Burbo Bank Extension Offshore Wind Farm

Paper 7: Red-throated Diver Displacement

Response to Natural England's representation dated 24 June 2013 paragraphs 4.2.1 to 4.2.5 and Natural Resources Wales' representation dated 24 June 2013, Annex 1, paragraphs 1.2.1 to 1.2.5

Version 5, September 2013

NIRAS Consulting Ltd
Sheraton House, Castle Park, Cambridge
CB3 0AX, UK

Reg. No.: 07470870
England & Wales
www.niras.com/uk

T: +44 (0)1223 370181
F: +44 (0)1223 370040

Document Details

NIRAS Project Number	N0084
Document Title	Paper 7: Red-throated Diver Displacement
Status	Final
Client	DONG Energy
Client Contact Name	Allen Risby

The following personnel are designated contacts for queries relating to this document:

Name	Job Title	Telephone	Email
Ian Ellis	Principal Ecologist	01223 370181	iel@niras.com
Robin Ward	Senior Ornithologist	01223 370181	rwa@niras.com

Document Issue Log

	Approval		Issue	
Author/Originator	**Initials**	**Date**	**NIRAS (DocWeb) version no.**	**Date**
RWA	**IEL**	**25/07/2013**	**2**	**25/07/2013**
RWA	**IEL**	**23/08/2013**	**3**	**23/08/2013**
RWA	**IEL**	**04/09/2013**	**4**	**04/09/2013**
FINAL				
RWA	**IEL**	**16/09/2013**	**5**	**16/09/2013**

Final Document Sign-Off

	Name	Signature	Date
Issued by (NIRAS)	Ian Ellis		16/09/2013
Accepted by (Client)	Allen Risby		16/09/2013

Third Party Disclaimer

Distribution log

Version	Distributed to	Date
5	Liam Fisher (Natural England)	16/09/2013
5	Delyth Rowlands (Natural Resources Wales)	16/09/2013

This is one of a number of Ornithology Papers produced by NIRAS Consulting Ltd on behalf of DONG Energy and the Burbo Bank Extension offshore wind farm Project. The papers address issues raised in relevant representations to the Planning Inspectorate by consultees with respect to this Project.

The documents in this series of Papers are listed below:

Paper 1: Manx shearwater displacement
Paper 2: Definition of regional bird populations
Paper 3: Historical data analysis
Paper 4: Common scoter displacement
Paper 5: Accounting for HRA breeding birds outside of the breeding season
Paper 6: Update to species group partitioning and collision risk modelling
Paper 7: Red-throated diver displacement
Paper 8: PBR analysis of common tern, lesser black-backed gull, and herring gull colonies
Paper 9: Review of evidence used in cumulative impact assessments
Paper 10: Implications of the BAES Warton gull control measures
Paper 11: Implications for Welsh SSSIs

Contents

1. Introduction

1.1. Background

1.1.1. This Paper provides clarification on the Burbo Bank Extension ornithological impact assessment, specifically the information and analysis performed to determine the cumulative assessment of displacement of red-throated diver. Following representations made by Natural England (paragraphs 4.2.1 – 4.2.5, 24 June 2013) and Natural Resources Wales (Annex 1, paragraphs 1.2.1 - 1.2.5, 24 June 2013), and as discussed at meetings held with these parties on the 3rd July 2013 and the 23rd July 2013, the analysis presented in the Environmental Statement Volume 2 - Chapter 15: Offshore Ornithology (PINS document reference 5.1.2.15) and Habitats Regulations Assessment Report (PINS document reference 4.3) has been refined using an alternative red-throated diver dataset provided by the Joint Nature Conservation Committee (JNCC). This dataset had been derived by JNCC from data on the number and distribution of red-throated divers in Liverpool Bay SPA as determined using visual aerial survey methods which have been corrected for distance related detection errors. Bird observations were smoothed by JNCC using kernel density estimation (KDE) and were combined to create a mean modelled density surface of red-throated diver in Liverpool Bay SPA.

1.1.2. This Paper considers the implication of the predicted changes in red-throated diver density within Liverpool Bay SPA as a result of displacement from the offshore wind farm alone and in-combination with a number of wind farms in the Liverpool Bay SPA.

1.2. Evidence of the need to assess red-throated diver displacement

1.2.1. The proposed Burbo Bank Extension Offshore Wind Farm ("the Project") is located partly within the Liverpool Bay SPA[1] and the displacement of red-throated diver, a qualifying feature of this SPA, has been identified as of potential concern by the relevant SNCB's (Natural England and Natural Resources Wales).

1.2.2. Liverpool Bay SPA was formally designated in August 2010 due to its importance for wintering populations of seabirds, particularly common scoter and red-throated diver. The site supports a wintering population of the Annex 1 listed (on the EC directive on the Conservation of Wild Birds 79/409/EEC) red-throated diver, with a mean peak count of 922 individuals recorded over the period 2001/02 – 2005/06. This accounts for 5.4% of the total estimated British wintering population. The species occurs throughout Liverpool Bay SPA with highest densities occurring off the Ribble Estuary, North Wales and the North Wirral Foreshore (Webb *et al*., 2006).

1.2.3. In a review of the sensitivity of seabird species to offshore wind farms, Furness and Wade (2012) found that red-throated divers had the second highest sensitivity score. Potential effects on the species include displacement due to disturbance from the turbines or from maintenance activities.

1.2.4. Further to consultation with Natural England, it was agreed that the magnitude of potential red-throated diver displacement from Burbo Bank Extension would be analysed in detail. This report details the cumulative impact assessment methodology and results using historical JNCC aerial data as the basis for a SPA wide study.

[1] 86% of the area of the wind farm site is within the SPA. All of the wind farm lies within English waters, part of the export cable route crosses Welsh waters to a landfall between Rhyl and Prestatyn in north Wales

1.3. **Cumulative impact assessment**

1.3.1. Appropriate estimates of displacement and indeed population and/or density are not available within Environmental Statements of the three wind farm sites considered to have the potential to contribute to an in-combination displacement effect with Burbo Bank Extension (Gwynt-y-Môr, Rhyl Flats and Burbo Bank). Therefore, to inform a cumulative impact assessment, counts of red-throated diver for the area of each of the four sites were extracted from the processed visual aerial survey data supplied by JNCC.

1.3.2. The use of a single data set circumvents any potential comparability issues between the survey techniques used to inform the assessments and those used to inform the SPA designation. Although a study by Rexstad and Buckland (2009) of common scoter in Camarthen Bay indicated that population estimates by digital aerial methods (as used at Burbo Bank Extension in 2011) were typically higher than from visual aerial techniques (as used to inform the designation of Liverpool Bay SPA), the review by Thaxter and Burton (2009) details other studies that give inconclusive results.

1.3.3. The analysis presented below uses the historical JNCC data only and provides further insight not only into potential cumulative impacts but further supporting information on the effects of Burbo Bank Extension alone.

2. Methodology

2.1. **The offshore wind farms assessed**

2.1.1. Four wind farm sites were assessed for cumulative displacement impacts on red-throated diver. These were:

- Burbo Bank Extension;
- Burbo Bank (operational October 2007);
- Gwynt-y-Môr (constructed from 2012);
- Rhyl Flats (operational July 2007).

2.1.2. Only the area of each wind farm that fell within Liverpool Bay SPA was assessed for displacement effects. Burbo Bank and Rhyl Flats Offshore Wind Farms are located wholly within the SPA, 86% of the area of the Burbo Bank Extension offshore wind farm falls within the SPA, and a substantial proportion of Gwynt-y-Môr lies outside of the SPA boundary. North Hoyle Offshore Wind Farm has been operational since 2003 and as such is considered part of the background environment.

2.2. **Data used**

2.2.1. To calculate the numbers of birds displaced, the density of red-throated divers expected to be present within and around the wind farm was estimated using JNCC aerial survey data. These were visual aerial surveys carried out during winter (October - March) between 2000/01 and 2009/10, using a line transect method. The data were processed and supplied by the Joint Nature Conservation Committee (JNCC). In processing the data, JNCC initially calculated population estimates for each survey using distance sampling analysis where data are corrected for distance related detection errors (see O'Brien *et al.,* 2008 and Webb *et al.,* 2009 for details of the method used).

2.2.2. In the second stage of processing, JNCC created a density surface. For each survey, raw bird observations were converted into point density estimates at five second intervals. Kernel density estimation (KDE), with a smoothing parameter of 3km, was used by JNCC

to smooth point density estimates to create a grid of estimated densities in 1km x 1km cells. The KDE output was scaled to the population estimate for the survey, as derived from distance sampling in the initial stage, such that the sum of all the 1km by 1km cells across the surface equalled the population estimate for the area of search. Finally, a single mean modelled density surface for the study area was created by overlaying all surveys and summing the density across all surveys for each 1 km by 1 km cell and then dividing the sum by the number of times that particular cell was surveyed, to control for varying survey effort across the study area. See O'Brien *et al.* (2012) for further details as to the methodology used by JNCC in creating the density surface. This provided a grid of estimated densities in 1 km x 1 km squares within the Liverpool Bay and adjacent sea areas. In order to calculate population sizes of red-throated diver, estimated densities at 1 km^2 resolution were extracted in the present study using ArcGIS for each site. Grid squares were included in a search area only if the centroid of the square fell within the boundary of that search area.

2.2.3. The dataset used was recommended for use within the assessment by Natural England (Burbo Bank Extension ornithology meeting 03/07/2013).

2.3. **Potential displacement**

2.3.1. The magnitude of potential displacement effects on red-throated divers at each wind farm has been quantified using the approach taken at Kentish Flats Offshore Wind Farm which used empirical data on displacement effects (Pizzola, 2011). The Burbo Bank Extension Environmental Statement and HRA Report compare the Kentish Flats scenario with that used at London Array (Skov, 2011).The number of birds displaced does not include those individuals within each wind farm and their respective 2 km buffer that are outside the SPA.

2.3.2. Table 1 summarises the assumptions about the proportions of birds displaced, using the '2 km density model' approach documented in the Kentish Flats Extension Appropriate Assessment (DECC 2013a) . The number of birds displaced from each of the regions was calculated (using the assumptions in Table 1) and summed to estimate the total number of birds expected to be displaced by each wind farm and their respective 2 km buffer. In some cases the buffers of two wind farms overlapped, with birds within these overlap zones applied to the sites who's boundary lay in closest proximity. These totals were compared to the red-throated diver population cited for Liverpool Bay SPA (922 individuals) (Stroud *et al.*, 2001). The number of birds displaced does not include those individuals within each wind farm and their respective 2 km buffer that are outside the SPA.

Table 1. Approaches to estimating the magnitude of displacement effects.

Region	Proportion of birds displaced using the 'Kentish Flats' approach (%)
Project asite	94
0-500m buffer	83
500 – 1000m buffer	77
1000 – 2000m buffer	59

3. Results

3.1.1. The number of divers potentially displaced from all four wind farm sites assessed for cumulative impact assessment totals 100 individuals (Table 2). The highest displacement occurs at Gwynt-y-Môr Offshore Wind Farm (35 individuals), with Burbo Bank Extension predicted to displace 30 individuals using this method of analysis.

3.1.2. The '2 km density model' approach, used for the Kentish Flats Extension, involves displacement up to a 2 km buffer. Percival (2010) suggests that displacement may occur beyond this buffer. However that analysis was updated in Vattenfall (2011) and Pizzola (2011) to provide the displacement scenario presented in Table 1 and was also critically reviewed in Skov (2011).

Table 2. Cumulative displacement analysis for red-throated diver at four offshore wind farm sites.

Wind farm	Kentish Flats displacement[2]				Total	% of SPA population
	Wind farm	0 – 500 m	500 – 1000 m	1000 – 2000 m		
Burbo Bank	4	2	2	3	11	1.19
Burbo Bank Extension	13	2	7	8	30	3.25
Gwynt-y-Môr	21	4	4	6	35	3.80
Rhyl Flats	6	5	4	9	24	2.60
Total					**100**	**10.85**

4. Review of the Environmental Statement assessment of cumulative displacement when using the mean modelled density surface for red-throated diver

4.1.1. The displacement results presented in the Environmental Statement and Habitats Regulations Assessment Report were reviewed for this Paper to reflect the outcome of the cumulative displacement of red-throated diver in the light of using mean modelled bird density surface data.

4.1.2. Overall using the mean modelled density surface for red-throated diver has increased the predicted total numbers of birds displaced at the four offshore wind farms from 70[3] to 100.

4.1.3. Little information is available on the mortality rates for species displaced from operational wind farms and as such the matrix approach to presenting the effects (Natural England and JNCC, 2012) inevitably involves a high level of speculation. In the absence of mortality rates for red-throated diver displaced from operational wind farms, an alternative approach is to use where available, information from a comparable surrogate species. Such an approach is set out below in Section 5.5.

[2] Figures rounded to the nearest individual

[3] ES Chapter 15 Table 15.36 (PINS document reference 5.1.2.15) gives a cumulative total displacement of 86 birds, of which 16 relate to displacement from North Hoyle Offshore Wind Farm, excluded from this analysis

5. Implication of changes in red-throated diver density within Liverpool Bay SPA

5.1. Background

5.1.1. The number of divers potentially displaced from all four wind farm sites assessed for cumulative impact assessment equates to 10.85% of the population as cited for Liverpool Bay SPA (JNCC 2010). To understand the magnitude of the impact of that displacement, it is necessary to consider the fate of displaced birds and how many of the displaced birds will be lost to the SPA population (through mortality or emigration[4]).

5.1.2. It is reasonable to consider as overly precautionary the assumption that 100% of displaced birds will emigrate from the SPA or die. A more realistic approach to consider the fate of displaced birds, and of others already occupying areas to which displaced birds may go, is to assume that birds displaced from the wind farm areas will move to other habitat areas within the SPA that are of comparable quality (i.e. support similar diver densities). It follows that the density of divers within these habitat areas will increase as a result of the relocation of the displaced birds. There is the possibility that there will be additional mortality experienced by these birds due to increased resource competition and that this "additional mortality" will be a function of density, i.e. the mortality rate increases as density increases. The rate of this additional density-dependent mortality in diver populations is not known.

5.2. Interaction figure

5.2.1. The percentage of the SPA population predicted to be displaced by the wind farms is for the purposes of this discussion termed the 'interaction figure'. If a proportion of divers successfully redistribute within the SPA, then the interaction figure should be adjusted to account for this (because the impact on the SPA population is less than is indicated by that figure). For example if the interaction figure calculated from the predicted displacement of divers is 10%, but it can be shown that 50% of the displaced birds are able to successfully redistribute within the remaining SPA area over the long-term, then the interaction should be multiplied (adjusted) by 0.5 to reflect this. In this example, the real ('adjusted') interaction figure is, therefore, 10% * 0.5 = 5%.

5.3. Interaction figures of consented Projects – an overview

5.3.1. Projects have been consented within the Thames Estuary (based on the "EIA displacement scenario"[5]) with red-throated diver interaction figures for the Outer Thames Estuary SPA population of between 3.1% (London Array Offshore Wind Farm initial phase development, alone) and 6.5% (London Array Offshore Wind Farm initial phase development in-combination with Greater Gabbard, Kentish Flats, Thanet and Gunfleet Sands I, (DBERR, 2008)). These interaction figures were based on a direct relationship between displacement and mortality, assuming 100% mortality of displaced birds.

[4] The analysis is not able to distinguish these outcomes and so assumes, on a precautionary basis, that all loss to the SPA is thorough mortality

[5] The EIA Displacement Scenario is based on the assumption that total displacement of red-throated divers will occur within the wind farm area and a further 50% displacement will occur out to 1 km from the wind farm. This scenario option was the approach undertaken in the London Array Offshore wind farm Appropriate Assessment (DTI 2006) and during the consenting process of Gunfleet Sands II. It was based on evidence available at that time.

5.4. **The Project's interaction figures for Liverpool Bay SPA**

5.4.1. The number of red-throated divers potentially displaced by the Project alone was assessed as 3.8%[6] of the citation population for Liverpool Bay SPA (JNCC 2010). At 100% mortality, the latter interaction figure is below that of the previously accepted level of impact of 6.5% for Gunfleet Sands II offshore wind farm in-combination with other plans or projects (DECC 2013b).

5.4.2. The number of divers potentially displaced from all four wind farm sites assessed for cumulative impact assessment equates to 10.85% of the Liverpool Bay SPA population (JNCC 2010). At 100% mortality, this interaction figure exceeds the Gunfleet Sands II figure (DECC 2013b). However, as previously discussed, 100% mortality of the birds displaced is considered as unrealistic. The extent to which the assumed mortality of the birds displaced can realistically be reduced from 100% based on the best available evidence, is discussed as follows.

5.5. **Density dependent mortality studies**

5.5.1. There are no directly applicable studies of the effects of displacement on mortality of wintering red-throated divers. The use of the closest available proxy, a wading bird (oystercatcher) study (Durell *et. al.*, 2000, Durell *et al.*, 2001, and Goss-Custard & Durell, 1984), is problematic in that the equivalent density dependent mortality effects are difficult to scale for red-throated diver. However, the study does provide the currently best available indication of the potential extent of density dependent mortality that can be expected for red-throated diver, given that the two species show high site fidelity in winter (i.e. similar sites are used each year, although there is no indication that the same birds return as this species is highly mobile), rely on a predictable and rich food supply, and generally experience a high annual survival rate.

5.5.2. Controlling for the severity of each winter between 1976 and 1991, there was a highly significant relationship between adult mortality and bird density in the Exe Estuary oystercatchers. As oystercatcher density doubled, the percentage winter mortality increased approximately five-fold (i.e. 500%). Considering the adverse conditions experienced in the latter two winters and excluding these data suggests that the increase in adult mortality could have been less than half, i.e. between 200% and 300%. Assuming a simple linear relationship, a 1% increase in density would therefore lead to an absolute increase in mortality rate of approximately 2.5% and 5%.

[6] Note this figure is higher than the 3.25% in the cumulative displacement analysis (Table 2) as it includes birds displaced from the zone of overlap with Burbo Bank and its respective buffers.

5.6. **Application of density dependent mortality as described for oystercatcher**

5.6.1. Use of the measures of density dependent mortality described for oystercatcher, allows an interaction figure to be derived for the predicted number of divers displaced from all four wind farm sites assessed for cumulative impact assessment. This has been undertaken using a simplified approach for which the steps of the calculation, parameters used and resulting interaction figures obtained (additional birds dying following displacement as percentage of the Liverpool Bay SPA) are documented in Table 3.

5.6.2. In using this simplified approach, no account has been undertaken of birds displaced from the wind farm areas moving to other habitat areas within the SPA that are of comparable quality. It should be noted that the annual mortality rate of those birds predicted not to be displaced from the buffers of the wind farms, in accordance of the Kentish Flats scenario, was considered to remain unaltered at 13.5%.

5.6.3. A natural mortality rate of 13.5% was assumed, based on published data on adult mortality of red-throated and black-throated divers from ringing schemes in the Nordic countries (Nilsson, 1997; Hemmingsson & Eriksson, 2002). These studies suggested a mean mortality of 11% for black-throated diver, and 16% for red-throated diver. The baseline adult mortality rate of 13.5% is therefore a reasonable assumption for natural mortality, given the limited number of studies on red-throated diver survival rates (Skov, pers. comm, 2012).

5.7. **Level of density dependent mortality**

5.7.1. On assuming the simple linear relationship, where a 1% increase in density would lead to an increase in mortality rate of approximately 5%, mortality amongst those red-throated divers displaced by the four wind farm sites assessed for cumulative impact assessment is predicted to be 76.1% (76 birds) (Table 3). In his assessment of London Array Phase 1 (DECC 2013b), the Secretary of State recognised that there is uncertainty over the level of density dependent mortality that might occur and considered as appropriate a precautionary 5% density dependent mortality. Though the equally contemporary Appropriate Assessment for Kentish Flats Extension (DECC 2013a) provides no numerical assessment for density dependant mortality, the Secretary of State agreed that displacement effects can lead to a density-dependant increase in mortality of the order of 30-60%. At the precautionary 5% density dependent mortality, the density-dependant increase in mortality at the Project in-combination with the other three other wind farms considered is 63.9%.

Table 3 Stepwise calculation of the interaction figure for those red-throated divers predicted to be displaced from four offshore wind farms (Burbo Bank, Burbo Bank Extension, Gwynt-y-Môr and Rhyl Flats), when using published density dependent mortality rates of Oystercatcher.

Successive steps of the analysis	Formulas used (using the parameters identified in first and third columns)	Value[7]
(a) No. of birds in SPA[8]		922
(b) No. of birds displaced		100
(c) No. of birds remaining in 2 km buffer (Kentish Flats scenario)		29
No. of birds within SPA, outside of OWFs + buffers:		
(d) Before displacement	d= a-(b+c)	793
(e) After displacement	e = d+b	893
Area of SPA (km^2):		
(f) Entire area		1,703
(g) Excluding OWFs + 2 km buffers		1,450
Density of birds (birds/km^2) in SPA, outside of OWFs + buffers :		
(h) Before displacement	h =d/g	0.549
(i) After displacement	i =(d+b)/g	0.616
(j) Percentage increase in density	j = (i-h)/h)*100	12.61
(k) Natural mortality rate		0.135
(l) New mortality rate for a density dependant mortality rate where for every 1% increase in density mortality increases by:		
2%	l = ((2 x [j/100])+1) x k	0.169
3%	l = ((3 x [j/100])+1) x k	0.186
5%	l = ((5 x [j/100])+1) x k	0.220
Birds dying within SPA, excluding birds inside of OWFs + buffers not displaced:		
(m) Before displacement	m = k x e	121
(n) After displacement, where for every 1% density increase, mortality increases:		
2%	n = l x e	151
3%	n = l x e	166
5%	n = l x e	197
Additional birds dying following displacement:		
(o) as an absolute number where for every 1% density increase, mortality increases:		
2%	o = n – m	30
3%	o = n – m	46
5%	o = n – m	76
(p) as % of the SPA population i.e. the 'interaction figure' where for every 1% density increase, mortality increases:		
2%	p = o/a	**3.3**
3%	p = o/a	**5.0**
5%	p = o/a	**8.2**

[7] Note the tabulated values are rounded numbers. So as to avoid rounding error, rounded numbers were not used in any stage of the calculations.

[8] JNCC (2010)

5.8. **Synthesis**

5.8.1. Table 4 presents interaction figures for red-throated diver with the Outer Thames Estuary SPA from three consented offshore wind farms (London Array Phase I, Kentish Flats Extension, Gunfleet Sands II) and the proposed London Array Phase II, where the species use of the Project sites has been of major conservation concern. In the same table, interaction figures for red-throated diver with Liverpool Bay SPA from the Project site are presented for comparative purposes.

Table 4. Interaction figures for red-throated diver with the Outer Thames Estuary SPA from some proposed/consented offshore wind farms

Offshore wind farm (Publication)	**Interaction figure (%)**[9] [*London Array Initial development option*]	**Interaction figure adjusted**[10] *[displacement model used]*	**Offshore wind farms included in assessment**	**Consent**
Kentish Flats Extension (Appropriate Assessment; DECC 2013a)	Alone = **0.5**	No *[Kentish Flats Displacement Scenario]*	Kent Flats Extension	Yes
	In-combination = **9.3**	No *[Kentish Flats Displacement Scenario]*	Kent Flats Extension, London Array Phase 1, Gunfleet I & II	
Gunfleet Sands II (Appropriate Assessment; DBERR 2008)	Alone = **0.62**	No *[EIA Displacement Scenario]*	Gunfleet II	Yes
	In-combination: **6.2** [*Option 1*] **6.5** [*Option 2*]	No *[EIA Displacement Scenario]*	London Array phase I, Gunfleet I & II, Greater Gabbard, Kentish Flats & Thanet	
London Array Phase I (Appropriate Assessment; DTI 2006)	Alone = **3.1** [*Option 1*] **3.4** [*Option 2*]	No *[EIA Displacement Scenario]*	London Array Phase 1	Yes
London Array Phase 1 (Appropriate Assessment; DECC 2013b)	Alone = 9.6	No *[Kentish Flats Displacement Scenario]*	London Array Phase 1	Yes
	Alone = **7.3**	Yes *[Kentish Flats Displacement Scenario]*		
	In-combination = **9.1**	Yes *[Kentish Flats Displacement Scenario]*	London Array Phase 1, Kent Flats Extension, Gunfleet I & II	
London Array Phase 2 (Appropriate Assessment; DECC 2013b)	Alone = **7.3**	Yes *[Kentish Flats Displacement Scenario]*	London Array Phase II	No
	In-combination = **16.4**	Yes *[Kentish Flats Displacement Scenario]*	London Array Phase 1 & II, Kent Flats Extension, Gunfleet I & II	

[9] Interaction figure is the percentage of the red-throated diver population as cited for Liverpool Bay SPA.
[10] An adjusted interaction figure is one where 5% density dependant mortality has been assumed as opposed to that of unadjusted which represents 100% mortality of birds displaced.

5.8.2. The mortality predicted amongst those red-throated divers displaced by the four wind farm sites assessed for cumulative impact assessment with a precautionary 5% density dependent mortality represents 8.2% of the Liverpool Bay SPA population of 922 birds (JNCC, 2010). This adjusted interaction figure exceeds that predicted for the consented Kentish Flats Extension, 9.3% unadjusted, when adjusted for density dependant mortality at the order of 30% - 60% considered likely, i.e. an adjusted interaction figure in the range 2.8% - 5.6%[11]. Superseding this decision however has been the Appropriate Assessment of London Array Phase 1 (DECC 2013b) for which an adjusted interaction figure of 9.1% was presented using a precautionary 5% density dependent mortality. The Secretary of State view that there would not be an adverse effects on the integrity of the Outer Thames Estuary SPA as a result of the London Array Phase I alone and in-combination with other plans and projects – both consented and planned –indicates as acceptable a level of adjusted interaction figure of up to 9.1% for the Outer Thames Estuary SPA. This exceeds the current Project's in-combination assessment adjusted interaction figure of 8.2% for Liverpool Bay SPA when using a precautionary 5% density dependent mortality.

5.8.3. Using the best scientific evidence known to be available, the preceding analysis has demonstrated the mortality expected amongst those divers predicted to be displaced from all four wind farm sites assessed for cumulative impact assessment to be, as a percentage of a SPA population, below a level previously accepted by the Secretary of State when consenting a wind farm development. Based on the outcome of the original cumulative analysis, the Project's HRA stated the cumulative displacement of 86 red-throated divers as a result of wind farm projects in Liverpool Bay, is not considered to result in an adverse effect on the integrity of the Liverpool Bay SPA. Birds displaced from within the Project's wind farm site are expected to successfully re-locate to other parts of Liverpool Bay SPA. This assessment remains no less valid given the analysis presented here of an 8.2% cumulative interaction figure for the Liverpool Bay SPA population.

5.8.4. The preceding analysis uses a precautionary 5% density dependent mortality relationship from a surrogate species that differs from red-throated diver in terms of foraging habitat and prey species resulting in the likelihood of differing predator-prey interactions. The true density dependent mortality relationship will be influenced by whether Liverpool Bay SPA is at carrying capacity for red-throated diver or whether the size of this population is limited on the breeding grounds or migratory staging areas.

6. References

APEM 2011. *Red-throated divers & offshore wind farms in the Outer Thames: historic data review.* APEM Scientific Report 411134. London Array Ltd., June 2011 v2 Final.

Department for Business, Enterprise and Regulatory Reform 2008. *Appropriate Assessment with regard to Gunfleet Sands II Offshore Wind Farm.* Energy Development Unit, Offshore Environment and Decommissioning.

DECC 2013a. *Record of the Habitats Regulations Assessment undertaken under Regulation 61(1) of the Conservation of Habitats and Species Regulations 2010 (as amended) for an application under the Planning Act 2008 (as amended). January 2013.* Department of Energy and Climate Change.

[11] Unadjusted interaction figure = 9.3%. Adjusted, the interaction figure for density dependant mortality at 60% equates to 9.3%*0.6 = 5.58%.

DECC 2013b. *Record of the appropriate assessment undertaken for projects consented under a) section 36 of the Electricity Act 1989; and b) section 66 of the Marine and Coastal Access Act 2009. Project: Review of the Outer Thames Estuary Special Protection Area (SPA) July 2013*. Department of Energy and Climate Change.

DTI 2006. *Appropriate Assessment with regards to London Array Wind Farm.* Department for Trade and Industry 2006.

Durell, S. E. A. Le V. dit, Goss-Custard, J. D., Clarke, R. T. and McGrorty, S. 2000. Density-dependent mortality in Oystercatchers *Haemaotpus ostralegus*. *Ibis*, 142, 132 – 138.

Durell, S. E. A. Le V. dit, Goss-Custard, J. D., Stillman, R. A. and West, A. D. 2001. The effect of weather and density dependence on oystercatcher *Haematopus ostralegus* winter mortality. *Ibis*, 143, 498 – 499.

Furness, B. and Wade, H. 2012. *Vulnerability of Scottish seabirds to offshore wind turbines*. MacArthur Green Ltd. Glasgow, Scotland.

Goss-Custard, J. D. and Durell, S. E. A. Le V. dit 1984. Winter mortality of adult oystercatchers on the Exe Estuary. *Wader Study Group Bulletin* 40, 37-38.

Hemmingsson, E. and Eriksson, M. O. G. 2002. Ringing of red throated diver Gavia stellata and black-throated diver *Gavia arctica* in Sweden. Diver/Loon Specialist Group, *Wetlands International, Newsletter vol. 4*.

JNCC, 2010. *Liverpool Bay Natura 2000 Standard Data Form*. Joint Nature Conservation Committee, Peterborough (http://jncc.defra.gov.uk/page-1401, accessed on 22/08/2013).

Natural England and JNCC, 2012. *Joint Natural England and JNCC Interim Advice Note – Presenting information to inform assessment of the potential magnitude and consequences of displacement of seabirds in relation of Offshore Windfarm Developments*. Natural England, Peterborough, UK.

Nilsson, S. G. 1977. Adult survival rate of Black-throated Diver *Gavia arctica. Ornis Scandinavica*, 8, 193 – 195.

NIRAS Consulting Ltd. 2012. *London Array Offshore Wind Farm Phase 2 – Report to Inform Appropriate Assessment.* NIRAS Consulting Ltd, Cambridge.

O'Brien, S.H., Wilson, L.J., Webb, A., and Cranswick, P.A. 2008. Revised estimate of numbers of wintering red-throated divers Gavia stellata in Great Britain. *Bird Study* 55, 152–160.

O'Brien, S.H., Webb, A., Brewer, M.J., & Reid, J.B. 2012. Use of kernel density estimation and maximum curvature to set Marine Protected Area boundaries: Identifying a Special Protection Area for wintering red-throated divers in the UK. *Biological Conservation* 156, 15-21.

Percival, S.M. 2010. *Kentish Flats Offshore Wind Farm: Diver Surveys 2009-10*. Ecology Consulting Report to DONG Energy.

Pizzola, P. 2011. *Kentish Flats Offshore Wind Farm Extension – Habitat Regulations Assessment Repor*t. Vattenfall Wind Power Ltd.

Skov, H. 2011. *Review of Kentish Flats Monitoring Reports*. DHI Group.

Stroud, DA, Chambers, D, Cook, S, Buxton, N, Fraser, B, Clement, P, Lewis, P, McLean, I, Baker, H & Whitehead, S (eds). 2001. *The UK SPA network: its scope and content*. JNCC, Peterborough

Rexstad, E. and Buckland, S. 2009. Comparison of aerial survey methods for estimating the abundance of common scoters. CREEM Technical Report 2009-01.

Thaxter, C.B. and Burton, N.H.K. 2009. High Definition Imagery for Surveying Seabirds and Marine Mammals: A Review of Recent Trials and Development Protocols. British Trust for Ornithology Report commissioned by COWRIE Ltd.

Vattenfall. 2011. *Kentish Flats Offshore Wind Farm Extension Environmental Statement: Offshore Ornithology.*

Webb, A., McSorely, C.A., Dean, B.J. and Reid, J.B. 2006. *Recommendations for the selection of, and boundary options for, an SPA in Liverpool Bay.* Joint Nature Conservation Committee Report No. 388.

Webb, A., Dean, B.J., O'Brien, S.H., Söhle, I., McSorley, C., Reid, J.B., Cranswick, P.A., Smith, L.E., and Hall, C. 2009. *The numbers of inshore waterbirds using the Greater Thames during the non-breeding season; an assessment of the area's potential for qualification as a marine SPA.* JNCC Report No. 374. JNCC, Peterborough.