including divers, auks, small and large gulls and gannets) could be subject to barrier effects associated with the presence of turbines which may affect migration; for instance, birds may have to increase energy expenditure to circumvent the East Anglia ONE site, and energy budgets are typically very restricted at migration times. However, this effect may be small for one-off avoidances (Speakman *et al*. 2009). Divers, auks, small and large gulls are all likely to make spring and autumn passage migrations en route to breeding or wintering grounds through the East Anglia ONE site and could potentially have to avoid the windfarm. Such an effect is unlikely to be experienced by fulmars as they are wide-ranging throughout the year, and gannets which were observed in the East Anglia ONE site infrequently outside of winter.

12.6.3.4.2 Red-throated divers

522 Red-throated divers are considered to have a *high* general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to barrier effects is considered to be *very high*.

523 It has been shown that divers avoid windfarms and take evasive detours, thereby potentially increasing energy expenditure (Petersen 2005; Petersen & Fox 2007). Studies from German waters have recorded red-throated divers taking evasive detours rather than crossing offshore windfarms (Dierschke & Garthe 2006).

524 Divers (all assumed to be red-throated divers) were recorded within the East Anglia ONE site during the winter (in regionally important numbers) and spring migration (in regionally and nationally important numbers) periods only, with peak numbers occurring in spring. Birds could therefore potentially have to avoid the East Anglia ONE site on route to breeding or wintering grounds. As red-throated divers are typically nocturnal migrants (Kahlert *et al.* 2012) and the aerial surveys are conducted during the day, it perhaps not surprising that very few birds were recorded in flight during the surveys. However, there is a definite increase during the spring migration period that suggests that birds may be moving through the site. It is possible that birds are moving to more easterly locations in mainland Europe as similar peaks have not been recorded offshore windfarms in the North Sea that are to the north of East Anglia ONE site, for instance in Hornsea or Dogger Bank.

525 Speakman *et al.* (2009) found that for one-off avoidances during migration the impact of windfarms on energy demands were relatively trivial (less than 2% of available fat reserves). Therefore, the magnitude of any barrier effects during migration could be considered to be *negligible*. For more frequent daily deviations, the impact was found to be more severe with daily energy demands elevated by 4.8 - 6% for every additional 15km flown each day, which could be significant if prolonged (Speakman *et al.* 2009). There is no evidence of red-throated divers regularly commuting through or in the vicinity of the East Anglia ONE site in order to reach important feeding areas. Therefore, the magnitude of any barrier effects during the winter period can also be considered to be *negligible*. As a result barrier effects could be considered to have at worst a **minor adverse impact** on red-throated divers within the East Anglia ONE site.

12.6.3.4.3 Fulmars

526 Fulmars are considered to have a low general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49*, the species is considered to be a medium value species. Therefore their site-specific sensitivity to barrier effects is considered to be *low*.

527 Fulmars were estimated to be present within the East Anglia ONE site in numbers of regional importance during winter, with low numbers during all other periods. Fulmars are known to be wide-ranging in the North Sea throughout the year (Stone *et al.* 1995) and also to have a large foraging range from breeding colonies estimated as a mean maximum of 400km away from colonies, with a maximum of up to 580km (Thaxter *et al.* 2012a),.

528 Any barrier effects on this species are considered to be very unlikely due to their tolerance of human activity and windfarms in general (Garthe & Hüppop 2004; Maclean *et al.* 2009), hence the effect is considered to of *negligible* magnitude.

Therefore, there is not anticipated to be a barrier effect on fulmars, or for it to be at worst of **negligible significance** on the species within the East Anglia ONE site.

12.6.3.4.4 Gannets

529 Gannets are considered to have a low general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49,* the species is considered to be a high value species. Therefore their site-specific sensitivity to barrier effects is considered to be *medium*.

530 Gannets were estimated to be present within the East Anglia ONE site in numbers of regional importance during autumn migration, with very low numbers during other periods. Data from the Egmond aan Zee windfarm monitoring program showed that seabirds including gannets strongly avoided of the windfarm (Krijgsveld *et al.* 2010; Leopold *et al.* 2011). Post-construction data from the Horns Rev windfarm found gannet numbers were lower than expected within the windfarm area (Petersen *et al.* 2004). Given the large foraging range of gannets (maximum range of 590km from a colony reported by Thaxter *et al.* 2012b), any increases in energy expenditure associated with close-range avoidance of the East Anglia ONE site wind turbines are considered unlikely to be significant and hence to be of *negligible magnitude*. Therefore, barrier effects could be considered to have a **negligible impact** on gannets within the East Anglia ONE site.

12.6.3.4.5 Kittiwakes

531 Kittiwakes are considered to have a low general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49*, the species is considered to be a very high value species. Therefore their site-specific sensitivity to barrier effects is considered to be *medium*.

532 Tagging data provided by RSPB from the Flamborough and Bempton Cliffs SPA during the breeding season suggest that birds do not forage as far south as East Anglia ONE, so no barrier effect is expected from this proposed windfarm during the breeding season. Kittiwake that winter in the East Anglia ONE site or migrate through it would be more susceptible to the barrier effect, but due to the species' ability to fly between wind turbines and not be deterred from entering a windfarm (Maclean *et al.* 2009), the magnitude of the impact is likely to be *negligible* and therefore the significance of the barrier effect on kittiwake is also predicted to be **negligible.**

12.6.3.4.6 *Common gulls*

533 Common gulls are considered to have a low general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49,* the species is considered to be a low value species. Therefore their site-specific sensitivity to barrier effects is considered to be *low*.

534 The number of common gulls estimated to be present within the East Anglia ONE site during all periods was below the regional 1% thresholds and therefore the magnitude of any barrier effects would be anticipated to be *negligible*. As a result the significance of any barrier effects could be considered to be **negligible** for common gulls within the East Anglia ONE site.

12.6.3.4.7 *Lesser black-backed gulls*

535 Lesser black-backed gulls are considered to have a low general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49*, the species is considered to be a very high value species. Therefore their site-specific sensitivity to barrier effects is considered to be *medium*.

536 Lesser black-backed gulls could be at risk of barrier effects on migration as birds may pass through the East Anglia ONE site on their return route from breeding grounds in western continental Europe and northern Europe to wintering areas in southern Europe and North Africa (Wernham *et al.* 2002) and could potentially have to avoid the site. The estimated numbers of lesser black-backed gulls present within the East Anglia ONE site during the migration period did not exceed that required for regional importance. Speakman *et al.* (2009) found that for one-off avoidances during migration the impact of windfarms on energy demands were trivial (less than 2% of available fat reserves), as such the magnitude of any barrier effects during the migration period is likely to be *negligible*.

537 The East Anglia ONE site is located within 141km of the Alde-Ore Estuary SPA, the estimated mean maximum foraging range for lesser black-backed gulls (Thaxter *et al.* 2012b) which encompasses the whole site. Although regionally important numbers were recorded within the East Anglia ONE site during the breeding season, initial tagging data from BTO and RSPB for lesser black-backed gulls from the Alde-Ore breeding colony suggest that it does not appear that the East Anglia ONE site is contained within the core foraging range of most birds examined (Thaxter *et al.* 2011; RSPB data). However, a revised paper (Thaxter *et al.* 2012a) suggests that a proportion of birds from the Alde-Ore SPA forage on the East Anglia ONE site during the breeding season.

538 Lesser black-backed gull are not anticipated to avoid windfarms and as such any impact will be at most of *negligible* magnitude, as they have been found to perch on individual wind turbines (Royal Haskoning 2011) and post-construction data from the Horns Rev windfarm found that gulls showed a preference for the windfarm area following its construction, which may reflect habituation to the presence of wind turbines (Petersen *et al.* 2004). As lesser black-backed gulls show signs of tolerance towards wind turbines during foraging and migration it is unlikely that any long term impact will be caused to birds as a result of them avoiding flying through the East Anglia ONE site, any impacts associated with the barrier effect will be of **negligible significance**.

12.6.3.4.8 Herring gulls

539 Herring gulls are considered to have a low general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49*, the species is considered to be a high value species. Therefore their site-specific sensitivity to barrier effects is considered to be *medium*.

540 Herring gulls being likely to habituate to the presence of a large array of wind turbines, the level of magnitude assigned to the birds flying within or through the East Anglia ONE site will be *negligible*. Further to this it is anticipated that the impact significance will be no more than **negligible**.

12.6.3.4.9 Great black-backed gulls

541 Great black-backed gulls are considered to have a low general sensitivity to barrier effects (*Table 12-45*). From *Table 12-49*, the species is considered to be a high value species. Therefore their site-specific sensitivity to barrier effects is considered to be *medium*.

542 However, great black-backed gulls have not been found to avoid areas of sea containing windfarms during foraging or migration, so it is therefore unlikely that the presence of the East Anglia ONE windfarm will have an impact of higher than *negligible* for magnitude and as a result will have an overall impact of **negligible significance**.

12.6.3.4.10 Auks

543 Guillemots and razorbills are considered to have low general sensitivities to barrier effects (*Table 12-45*). From *Table 12-49*, both species are considered to be of high value. Therefore their site-specific sensitivities to barrier effects are considered to be *medium*.

544 The offshore cable corridor is considered unlikely to affect spring passage migrants or birds during their autumn dispersal from colonies as it will not present a potential barrier effect.

545 The nearest breeding colony of guillemots or razorbills to the East Anglia ONE site is a minimum of 275km away. The East Anglia ONE site is considered unlikely to be of importance for feeding guillemots or razorbills during the breeding season as guillemot density is thought to decline sharply beyond 100km from the coast (Camphuysen *et al.* 2006). Therefore, barrier effects between colonies and foraging areas are considered likely to be of *negligible* magnitude during the summer breeding period.

546 Regionally important numbers of razorbills and guillemots were estimated to be present within the East Anglia ONE site during the winter and during spring migration. However, guillemots and razorbills are generally dispersive rather than migratory and are unlikely to be making established point to point migration journeys. The general drift away from and towards colonies perhaps suggests that any avoidance of turbines will affect the birds across a broad front, and that turbine presence will simply be another factor influencing movements around the North Sea.

547 Additionally, both guillemots and razorbills are distributed widely across the North Sea during the winter and there is no evidence to suggest that either species must regularly commute through or in the vicinity of the East Anglia ONE site in order to reach important feeding areas. Therefore even if a higher general sensitivity was applied to the barrier effect on auks during the winter and spring migration periods the magnitude of impact would still only be *low*, but it is most likely to be *negligible* in magnitude. As a result, barrier effects could be considered to have a **negligible impact** on both guillemots and razorbills within the East Anglia ONE project.

Summary of Potential Barrier Effects during Operation					
Species	**Non Impact-specific Value**	**General Barrier Effects Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Barrier Effect during Operation**
Red-throated diver	**Very high** - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	**High** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009).	**Very high** – A combination of both a very high non impact-specific value and a high general sensitivity to barrier effects.	**Negligible** – Birds are not known to be making daily trips into or out of the area of sea that the proposed windfarm is to be developed in. Peak numbers present during spring migration and therefore one-off movements would be involved.	**Minor adverse** – A combination of both a very high site-specific sensitivity to barrier effects and a negligible magnitude of impact.
Fulmar	**Medium** - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	**Low** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009).	**Low** – A combination of both a medium non impact-specific value and a low general sensitivity to barrier effects.	**Negligible** – Wide ranging and birds are not known to be making daily trips into or out of the area of sea that the proposed windfarm is to be developed in. So only birds migrating through the site may be impacted slightly when moving around the windfarm in the future.	**Negligible** – A combination of both a low site-specific sensitivity to barrier effects and a negligible magnitude of impact.
Gannet	**High** - Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during	**Low** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009), which suggests medium, but reduced	**Medium** – A combination of both a high non impact-specific value and a low general sensitivity to barrier	**Negligible** – Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds	**Negligible** – A combination of both a medium site-specific sensitivity to barrier effects and a negligible

Summary of Potential Barrier Effects during Operation					
Species	**Non Impact-specific Value**	**General Barrier Effects Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Barrier Effect during Operation**
	the breeding season it can be assumed that the area of sea within the East Anglia ONE is not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.	after expert judgement applied based on the fact that barrier effects are greatest when in relation to regularly occurring movements (e.g. birds foraging around a windfarm each time they forage from a colony). Gannets do not suffer from a barrier effect of this kind so the significance of the barrier effect is only in relation to one off movements during migration, therefore is low.	effects.	migrating through the site may be impacted slightly when moving around the windfarm in the future.	magnitude of impact.
Kittiwake	**Very high** - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter,	**Low** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009).	**Medium** – A combination of both a very high non impact-specific value and a low general sensitivity to barrier effects.	**Negligible** – Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may	**Negligible** – A combination of both a medium site-specific sensitivity to barrier effects and a negligible magnitude of impact.

Summary of Potential Barrier Effects during Operation					
Species	**Non Impact-specific Value**	**General Barrier Effects Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Barrier Effect during Operation**
	breeding and migration periods throughout the East Anglia ONE site.			be impacted slightly when moving around the windfarm in the future.	
Common gull	**Low** - The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally important numbers during the aerial surveys during any biologically relevant period.	**Low** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009).	**Low** – A combination of both a low non impact-specific value and a low general sensitivity to barrier effects.	**Negligible** – No breeding colonies within foraging distance of the East Anglia ONE site and therefore birds will not be making daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future.	**Negligible** – A combination of both a low site-specific sensitivity to barrier effects and a negligible magnitude of impact.
Lesser black-backed gull	**Very high** - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	**Low** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009).	**Medium** – A combination of both a very high non impact-specific value and a low general sensitivity to barrier effects.	**Negligible** – East Anglia ONE site is within the maximum foraging range of lesser black-backed gulls from the Alde-Ore SPA colony. Data from tagging studies suggest that although birds have been recorded within the East Anglia ONE	**Negligible** – A combination of both a medium site-specific sensitivity to barrier effects and a negligible magnitude of impact.

Summary of Potential Barrier Effects during Operation					
Species	**Non Impact-specific Value**	**General Barrier Effects Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Barrier Effect during Operation**
				site, the site does not appear to be within the core foraging area of birds from this colony. Avoidances during one-off movements such as migration are unlikely to have a significant energetic effect. However, the species is tolerant of windfarm structures and activities and has potentially shown habituation to the presence of turbines.	
Herring gull	**High** - Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC	**Low** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009).	**Medium** – A combination of both a high non impact-specific value and a low general sensitivity to barrier effects.	**Negligible** – Tolerant of windfarm structures and activities and has potentially shown habituation to the presence of turbines.	**Negligible** – A combination of both a medium site-specific sensitivity to barrier effects and a negligible magnitude of impact.

Summary of Potential Barrier Effects during Operation					
Species	**Non Impact-specific Value**	**General Barrier Effects Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Barrier Effect during Operation**
	red list.				
Great black-backed gull	**High -** The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	**Low** – Based on the sensitivities to barrier effects in Maclean *et al.* (2009).	**Medium** – A combination of both a high non impact-specific value and a low general sensitivity to barrier effects.	**Negligible** – Tolerant of windfarm structures and activities and has potentially shown habituation to the presence of turbines.	**Negligible** – A combination of both a medium site-specific sensitivity to barrier effects and a negligible magnitude of impact.
Guillemot	**High -** Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider number of colonies and not exclusively from the	**Low** – Based on recent studies from operational offshore windfarms that predict that auks are little or not deterred from entering areas of sea within offshore windfarms (Vannerman *et al.* 2009).	**Medium** – A combination of both a high non impact-specific value and a low general sensitivity to barrier effects for both species.	**Negligible** – Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future. However, auks are considered to be dispersive rather than truly migratory. Recent studies in UK waters comparing pre-construction	**Negligible** – A combination of both a medium site-specific sensitivity to barrier effects and a negligible magnitude of impact for both species .

Summary of Potential Barrier Effects during Operation					
Species	**Non Impact-specific Value**	**General Barrier Effects Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Barrier Effect during Operation**
	Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.			and post-construction numbers of auks within offshore windfarms have shown tolerance towards windfarms.	

*Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Barrier Effect Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

**Predicted Impact Significance is a product of combining the Site-specific Sensitivity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-70 Summary of Barrier Effects during Operation

12.6.3.5 Habitat Loss

12.6.3.5.1 Overview

548 The worst case scenario for habitat loss relates to the impacts on foraging birds and is in line with the *Volume 2, Chapter 9 Benthic and Epibenthic Environment* and *Volume 2, Chapter 10 Fish Ecology*. The worst case scenario is based on the installation of 240 gravity base foundations (GBFs) with a 50m base diameter and scour protection across the extent of the 120m by 120m seabed preparation area, representing the largest footprint.

549 Gravity base foundations and associated scour protection are likely to represent the most significant cha*nge to the benthic community as they have the greatest* foot*print and therefore the most potential for increasing the biodive*rsity associated with the increase in heterogeneity on the seabed. Habitat loss from the installation of GBFs will result from levelling the seabed, placement of scour material and the installation of the foundation itself.

550 The presence of the wind turbines, collector stations, converter stations and their foundations are likely to result in a permanent direct habitat loss impact. The habitat generally lost due to windfarm developments involves the areas lost to wind turbine bases and ancillary structures, which typically equates to a small area of approximately 1% of the total development footprint area (Drewitt & Langston 2006). Habitat loss for East Anglia ONE will directly affect birds where areas of seabed or sea surface have been developed on. However, as the worst case scenario calculates that the area of seabed lost to the development would be approximately 1% of the area it is not anticipated that this cause anything other than a negligible effect on any species found within the East Anglia ONE site.

551 It is considered that seabirds will be less affected by loss of habitat from the windfarm structures, but more from the indirect disturbance or displacement from the entire East Anglia ONE site.

552 The worst case installation for offshore export cables assumes 80% jetting and 20% trenching (nearer the intertidal area) which have a predicted direct disturbance of 5m width and 50m width respectively. Cables are anticipated to be buried across the length of the route except where they are required to cross existing cables, a pipeline, or areas of hard ground. Up to 40 cable crossings are anticipated required in the offshore cable corridor, and up to five within the East Anglia ONE site with dimensions detailed in the worst case tables. As a worst case, habitat would be considered lost as a result of the cable crossing protection methods employed. The total area covered by cable crossings would be $0.03km^2$. Few benthic feeding birds (eg common scoter) have been recorded in the offshore cable corridor area.

553 The presence of the foundations could generate localised new habitat for fish and benthic communities, as offshore windfarms may function as combined artificial reefs and fish aggregation devices, particularly for small demersal fish (Wilhelmsson *et al.* 2006). This could affect the prey availability in the immediate vicinity of the wind turbines and create new foraging opportunities for diving species such as divers and auks, which could alter the distribution of seabirds. This benefit could be counteracted slightly by attracting birds into an area where they face a risk of collision with the development. The extent of this (positive) effect is unknown, though it is likely to be small (ABPmer 2011) for all key receptor species / groups.

554 It is possible that changes to seabed habitat conditions could occur following the installation of the offshore cables; a corridor of seabed (including the intertidal seabed) would be affected. This could lead to changes in feeding habitat suitability for prey species and hence to changes in bird distribution in the area, and / or to a change in the community composition of the bird species using the area, albeit on a local scale and in an unknown direction (ie positive or negative).

12.6.3.5.2 Red-throated divers

555 Red-throated divers have fairly specific habitat requirements in terms of water depth requirements, being associated with shallow (between 0-20m in depth, less frequently in depths of around 30m) inshore waters (Natural England 2010). This habitat requirement may explain why the East Anglia ONE site is sub-optimal for red-throated divers and thus holds them in low densities. Red-throated divers are considered to have a *high* general sensitivity to habitat loss (*Table 12-45*). From *Table 12-49*, the species is considered to be a *very high* value species. Therefore their site-specific sensitivity to habitat loss is considered to be *very high.*

556 However, the actual amount of direct habitat lost from the development of the East Anglia ONE site will be minimal in comparison to the entire area and so the effect will be of *negligible* value. The significance of the impacts of any habitat loss during the operational period of East Anglia ONE will therefore be **minor adverse**.

12.6.3.5.3 Fulmars and Gannets

557 Fulmars and gannets are both considered to have *low* general sensitivities to habitat loss (*Table 12-45*). From *Table 12-49,* fulmars are considered to be a *medium* value species and therefore the specific sensitivity of fulmars to habitat loss is considered to be *low*.

558 From *Table 12-49* gannets are considered to be a *high* value species and therefore the site-specific sensitivity of gannets to habitat loss is considered to be *medium*.

559 As the percentage of direct habitat loss across the entire East Anglia ONE site is less than 1% the magnitude of any loss will be *negligible* on fulmars and gannets. The impact of minimal habitat loss on fulmars and gannets will be of **negligible significance**.

12.6.3.5.4 Gulls

560 All of the gull species considered in the East Anglia ONE assessment are considered to have low general sensitivities to habitat loss (*Table 12-45*).

561 Gulls species recorded within the East Anglia ONE site were recorded in numbers of varying importance levels during different times of the year. From *Table 12-49*, kittiwakes and lesser black-backed gulls are considered to be *very high* value species, herring gulls and great black-backed gulls are considered to be *high* value species and the common gull is considered to be a *low* value species.

562 Therefore, the site-specific sensitivities to habitat loss are considered to be *low* for common gulls and *medium* for kittiwakes, lesser black-backed gulls and herring gulls, great black-backed gulls.

563 No gull species are anticipated to be effected by the minimal actual loss of sea bed from the construction of wind turbines within the East Anglia ONE site, so the level of magnitude will be *negligible* for all. This will equate to a predicted significance of habitat loss of **negligible** for all gulls species at worst. However, as it is known that herring gulls, lesser black-backed gulls and great black-backed gulls habituate to windfarms and that they have been found resting and even nesting on wind turbines and associated ancillary structures. With this in mind the creation of new areas for herring gulls and lesser black-backed gulls to use for resting or nesting (substations) has the potential to have a very *minor benefit* to the birds within the East Anglia ONE site.

12.6.3.5.5 Auks

564 Both guillemots and razorbills are considered to have *medium* general sensitivities to habitat loss (*Table 12-45*). From *Table 12-49* both species are considered to be of *high* value. Therefore, the site-specific sensitivities for both species to habitat loss are considered to be *high*.

565 However, the actual amount of direct habitat lost from the development of the East Anglia ONE site will be minimal in comparison to the entire area and so the effect will be of *negligible* value. The significance of the impacts of any habitat loss during the operational period of East Anglia ONE will therefore be of *negligible* value.

Summary of Potential Habitat Loss during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Habitiat Loss during Operation**
Red-throated diver	Very high - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	High – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Very high – A combination of both a very high non impact-specific value and a high general sensitivity to habitat loss.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant**.**	**Minor adverse** – A combination of both a very high site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Fulmar	Medium - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Low – A combination of both a medium non impact-specific value and a low general sensitivity to habitat loss.	**Negligible**– With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a low site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Gannet	High - Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during the breeding season it can be assumed that the area of sea within the East Anglia	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Habitat Loss during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Habitiat Loss during Operation**
	ONE is not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.				
Kittiwake	Very high - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods throughout the East Anglia ONE site.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Habitat Loss during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Habitiat Loss during Operation**
Common gull	Low - The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally important numbers during the aerial surveys during any biologically relevant period.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Low – A combination of both a low non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a low site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Lesser black-backed gull	Very high - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Herring gull	High - Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Habitat Loss during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Habitiat Loss during Operation**
	part of the assemblage qualifications for both the Alde-Ore Estuary SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC red list.				
Great black-backed gull	High - The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Habitat Loss during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Habitiat Loss during Operation**
Guillemot Razorbill	High - Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during migration periods are likely to be from a wider number of colonies and not exclusively from the Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.	Medium – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009) for both species.	High – A combination of both a high non impact-specific value and a medium general sensitivity to habitat loss for both species.	**Negligible** – With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant.	**Negligible** – A combination of both a high site-specific sensitivity to habitat loss and a negligible magnitude of impact for both species.

*Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Habitiat Loss Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

**Predicted Impact Significance is a product of combining the Site-specific Sensitivity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-71 Summary of Habitat Loss during the Operational Life of the East Anglia ONE Site

12.6.3.6 Indirect Effects

12.6.3.6.1 Overview

566 Maintenance activities requiring the use of vessels and the presence of lighting offshore have the potential to disturb prey species (fish and benthic invertebrates) and hence have an indirect effect on birds, in a similar way to construction activities, but on a greatly reduced scale.

567 Lit structures offshore also have the potential to attract or repel birds to or from individual wind turbines. Strong continuous lights have the strongest attracting effect (Cook *et al* 2011), particularly during the hours of darkness during migration periods. Birds that are migrating through the windfarm may potentially be impacted most by the addition of new lights across the East Anglia ONE site, as they may suffer from disorientation and fly off course as a result, thus increasing energy expenditure, particularly during inclement weather. Other birds may be attracted to the lit structures and as a result they may potentially have an increased chance of colliding with the rotors of the wind turbines themselves.

568 Depending on the technology chosen, there is also the possibility of avoidance of the cable areas by fish due to electro-magnetic fields (EMF), which could lead to a more permanent change in bird feeding areas (Gill 2005). Most fish species are sensitive to EMFs to a certain degree; however, two groups have been recognised as giving the most concern:

- Elasmobranchs (eg sharks, skates, rays); and
- Migratory species such as salmon, sea trout and eels.

569 There is no evidence of direct predation by the key receptor species / groups on elasmobranchs, with their prey considered to be largely pelagic and non-elasmobranch species. Although, Harris (1965) found evidence of elasmobranch fishery waste in the diet of herring, lesser black-backed and great black-backed gulls.

570 The level of sensitivity to indirect effects for each species has followed MacLean *et al* (2009), with further additional information on species behaviour relating to feeding behaviour from scientific literature and the survey results. In order to account for potential indirect effects on the species of interest in the East Anglia ONE site each has been evaluated at species group level or species level where a stronger impact was identified. Any predicted indirect impacts have then been made from the worst case scenario and information contained within both *Volume 2, Chapter 9 Benthic and Epibenthic Environment* and *Volume 2, Chapter 10 Fish Ecology Chapters*.

571 The impacts associated with noise from the operational wind turbines is much reduced in comparison to the noise created from construction activities, but may still alter fish behaviour. However, over time it is likely that most fish species will habituate to the noises associated with the rotation of the operational wind turbines, so any effect on birds' food sources is likely to be minimal across the whole East Anglia ONE site. Therefore it is unlikely that any significant indirect impacts will occur during the operational lifetime of the East Anglia ONE project.

12.6.3.6.2 Red-throated divers

572 Red-throated divers have fairly specific habitat requirements in terms of water depth requirements and depend mostly on a mixture of cod, herring, sprat and sandeels (BWPi) for food, that are also associated with shallow (between 0-20m in depth, less frequently in depths of around 30m) inshore waters (Natural England 2010). Based on the scores in Garthe & Hüppop (2004) and the sensitivities used in Maclean *et al.* (2009), red-throated divers are considered to have a *high* general sensitivity to indirect impacts associated with windfarms. From *Table 12-49*, the species is considered to be a very *high* value species. Therefore their site-specific sensitivity to indirect effects is considered to be *very high.*

573 However, as red-throated diver are expected to avoid the East Anglia ONE site due to the presence of the wind turbines (as is examined in *Section 12.6.3.2* on operational disturbance and displacement) it is unlikely that any indirect effects associated with maintenance vessels or changes to fish availability will have an impact. As a result the level of magnitude of indirect effects on the birds within the East Anglia ONE site will be *negligible*, resulting in a **minor adverse impact** at worst, but more probably **negligible**. There could be a slight positive effect outside of the site if fish stocks increase.

12.6.3.6.3 Fulmars and Gannets

574 Fulmars and gannets are both considered to have low general sensitivities to indirect effects from operational windfarms (Garthe & Hüppop 2004; Maclean *et al.* 2009). With respect to non-impact specific sensitivities fulmars are considered to be of *medium* value and gannets are considered to be a *high* value species (*Table 12-49*). Therefore, the site-specific sensitivities to indirect effects are considered to be *low* for fulmars and *medium* for gannets.

575 Both fulmars and gannets prey on a variety of fish that are unlikely to be permanently impacted by a windfarms operational noise, so it is unlikely that these effects will be more than *negligible*. Therefore the indirect impacts from fish on fulmar and gannet will be **negligible**. However, there is potential that an increase in fish stocks within the East Anglia ONE site may offer a more favourable feeding

area to fulmars and gannets, so increasing numbers of birds may be attracted to the site. This may be a beneficial effect on the population, but due to the increased risk of collision from entering the site in the first instance the assessed impact is unlikely to change.

12.6.3.6.4 Gulls

576 All of the gull species considered in the East Anglia ONE assessment are considered to have low general sensitivities to indirect impacts (Garthe & Hüppop 2004). From *Table 12-49*, kittiwakes and lesser black-backed gulls are considered to be very high value species, herring gulls and great black-backed gulls are considered to be high value species and the common gull is considered to be a low value species. Therefore, the site-specific sensitivities to indirect effects are considered to be *medium* for kittiwakes, lesser black-backed gulls, herring gulls and great black-backed gulls, but *low* for common gulls.

577 Although a *medium* value may be applicable for site specific sensitivities for some gull species, none should be affected in a negative way by potentially increasing stocks of fish from the creation of artificial reefs offering fish species new habitat, although attraction to the site could increase the risk of collision.

578 Gulls are also known to use substations as resting, loafing and even nesting locations, so as a result of the presence of infrastructure in the East Anglia ONE site the effects may be either of *negligible* value or have a very *minor positive* effect. This will create impacts that will be of **negligible significance**.

12.6.3.6.5 Auks

579 Both guillemots and razorbills are considered to have *medium* general sensitivities to indirect effects (Garthe & Hüppop 2004; Maclean *et al.* 2009). From *Table 12-49* both species are considered to be high value species. Therefore the site-specific sensitivities to indirect effects are considered to be *high*.

580 As auks are likely to be displaced from the East Anglia ONE site during the operation phase of the windfarm it is likely that any indirect effects on them will be *negligible* so the significance of the indirect impacts will be of **negligible** nature for auks. They may benefit slightly from any increase in fish stocks outside of the windfarm area.

Summary of Potential Indirect Effects during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Indirect Effects during Operation**
Red-throated diver	Very high - Designated feature of the Outer Thames Estuary SPA. It is also an Annex I and Schedule 1 listed species.	High – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Very high – A combination of both a very high non impact-specific value and a high general sensitivity to habitat loss.	Negligible – As red-throated diver are expected to avoid the East Anglia ONE site due to the presence of the wind turbines it is unlikely that any indirect effects associated with maintenance vessels or changes to fish availability will have an impact.	**Negligible** – A combination of both a very high site-specific sensitivity to habitat loss and a negligible magnitude of impact and a negligible impact being considered more likely.
Fulmar	Medium - Regionally important numbers have been recorded within the East Anglia ONE site in winter and the species is on the BoCC amber list.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009).	Low – A combination of both a medium non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources.	**Negligible** – A combination of both a low site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Gannet	High - Found in regionally important numbers during migration periods. As birds are not found in regionally important numbers during the	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.*	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Indirect Effects during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Indirect Effects during Operation**
	breeding season it can be assumed that the area of sea within the East Anglia ONE is not an important one for the species with respect to foraging from the Flamborough Head and Bempton Cliffs SPA. However, gannets are an important component of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.	(2009).			
Kittiwake	Very high - Designated feature of the Flamborough Head and Bempton Cliffs SPA and were recorded in regionally important numbers during the winter, breeding and migration periods throughout the East Anglia ONE site.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Indirect Effects during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Indirect Effects during Operation**
Common gull	Low - The species is on the BoCC amber list. Has not been recorded in the East Anglia ONE site in regionally important numbers during the aerial surveys during any biologically relevant period.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Low – A combination of both a low non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources.	**Negligible** – A combination of both a low site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Lesser black-backed gull	Very high - Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a very high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Herring gull	High - Herring gulls have been recorded in regionally important numbers within the East Anglia ONE site during migration. Breeding herring gulls are also a part of the assemblage qualifications for both the Alde-Ore Estuary	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.

Summary of Potential Indirect Effects during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Indirect Effects during Operation**
	SPA and Flamborough Head and Bempton Cliffs SPA and the species is on the BoCC red list.				
Great black-backed gull	High - The species is on the BoCC amber list. However, as it has been recorded in the East Anglia ONE site in regionally and nationally important numbers during the aerial surveys in migration periods.	Low – Based on the habitat flexibility scores in Garthe & Hüppop (2004).	Medium – A combination of both a high non impact-specific value and a low general sensitivity to habitat loss.	Negligible – Wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources.	**Negligible** – A combination of both a medium site-specific sensitivity to habitat loss and a negligible magnitude of impact.
Guillemot Razorbill	High - Both species are recorded in regionally important numbers within the East Anglia ONE site during the winter and migration periods. The birds present within the East Anglia ONE site during winter and during	Medium – Based on the habitat flexibility scores in Garthe & Hüppop (2004) and the sensitivities of flexibility in habitat use in Maclean *et al.* (2009) for both species.	High – A combination of both a high non impact-specific value and a medium general sensitivity to habitat loss for both species.	Negligible – Both species are wide ranging during the winter months when numbers peaked.	**Negligible** – A combination of both a high site-specific sensitivity to habitat loss and a negligible magnitude of impact for both species.

Summary of Potential Indirect Effects during the Operational Life of the East Anglia ONE Site					
Species	**Non Impact-specific Value**	**General Habitat Loss Sensitivity**	**Site-specific Sensitivity***	**Impact Magnitude**	**Predicted Significance** of Indirect Effects during Operation**
	migration periods are likely to be from a wider number of colonies and not exclusively from the Bempton Cliffs SPA. However, these species are important components of the breeding seabird assemblage of the Flamborough Head and Bempton Cliffs SPA.				

*Site-specific Sensitivity is a product of combining the Non Impact-specific Value with the General Indirect Effects Sensitivity, as outlined in Section 12.4 on impact assessment methodologies

**Predicted Impact Significance is a product of combining the Site-specific Sensitivity value with the Impact Magnitude, as outlined in Section 12.4 on impact assessment methodologies used in this EIA

Table 12-72 Summary of Indirect Effects during the Operational Life of the East Anglia ONE Site

12.6.4 Potential Impacts during Decommissioning

581 The main sources of impact from the decommissioning phase of the East Anglia ONE site and all its associated infrastructure are from:

- Acoustic impacts associated with removing wind turbine, collector station and, converter station foundations/scour protection, resulting in disturbance and displacement; and
- Habitat loss associated with the removal of turbine foundations and bases that may have established benthic and / or fish communities.

582 Foundation removal may cause disturbance to birds foraging and migrating within the East Anglia ONE site, of similar scope but generally of lesser extent to those experienced during the construction phase, due to a lower level of 'ground' works. Noise impacts through piled foundation removal would be reduced as the current anticipated method is to cut the piles to an as yet to be determined level below the seabed surface. As with construction efforts, removal works would likely be undertaken on a phased basis rather than all foundations simultaneously. The level of impact would depend on the bird species present at the time of decommissioning, which cannot be reliably predicted at this stage. However, it is likely that impacts would be temporary at most, and works would not be as extensive as those associated with construction. In view of this, the impacts are predicted to be *low*.

583 Impacts predicted during the decommissioning phase include direct disturbance and displacement and habitat loss or change. However, with no offshore windfarms having been decommissioned it is anticipated that any future activities will be programmed with consultation with SNCBs, to allow any future guidance and best practice to be incorporated to minimise any potential impacts.

584 Impacts generated during the decommissioning phase of the project are expected to be similar to the impacts generated during the construction phase, as this phase would involve the removal of all the materials installed during the construction phase. Similar short-term disturbance and displacement impacts on birds using the area, particularly pursuit divers such as red-throated divers and auks that spend much time on and in the water are predicted.

585 Depending on the decommissioning methods adopted, there could be short-term changes in water turbidity. This could lead to changes in feeding habitat suitability for sub-surface visual hunters and changes in bird distribution in the area, albeit on a short-term, local scale.

586 The precautionary worst case scenario involves removing wind turbines, collector stations, converter stations, and the met mast from the East Anglia ONE site and transported to land by boat. It is not anticipated that piles securing foundations to the seabed would be totally removed, but instead would be cut to a level beneath the seabed, leaving a portion of the piles in situ. By ensuring these elements are removed it is not anticipated that any long term impacts would occur to the bird life in the East Anglia ONE site, as the environment will return to a similar state to that prior to the windfarm being in place.

587 The decommissioning activities would involve a similar amount of vessel activity to that during the construction period, so there is likely to be an element of disturbance and displacement of birds throughout this period. However, those birds that are most likely to be impacted will already have been displaced from the East Anglia ONE site throughout the operational life span of the windfarm, so there will be only limited effects on birds. In addition to this, the decommissioning activities effectively mark the end of the wind turbines life within the East Anglia ONE site, and thus any effects should be localised, temporary and once completed would be the last impacts associated with the development. Therefore the overall impact associated with disturbance and displacement would be beneficial in the medium-term, as the area would be returning to its pre-development condition.

588 It is proposed that offshore cables remain *in situ*, as recovery from the seabed would cause more disturbance to offshore marine life than leaving it *in situ*. The only actions associated with offshore cables would be to disconnect them from the wind turbines, collector and converter stations. As a result, the impact on the ornithological receptors within the East Anglia ONE site and along the offshore cable corridor from cable decommissioning is **negligible.**

589 The overall magnitude of impacts associated with habitat loss / change and disturbance and displacement is not anticipated to be more than **negligible** on any of the species within the East Anglia ONE site. Therefore, with respect to any level of significance associated with the decommissioning impacts it can be estimated to also be **negligible**, as the net result will to revert the condition of the area to that prior to the windfarm being *in situ*. A more likely outcome though, is that the sea and seabed within the East Anglia ONE site will be in an improved state for benthic, fish and bird communities.

12.6.5 Ornithological Ecosystem Impacts Assessment

590 As part of the EIA for East Anglia ONE consideration of the role that individual receptors play within the wider ecosystem within the individual baseline topics have been set out. To ensure that this is taken into account when undertaking the individual topic impact assessments the ES has also included this summary section which sets out the potential ecosystem impacts for each receptor, highlighting in one section the potential overall effects to the ecosystems which the development will impact on.

591 Although common scoters have not been recorded in the East Anglia ONE site in numbers of at least regional importance during the aerial surveys, they are listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) and are on the Birds of Conservation Concern (BoCC) red list. Common scoters are considered to be of medium importance for ecosystem support, through the transfer of nutrients from one ecosystem to another.

592 Red-throated divers are listed on Annex I of EC Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive).They are also listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Furthermore, red-throated divers are a qualifying feature of the Outer Thames Estuary Special Protection Area (SPA) during the winter months. Red-throated divers are considered to be of medium importance for ecosystem support, through the transfer of nutrients from one ecosystem to another.

593 A large breeding population of northern fulmar resides in the UK (*c.*500,000 pairs; Baker *et al.* 2006) and regionally important numbers have been recorded in the East Anglia ONE site in winter and on migration. The fulmar is also on the BoCC amber list. Fulmars are considered to be of medium importance for ecosystem support and as an ecosystem regulator.

594 The UK holds internationally-important breeding numbers of gannet (around 218,000 pairs; Baker *et al.* 2006). Indeed, gannets are part of the assemblage qualification at the Flamborough Head and Bempton Cliffs SPA. Furthermore, gannets are on the BoCC amber list. Gannets are considered to be of medium importance for ecosystem support and as an ecosystem regulator.

595 A significant proportion of the biogeographical population of breeding great skua (a BoCC amber species) is found on migration in the North Sea, although great skuas were not recorded in the East Anglia ONE site in numbers of regional importance during any season. Great skuas are considered to be of medium importance for ecosystem support, through the transfer of nutrients between ecosystems.

596 The UK is home to a large population of breeding kittiwakes (379,892 pairs; Baker *et al*. 2006) and this species was recorded in regionally important numbers within the East Anglia ONE site during winter, breeding and migration periods. This species is also on the BoCC amber list. Furthermore, breeding kittiwakes are a designated feature of the Flamborough Head and Bempton Cliffs SPA. Kittiwakes are considered to be of medium importance as an ecosystem regulator.

597 Black-headed gulls have not been recorded in the East Anglia ONE site in numbers of regional importance during the aerial surveys. However, they are part of the assemblage qualification at the Alde-Ore Estuary SPA and are of medium conservation concern (amber) on the BoCC list.

598 The common gull is also on the BoCC amber list and has been recorded in the East Anglia ONE site in regionally important numbers during migration. Both black-headed and common gulls are considered to be of medium importance for ecosystem support, through the transfer of nutrients between ecosystems.

599 Breeding lesser black-backed gulls are a designated feature of the Alde-Ore Estuary SPA and the species is also on the BoCC amber list. Lesser black-backed gulls are considered to be of medium importance as an ecosystem regulator.

600 Herring gulls are of high conservation concern (red) of the BoCC list and breeding herring gulls are part of the assemblage qualifications of both the Alde-Ore Estuary and Flamborough Head and Bempton Cliffs SPAs. The species has been recorded in regionally important numbers within the East Anglia ONE site during migration.

601 The great black-backed gull is on the BoCC amber list and has been recorded in the East Anglia ONE site in nationally important numbers during the winter. Both herring and great black-backed gulls are considered to be of medium importance as ecosystem regulators and for ecosystem support, through the transfer of nutrients between ecosystems.

602 Little, common and sandwich terns are all listed on Annex I of EC Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive), and little terns are also listed on Schedule I of the Wildlife and Countryside Act 1981 (as amended). Both the Alde-Ore Estuary and Hamford Water SPAs are designated for little terns. All three tern species are listed as species of medium conservation concern on the BoCC. Terns are considered to be of medium importance for ecosystem support and as ecosystem regulators.

603 Guillemots and razorbills are both of medium conservation concern (amber) on the BoCC list and both species have been recorded in regionally important numbers within the East Anglia ONE site during wintering and migration periods. Breeding

guillemots and razorbills are part of the assemblage qualification of the Flamborough Head and Bempton Cliffs SPA. Auks are considered to be of medium importance as ecosystem regulators.

12.6.6 Potential Cumulative Impacts

12.6.6.1 Other Windfarm Developments - Overview

604 The UK is currently planning to construct the largest offshore wind capacity in the world. With these plans are a large amount of associated infrastructure, some of which have been constructed, some of which are currently being constructed and some that are currently at the design or planning stage.

605 This assessment takes into consideration other offshore windfarm developments along the east coast of England that may have the potential of cumulative impacts on bird populations in the North Sea along with the East Anglia ONE project.

606 Cumulative effects to be considered during the construction and operational phases include disturbance, displacement (habitat loss), collision risk, barrier effects and indirect effects on prey species.

607 Installation impacts of disturbance, displacement and habitat alteration / loss associated with offshore cable corridor installation and operation have the potential to act cumulatively with the impacts of the proposed East Anglia ONE site itself.

608 Ornithological interests considered will be those species recorded on aerial surveys of the East Anglia ONE site in at least regionally important numbers, plus those migratory species likely to be crossing the North Sea at times of migration. The latter will be informed by specific modelling of data to estimate likely impacts.

609 In-combination effects will consider impacts to lesser black-backed gulls associated with the Alde-Ore Estuary SPA and those designated for the same species in continental Europe; the impacts to red-throated divers associated with the Outer Thames Estuary; and the potential impacts to east coast SPA breeding tern species from offshore cable laying activities. The exact nature of in-combination effects on European protected sites will be determined as part of the HRA.

610 Projects included in this assessment will include those projects that are already built, are in construction, are in the formal planning process or which can be reasonably foreseen. The assessments will use data presented in the Environmental Statements for other developments and the conclusions of scientific studies to identify potential cumulative / in-combination interactions. Based on this, the windfarms listed in *Table 12-73* will be considered.

Other East Coast Windfarm Developments Considered in the Cumulative Assessment			
Site	**Leasing Round**	**Status**	**Dates of Construction**
Kentish Flats	1	Operational	Operational since June 2005
Gunfleet Sands I	1	Operational	Operational since March 2010
Gunfleet Sands II	1	Operational	Operational since March 2010
Scroby Sands	1	Operational	Operational since December 2004
Thanet	2	Operational	Operational since May 2010
London Array (Phase I)	2	Under construction	Began March 2011, completion by 2012
Greater Gabbard	2	Under construction	Began March 2011, completion by 2012
Galloper	2.5	In planning	To commence 2015-2016
Greater Thames (includes London Array Phase II, Kentish Flats II)	2.5	In planning	London Array Phase II after 2012, Kentish Flats II planned 2013-2014
Dogger Bank	3	Pre-planning	Project One 2015-2017
Hornsea	3	Pre-planning	Project One 2014-2017
Sheringham Shoal	2	Under construction	To be completed in 2011
Dudgeon	2	In planning	Consent Granted, estimated 2012-2013
Triton Knoll	2	Pre-planning	Estimated commencement 2017
Lynn & Inner Dowsing	1	Operational	Operational since March 2009
Race Bank	2	In planning	Consent Granted
Docking Shoal	2	In planning	Consent rejected in mid-2012, but included in assessments

Other East Coast Windfarm Developments Considered in the Cumulative Assessment			
Site	**Leasing Round**	**Status**	**Dates of Construction**
			as may appeal decision
Lincs	2	Under construction	Construction began March 2011, completion due 2012
Humber Gateway	2	In planning	Consent granted, construction estimated to take 2 years
Westernmost Rough	2	In planning	Approximately 2014

Table 12-73 Other East Coast Windfarm Developments Considered in the Cumulative Assessment

12.6.6.2 Cumulative Impacts during Construction

611 Although there may be cumulative impacts associated with many of the effects caused by the East Anglia ONE project windfarm's proposed construction activities, the main impacts are from:

- Cumulative disturbance and displacement from vessel and construction activities increasing boat traffic and noise levels, and
- Indirect cumulative impacts on prey stocks including invertebrates and fish.

12.6.6.2.1 Cumulative Disturbance and Displacement

612 There is the potential for temporal overlap in construction activity with other regional windfarm developments. These include: London Array, Greater Gabbard, Galloper, Sheringham Shoal, Dudgeon, Race Bank, Docking Shoal, Lincs, Triton Knoll, Humber Gateway, Westernmost Rough, Greater Thames (project extensions), Greater Wash (extension to projects), Dogger Bank Zone and Hornsea Zone. The main cumulative impacts expected during construction are disturbance and displacement. However, as construction effects will be short-term in nature, cumulative impacts would only occur if the construction phases of these windfarms coincide with the construction of the East Anglia ONE site. Given that the construction of the East Anglia ONE site would not begin until 2016 at the earliest, from *Table 12-73* above, in reality only the construction of four other windfarms are likely to coincide with that at the East Anglia ONE site. The distance between the sites listed above and East Anglia ONE determines whether the disturbance and displacement effects of construction activities are likely to interact. Post-construction

monitoring at Horns Rev in Denmark indicates that divers and auks show increased avoidance of areas up to 2km from the boundary of the windfarm (Petersen *et al.* 2004; Petersen 2005; Drewitt & Langston 2006). Maclean *et al.* (2009) suggest that a 4km buffer is used to judge cumulative displacement.

613 Diving birds (divers and auks) are considered the most likely species to be sensitive to construction noise (particularly pile driving).

614 Divers are likely to be present at low densities in most of the windfarm areas that may temporally overlap in construction activity with the development of East Anglia ONE through the winter months and in some areas during the migration periods. The highest densities of divers (up to 1.00+ birds / km^2) have been recorded in the Greater Wash area (Docking Shoal and Lincs) in October and November (Stone *et al.* 1995). In addition, London Array and Kentish Flats extension (part of the Greater Thames project extensions) overlap with the Outer Thames Estuary SPA, designated for red-throated divers during the winter. Therefore, these windfarms have the greatest potential for cumulative disturbance and displacement effects with the East Anglia ONE project.

615 It is considered in *Section 12.6.2.2.2* above that *minor* adverse effects of disturbance and displacement are anticipated on red-throated divers during the construction of the East Anglia ONE project. The non-technical summary of the ES for Docking Shoal states that impacts of the windfarm on ornithology were either negligible or minor, therefore as a worst case it is assumed the effect of disturbance / displacement during construction on RTDs to be minor. The ES for the Lincs offshore windfarm (OWF) states that the site was thought to be of low sensitivity for red-throated diver foraging due to the water depths at the site. Therefore, disturbance / displacement during construction is considered to be minor for red-throated divers. From the Galloper OWF ES cumulative impact section, the potential significance of cumulative disturbance (during construction and operation) on red-throated divers for London Array I and II was considered to be major. No information was provided for Kentish Flats 2 (given as n/a), though, the impact for Kentish Flats was given as minor. With respect to the overall pattern of disturbance and displacement during construction of all of the above mentioned windfarms an overall **minor to moderate** cumulative impact may occur locally around the individually constructed windfarms. However, as relatively few wind turbines would actually be constructed simultaneously and all development areas are very far apart it is likely that construction activities would have only a **minor cumulative impact** on the population of red-throated divers.

616 Guillemots and razorbills are widely dispersed throughout the autumn and winter with low densities (0.01 to 1.99 birds/km^2) expected in most of the windfarms that may temporally overlap in construction activity with the East Anglia ONE site (Stone

et al. 1995). Distribution in offshore areas during the breeding season is particularly low as sexually mature birds are generally visiting colonies to the north. However, moderate to high densities of guillemots (2.00 to 4.99 and up to 5.00+ birds/km^2) were recorded by Stone *et al.* (1995) in the Dogger Bank area throughout much of the year. Skov *et al.* (1995) described large areas hosting high densities of guillemots over Dogger Bank. Kober *et al.* (2010) reported that Dogger Bank would qualify numerically as an SPA for guillemots during winter at stage 1.2 of the selection guidelines, but not on a regular basis. The Dogger Bank zone is located approximately 255km north from the East Anglia ONE site, meaning that there would not be any overlap of potential disturbance footprints. Therefore, no significant cumulative disturbance and displacement effects would be anticipated.

617 It is also noted in Stone *et al.* (1995) that densities within these other areas are low and so effects would not be anticipated to be of any more than **minor significance** and therefore an overall **minor cumulative significance** may be expected on guillemots and razorbills.

618 It is considered in *Section 12.6.2.2* above that no significant effects of disturbance and displacement are anticipated on fulmars, gannets, kittiwakes, common gulls, lesser black-backed gulls, herring gulls and great black-backed gulls during the construction of the East Anglia ONE site. This is because the worst-case scenario has assumed that no more than two foundation piling events are expected to be underway at any one time leading to only localised and short-term effects on these species. Therefore, based on this and the above, it is not considered likely that construction activities within the East Anglia ONE site with the construction of any of the other windfarms along the east coast, that may be constructed during the same period, would have a significant cumulative disturbance and displacement effect on these species.

12.6.6.2.2 Cumulative Habitat Loss

619 The amount of habitat directly lost due to foundations for wind turbines and other infrastructure (met masts, offshore substations, etc) is considered to be very small in relation to the availability of habitat across the whole area being considered. Therefore, cumulative direct habitat loss is considered to be of **negligible significance** for all species.

12.6.6.2.3 Cumulative Indirect Impacts

620 The main indirect impacts to the birds relate to a potential loss of prey items (fish and benthic invertebrates), to noise and vibration, and to suspended sediment concentrations (SSCs) that could impair the foraging ability of some species of diving birds that hunt their prey by sight.

621 Most species or individuals of fish large enough to be important prey items for birds will avoid the immediate area affected by high levels of SSCs (*Volume 2 Chapter 10 Fish Ecology*), and thus any visual impairment to foraging birds is unlikely to affect their hunting success. As juvenile and adult fish are low sensitivity receptors not significantly affected by increased SSCs, and that the increase in SSCs will take place over a restricted temporal and spatial scale, any indirect effect of the increase in SSCs on fish prey is not expected to significantly affect any birds that remain in the area during the windfarm construction.

622 Piling noise and vibration is assessed in *Volume 2 Chapter 9 Benthic and Epibenthic Environment, and Volume 2, Chapter 10 Fish Ecology*. It is possible that there could be a short-term decline in prey availability near to the pin piling activity, but that the fish would return to the affected area once the pin piling activity has ceased. This temporary loss of prey mediated by piling noise is therefore considered at most to have a **minor adverse** effect to the birds.

623 The benthic and epibenthic invertebrates that some diving duck and divers feed upon would be affected by the construction of the windfarm as a result of changes to the seabed habitat, changes in sediment type, smothering, changes in water quality, and increases in noise and vibration (*Volume 2 Chapter 9 Benthic and Epibenthic Environment*). However, due to the temporary nature of the works and the expected rapid return of the large majority of the habitat to pre disturbance conditions the magnitude of the construction operations on the majority of the benthic organisms is expected to be not significance (*Volume 2 Chapter 9 Benthic and Epibenthic Environment*). Furthermore, as these changes to the benthic and epibenthic prey are expected only to cover some 1% of the total area for the East Anglia ONE site, they are thus not expected to cumulatively have more than a **minor adverse** effect on the relatively few, very mobile birds present in the area that are dependent on such prey.

12.6.6.3 Cumulative Impacts during Operation

12.6.6.3.1 Cumulative Disturbance and Displacement

624 It is possible that a series of discrete disturbance events could occur on individuals of the same population.

625 Divers are likely to be present at low densities during the winter months at most of the other windfarm areas considered (Stone *et al*. 1995). The red-throated diver is the sole qualifying species for the Outer Thames Estuary SPA during winter. The UK wintering population of red-throated divers is approximately 17,000 individuals (O'Brien *et al*. 2008) and the estimated Greater Thames population is 7,998

individuals (DBERR 2007). The cited population of the SPA is 6,466 individuals (Webb *et al.* 2009).

626 The East Anglia ONE project is located a minimum of 7km and a maximum of 160km from the boundary of the Outer Thames Estuary SPA, whilst the Kentish Flats, Kentish Flats extension (part of Greater Thames project extensions), London Array I, Gunfleet Sands 1 and 2 and Scroby Sands windfarm areas overlap or are within this SPA. Most red-throated divers using the East Anglia ONE site are unlikely to be birds from the Outer Thames SPA, due to the greater and less preferred water depths found in the East Anglia ONE site. The birds using the East Anglia ONE site are likely to be part of the larger east coast English population estimate of around 10,000 birds (O'Brien *et al*. 2008). Divers moving between foraging areas during the winter and avoiding developed areas within the Outer Thames Estuary SPA have the greatest potential to increase their required energy budgets.

627 Early offshore wind development rounds tended to focus on marine environment with shallower water depths, and so often coincide with suitable diver habitats; there may thus be a knock on effect on energy budget for divers from increased foraging time away from key areas, or from greater distances travelled to avoid several windfarms. During the winter diver locations are fairly well known as they have fairly specific habitat requirements in terms of water depth, being associated with shallow (0 to 20m in depth, less frequently depths of around 30m) inshore waters (Natural England 2010).

628 Taking into account the low population estimates for the East Anglia ONE site and the likely sub-optimal foraging conditions found in the area due to deep water (>30m) it is not anticipated that cumulatively that the East Anglia ONE site would contribute to a significant impact on the overall population. The effect of other multiple windfarms on the population of red-throated divers is therefore likely to be of a **minor to moderate** (but tolerable) magnitude, as the inshore environment is more favoured by red-throated divers and the population within the East Anglia ONE site may be from both UK SPAs and other Continental SPAs combined, spreading any impacts more widely and therefore reducing their significance.

629 Fulmars are found throughout the southern North Sea in low densities throughout the year and peak within the East Anglia ONE site during autumn. It is considered in 12.6.3.2.3 above that no significant effects of disturbance and displacement are anticipated on fulmars during the operational life of the East Anglia ONE site. Thus cumulatively at worst an effect of *negligible* magnitude effect is expected regionally. The impact on fulmar populations present within the East Anglia ONE site and in other surrounding operational and proposed windfarms will therefore be of **minor adverse significance** at most.

630 Gannets are likely to be present throughout the year at low densities, with a peak through the winter months in all the surrounding southern North Sea proposed windfarm areas. Although gannets are known to show low sensitivity to disturbance (Maclean *et al*. 2009) they have also been found to avoid areas of sea with operational windfarms within them (Krijgsveld *et al.* 2010; Leopold *et al.* 2011).

631 Gannets are an important component of the wider breeding seabird assemblage qualification of the Flamborough Head and Bempton Cliffs SPA. Birds from this SPA are likely to forage predominantly closer to their colony. Survey data suggest that very low numbers of gannets are present within the East Anglia ONE site during the breeding season and data from tracking studies also indicate that gannets from Bempton colony do not forage in the vicinity of East Anglia ONE (Langston & Boggio 2011), reinforcing the low numbers recorded during the summer, ensuring that there would be no overlap in potential disturbance footprints with other windfarm developments. Thus no significant effects of disturbance and displacement are anticipated on gannets during the breeding season throughout the operational life of the East Anglia ONE site. The regional impact on gannet populations present with the East Anglia ONE site and in other surrounding operational and proposed windfarms during the breeding season will be **not significant**.

632 Gannets are found throughout the southern North Sea during the winter at a relatively low abundance. As the majority of the flyway population of gannets exits the North Sea during the autumn migration period to more southerly latitudes it is unlikely that this area is of great importance to the species in this period, thus limiting the significance of any effects of disturbance and displacement. As a result of the gannets more southerly distribution during the winter and their dependence on more northerly areas of the North Sea for foraging during the breeding season it is considered most likely that any cumulative impacts would be of **minor significance** on gannets.

633 Gulls (including kittiwakes, common gulls, lesser black-backed gulls, herring gulls and great black-backed gulls) are believed to have a high level of tolerance to increased levels of noise and disturbance associated with operational windfarms (Maclean *et al*. 2009), are highly adaptive in their use of habitats for foraging (Maclean *et al.* 2009; Garthe & Hüppop 2004) and are tolerant of man-made structures and activities. Lesser backed gulls are often seen perching on wind turbine bases and great black-backed gulls have been observed roosting on operational offshore windfarm structures (Royal Haskoning 2011). In addition, most gull species have been found to remain undisturbed by the presence of boats even when they are in close proximity, for example, survey data from the Greater Gabbard windfarm in December 2010 observed lesser black-backed gulls in association with a construction vessel (GGOWL 2011). Therefore, they are unlikely to be disturbed by maintenance vessels.

634 Kittiwakes are present within the East Anglia ONE site in all seasons in regionally important numbers and common gulls have been recorded in all seasons except during the autumn migration, but were only recorded in numbers of regional importance during the spring migration period. Both species are likely to also be part of the assemblage of species present throughout the neighbouring operational and proposed windfarms. Due to the ability of both species to adapt to changing habitats and their tolerance of noise and disturbance they are not considered to be of significant risk from the cumulative impact of windfarm developments along the east coast. Therefore the cumulative effect will be low for both species and the overall cumulative impact on these two species will be of **negligible significance** to all populations in any season.

635 Lesser black-backed gulls, herring gulls and great black-backed gulls are present within the East Anglia ONE site in all seasons. The estimated numbers of lesser black-backed gulls were of regional importance during the breeding (summer) season and during the winter, herring gulls are present in regionally important numbers during the migration period only, whilst great black-backed gulls were present in nationally important numbers in winter and regionally important numbers on migration. Due to the ability of both species to adapt to changing habitats and their tolerance of noise and disturbance, it was considered in *Section 12.6.3.2.6* above that disturbance and displacement due to the operation of the East Anglia ONE site would have a **minor adverse impact** on lesser black-backed gulls, herring gulls and great black-backed gulls.

636 There is the possibility for potential cumulative effects, particularly in the windfarm sites during the seasons when the densities of certain species are highest (eg great black-backed gulls in winter around the Galloper, Greater Gabbard and Dogger Bank areas). However, because of the low sensitivity to displacement and the apparent tolerance to structures and activity discussed above, this is not anticipated to occur to such an extent as to increase the effect of disturbance and displacement from **minor adverse** with respect to these species.

637 Guillemots and razorbills are considered to be more sensitive to noise and disturbance than gulls, gannets and fulmars (Maclean *et al.* 2009), making the wider population more vulnerable to cumulative impacts from surrounding operational and proposed windfarm developments. Evidence from Thorntonbank and Bligh Bank (Vannerman *et al.* 2010) and North Hoyle (RWE 2008) has shown no avoidance from the windfarm footprint or buffer up to 3 km and some increase in numbers. As no impacts are anticipated from the operational windfarms there should be no cumulative impacts from surrounding operational or proposed windfarm developments on guillemots and razorbills.

12.6.6.3.2 Cumulative Collision Risk

12.6.6.3.2.1 Overview

638 Cumulative impacts due to collision arise due to multiple windfarm developments within one area (King *et al.* 2009). Comparison of predicted mortality from collision risk between multiple windfarms has been highlighted as problematic due to the differing assumptions made within the calculations in different studies and limited amount of data presented in ES chapters (see Maclean *et al.* 2009). Within this ES chapter, these difficulties are compounded due to the use of the most recent Band model in comparison to that used in historical offshore windfarm ES chapters. An attempt has been made however to assess the cumulative impacts posed by the East Anglia ONE site in conjunction with other sites.

639 To calculate the likely range of birds predicted to be affected by cumulative collision the worst case estimates were taken through to assessment. To estimate the likely range of mortality in relation to the baseline, where a population range existed, the largest predicted mortality was assessed against the smallest population. This provided the worst case for increased baseline mortality (*Table 12-75*).

640 For each species of seabird assessed within the cumulative collision risk, a standard 98% avoidance rate was used, which represents a precautionary assessment. In some instances this required correction of the published collision risk estimates to ensure consistency within the results using the following calculation:

Corrected estimate of annual mortality = number of annual collisions × (corrected collision proportion) / (calculated collision proportion).

For example:

Corrected estimate of annual mortality = 9 X (0.02 / 0.01) = 18 collisions annually at 98% avoidance rate.

641 Due to a lack of seasonal information, cumulative collision mortality has been assessed on an annual basis. To this end, assessment of the increased mortality relative to the baseline mortality has been undertaken at a national and international level, using the population estimates as detailed in Wright *et al.* (2012). These provide more realistic assessments of increases to baseline mortality than assessment of an annual mortality against breeding or wintering population estimates.

642 A number of windfarms have been included in this assessment of cumulative collision risk (*Table 12-74*). However, it is important to note that different versions of the Band model were used for collision risk assessments by the various windfarms.

643 Banks *et al.* (2006) present quantitative assessment of collision for lesser black-backed gull, great black-backed gull and great skua for the Greater Gabbard windfarm.

644 The ES chapter for London Array presents an unconventional collision risk assessment, presenting the calculation for each species of a threshold avoidance rate, above which no significant additional mortality beyond the natural rate and therefore it was not deemed possible to include these results within this cumulative collision assessment.

645 Phase I and II of Gunfleet Sands are currently operational. Despite no quantitative collision risk assessments included within the ES chapter for this site, **minor/negligible impacts** were predicted for each species.

646 The Kentish Flats windfarm is operational. The draft ES for the extension phase contained quantitative assessments of collision risk. However no values were presented for the initial phase of the windfarm.

647 The ES chapter for the Thanet windfarm, which is currently operational, presents annual collision risk estimates for multiple seabirds.

648 Due to the extensive foraging range of gannets, additional windfarm sites have been incorporated into the cumulative collision assessment for this species (*Table 12-78).*

Number of possible or actual turbines at each windfarm site included within the cumulative collision risk assessment.	
Windfarm	**Number of turbines**
East Anglia ONE	<325
Galloper	>140
Greater Gabbard	140
London Array I & II	175 + 166
Gunfleet Sands I, II and III	48 (+2 for Phase III)
Kentish Flats and extension	30 + 17
Hornsea	332
Thanet	100
Westermost Rough	80
Scroby Sands	30
Humber Gateway	83
Lincs	75
Lynn and Inner Dowsing	54
Sheringham Shoal	88
Teeside	27
Race bank	88
Triton Knoll	333
Dudgeon	168
Docking shoal	83-177
Beatrice demonstrator site	2

Table 12-74 Number of possible or actual turbines at each windfarm site included within the cumulative collision risk assessment.

12.6.6.3.2.2 Cumulative mortality assessment

649 Kittiwakes have a *very high* site specific sensitivity to collision risk. An overall cumulative annual mortality of 1,212 birds assuming a 98% avoidance rate would result in a 0.08% increase relative to the baseline mortality at an international population level and a 0.84% increase relative to the baseline mortality at a national population level. Such increases are considered to be of *negligible* magnitude, resulting in a cumulative impact of **minor adverse significance** at both the national and international level.

650 Common gulls are predicted to be present within the East Anglia ONE site in regionally important numbers during migration only. This combined with their flight behaviour gives them a *low* site specific sensitivity to collision risk. Cumulative collision mortality of 181 birds results in a 0.11% increase relative to the baseline mortality at an international population level and a 0.16% increase relative to the baseline mortality at a national population level. Such increases are considered to be of *negligible* magnitude, resulting in a **negligible significance** of the cumulative impact of the East Anglia ONE project at both the national and international level.

651 As detailed previously, lesser black-backed gulls are considered to be one of the most sensitive species to the proposed East Anglia ONE windfarm. The potential effects of other windfarms that are within foraging distance of the Alde-Ore Estuary SPA are considered in-combination with East Anglia ONE. The maximum foraging range is 181km, whilst the generic foraging range for UK lesser black-backed gulls is 141km mean maximum (Thaxter et al. 2012a), but this reduces to 91km for lesser black-backed gulls foraging offshore from the Alde-Ore SPA during the breeding season (Thaxter et al. 2012b). The latter study suggests that offshore windfarms further than 91km from the Alde-Ore SPA should not be included in any potential in-combination collision effects. By taking this approach all Dutch and Belgian offshore windfarms are outside of the foraging range for lesser black-backed gulls. This assumption is supported by the individual birds that were tagged during Thaxter's 2010 and 2011 studies of lesser black-backed gulls from the Alde-Ore SPA colony, as no birds flew outside of British waters during the breeding season.

652 The same assumptions on foraging ranges may also be applied to the assessment of in-combination effects from UK offshore windfarms on lesser black-backed gulls. As recognised by Thaxter et al. (2012b) only 4% of recorded flights from tagged birds' trips straddled both inshore and offshore environments, and the most appropriate measurement of foraging ranges offshore is likely to be the maximum foraging range from the Alde-Ore SPA over water only and not across land and sea.

653 As a precautionary measure this chapter has included in its in-combination impact assessment all UK offshore windfarms that lie within the generic mean maximum

range of 141km from the SPA, where flight lines are from the SPA over water around the north Norfolk coast. By taking this precautionary approach the projects that are known to be within foraging range include:

- Greater Gabbard Offshore Wind Farm;
- Galloper Wind Farm;
- London Array I & II;
- Gunfleet Sands I, II & III;
- Scroby Sands;
- Kentish Flats and Extension;
- Thanet;
- Sheringham Shoal; and
- Dudgeon.

654 The following numbers of lesser black-backed gulls predicted to potentially suffer mortality form collision within each of the above offshore windfarms are collated within *Table 12-75* and *Table 12-76*. It must be noted that the numbers presented within *Table 12-75* are those presented within publically available documents for each of the developments, and as such provide limited information relating to the seasonal split of collisions, or of adult / sub-adult proportions, and of the avoidance rates used to estimate the number of collisions differs between windfarms. However, where information was provided it has been included within *Table 12-75* and in some instances simple assumptions have been drawn from the available information in an attempt to make the predictions more comparable. A further breakdown of the number of collisions linked to SPA birds has been included within *Table 12-76.*

Predicted mortality (number of individuals) of lesser black-backed gulls through collision for OWFs in-combination with East Anglia ONE.			
Windfarm	**Annual Figure**	**Summer Breeding**	**SPA Linked**
Values in bracket avoidance rate used			
East Anglia ONE (98%)	394	14	**16*** **
Greater Gabbard (99%)	120	60**	**60** ^**
Galloper (99%)	225-330	122*	**122***
London Array I & II	n/a	n/a	**n/a**
Gunfleet sands I & II (99%)	2	?	**2^**
Scroby Sands	-n/a	n/a	**n/a**
Kentish flats + Extension	4	?	**4 ^**
Thanet (99%)	32	?	**33 ^**
Sheringham Shoal	16	?	**16****
Dudgeon	153	38#	**38#**
Overall Mortality	809-814	n/a	**291**

* This figure is for Galloper Wind Farm's breeding season (Mar to Aug). They have only considered birds in this period to be linked to the SPA.
** This figure represents the annual mortality rate. However, although assumptions are not put forward for the split of birds across the seasons or those linked to the SPA the figures within the ES suggest that using 50% of birds for the summer period is precautionary.
*** This figure is for the total adult birds from the SPA within the project area across the year.
\# This figure (25% of the total) is based on a split of the collisions across each biological period (with four seasons at 25% for each). This is precautionary, as the ES states that the lowest abundance of birds is during the breeding season.
^ All birds assumed to be from SPA as not split by provenance in relevant ES reports – likely to be highly precautionary but involved relatively small numbers only.
n/a No figures currently available for use in assessment.

Table 12-75 Predicted mortality (number of individuals) of lesser black-backed gulls through collision for OWFs in-combination with East Anglia ONE.

Predicted mortality (number of individuals) of SPA Linked lesser black-backed gulls through collision for OWFs in-combination with East Anglia ONE.			
Windfarm	**Annual Figure**	**Summer Breeding**	**SPA Linked**
Overall Mortality	809-814	n/a	**291**
Flyway population	530,000 – 570,00	-	**-**
Additional Mortality (International) (%)	0.14	-	**-**
National population	340,202	-	-
Additional Mortality (National) (%)	0.24	-	
Alde-Ore SPA (Orplands) population	-	-	**3,200**
Additional Mortality (Alde-Ore SPA) due to East Anglia ONE alone (%)	-	-	**0.5**
Additional Mortality (Alde-Ore SPA) due to all proposed wind farms (%)	-	-	**9.09**

Table 12-76 Predicted mortality (number of individuals) of SPA Linked lesser black-backed gulls through collision for OWFs in-combination with East Anglia ONE.

655 As all of the other offshore windfarms within the in-combination assessment have concluded that they have **negligible impacts** individually and will not cause more than a **minor adverse** effect on lesser black-backed gulls in-combination with each other, the proportionally small increase in estimated mortality brought about by the East Anglia ONE project is unlikely to add to a statistically detectable change to these conclusions. It is therefore logical to conclude that the East Anglia ONE project poses little threat to lesser black-backed gulls in-combination with other offshore windfarms.

656 Herring gulls are considered to have *high* site specific sensitivity to collision risk. An overall cumulative annual mortality of 446 birds assuming a 98% avoidance rate would result in a less than 1% increase relative to the baseline mortality at both the national and international level resulting in a *negligible* magnitude impact. Therefore, it is considered that the significance of the impact from cumulative collision risk will be **negligible** on the national and international populations of herring gulls.

657 Great black-backed gulls are considered to have a *high* site specific sensitivity to collision risk. The annual collision mortality of 606 birds is predicted to result in a

2.62% increase relative to the baseline mortality at an international population level and a 7.85% increase relative to the baseline mortality at a national population level. Such increases are considered to be of *low* magnitude at an international level and of *medium* magnitude at a national level. Given the *high* sensitivity of this species this has a predicted significance level of **minor adverse significance** at an international level, but a **moderate adverse significance** at a national level. Given the very precautionary assumptions made to provide the highest mortality rate and therefore highest increase in baseline mortality, it is deemed *very unlikely* that this will occur. Therefore there is more likely to be a *low i*mpact of magnitude resulting in a **minor adverse** level of significance on the national population of great black-backed gulls.

Corrected estimates of annual collision rates of seabirds at OWFs for which ES data were obtained.				
Windfarm	**Black-legged Kittiwake**	**Common Gull**	**Herring Gull**	**Great black backed gull**
Avoidance rate (%)	98	98	98	98
East Anglia ONE	1056	41	230	496
Galloper Wind Farm	148	18	108	104
Greater Gabbard Offshore Wind Farm	-	-	-	24
London Array I & II	-	-	-	-
Gunfleet sands I & II	2	2	2	2
Kentish flats + Extension	4	86	8	2
Thanet	2	34	98	2
Overall Mortality	1212	181	446	606
Flyway population	8,400,00	1,200,000	560,000	330,000
% Increase Relative to Baseline Mortality (International)	0.08	0.11	0.66	2.62
National population	759,784	797,440	1,008,618	110,320
% Increase Relative to	0.84	0.16	0.37	7.85

Corrected estimates of annual collision rates of seabirds at OWFs for which ES data were obtained.				
Windfarm	**Black-legged Kittiwake**	**Common Gull**	**Herring Gull**	**Great black backed gull**
Baseline Mortality (National)				

Table 12-77 Corrected estimates of annual collision rates of seabirds at OWFs for which ES data were obtained.

658 Gannets are considered to be a species of *high* value as they are an important component of the breeding seabird assemblage qualification of the Flamborough Head and Bempton Cliffs SPA. Therefore, their site-specific sensitivity to collision risk is considered to be *high*. Due to the far ranging foraging distance of this species additional windfarms were included within this cumulative assessment. An overall cumulative annual mortality of 1,960 birds assuming a 98% avoidance rate would result in a 5.54% increase relative to the baseline mortality at a national population level. Such increases are considered to be of *low* magnitude on this species, resulting in an impact of **minor adverse significance**. However, a recent study in to the effect of offshore windfarms on gannets in the North Sea (WWT, SOSS-04, 2012) suggests that the presently expanding population can support higher levels of mortality than are currently experienced due to the existing and consented offshore windfarms.

Estimated annual collision rates for gannet for which ES data was obtained.	
Windfarm	**Gannet**
East Anglia ONE	850
Galloper Wind Farm	112
Greater Gabbard Offshore Wind Farm	n/a
London Array I & II	n/a
Gunfleet Sands I, II and III	n/a
Kentish Flats and extension	6
Hornsea	236
Thanet	2
Westermost Rough	1
Scroby Sands	n/a
Humber Gateway	8
Lincs	9
Lynn and Inner Dowsing	n/a
Sheringham Shoal	31
Teeside	12
Race bank	198
Triton Knoll	271
Dudgeon	145
Docking shoal	75
Beatrice demonstrator site	4
Total at 98% avoidance	1,960
% Increase Relative to Baseline Mortality (National)	5.54

Table 12-78 Estimated annual collision rates for gannet for which ES data was obtained.

Summary of cumulative collision risk assessment. Where national and international impacts differ the worst case assessment has been included within the table					
Species	**Non Impact-specific Value**	**General Collision Risk Sensitivity**	**Site-specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**
Gannet	High	Medium	High	Low	**Minor adverse**
Kittiwake	Very high	Medium	Very high	Negligible	**Minor adverse**
Common gull	Low	Low	Low	Negligible	**Negligible**
Lesser black-backed gull	Very high	Medium	Very high	Negligible	**Minor adverse**
Herring gull	High	Medium	High	Negligible	**Negligible**
Great black-backed gull	High	Medium	High	Low*	**Minor adverse***

* *See text above for explanation of why impact magnitude and predicted significance have been downgraded*

Table 12-79 Summary of cumulative collision risk assessment. Where national and international impacts differ the worst case assessment has been included within the table

12.6.6.3.3 *Cumulative Barrier Effect*

659 It has been shown that some species (for example divers and scoters) avoid windfarms and take evasive detours, thereby potentially increasing energy expenditure (Petersen *et al.* 2005; Petersen & Fox 2007). This effect may be negligible when considering just one windfarm. However, if a series of windfarms are arranged in such a way that they present a near-continuous barrier, this could require birds to make a large or several small detours. Such longer trips would result in increased migration length or reduced foraging or roosting time. Such effects are more likely to have a greater energetic impact on birds that regularly commute around a windfarm (eg birds heading to / from foraging grounds and roosting / nesting sites) than passage migrants that will pass through a site once per season. Speakman *et al.* (2009) found that for one-off avoidances during migration the impact of windfarms on energy demands were trivial (less than 2% of available fat reserves). For more frequent daily deviations, the impact was found to be more severe with daily energy demands elevated by 4.8 to 6% for every additional 15km flown each day, which could be significant if prolonged (Speakman *et al.* 2009).

660 Of the key species, red-throated divers, fulmars, gannets, kittiwakes, common gulls, herring gulls, great black-backed gulls, guillemots and razorbills are estimated to be present in the East Anglia ONE site in numbers of at least regional importance during the migration period.

661 Red-throated divers are estimated to be present within the East Anglia ONE site in numbers of national importance during the migration period. The windfarms within the vicinity of the Outer Thames Estuary SPA (Kentish Flats, Greater Thames projects, London Array, Gunfleet Sands 1 and 2, Scroby Sands, Greater Gabbard, Thanet and Galloper as well as East Anglia ONE) could have the greatest potential to increase the energy budget of divers on migration to or from breeding grounds in the north, as could the windfarm areas further north that support the highest densities of divers during the migration period (Docking Shoal, Lincs, Lynn and Inner Dowsing). However, even in these areas of highest densities, divers have only been recorded at relatively low densities (*circa* 1.00 bird/km^2) during the winter and migration periods (Stone *et al.* 1995). Due to the location of the East Anglia ONE site, it is likely that red-throated divers from SPAs on the coast of Continental Europe will also contribute to the numbers found within it, therefore reducing any impact on UK SPA individuals.

662 As red-throated divers are not known to commute between East Anglia ONE and other windfarm areas during individual foraging trips the cumulative barrier effect on foraging birds would be minimal, and therefore the impact would be **not significant**. However, it is expected that during migration periods red-throated diver would make avoidance flights around multiple windfarms on their way to staging and breeding sites in Scotland, Scandinavia, Russia and other northern European sites. The cumulative effect of these avoidance flights in-combination would be likely to cause increased energy expenditure during these flights and as a result are predicted to be of *minor* effect. The cumulative barrier effect on migrating red-throated diver would also have a **minor impact**.

663 Fulmars are also wide ranging and are generally found at relatively low densities (0.01 to 0.99 birds/km^2) within the other windfarm areas considered throughout the year (Stone *et al.* 1995). The only exception to this is Dogger Bank, which appeared to hold consistently high (5.00+ birds/km^2) or moderate (2.00 to 4.99 birds/km^2) densities throughout year (Stone *et al.* 1995). Given this distribution and the wide ranging nature of fulmars in the North Sea and that the location of Dogger Bank is greater than 4km from the East Anglia ONE site, no significant cumulative barrier effects would be anticipated on fulmars. Therefore the significance of any cumulative impact on fulmars will be that predicted for the operational barrier effects, which is a **negligible impact**.

664 The risk of a barrier effect to gannet is more significant on the breeding rather than the migratory birds, as the former could theoretically make repeat movements through the region due to their large foraging range. Gannets were observed infrequently outside of winter within the East Anglia ONE site and densities in the other windfarm areas considered were largely low (0.01 to 0.99 birds/km^2) during all seasons (Stone *et al.* 1995). Therefore, given the wide ranging behaviour of this species, relatively large deviations in migration routes and foraging paths may not lead to any significant increase in energy expenditure. Consequently no significant cumulative barrier impacts would be anticipated and the overall level of impact is predicted to be **negligible**, or at worst **minor adverse**.

665 Small gull numbers in Britain increase greatly during the winter months with many birds (particularly black-headed and common gulls) moving from northern and eastern Europe to the east coast of Britain (Wernham *et al.* 2002). Such movements peak during the autumn passage (September and October) and during the return spring passage around March. There is also evidence to suggest that British breeding birds are also partial migrants with a general southerly movement in autumn and a northerly movement in spring.

666 The North Sea holds many juvenile dispersing kittiwakes in autumn, with a tendency for these birds to move south during October and November (Wernham *et al.* 2002). Although kittiwakes and common gulls could potentially pass through and hence need to avoid the windfarms under consideration once during each spring and autumn migration passage, this is likely to affect relatively few individuals as these areas do not hold particularly high densities of any of these species during migration. Therefore, although there is the possibility for potential cumulative effects through increased energy expenditure on migration, it is not anticipated that these would be significant for kittiwakes or common gulls. With no significant cumulative effects anticipated it is predicted that the impacts cumulatively will be no more than that predicted for the East Anglia ONE site on its own, which is **negligible** for both species.

667 Lesser black-backed gulls make autumn migrations to wintering grounds to the south, returning north to their breeding grounds in spring. As lesser black-backed gulls were estimated to be present in low numbers in the East Anglia ONE site and other windfarms being considered in spring and autumn it is unlikely that these windfarms would provide a significant cumulative barrier effect to the species during migration. The mean maximum foraging range of lesser black-backed gulls during the breeding season is up to 141 ± 50.8km (Thaxter *et al.* 2012b), making the East Anglia ONE, Scroby Sands and Greater Thames (Greater Gabbard, Galloper extension, London Array, Thanet, Gunfleet Sands 1 and 2, Kentish Flats and Kentish Flats extension) windfarms fall within the foraging range of the Alde-Ore Estuary SPA lesser black-backed gull breeding colony. The tracking studies of

Thaxter *et al*. (2011; 2012a) confirm that East Anglia ONE, the Greater Gabbard and the Galloper extension are reached by Alde-Ore Estuary SPA birds, though East Anglia ONE is likely to be at the edge of their daily foraging range. These windfarms may therefore form a barrier effect to SPA foraging birds in the summer. The effects of daily deviations (eg foraging movements from colonies) were found by Speakman *et al.* (2009) to be more severe on energy demands than one off avoidances (eg migration movements). Stone *et al.* (1995) recorded low densities of lesser black-backed gulls (typically 0.01 to 0.99 birds/km^2) in the other windfarm areas that fall within the lesser black-backed gull 141km mean maximum foraging range from breeding colonies. Therefore, it can be assumed that few birds forage within these areas and thus, although the East Anglia ONE site could pose a barrier effect to birds from the Alde-Ore colony, it would not significantly increase the levels experienced through the existing or planned sites. The cumulative impact from multiple windfarms would therefore be of **minor significance** at most.

668 Herring gulls tend to be more dispersive and when not breeding, their range extends further south and even to the northern tropics (Wernham *et al.* 2002). Great black-backed gull numbers in Britain also increase greatly during the winter months as birds breeding in Norway and the Murmansk region migrate westwards and southwards towards the east coast (particularly the south east) of Britain (Wernham *et al.* 2002). Although both species could pass through, and hence have to avoid any of the other windfarm areas under consideration on their spring and autumn migrations, none of these areas are thought to hold particularly high densities of either species during these times. In addition, these birds are on passage migration and would only be travelling the route once per season. Therefore, although there is the possibility for potential cumulative effects through increased energy expenditure on migration, it is not anticipated that there would be any significant cumulative impact on herring gulls or great black-backed gulls during these periods. Therefore it is predicted that the cumulative impacts would be of similar significance to that associated with East Anglia ONE on its own, which is **negligible** for both species.

669 After the breeding season and post-breeding moult there is a gradual movement of guillemots and razorbills southwards during the autumn, with a return of birds from more northern breeding colonies in the spring (Wernham *et al.* 2002). Guillemots and razorbills are expected to be present at low densities in all windfarm areas, with the exception of Dogger Bank. Although Dogger Bank has been recorded as holding high densities of guillemots by Stone *et al.* (1995) and Skov *et al.* (1995), this was not considered by Kober *et al.* (2010) to be a regular occurrence. Given the fact that the Dogger Bank Zone is widely separated from the East Anglia ONE site, the East Anglia ONE and the Dogger Bank Zone windfarms should not form a cumulative barrier to any one bird. Furthermore as guillemots and razorbills are generally dispersive rather than migratory they are unlikely to be making established point to point migration journeys. The general drift away from and towards colonies

perhaps indicates that any avoidance of turbines will be across a broad front, and that wind turbine presence may simply be another factor that influences the direction of movements around the North Sea. Therefore, no significant cumulative barrier effects would be anticipated for guillemots or razorbills and the impacts are predicted to be of **minor adverse significance** at most.

12.6.6.4 Cumulative Impacts of Non-windfarm Developments

12.6.6.4.1 Overview

670 In addition to the impacts resulting from the development and operation of windfarms in the North Sea, cumulative impacts may arise from non-windfarm activities such as subsea cables, shipping, commercial fisheries, aggregates and recreational activities. Relevant sites and activities including the following:

- Cable laying;
- Anglian / East Coast and Thames dredging;
- Aggregates abstraction;
- Shipping; and
- Fishing.

12.6.6.4.2 Cumulative Impacts of Sub-sea Cables

671 As the cables for East Anglia ONE would be buried, existing cables would have a **negligible impact** on the habitat supporting seabirds and would not lead to any disturbance / displacement. However, the repair of any cable breakages and the laying of any new cables across existing cables within the East Anglia ONE site and offshore cable corridor would impact on the ornithological receptors through direct disturbance to the seabed and loss of seabed associated with cable protection, although this would be very localised, and vessels disturbance short-term. Based on the findings of Stone *et al.* (1995) densities of all key species would be expected to be relatively low throughout much of the year in the areas of sub-sea cables. Particularly low densities are expected to the east of the East Anglia ONE site due to the distance from the coast and in all areas during the summer when birds are less frequently found offshore.

672 Due largely to the presence of vessels, the maintenance activities of sub-sea cables are likely to have similar disturbance and displacement effects to those of oil and gas pipelines and platforms. Although, the maintenance activities at a platform will

be more spatially restricted than those of a sub-sea cable, both are likely to be carried out over a short time period. Given this, and that bird densities in the relevant areas are expected to be relatively low, no significant in-combination disturbance and displacement effects are anticipated for any of the key species. This would lead to no significant cumulative impact.

12.6.6.4.3 Cumulative Impacts of Dredging and Aggregate Extraction

673 The closest dredging area is the licence area 430, which is located to the south of the East Anglia ONE offshore cable corridor. The Crown Estate East Coast Region is located off the coast near Great Yarmouth and The Crown Estate Thames Region is located southwest from Felixstowe.

674 Dredging could potentially lead to disturbance and displacement due to the presence of the dredger, which is again most likely to impact the most sensitive species (divers and auks) and have little or no impact on more tolerant groups (gulls, gannets and fulmars). Although impacts are likely to be minor owing to the timing (mostly summer), localised nature and restricted influence of the activity, if dredging areas coincide with important foraging areas, there may be an indirect effect on any of the key species due to a reduction in food resources. A further indirect impact may occur to the overall ecosystem, as a result of habitat loss or change. However, any disturbance would be short-term and localised and assuming dredge sites would be accessed using existing shipping lanes, recovery from disturbance would be anticipated to be fairly fast.

675 Increased turbidity due to dredging activities might displace visual feeders like divers and auks from areas larger than the avoidance distance associated with dredging vessels.

676 The Humber and Greater Wash MAREA (located more than 4km north of the East Anglia ONE site) expects a 100% increase in dredging activities during the coming years, potentially doubling all associated impacts on seabirds. However, given the distance of this site from the East Anglia ONE site, it is considered unlikely that any effects due this increased activity would have a significant effect in combination with the East Anglia ONE project.

677 Densities of divers across the dredge areas have been recorded at around 0.50 to 0.99 birds/km^2 during the winter months (Stone *et al.* 1995). The Crown Estate Thames Region located southwest from Felixstowe overlaps with the Outer Thames Estuary SPA boundary, which is designated for red-throated divers during the winter months.

678 Fulmars and gannets have been recorded by Stone *et al.* (1995) at low densities (0.01 to 0.99 birds/km^2) throughout the year in all the dredging areas. Kittiwakes, common gulls, lesser black-backed gulls, herring gulls, great black-backed gulls, guillemots and razorbills are typically present at low densities (0.01 to 0.99 birds/km^2) in both area 430 and the Crown Estate East Coast Region throughout the year. High densities of great black-backed gulls (up to 5.00+ birds/km^2) and moderate densities of common gulls (up to 1.00+ birds/km^2) could be expected to occur during the winter months in the Crown Estate Thames Region (Stone *et al.* 1995).

679 Given that the dredging areas are sufficiently far from the East Anglia ONE site (exceeding 4km from the site), it is considered unlikely that any birds, particularly divers and auks, displaced from these areas would re-distribute into East Anglia ONE waters and interact in such a way that would exceed the carrying capacity of a sensitive habitat and / or foraging area.

680 There are several operational aggregate extraction sites in the vicinity of the East Anglia ONE site. Aggregate extraction could lead to similar effects as dredging.

681 It can be expected that any increase in cumulative displacement effects would only be potentially significant for any species / group if there was a concentration of activity in a single year within the main foraging areas for each species.

682 Therefore, it can be concluded that combining the East Anglia ONE project with the ongoing effects of dredging and aggregate extraction key species would be minimal cumulatively. For the species of interest, the cumulative effects of dredging and aggregate extraction would be no more than the predicted levels of significance assigned for the operational activities relating to disturbance and displacement.

12.6.6.4.4 Cumulative Impacts of Shipping and Navigation

683 Gannets and fulmars are wide ranging, have low sensitivity to human activity disturbance and are relatively flexible in their habitat choice (Garthe & Hüppop 2004) and are therefore unlikely to be significantly affected by an in-combination disturbance and displacement from shipping and navigation. Subsequently, the cumulative impacts will be insignificant.

684 As most gull species have been found to remain undisturbed by the close proximity of boats, no potential interaction is expected for kittiwakes, common gulls, lesser black-backed gulls, herring gulls or great black-backed gulls. Therefore they are unlikely to be affected by an in-combination disturbance and displacement from shipping and navigation. Subsequently, the impacts will be insignificant cumulatively.

685 Divers and auks are the most likely species to be affected. Divers, particularly red-throated divers, are normally sensitive to disturbance, and will avoid ships by as much as a few kilometres. Consequently, they usually occur in areas with light sea traffic (Mitschke *et al.* 2001). It is expected that any red-throated divers, guillemots or razorbills in or near to the paths of the boats would be displaced and the effects of nearby existing shipping lanes would already be accounted for in baseline data. 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.

686 As it is likely that the current seabird populations have already “adapted” to shipping operations in the area, and that any increase in shipping activities associated with constructing the East Anglia ONE site would be short-term and temporary, it is not anticipated that there would be any significant in-combination disturbance and displacement effects on red-throated divers, guillemots or razorbills from shipping and navigation. Therefore, the cumulative impacts are predicted to be not significant.

12.6.7 Potential Transboundary Impacts

687 There is the potential for transboundary effects to occur on offshore ornithology as a result of the construction, operation or decommissioning of the proposed East Anglia ONE project. Some SPAs on the Belgian and Netherlands coasts are reasonably close the site and hold to protected species (eg lesser black-backed gulls and sandwich terns) which have been recorded within the area of the proposed East Anglia ONE windfarm. Some of these SPAs hold breeding species that could potentially forage within the East Anglia ONE site, whilst others are designated for staging birds that may pass through the site on migration. These SPAs (see *Table 12-80*) vary in proximity to the East Anglia ONE site from 75 to 422km.

688 The likely impacts are considered to be collision risks with wind turbines, which could be potentially fatal, disturbance and displacement from foraging/loafing areas and barrier effects due to avoidance and hence increased energy budgets. Effects can be considered to be long-term as there is the potential to exposure for the operational life of the East Anglia ONE site. Breeding birds mainly could be present from April to July, whilst staging species mainly could be present during the spring from and in autumn migration periods from March to April and September to October, respectively.

689 Based on the mean, mean maximum and maximum foraging ranges from breeding colonies reported in Thaxter *et al.* (2012b) and provided by the Birdlife (2012) seabird wiki spaces webpage (http://seabird.wikispaces.com) there is no overlap between even the maximum foraging ranges of little terns, common terns, arctic terns, sandwich terns, or little gulls and any of the SPAs identified in the 'Consideration of Transboundary Impacts' document. Additionally, the Waddenzee SPA is located further from the East Anglia ONE site than the 141km mean maximum foraging range recorded by Thaxter *et al.* (2012b) for lesser black-backed gulls during the breeding season, but the site is within the 181km maximum foraging range recorded for this species by Thaxter *et al.* (2012b) (see *Table 12-80* below). However, it is recognised that most birds will not fly to their maximum foraging range during each foraging journey.

690 It is possible that these species (eg lesser black-backed gulls and sandwich terns) could pass through the East Anglia ONE site on migration, as well as dark-bellied brent geese (feature of the Waddenzee SPA), red-throated divers (feature of the Voordelta, Noordzeekustzone, SBZ/ZPS 1 and SBZ/ZPS 2 SPAs) and common scoters (feature of Voordelta SPA). Impacts at this time are likely to be barrier effects and collision risk. As Speakman *et al.* (2009) found that for one-off avoidances during migration the impact of windfarms on energy demands were minor (less than 2% of available fat reserves), any transboundary barrier effects could be considered to be relatively insignificant. The likelihood of staging birds colliding with wind turbines depends on the collision risk values, but is likely to be low. These species have been assessed for potential collision risk within this impact assessment for the East Anglia ONE project. Red-throated diver however are considered to fly under the rotor sweep of wind turbines, so are not susceptible to collision, and terns have not been identified as a key migration modelling species group, so have not been included also. However, additional work has been undertaken to asses both common scoter, dark-bellied brent goose and other species through a separate migration modelling exercise. Large numbers of dark-bellied brent geese were predicted to pass through the East Anglia ONE site, with 51 birds (less than 0.1% of the flyway population) predicted to collide with the wind turbines on an annual basis suggesting low risk from transboundary impacts. Similarly, common scoters are also deemed to be at low risk from transboundary effects as their flight height places them at negligible risk of collision. The only other species of concern from transboundary impacts is lesser black-backed gull, which during migration periods was low at 0 to 15 individuals in spring and 22 to 127 individuals in autumn, so is considered to be at low risk from transboundary impacts based on the survey data.

691 In all cases it can be concluded that the potential impacts arising, by virtue of the predicted spatial and temporal magnitude of the effects, would not give rise to

significant transboundary effects on the environment of another European Economic Area (EEA) member state.

Distances of Continental SPAs from the East Anglia ONE Site and Foraging Ranges of Designated Species Potentially Breeding at these Sites						
SPA	**Approx distance of SPA from East Anglia ONE Site (km)**	**Species designated (potentially breeding)**	**Mean foraging range (km)[1]**	**Mean maximum foraging range (km)[1]**	**Maximum foraging range (km)[1]**	**Likelihood of foraging birds utilising East Anglia ONE site during breeding season**
Waddenzee (Netherlands)	159	Lesser black-backed gull	71.9 ± 10.2	141 ± 50.8	181	Unlikely
		Little tern	2.1	6.3 ± 2.4	11	Very unlikely
		Common tern	4.5 ± 3.2	15.2 ± 11.2	30	Very unlikely
		Arctic tern	7.1 ± 2.2	24.2 ± 6.3	30	Very unlikely
		Sandwich tern	11.5 ± 4.7	49.0 ± 7.1	54	Very unlikely
Voordelta (Netherlands)	75	Little gull	23.88		50	Unlikely
Noordzeekustzone (Netherlands)	170	Little tern	2.1	6.3 ± 2.4	11	Very unlikely
		Little gull	23.88		50	Very unlikely
SBZ/ZPS 1 (Belgium)	95	Common tern	4.5 ± 3.2	15.2 ± 11.2	30	Unlikely

Distances of Continental SPAs from the East Anglia ONE Site and Foraging Ranges of Designated Species Potentially Breeding at these Sites						
SPA	**Approx distance of SPA from East Anglia ONE Site (km)**	**Species designated (potentially breeding)**	**Mean foraging range (km)[1]**	**Mean maximum foraging range (km)[1]**	**Maximum foraging range (km)[1]**	**Likelihood of foraging birds utilising East Anglia ONE site during breeding season**
		Sandwich tern	11.5 ± 4.7	49.0 ± 7.1	54	Unlikely
		Little gull	23.88		50	Unlikely
SBZ/ZPS 2 (Belgium)	83	Common tern	4.5 ± 3.2	15.2 ± 11.2	30	Unlikely
		Sandwich tern	11.5 ± 4.7	49.0 ± 7.1	54	Unlikely
		Little gull	23.88		50	Unlikely
SBZ/ZPS 3 (Belgium)	88	Little tern	2.1	6.3 ± 2.4	11	Very unlikely
		Common tern	4.5 ± 3.2	15.2 ± 11.2	30	Unlikely
		Sandwich tern	11.5 ± 4.7	49.0 ± 7.1	54	Unlikely
		Little gull	23.88		50	Unlikely

[1] All foraging ranges from Thaxter *et al.* (2012b), with the exception of those for little gull which were taken from BirdLife (2012)

Table 12-80 Distances of Continental SPAs from the East Anglia ONE Site and Foraging Ranges of Designated Species Potentially Breeding at these Sites

12.7 Mitigation Measures

692 The East Anglia ONE site would develop and construct all associated infrastructure to satisfy the requirements of the Civil Aviation Authority (CAA) and the Trinity House Lighthouse Service (THLS) in respect of marking, lighting and fog horn specifications. During operations lighting would be as per the guidance and take into account any new directives from the current lighting trials being undertaken by NOREL (Navigation and Offshore Renewable Energy Liaison) group. However, where practicable and within the guidance, action would be taken to reduce any unnecessary lighting, particularly that which is directed out from the structures. This should help to minimise the attractive influence of lighting on migrating and or flying birds through the East Anglia ONE site. This is considered to be one of the most effective mitigation options (Cook et al.2011).

693 In advance of the detailed decommissioning plan it is the expectation of EAOW (see *Volume 1, Chapter 4 Project Description*), that following completion of the 25 year design life of the wind turbines, they would be uninstalled and removed from site, generally in the reverse of their installation method. Similarly, it is assumed that the process for removing foundations is generally the reverse of the process to install them. Cables are unlikely to be removed from site as per current best practice, and would be de-rated, snipped and left *in situ* on the seabed.

12.8 Residual Impacts

694 Residual impacts are those that remain following the application of mitigation measures and are likely to have been reduced in magnitude as a result of the mitigation measure implemented.

695 As no effects of major significance have been predicted as a result of the proposed development, no additional, major mitigation / compensation measures are considered to be necessary and therefore there are no additional residual impacts to consider.

12.8.1 Residual Impacts during Construction

696 Residual impacts during construction are discussed in *Table 12-81*.

12.8.2 Residual Impacts during Operation

697 Residual impacts during operation are discussed in *Table 12-82*.

12.8.3 Residual Impacts during Decommissioning

698 Residual impacts during decommissioning are discussed in *Table 12-83*.

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
Red-throated diver	Direct disturbance	Very high	Negligible	Minor adverse	Effects are considered to be short-term and restricted to a localised subset of the population.	Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	**Minor adverse**
	Habitat loss	Very high	Negligible	Minor adverse	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Minor adverse**
	Indirect effects	Very high	Negligible	Minor adverse	Effects are considered to be short-term and restricted to a localised subset of the population.	None required	**Minor adverse**
Fulmar	Direct disturbance	Low	Negligible	Negligible	Species is wide ranging and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations	**Negligible**

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
						being worked on simultaneously reduces the likelihood of an impact occurring.	
	Habitat loss	Low	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**
	Indirect effects	Low	Negligible	Negligible	Prey on a variety of fish species that may be affected by noise associated with pile driving. However, these effects are considered to be short-term and localised.	None required	**Negligible**
Gannet	Direct disturbance	Medium	Negligible	Negligible	Species is wide ranging and effects are considered to be short-term and restricted to a localised subset of the population. Present in low abundance in the East Anglia ONE site.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	**Negligible**
	Habitat loss	Medium	Negligible	Negligible	Approximately 1% of habitat within	None required	**Negligible**

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					East Anglia ONE will be lost		
	Indirect effects	Medium	Negligible	Negligible	Prey on a variety of fish species that may be affected by noise associated with pile driving. However, these effects are considered to be short-term and localised.	None required	**Negligible**
Kittiwake	Direct disturbance	Medium	Negligible	Negligible	Species wide ranging and fairly tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	**Negligible**
	Habitat loss	Medium	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	Species is wide ranging and has a variety of foraging strategies to cope with prey disturbance. However, these effects are considered to be	None required	**Negligible**

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					short-term and localised.		
Common gull	Direct disturbance	Low	Negligible	Negligible	Species wide ranging and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population. Present in low abundance in the East Anglia ONE site.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	**Negligible**
	Habitat loss	Low	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**
	Indirect effects	Low	Negligible	Negligible	Species is wide ranging and has a variety of foraging strategies to cope with prey disturbance. However, these effects are considered to be short-term and localised.	None required	**Negligible**
Lesser black-backed gull	Direct disturbance	Medium	Negligible	Negligible	Species wide ranging and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the	None required. Embedded mitigation has involved the careful selection of the East	**Negligible**

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					population.	Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	
	Habitat loss	Medium	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	Species is wide ranging and has a variety of foraging strategies to cope with prey disturbance. However, these effects are considered to be short-term and localised.	None required	**Negligible**
Herring gull	Direct disturbance	Medium	Negligible	Negligible	Species wide ranging and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population. Present in low abundance in the East Anglia ONE site.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on	**Negligible**

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
						simultaneously reduces the likelihood of an impact occurring.	
	Habitat loss	Medium	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	Species is wide ranging and has a variety of foraging strategies to cope with prey disturbance. However, these effects are considered to be short-term and localised.	None required	**Negligible**
Great black-backed gull	Direct disturbance	Medium	Negligible	Negligible	Species wide ranging and tolerant of human activities. Effects are considered to be short-term and restricted to a localised subset of the population.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	**Negligible**
	Habitat loss	Medium	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
	Indirect effects	Medium	Negligible	Negligible	Species is wide ranging and has a variety of foraging strategies to cope with prey disturbance. However, these effects are considered to be short-term and localised.	None required	**Negligible**
Guillemot	Direct disturbance	High	Negligible	Negligible	Species is wide ranging during the winter months when numbers peaked. Effects of disturbance to prey are considered to be short-term and localised.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	**Negligible**
	Habitat loss	High	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**
	Indirect effects	High	Negligible	Negligible	Species is wide ranging during the winter months when numbers peaked. Effects of disturbance to prey are considered to be short-term and localised.	None required	**Negligible**

Residual Impacts during Construction							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
Razorbill	Direct disturbance	High	Negligible	Negligible	Species is wide ranging during the winter months when numbers peaked. Effects of disturbance to prey are considered to be short-term and localised.	None required. Embedded mitigation has involved the careful selection of the East Anglia ONE site to avoid European designated sites. Construction of a small number of foundations being worked on simultaneously reduces the likelihood of an impact occurring.	**Negligible**
	Habitat loss	High	Negligible	Negligible	Approximately 1% of habitat within East Anglia ONE will be lost	None required	**Negligible**
	Indirect effects	High	Negligible	Negligible	Species is wide ranging during the winter months when numbers peaked. Effects of disturbance to prey are considered to be short-term and localised.	None required	**Negligible**

Table 12-81 Residual Impacts during Construction

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
Red-throated diver	Disturbance & displacement	Very high	Low	Minor to Moderate adverse	East Anglia ONE site is not as important for the species compared to the Thames region and Outer Thames Estuary SPA. 100% displacement from the site and 4km buffer is considered unlikely, with suitable habitat available for birds to move into between 2-4 km.	None required	**Minor - Moderate adverse (but tolerable)**
	Collision risk	Very high	Negligible	Negligible	Typical flight behaviour is to fly close to the sea surface and that birds fly less frequently in the non-breeding season. <1% of flights at collision height.	None required	**Negligible**
	Barrier effect	Very high	Negligible	Minor adverse	Birds are not known to be making daily trips into or out of the area of sea that the proposed windfarm is to be developed in. Peak numbers present during spring migration and therefore one-off movements would be involved	None required	**Minor adverse**
	Habitat loss	Very high	Negligible	Minor adverse	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Minor adverse**
	Indirect effects	Very high	Negligible	Negligible	As red-throated diver are expected to avoid the East Anglia ONE site due to the presence of the wind turbines it is unlikely that any indirect effects	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					associated with maintenance vessels or changes to fish availability will have an impact.		
Fulmar	Disturbance & displacement	Low	Low / Negligible	Negligible	The species has shown no signs of avoidance towards vessel activities or operational wind turbines.	None required	**Negligible**
	Collision risk	Low	Negligible	No Impact	<1% of flights at collision height. The increase relative to the baseline mortality is predicted to be 0% at the regional, national and international populations.	None required	**No Impact**
	Barrier effect	Low	Negligible	Negligible	Species is wide ranging and birds are not known to be making daily trips into or out of the area of sea that the proposed windfarm is to be developed in. So only birds migrating through the site may be impacted slightly when moving around the windfarm in the future	None required	**Negligible**
	Habitat loss	Low	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
	Indirect effects	Low	Negligible	Negligible	The species is a wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources	None required	**Negligible**
Gannet	Disturbance & displacement	Medium	Medium	Minor adverse	Birds show a preference to avoid flying into or through windfarm arrays	None required. Species is wide ranging and will forage in similar nearby suitable habitat	**Minor adverse**
	Collision risk	High	Negligible	Negligible	The additional rate of annual mortality results in a 1.26% at worst increase relative to the baseline mortality at the regional population level during the breeding season, but is less than 0.1% at the national and international population levels.	It is likely that birds will show a preference to avoid flying into or through the windfarm array, so a natural mitigating factor of increased avoidance is likely. This will have the effect of raising the avoidance rate to above 98%, so decrease the number of birds predicted to collide with	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
						turbines. This may be aided by individual blades being painted with stripes to make birds more aware of their presence and ensure they repel more gannets from the windfarm.	
	Barrier effect	Medium	Negligible	Negligible	Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future	None required	**Negligible**
	Habitat loss	Medium	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	The species is a wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
Great skua	Disturbance & displacement	Medium	Low	Minor adverse	As the species does not generally reside within the site it will not suffer from impacts of D&D	None required	**Minor adverse**
	Collision risk	Very high	Negligible	Minor Adverse	Due to flight behaviour, no birds are predicted to be killed by collision with turbines	None required	**Negligible**
Kittiwake	Disturbance & displacement	Medium	Negligible	Negligible	Species is tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	None required	**Negligible**
	Collision risk	Very high	Negligible	Minor adverse	The additional rate of wintering mortality results in a 5.94% at worst increase relative to the baseline mortality at the regional population level. However, birds present in the East Anglia ONE site at this time are considered likely to be from the wider national population and an increase of 0.24% relative to the baseline mortality rate is predicted for the national population	None required.	**Minor adverse**
	Barrier effect	Medium	Negligible	Negligible	Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					slightly when moving around the windfarm in the future		
	Habitat loss	Medium	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	The species is a wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources	None required	**Negligible**
Common gull	Disturbance & displacement	Low	Negligible	Negligible	Species is tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	None required	**Negligible**
	Collision risk	Low	Negligible	Negligible	The additional rate of mortality is predicted to result in an increase relative to the baseline mortality rates of less than 1% at the regional, national or international population level.	None required.	**Negligible**
	Barrier effect	Low	Negligible	Negligible	There are no breeding colonies within foraging distance of the East Anglia ONE site and therefore birds will not be making daily foraging trips into the area	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future		
	Habitat loss	Low	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**
	Indirect effects	Low	Negligible	Negligible	The species is a wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources	None required	**Negligible**
Lesser black-backed gull	Disturbance & displacement	Medium	Negligible	Negligible	Species is tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.	None required	**Negligible**
	Collision risk	Very high	Negligible	Minor adverse	An additional mortality of 16 adult lesser black-backed gulls has a negligible effect on lesser black-backed gulls expected to be from the Alde-Ore SPA. On this basis it is considered that there will be a minor adverse effect on breeding lesser black-backed gulls due to collision mortality arising from the	None required	**Minor adverse**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					operation of East Anglia ONE.		
	Barrier effect	Medium	Negligible	Negligible	The East Anglia ONE site is within the maximum foraging range of lesser black-backed gulls from the Alde-Ore SPA colony. Data from tagging studies suggest that although birds have been recorded within the East Anglia ONE site, the site does not appear to be within the core foraging area of birds from this colony. Avoidances during one-off movements such as migration are unlikely to have a significant energetic effect. However, the species is tolerant of windfarm structures and activities and has potentially shown habituation to the presence of turbines.	None required	**Negligible**
	Habitat loss	Medium	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	The species is a wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources	None required	**Negligible**
Herring	Disturbance &	Medium	Negligible	Negligible	Species is tolerant of the activities	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
gull	displacement				associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging.		
	Collision risk	High	Low	Minor adverse	The additional rate of breeding mortality is predicted to result in a 1.22% increase relative to the baseline mortality rate at the regional population level.	None required.	**Minor adverse**
	Barrier effect	Medium	Negligible	Negligible	The species is tolerant of windfarm structures and activities and has potentially shown habituation to the presence of turbines.	None required.	**Negligible**
	Habitat loss	Medium	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	The species is a wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources	None required	**Negligible**
Great black-backed gull	Disturbance & displacement	Medium	Negligible	Negligible	Species is tolerant of the activities associated with operational windfarms, including vessel activity and rotating turbine blades and is also wide ranging .	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
	Collision risk	High	Low	Minor adverse	The additional rate of breeding mortality is predicted to result in a 2.57% increase relative to the baseline mortality rate at the regional population level.	None required.	**Minor adverse**
	Barrier effect	Medium	Negligible	Negligible	The species is tolerant of windfarm structures and activities and has potentially shown habituation to the presence of turbines.	None required.	**Negligible**
	Habitat loss	Medium	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**
	Indirect effects	Medium	Negligible	Negligible	The species is a wide ranging aerial forager and therefore will not suffer from any indirect impacts associated with food sources	None required	**Negligible**
Guillemot	Disturbance & displacement	Medium	Negligible	Negligible	Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future. However, auks are considered to be dispersive rather than truly migratory. Recent studies in	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					UK waters comparing pre-construction and post-construction numbers of auks within offshore windfarms have shown tolerance towards windfarms.		
	Collision risk	Medium	Negligible	No Impact	Typical flight behaviour is to fly close to the sea surface. <0.01% of flights at collision height. No additional mortality is predicted	None required	**No impact**
	Barrier effect	Medium	Negligible	Negligible	Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future. However, auks are considered to be dispersive rather than truly migratory. Recent studies in UK waters comparing pre-construction and post-construction numbers of auks within offshore windfarms have shown tolerance towards windfarms.	None required	**Negligible**
	Habitat loss	High	Negligible	Negligible	With approximately 1% actual habitat lost, which will be replaced by new communities in a short space of time this impact will be insignificant	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
	Indirect effects	High	Negligible	Negligible	Species is wide ranging during the winter months when numbers peaked.	None required	**Negligible**
Razorbill	Disturbance & displacement	Medium	Negligible	Negligible	Recent studies in UK waters comparing pre-construction and post-construction numbers of auks within offshore windfarms have shown tolerance towards windfarms.	None required	**Negligible**
	Collision risk	Medium	Negligible	No Impact	Typical flight behaviour is to fly close to the sea surface. <0.01% of flights at collision height. No additional morality is predicted	None required	**No impact**
	Barrier effect	Medium	Negligible	Negligible	Birds are not known to make daily foraging trips into the area of sea that the proposed windfarm is to be developed in, so only birds migrating through the site may be impacted slightly when moving around the windfarm in the future. However, auks are considered to be dispersive rather than truly migratory. Recent studies in UK waters comparing pre-construction and post-construction numbers of auks within offshore windfarms have shown tolerance towards windfarms.	None required	**Negligible**
	Habitat loss	High	Negligible	Negligible	With approximately 1% actual habitat	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					lost, which will be replaced by new communities in a short space of time this impact will be insignificant		
	Indirect effects	High	Negligible	Negligible	Species is wide ranging during the winter months when numbers peaked.	None required	**Negligible**
Bewick's swan	Collision risk	Very high	Negligible	Minor adverse	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Minor Adverse**
Taiga bean goose	Collision risk	Very high	Negligible	No Impact	Due to flight behaviour, no birds are predicted to be killed by collision with turbines	None required	**No Impact**
European white-fronted goose	Collision risk	Very high	Negligible	No Impact	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**No Impact**
Dark-bellied brent goose	Collision risk	Very high	Negligible	Minor adverse	The additional rate of mortality is predicted to result in a <1%increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Minor adverse**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
Shelduck	Collision risk	Very high	Negligible	Minor adverse	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Minor adverse**
Common scoter	Collision risk	Medium	Negligible	No Impact	Due to flight behaviour, no birds are predicted to be killed by collision with turbines	None required	**No impact**
Avocet	Collision risk	Very high	Negligible	Negligible	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Negligible**
Golden plover	Collision risk	Medium	Negligible	Negligible	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Negligible**
Knot	Collision risk	Medium	Negligible	Negligible	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Negligible**

Residual Impacts during Operation							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
Dunlin	Collision risk	Medium	Negligible	Negligible	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Negligible**
Black-tailed godwit	Collision risk	Very high	Negligible	Negligible	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Negligible**
Bar- tailed godwit	Collision risk	Very high	Negligible	Negligible	The additional rate of mortality is predicted to result in a <1% increase relative to the baseline mortality rate at the national or international population level in both spring and autumn.	None required	**Negligible**

Table 12-82 Residual Impacts during Operation

Residual Impacts during Decommissioning							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
Red-throated diver	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Fulmar	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Gannet	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Kittiwake	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Common gull	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be	None required	**Potentially minor beneficial**

Residual Impacts during Decommissioning							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					void of turbines and have an expected healthier stock of resources to feed on		
Lesser black-backed gull	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Herring gull	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Great black-backed gull	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Guillemot	All impacts	Low	Negligible	Negligible	No significant negative impacts predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on	None required	**Potentially minor beneficial**
Razorbill	All impacts	Low	Negligible	Negligible	No significant negative impacts	None required	**Potentially minor**

Residual Impacts during Decommissioning							
Species	**Impact**	**Site Specific Sensitivity**	**Impact Magnitude**	**Predicted Significance**	**Rationale**	**Relevant Mitigation**	**Residual Impact**
					predicted. Potentially a net gain, as birds will return to an area that will be void of turbines and have an expected healthier stock of resources to feed on		**beneficial**

Table 12-83 Residual Impacts during Decommissioning

12.9 Monitoring Recommendations and Summary

12.9.1 Monitoring Recommendations

699 The survey data from the Crown Estate Enabling Actions and the APEM aerial surveys data have provided a continuous 24 month baseline (pre-construction) monitoring data set. It is anticipated that construction and post-construction monitoring surveys will be required as part of the Marine Licence for all Round 3 offshore windfarms. Further post-construction ornithological monitoring if required would be focused on key species and designed to maximise the potential to detect significant change and may follow the same standard set of methodologies that were carried out in the 24 month baseline monitoring data set. EAOW are committed to further engagement with the industry to allow for future joint working to research and investigate impacts on birds. In addition to this a focus would be centred on post-construction monitoring that would enable any significance changes to be detected to key species from the operations associated with the East Anglia ONE project.

700 Walker & Judd (2010) reviewed offshore windfarm monitoring data and developed recommendations for project developers that are outlined below. Survey monitoring plans must be constructed in consultation with the Licensing Authority who will liaise with relevant stakeholders and SNCBs, such as the JNCC, NE and the RSPB with a view to conducting surveys during the construction and post-construction periods. Data should be of sufficient quality to quantify significant changes in bird distribution and abundance within the East Anglia ONE site (and appropriate buffer zone) to measure any evidence of displacement due to either the construction or operation of the windfarm.

701 A combination of all or some of the above methodologies for completing monitoring for the East Anglia ONE site would be appropriate to continue the assessment of impacts on birds within the site and its buffer. In order to formally agree a protocol for the monitoring programme for the East Anglia ONE project a full consultation with SNCBs and the Crown Estate is envisaged. This process would enable all relevant stakeholders to be consulted on before an agreed monitoring programme is initiated.

12.10 Summary

702 Within *Table 12-81, Table 12-82 and Table 12-83* summaries of all the predicted impacts for each of the key species of concern during the construction, operation and decommissioning periods of the East Anglia ONE project can be found. The impacts are based on the site-specific sensitivity levels assigned to them, the predicted magnitude of effect for each period and the subsequent theoretical

level of significance (and the modified level if applicable), followed by the rationale behind the decision. In addition to this a final residual impact significance level is shown, which is based on the predicted impact after any relevant mitigation measures have been accounted for, which are also outlined in the same tables or further explained in *Section 12.7*.

703 From the analysis of baseline surveys and subsequent impact assessment it is evident that in the majority of instances the effects predicted from an operational windfarm within the East Anglia ONE site and offshore cable corridor are **negligible** in the main, **minor** in some instances and **minor to moderate** in even fewer instances (before mitigation). The highest residual impacts are those associated with red-throated diver (**minor to moderate** (but tolerable)) from disturbance and displacement during the operation period; **minor** for regional population overall and **moderate** for local population during winter only. Residual impacts for lLesser black-backed gulls from collision with wind turbines during the operational period are considered **minor adverse**.

704 Although a reduction in the likely impact on red-throated diver is not possible through mitigation it is yet to be proven that the levels of displacement are in fact as severe as predicted within this environmental impact assessment. New, currently unpublished, research is in the process of assessing the levels of disturbance and displacement on divers from offshore windfarms.

705 The main area of interest for lesser black-backed gulls is the Alde-Ore SPA population that has suffered serious decline in the last decade, but has recently shown an increase in productivity. An additional mortality of 20 adult lesser black-backed gulls, more than the 16 adults predicted to occur annually as a result of the proposed construction of East Anglia ONE, has a negligible effect on the number of breeding pairs of lesser black-backed gulls expected to be present at the Alde-Ore SPA after 25 years under the medium scenario from a colony specific PVA carried out by MacArthur Green (Trinder, 2012). Under the medium scenario, 3,758 breeding pairs would be expected on the SPA rather than 3,590 breeding pairs, a difference of under 5% that is likely to be well within the margins of error for the model and most importantly does not stop the upward trend in breeding pairs. Following the construction of East Anglia ONE, it is therefore expected that in due course the SPA target would be met.

706 On this basis it is considered that there would not be an adverse effect on breeding lesser black-backed gulls or the integrity of the Alde-Ore SPA due to collision mortality arising from the operation of East Anglia ONE.

707 The cumulative impact assessment in *Section 12.6.6* shows that when considering other projects within the southern North Sea there would be no

significant changes to the predicted level of effects on any species due to possible cumulative additional effects.

708 In summary, when embedded and additional mitigation measures are accounted for, there is a minimal risk of potential significant effects on species' populations within and surrounding the East Anglia ONE site on a regional, national and international level as a direct result of activities and operations associated with the East Anglia ONE project.