THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES

2010

East Anglia TWO Offshore Wind Farm

Appendix A18 to the Natural England Deadline 7 Submission

TRACKED Change Version of The Applicant's Displacement of Red-throated Divers in the Outer Thames Estuary SPA [REP6-019]

For:

The construction and operation of East Anglia TWO Offshore Wind Farm, a 900MW wind farm which could consist of up to 75 turbines, generators and associated infrastructure, located 37km from Lowestoft and 32km from Southwold.

Planning Inspectorate Reference: EN010078

4th March 2021

TRACKED Change Version of The Applicant’s Displacement of Red-throated Divers in the Outer Thames Estuary SPA [REP6-019]

Summary

Natural England received an email, from the Applicant on 26th February 2021, which included a tracked change version of their Deadline 6 submission “EA1N&EA2 Displacement of red-throated divers in the Outer Thames Estuary SPA - Version 03”. Therefore, Natural England wishes to submit this into Examination as the changes are referred to in our Deadline 7 response Appendix A14b.

East Anglia ONE North and East Anglia TWO Offshore Windfarms

Displacement of red-throated divers in the Outer Thames Estuary SPA ~~-~~– Deadline 6 Update

Applicants: East Anglia ONE North Limited and East Anglia TWO Limited
Document Reference: ExA.AS-~~4.D5.V2~~10.D6.V3
SPR Reference: EA1N_EA2-DWF-ENV-REP-IBR-001138 Rev 03

Date: ~~3rd~~24th February 2021
Revision: Version ~~02~~03
Author: MacArthur Green / Royal HaskoningDHV

Applicable to East Anglia ONE North and East Anglia TWO

Revision Summary				
Rev	**Date**	**Prepared by**	**Checked by**	**Approved by**
01	15/12/2020	Mark Trinder / Jason Matthiopolous	Lesley Jamieson	Rich Morris
02	03/02/2021	Mark Trinder / Jason Matthiopolous	Lesley Jamieson	Rich Morris
03	24/02/2021	Mark Trinder / Jason Matthiopolous	Lesley Jamieson	Rich Morris

Description of Revisions			
Rev	**Page**	**Section**	**Description**
01	n/a	n/a	Final for submission at Deadline 3
02	n/a	n/a	Minor revisions following receipt of Natural England Deadline 4 review
03	n/a	n/a	Minor revisions following further legal review

There are three appendices associated with this assessment which are detailed in the following table

Appendix Number	Appendix Name
Appendix 1	Modelling the displacement effects of windfarms on red throated divers *Gavia stellata* in the Thames Estuary area from 2003 to 2018
Appendix 2	Literature Review of Potential Red-Throated Diver Displacement
Appendix 3	Spatial Modelling Assessment for the Projects Prior to the Reduction in the Order Limits of the East Anglia ONE North Project

Table of Contents

Glossary of Acronyms

HRA	Habitat Regulation Assesment
MMO	Marine Management Organisation
NE	Natural England
RR	Relevant Representation
RSPB	Royal Society for the Protection of Birds
SPA	Special Protection Area
TDR	Time Depth Recorder
UK	United Kingdom

Glossary of Terminology

Applicant	East Anglia TWO Limited / East Anglia ONE North Limited
Birds Directive	Directive 2009/147/EC of the European Parliament and of the Council on the Conservation of Wild Birds.
East Anglia TWO	The proposed project consisting of up to 75 wind turbines, up to four offshore electrical platforms, up to one construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia ONE North project	The proposed project consisting of up to 67 wind turbines, up to four offshore electrical platforms, up to one construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia TWO windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
East Anglia ONE North windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
Generation Deemed Marine Licence (DML)	The deemed marine licence in respect of the generation assets set out within Schedule 13 of the draft DCO.
Habitats Directive	European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.
Habitats Regulations	The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017
Inter-array cables	Offshore cables which link the wind turbines to each other and the offshore electrical platforms, these cables will include fibre optic cables.
Landfall	The area (from Mean Low Water Springs) where the offshore export cables would make contact with land, and connect to the onshore cables.
Meteorological mast	An offshore structure which contains metrological instruments used for wind data acquisition.
Monitoring buoys	Buoys to monitor *in situ* condition within the windfarm, for example wave and metocean conditions.
Natura 2000 site	A site forming part of the network of sites made up of Special Areas of Conservation and Special Protection Areas designated respectively under the Habitats Directive and Birds Directive.
Offshore cable corridor	This is the area which will contain the offshore export cables between offshore electrical platforms and landfall.
Offshore electrical infrastructure	The transmission assets required to export generated electricity to shore. This includes inter-array cables from the wind turbines to the offshore electrical platforms, offshore electrical platforms, platform link cables and export cables from the offshore electrical platforms to the landfall.
Offshore electrical platform	A fixed structure located within the windfarm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.

Offshore export cables	The cables which would bring electricity from the offshore electrical platforms to the landfall. These cables will include fibre optic cables.
Offshore infrastructure	All of the offshore infrastructure including wind turbines, platforms, and cables.
Offshore platform	A collective term for the construction, operation and maintenance platform and the offshore electrical platforms.
Platform link cable	Electrical cable which links one or more offshore platforms. These cables will include fibre optic cables.
Safety zones	A marine area declared for the purposes of safety around a renewable energy installation or works / construction area under the Energy Act 2004.
Transmission DML	The deemed marine licence in respect of the transmission assets set out within Schedule 14 of the draft DCO.

1 Introduction

1. This document provides an analysis of red-throated diver displacement from offshore windfarms in the Outer Thames Estuary Special Protection Area (SPA) and wider region. East Anglia TWO Limited and East Anglia ONE North Limited (the Applicants) have been undertaking new analysis of red-throated diver information since the receipt of the Natural England (NE) Relevant Representation (RR-059) regarding the examination of the East Anglia TWO project and the East Anglia ONE North project (the Projects), reflecting the fact that NE's position on this matter has become more conservative than it was pre-application.

2. Based on latest research from Germany, NE initially informed the Applicants of an increase in red-throated diver displacement out to at least 10km. The Applicants prepared an updated red-throated diver assessment out to 10km which was presented to NE, the Royal Society for the Protection of Birds (RSPB) and the Marine Management Organisation (MMO) at a workshop held on the 28th of July. It was agreed at that workshop that the Applicants would further revise the assessment to consider displacement out to 12.5km within 1km increments. Furthermore, NE requested modelling of the distribution of birds from the available survey data for the SPA to investigate how windfarms have affected the distributions.

3. The preliminary findings of this new analysis were presented to NE the RSPB and the MMO at a second workshop held on the 22nd of October. A draft report on the modelling component of the updated red-throated diver assessment was provided to NE, the RSPB and the MMO on the 16th of November, ahead of a further workshop on the 7th of December where the results of the analyses and implications for HRA were presented prior to submission of the final document at Deadline 3 (REP3-049). This report is an update of REP3-049 which has taken into account NE's detailed comments received at Deadline 4 (REP4-087). NE have provided a legal submission that the Applicants will provide a response to at Deadline 6, therefore no changes have been made to ***section 4*** in this version of the report.

4. Given the closer proximity of East Anglia ONE North to the Outer Thames Estuary SPA, which is designated for wintering red-throated diver, the report focuses on that Project.

5. Following a design review, the East Anglia ONE North boundary, which at the application stage was approximately 400m from the Outer Thames Estuary SPA, has been altered to provide a 2km buffer between the boundary of the SPA and

the boundary of the East Anglia ONE North windfarm site . This commitment to a 2km buffer is secured through an updated ***Work Plan*** (document updated at Deadline 6, document reference 2.3.1) submitted at Deadline 3. ***Figure 1*** shows the old and new East Anglia ONE North Order Limits, the other windfarms considered in the analysis and the Outer Thames Estuary SPA.

6. The remainder of this document contains the following sections:

- Spatial modelling – details of the data and analysis conducted to inform the magnitude of potential displacement of red-throated diver in the Outer Thames Estuary SPA;
- Ecological consequences of displacement – consideration of the potential impacts on displaced individuals, in terms of foraging competition and energy intake;
- Residual effects from East Anglia ONE North – consideration of 2km buffer commitment;
- Conclusions – presents the findings of the analysis and consideration of ecological consequences in relation to the conservation objectives for the Outer Thames Estuary SPA;
- Appendix 1 – this contains the spatial modelling technical report and code sections; and
- Appendix 2 – review of the published literature on red-throated diver displacement from offshore windfarms.
- Appendix 3 – spatial modelling results for the East Anglia ONE North project prior to the 2km buffer commitment.

7. The spatial modelling was designed and undertaken by Jason Matthiopolous, Professor of Spatial and Population Ecology (Institute of Biodiversity Animal Health & Comparative Medicine) at the University of Glasgow.

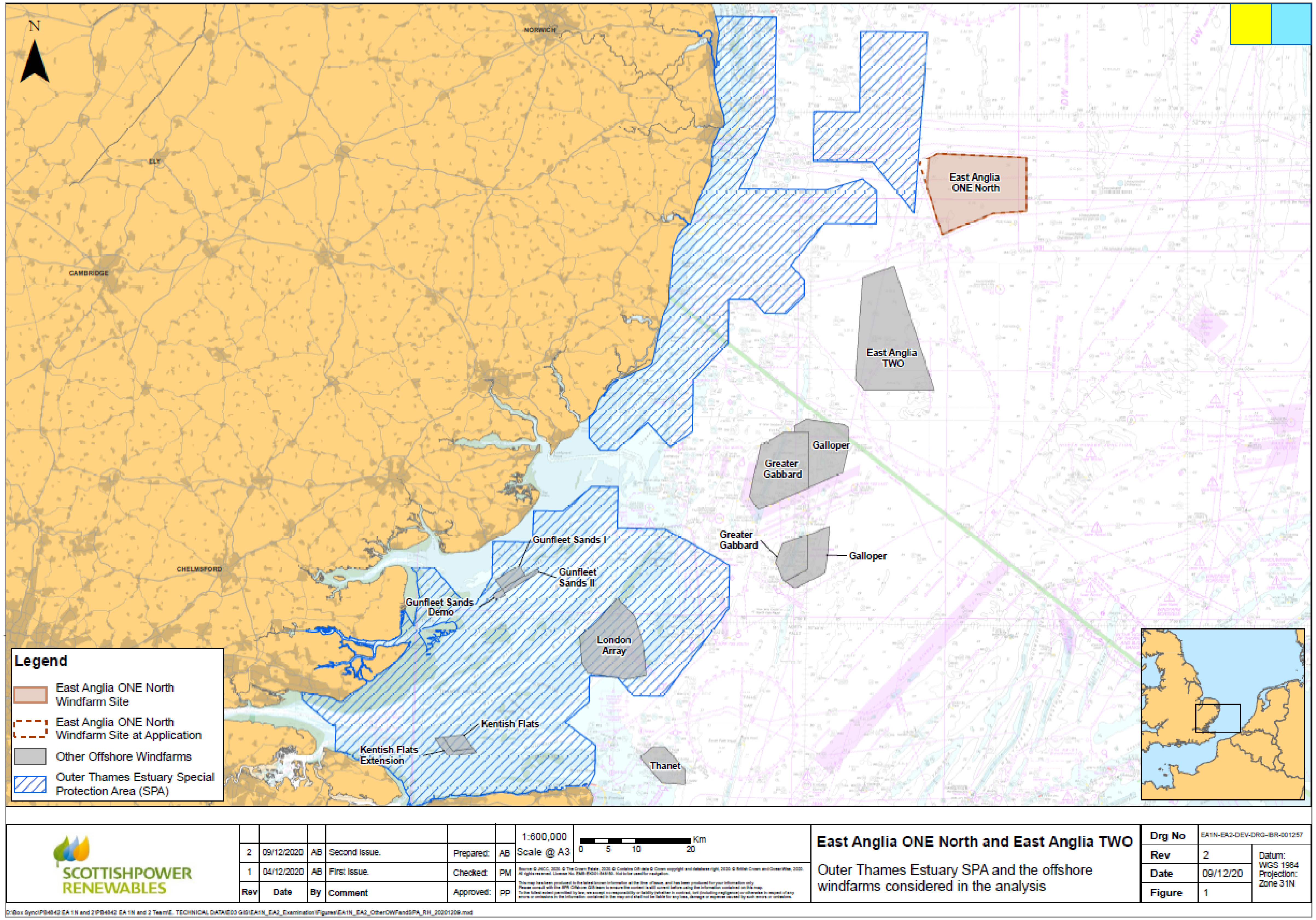

Figure 1 Outer Thames Estuary SPA and the East Anglia TWO, East Anglia ONE North (with buffer commitment shown) and other offshore windfarms in the Outer Thames region

2 Spatial modelling

8. Wintering red-throated divers are understood to be highly sensitive to anthropogenic sources of disturbance, including shipping traffic and offshore windfarms. Analyses of distribution data collected in the German Bight (Mendel et al. 2019, Vilela et al. 2020) have reported strong evidence for windfarm avoidance by red-throated divers in that area.

9. However, these studies have also reported variations in the apparent strength of effect across sub-regions and seasons:

10. Vilela et al. (2020):

‘In winter, large differences in the displacement distance to offshore wind farms were observed between the northern and southern sub-area, potentially due to the considerably lower diver densities and the resulting greater uncertainties in the analyses. Nevertheless, these differences show that seasonal and spatial factors may play a role in the specific response of divers to offshore wind farms and results found here are therefore not directly transferable to areas other than those considered in this study.’

11. Furthermore, while the distribution of red-throated divers has changed in the German Bight, Vilela et al. (2020) also state there is no indication that the abundance has changed:

‘…it is apparent, however, that the local population within the German North Sea is stable during the time period analysed.’

‘Over the study period (2001 - 2018), the spring abundance of divers was stable but showed inter-annual fluctuations without any clear trend. No connection was found between diver abundance and the expansion of wind power in the German North Sea. In spring, divers reached the highest numbers and an average abundance of 16,500 divers was estimated for the German North Sea.’

12. The Applicant undertook a comprehensive literature review (see Appendix 2) and preliminary analysis and presented the results to Natural England and the RSPB at a workshop on the 28th July 2020. Natural England requested further analysis, including investigation of the potential for displacement effects at distances up to at least 12.5km.

13. In order to investigate the relationship between windfarms in the Outer Thames area of the southern North Sea and red-throated diver distributions, the Applicants have undertaken a detailed statistical modelling analysis of survey data collected between 2002 and 2018, utilising a combination of static covariates

(e.g. bathymetry and distance to coast) and a time-varying spatial smoothing term. Our modelling is similar to that used in the studies in the German Bight and as with those studies is based on analysis of aerial survey data.

14. This analysis (see ***Appendix 1***) used the modelled relationship between the explanatory variables and observed red-throated diver usage to predict bird distributions throughout the region.

15. The model demonstrates a clear avoidance of offshore windfarms which declines with distance. Avoidance was detected to a distance of approximately 7km from the windfarm boundaries.

2.1 Methods

16. Detailed methods are provided in ***Appendix 1***. The survey data comprised visual aerial surveys collected between January 2002 and January 2007 (see O'Brien et al., 2012 for details), digital aerial still-based surveys in January and February 2013 (see APEM, 2013 for details) and digital aerial video-based surveys in February 2018 (see Irwin et al., 2019 for details).

17. Covariates included were:

    - Distance to coast,
    - Bathymetry,
    - Shipping traffic (using the annual average from 2015, the latest data available on the MMO website[1]), and
    - Distance to windfarm, with three layers, corresponding to no windfarms (prior to 2005), with Kentish Flats only (for data collected between 2005 and 2007) and with all the current operational windfarms (Kentish Flats, Gunfleet Sands, London Array, Thanet and Greater Gabbard; for 2013 onwards).

18. To check the assumption that it was reasonable to treat shipping traffic recorded in 2015 as a static variable across the analysis period, a comparison was made with the equivalent data collected in 2012 (the earliest dataset available from the MMO website) and 2014. These revealed very similar shipping densities and therefore indicated this to be a reasonable simplification.

19. A suite of nine models were evaluated, using three different error structures for the survey data (Poisson, Tweedie and negative binomial) with either no spatial smoother term, a fixed (i.e. time-invariant) smoother term or an interaction between the smoother term and year (i.e. time-varying). The negative binomial model with a spatiotemporal smooth term yielded the best performance. A further

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[1] https://data.gov.uk/dataset/b7ae1346-7885-4e2d-aedf-c08a37d829ee/vessel-density-grid-2015

two models with stricter penalisation of their flexibility were examined but rejected on the basis of their performance.

20. To generate confidence intervals around the point estimates for the predicted windfarm effect, a bootstrap resampling method was used. The best-fit model was re-run 100 times with the survey data randomly resampled from the full dataset each time. The model predictions from each of the 100 re-runs was saved and the 95% confidence intervals calculated across the predictions. These confidence intervals (***Table 1*** and ***Table 2***) replace those presented in the original version of this report (REP3-049) which were calculated using the model parameter standard errors (due to the computer intensive nature of this analysis there was insufficient time to undertake the bootstrap analysis for inclusion in the original submission, REP3-049).

21. In the comments provided by Natural England (REP4-087) following their review of the original version of this report (REP3-049), it was suggested that differences in the survey methods (visual aerial and digital aerial) across the data collection period had not been accounted for, and that this meant the model results were unreliable.

22. However, while the current model treats the survey data as a reliable source, at the same time the modelling allows for fluctuations over time, so the spatial predictions do not suffer as a result of changes in methodology, although the absolute numbers (of individuals) generated by the model should be treated with caution. For this reason, the model predictions were normalised to ensure the comparisons of the model predictions with and without the windfarms were robust. By basing the outputs on this comparison of relative predictions the results are insulated against the effects of varying methodologies in data collection.

23. Natural England (REP4-087) also considered that, because the models included both a ‘year’ term and the ‘distance-to-windfarm’ term, the comparison of model predictions with and without the distance-to-windfarm term (i.e. the measure on which windfarm effects are based) was flawed, since the year term, present in both sets of predictions, would also capture some of the windfarm effects, due to the temporal trend in windfarm development.

24. However, the Applicants have interpreted the spatiotemporal term in the selected model to include missing covariates or intrinsically driven species aggregations, but no direct effects of windfarms. This carries the implicit assumption that there are no residual effects of distance to windfarms that are not captured by the distance-to-windfarm term itself. We base this on the fact that distance to windfarms is known with high accuracy and the time points at which different windfarms are introduced to the system are also precisely known. Most

importantly, the distance to windfarm term is modelled with as much flexibility as the spatial term (i.e. they are both composites of ~~basis~~basic functions) and hence the model tailors the distance-to-windfarm covariate to match the observed effects.

25. To evaluate this assumption, the Applicants inspected the partial plots of the time specific spatial layers (***Figure 4*** in ***Appendix 1***) which show no similarity between the fitted spatial effects and the location of windfarms. Nevertheless, it is possible that if there are *indirect* effects of the windfarms on red-throated diver distributions which do not radiate symmetrically from the wind farms, these would not be captured by the structure of the distance-to-wind-farm layer and may instead be incorporated into the spatial term. Such effects could include changes in prey distributions due to hydrodynamic or prey-behaviour changes brought about by the placement of turbines, however identifying and obtaining appropriate covariates which would need to be closely matched in time to the original surveys, and there is no guarantee that suitable data were collected.

26. The other key methodological request made by Natural England was to provide further validation of the model outputs, specifically through comparisons of the model predictions with survey results recorded in and around windfarms, and through formal cross-validation.

27. As noted above, the Applicants consider the modelling results are robust for predicted distributions. Given the inherent variability in seabird distributions, it is not clear how much confidence would be gained from a comparison of the current model predictions with smaller scale windfarm surveys which lack the wider spatial context. These might provide a close correspondence, or not, but either way the results could equally be considered as chance.

28. The current analysis has instead presented counterfactual outputs which avoid these issues, and are able to provide a clear presentation of the differences in distributions due to each individual term in the model. In this aspect the outputs are equivalent to those from population models, where the relative impacts with and without windfarms have become the accepted metrics for assessing consequences. This is a reflection of the fact that model predictions are sensitive to their underlying assumptions with the consequence that predictions of real change must be treated with caution. In contrast, comparing alternative model predictions (i.e. with and without an impact) greatly reduces the risk of this sensitivity affecting the conclusions reached. This is the strength of such counterfactual approaches~~,~~ and comparing relative model predictions (with/without effects) thereby removes as much extraneous influence as possible.

29. NE has suggested that cross-validation be undertaken for this analysis, however from the context of NE's comment (REP3-087, paragraph 21) it appears the

request is in fact to undertake independent validation. For clarity, cross-validation is a resampling method used for model fitting and model selection. It is the gold standard for those two procedures, because it gets directly at the comparison between explanatory and predictive power. However, for the current models and size of dataset the time-scale could be in the order of years to undertake this analysis. As a consequence the statistical community (who author the statistical software used in this analysis) has replaced these impractical methods with considerably more expedient ones such as maximum likelihood (in the case of model fitting) and penalised likelihood criteria such as the AIC (for model selection), both of which have been used in the current analysis.

30. Therefore, the following provides a response on the assumption that NE is suggesting the Applicants undertake independent validation of the results (as opposed to cross-validation). Such a procedure could be conducted with a subset of the data withheld (e.g. removal of the spatially innermost 20% of the data), and the results compared with those obtained using the full dataset. However, crucially there is no objective means to judge the quality of fit between the two surfaces this would generate, hence this would not assist in reaching a judgement on model performance. Furthermore, since the candidate suite of models analysed is considered to be an appropriate starting point for model investigation, by using industry standard methods for model selection (maximum likelihood methods for model fitting and penalised likelihood criteria (e.g. AIC) for model selection) means the Applicants have a high degree of confidence in the selected best-fit model.

31. Alternatively, and whilst not specifically providing a measure of the model's predictive performance, the bootstrap resampling procedure used to estimate confidence intervals around the mean predicted results (as included in this revised report) provides a robust quantification of uncertainty around the point estimates. In practice, the Applicants consider the latter (i.e. robust estimates of uncertainty) to be a more useful measure of model performance than a "*yes/no*" answer to the question of "*does this predicted density surface closely match another one?",* especially when (as noted above) there is no objective yardstick to answer this question, meaning that the answer will instead rely on subjective appraisal.

2.2 Results

32. In total, the covariates in the best-fit model explained a good level of the variation in the data (44% of the variation in the survey data, of which 20% was due to the spatiotemporal term, that captured spatial patterns but carried no physical interpretation).

33. The partial response outputs (***Appendix 1***, ***Figure 4***) indicate the relative magnitude of response for each covariate with positive values indicating preference and negative values indicating avoidance. On this basis, red-throated divers:

- Preferred depths of less than 20m,
- Avoided distances to coast of less than 15km,
- Avoided areas with weekly average total shipping traffic above 150 (average shipping movements per week); and
- Show some displacement within 7km of windfarms and an increase in numbers at distances between 7 and 15km.

34. The strengths of the effects of all explanatory variables (distance from coast, bathymetry, shipping and distance from windfarms) was comparable, but the greatest uncertainty was evident in the distance from windfarms variable.

35. Comparison of the diver distribution prior to any windfarm installation (***Appendix 1***, ***Figure 6a***) with that following installation of all the windfarms in the analysis (***Appendix 1, Figure 8b***) indicates a consistent presence in the region equidistant between Kentish Flats, Gunfleet Sands and London Array (this was also reported in O'Brien et al. 2012). An area to the east of London Array appears to have an increase in density, while that around Kentish Flats has decreased.

36. Counterfactual outputs, predicting the distribution of divers to be expected in the absence of the current windfarms (***Appendix 1***, ***Figure 8a*** and ***7b***) reveal remarkably similar distributions: ***Appendix 1***, ***Figure 7a*** and ***6b*** for 2013 and ***Figure 8a*** and ***7b*** for 2018. Therefore, while the windfarms in the Outer Thames Estuary have influenced the distribution of divers, the effect does not appear to be as strong as that reported in the German Bight, and this echoes the recommendation in Vilela et al. (2019) that caution should be applied in drawing the results to other geographic areas.

37. The model generated predictions in terms of the relative density within the prediction grid cells. These relative densities were used to estimate the abundance in each cell by setting the SPA population to 20,000 individuals. This figure was selected as a realistic current population estimate; slightly higher than the estimated SPA population of 18,000 but slightly lower than the most recent survey estimates of 22,000 (Irwin et al. 2019).

38. On the basis of a nominal SPA population of 20,000 individuals, the average density within the SPA is estimated to be 5.1 birds/km^2. In ***Appendix 1, Figure 9***, the estimated average reduction in density with increasing distance from windfarms is plotted from a comparison of the modelled distributions, with and

without windfarms, for the 2013 density surface, 2018 density surface, and combined across both years. The densities were estimated at the scale of 0.25km^2 in the analysis, so when multiplied by four these provide densities per km^2.

39. This analysis indicates that the average maximum reduction in density at zero km (i.e. the region within the windfarm boundaries) was 0.52 birds/km^2. This declines to a zero reduction in density at 6 to 7 km.

40. The response to windfarms beyond 10km, with fluctuations around the line of neither strong avoidance nor attraction, dipping below (i.e. avoidance) at 20km is difficult to explain. There is no plausible explanation for why divers would show little or no response between 7km and 15km, followed by a subsequent increase in avoidance at greater distances, so this is considered to be an artefact of the analysis. It may also reflect the distribution of windfarms in the region, which are approximately regularly spaced, which could result in this pattern.

41. The predicted abundance within the windfarms inside the SPA (London Array, Kentish Flats and Gunfleet Sands) and sequential 1km buffers, obtained from the 2013 and 2018 model predictions and derived with and without the windfarm effect are provided in ***Table 1*** and ***Table 2***. The percentage reduction in each spatial area, calculated as the ‘with windfarm’ abundance divided by the ‘without windfarm’ abundance, is also presented.

42. Only the buffer regions within the SPA were included in the calculations (i.e. the buffers around London Array to the south which lie outside the SPA boundary were not included in the calculations).

Table 1 Comparison of modelled abundance and densities in all windfarms within the SPA and sequential 1km buffers, estimated using the 2013 model predictions calculated with and without the windfarm effect. Note that the right-most three columns now present the revised confidence intervals derived from bootstrap resampling (see text for details).

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarms	553	828	275	33.2%	-39.5 : 58.7	-327	486
0-1km	366	536	170	31.8%	-35.3 : 56.3	-189	302
1-2km	471	660	189	28.7%	-36.9 : 51.4	-244	339
2-3km	551	736	185	25.2%	-45.5 : 47.1	-335	347
3-4km	644	814	170	20.9%	-52.5 : 43.4	-427	353

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
4-5km	756	894	139	15.5%	-58.6 : 37.7	-524	337
5-6km	838	920	82	8.9%	-67.9 : 33.3	-625	306
6-7km	944	952	8	0.8%	-80.8 : 26.8	-769	255
7-8km	988	913	-76	-8.3%	-96.7 : 20.1	-882	184
8-9km	1055	902	-154	-17.1%	-104.4 : 15.2	-942	137
9-10km	1136	918	-218	-23.7%	-118.3 : 12.3	-1086	113
10-11km	1148	906	-242	-26.7%	-129.8 : 10.7	-1176	97
11-12km	1071	856	-215	-25.1%	-125.1 : 9	-1071	77
12-13km	928	778	-150	-19.3%	-113.9 : 7.4	-886	58
13-14km	632	573	-59	-10.3%	-103.9 : 8	-595	46
14-15km	374	375	0	0.1%	-91 : 20.2	-341	76

Table 2 Comparison of modelled abundance and densities in all windfarms within the SPA and sequential 1km buffers, estimated using the 2018 model predictions calculated with and without the windfarm effect. Note that the right-most three columns now present the revised confidence intervals derived from bootstrap resampling (see text for details).

Region	2018 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarms	685	1017	331	32.6%	-9.6 : 57.2	-98	582
0-1km	440	639	198	31.0%	-8.3 : 54.6	-53	349
1-2km	555	770	215	27.9%	-8.3 : 50.8	-64	391
2-3km	637	843	206	24.4%	-6.5 : 45	-54	379
3-4km	759	950	191	20.1%	-6.8 : 39.8	-65	378
4-5km	924	1083	159	14.7%	-7.5 : 35.7	-81	387

Region	2018 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
5-6km	1064	1156	91	7.9%	-13.2 : 29.1	-153	337
6-7km	1212	1209	-3	-0.3%	-23.6 : 20.1	-285	243
7-8km	1296	1185	-113	-9.5%	-36.5 : 10	-432	119
8-9km	1399	1184	-215	-18.2%	-47 : 7.7	-557	91
9-10km	1513	1211	-302	-24.9%	-59.3 : 5.5	-718	66
10-11km	1576	1232	-344	-27.9%	-63.4 : 3.6	-781	44
11-12km	1503	1190	-313	-26.3%	-65.1 : 1.4	-775	16
12-13km	1296	1075	-218	-20.3%	-59.8 : 0.8	-643	9
13-14km	815	730	-81	-11.1%	-53.2 : 1	-388	7
14-15km	466	462	-3	-0.5%	-87.7 : 47.3	-405	218

43. Positive percentage values indicate a lower abundance in the ‘with windfarm’ scenario compared to the ‘without windfarm’ scenario, while negative values indicate the opposite (i.e. higher values in the ‘with windfarm’ outputs). In both years a maximum reduction in abundance of 33% was estimated within the windfarms themselves, declining to a zero reduction in abundance in the 6-7 km buffer. Beyond 6-7 km the predicted abundances are higher with the windfarm effect included, indicating the shift in distribution caused by the reduced numbers in closer proximity to the windfarms.

44. These observations are similar to those reported for the London Array windfarm (APEM, 2018). From a comparison of pre- and post-construction densities, the estimated displacement within the London Array windfarm site was 55% and within 11km of the windfarm site, densities were lower post-construction compared with pre-construction, following a slope of displacement from 55% to 0% by 11km. It should be noted that this distribution was not a wholesale change from that observed prior to windfarm construction which showed similar densities (within up to 9km). Therefore, while the windfarm does appear to have reduced densities, the windfarm appears to have amplified the existing distribution of high and low densities rather than changed it overall. As with the results of the current

analysis, divers were not completely displaced from any parts of the study area, including London Array itself.

45. The difference between the summed predicted abundance within 7km, with windfarms and without, was 1,218 and 1,393 in 2013 and 2018, respectively. This represents approximately 6-7% of the SPA population.

46. Further evidence for different behaviour and habitat preference between UK southern North Sea and German Bight can be seen in the estimated relationship with depth (***Appendix 1***, ***Figure 4***). In the current study, the relationship with depth is a straight line with all depths less than 20m preferred. In Dorsch et al. (2019) a peak in depth preference was found at 25m, with both shallower (<10m) and deeper regions depths avoided. This may reflect differing prey preferences which influence foraging behaviour.

47. The 2013 and 2018 model predictions have also been used to predict the potential displacement effect in the SPA caused by East Anglia ONE North (***Table 3*** and ***Table 4***). The East Anglia ONE North windfarm site does not overlap the SPA, and following the project design revision there is now a 2km buffer between the closest part of the windfarm and the SPA boundary. However, the area of potential effect still overlaps part of the SPA. The estimated diver abundance in the windfarm site itself using the 2013 model predictions was 7 individuals and using the 2018 model predictions was 38 individuals. The respective estimates without the windfarm effect were 13 and 69 individuals. It should be noted that the maximum extent of displacement estimated using the 2013 predictions was in the 7-8km buffer (i.e. to 8km) while the equivalent for the 2018 predictions was the 8-9km buffer (i.e. to 9km).

Table 3 Comparison of modelled abundance and densities in East Anglia ONE North and sequential 1 km buffers, estimated using the 2013 model predictions calculated with and without the wind farm effect. Note that the right-most three columns now present the revised confidence intervals derived from bootstrap resampling (see text for details).

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarm	7.5	13	5	42.2%	-20.4 : 64.3	-3	8
0-1km	0.6	1	0	40.7%	-17.1 : 62.2	0	1
1-2km	4	6.4	2	38.2%	-18.6 : 57.9	-1	4
2-3km	7.8	12	4	35.1%	-25.8 : 54.3	-3	7

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
3-4km	13.8	20.2	6	31.4%	-31.8 : 51.1	-6	10
4-5km	20.3	27.8	7	26.8%	-37 : 46.2	-10	13
5-6km	27.7	35.2	7	20.9%	-45.2 : 42.3	-16	15
6-7km	36.4	42.5	6	13.9%	-56.6 : 36.6	-24	16
7-8km	39.1	41.7	3	6.2%	-70.2 : 30.9	-29	13
8-9km	44.4	43.9	-1	-1.3%	-76.5 : 26.8	-34	12
9-10km	57.1	53.4	-4	-7.1%	-88.5 : 24.3	-47	13
10-11km	77.2	70.6	-7	-9.7%	-98.4 : 22.9	-69	16
11-12km	93.8	86.8	-7	-8.3%	-94.2 : 21.5	-82	19
12-13km	102.4	99.7	-3	-3.1%	-84.2 : 20.3	-84	20
13-14km	95.5	100.6	5	4.9%	-75.3 : 20.9	-76	21
14-15km	98.3	114.4	16	13.8%	-64.3 : 31.4	-74	36

Table 4 Comparison of modelled abundance and densities in East Anglia ONE North and sequential 1 km buffers, estimated using the 2018 model predictions calculated with and without the wind farm effect. Note that the right-most three columns now present the revised confidence intervals derived from bootstrap resampling (see text for details).

Region	2018 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarm	38.3	68.8	30	44.2%	6.3 : 63.4	4	44
0-1km	0.2	0.3	0	43.0%	7.3 : 61.1	0	0
1-2km	1.3	2.1	1	40.4%	7.3 : 57.9	0	1
2-3km	2.3	3.7	1	37.5%	8.9 : 52.9	0	2
3-4km	3.9	5.8	2	34.0%	8.5 : 48.4	0	3
4-5km	4.7	6.7	2	29.5%	8.0 : 45.0	1	3
5-6km	5.3	7.0	2	23.8%	3.2 : 39.4	0	3
6-7km	6.1	7.4	1	17.1%	-5.8 : 31.5	0	2
7-8km	6.0	6.6	1	9.5%	-16.8 : 23	-1	2
8-9km	6.6	6.7	0	2.2%	-25.8 : 21	-2	1
9-10km	9.0	8.7	0	-3.3%	-36.2 : 19.1	-3	2
10-11km	13.6	12.9	-1	-5.8%	-39.7 : 17.6	-5	2
11-12km	16.8	16.1	-1	-4.5%	-41.2 : 15.7	-7	3
12-13km	18.1	18.3	0	0.4%	-36.5 : 15.3	-7	3
13-14km	17.1	18.7	2	8.1%	-30.8 : 15.5	-6	3
14-15km	18.0	21.6	4	16.8%	-30.8 : 26.2	-7	6

48. Using both prediction years, the maximum reduction in abundance in the windfarm was 42-44% declining to a zero reduction in abundance in the 8-9 km buffer using both the 2013 and 2018 predictions. While the predicted distance over which the displacement effect extends is slightly further for East Anglia ONE North, the actual number of individuals involved is much smaller than for the windfarms located within the SPA: two orders of magnitude smaller using the 2013 data and three orders of magnitude smaller using the 2018 data. Thus, the

sum of individuals in the overlap of the SPA and the windfarm buffers (i.e. 2 to 8km with the windfarm) using the 2013 predictions is 145, compared to the without windfarm total of 179, indicating that even using the higher predictions, only 34 individuals would be displaced[2]. The 2018 equivalents (up to 9km) are 35 with the windfarm and 44 without, indicating that 9 individuals would be displaced[2]. These represent reductions in displacement of 8% compared with the equivalent estimates calculated with the inclusion of the 0-1km and 1-2k windfarm buffers (i.e. the estimates prior to the windfarm boundary commitment of pulling back to a minimum of 2km from the SPA (see ***Appendix 3***).

49. The low number of individuals predicted to be at risk is largely a reflection of the low densities recorded in the part of the SPA adjacent to East Anglia ONE North, which would appear to be a less preferred region of the SPA.

50. Notably, if the alternative (and previously advised) approach of assuming 100% displacement within the 4km buffer is applied, the total numbers at risk of displacement are 40 and 12 in 2013 and 2018, respectively. These are very similar to the results obtained from the spatial modelling conducted here (34 and 9) and therefore the methods applied in the original assessment (i.e. 100% displaced within 4km), based on previous study observations, appears to have been a robust basis for assessing displacement for this species.

51. Following their review of the original version of this report (REP3-049), NE advised that assessment should also be presented on the assumption of a displacement distance of up to 12km and a within windfarm displacement rate of up to 100%, declining to 0% at 12km.

52. ***Table 5*** provides these outputs, alongside those presented in ***Table 3***. The abundance in each 1km buffer are those estimated from the 2013 without windfarm predictions, on the basis that these were higher than the 2018 predictions and therefore represent the worst case. The percentage displaced in each 1km buffer was calculated as a straight-line relationship (from 100% at 0km to 0% at 12km).

53. The displacement within the East Anglia ONE North buffers from 2km to 8km estimated using the spatial models was a total 34 individuals, which at a precautionary 10% mortality rate suggests 3 individuals might suffer mortality. The NE advised outputs, across the 2km to 12km buffers, gives an estimate of 127 displaced individuals, which equates to 13 individuals at risk of mortality. In terms of population level effects, the difference between 3 mortalities and 13 would not materially change the predicted population impact of displacement.

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[2] The shaded cells in ***Table 3 & 4***

54. Furthermore, although this comparison has not been undertaken using the 2018 predictions, since the modelled abundance was less than a third of the 2013 outputs, the NE proposed method would produce outputs in the same scale, that is the mortality of 13 would be predicted to be in the region of 4 individuals.

Table 5 Comparison of modelled abundance and densities in East Anglia ONE North and sequential 1 km buffers, estimated using the 2013 model predictions and compared with Natural England's advised 100% within windfarm displacement declining to 0% at 12km

Region	2013 Modelled abundance				Natural England advised 100% within windfarm to 0% at 12km		
	With wind farms	Without wind farms	Difference	Percentage reduction	Percentage displaced	Abundance with windfarms	Difference (compared to column 2 'without wind farms')
Windfarm	7.5	13	5	42.2%	100%	0	13
0-1km	0.6	1	0	40.7%	100%	0	1.0
1-2km	4	6.4	2	38.2%	91%	0.6	5.8
2-3km	7.8	12	4	35.1%	82%	2.2	9.8
3-4km	13.8	20.2	6	31.4%	73%	5.5	14.7
4-5km	20.3	27.8	7	26.8%	64%	10.0	17.8
5-6km	27.7	35.2	7	20.9%	55%	15.8	19.4
6-7km	36.4	42.5	6	13.9%	46%	23.0	19.6
7-8km	39.1	41.7	3	6.2%	37%	26.3	15.4
8-9km	44.4	43.9	-1	-1.3%	28%	31.6	12.3
9-10km	57.1	53.4	-4	-7.1%	19%	43.3	10.1
10-11km	77.2	70.6	-7	-9.7%	10%	63.5	7.1
11-12km	93.8	86.8	-7	-8.3%	1%	85.9	0.9
12-13km	102.4	99.7	-3	-3.1%	0%	99.7	
13-14km	95.5	100.6	5	4.9%	0%	100.6	
14-15km	98.3	114.4	16	13.8%	0%	114.4	

2.3 Implications

55. The current analysis has found a similar diver response to windfarms in the Outer Thames Estuary SPA as reported elsewhere, however, importantly it has also found evidence that the strength of this response is unlikely to be the same in all regions. In the German Bight, where divers congregate in spring, avoidance distances of up to 15-20km have been reported. In the Outer Thames Estuary, avoidance appears to occur over a much shorter range, with densities approaching background (i.e. unaffected) levels by 7km from offshore windfarms. The reasons for this are not currently apparent, but it is likely that this reflects a combination of habitat preferences and seasonality. However, the key message is that this is a clear indication that results obtained in one region are not automatically transferable to others.

56. This has considerable implications for how many individuals would be predicted to be affected by windfarm displacement, with a buffer of 4km combined with 100% displacement appearing to ensure a precautionary impact prediction (as has been recommended until very recently by Natural England). Application of a larger buffer of complete avoidance (e.g. up to 10km) is not supported by the current analysis and would result in over-estimating the potential displacement effects. It is also important to consider both the percentage of effect and also the actual numbers involved. In the case of East Anglia ONE North, on the basis of percentage of change (i.e. between with and without windfarms) a displacement effect of up to 40% would indicate a potentially large effect, until consideration is given to the numbers of individuals affected: no more than 37 birds would be displaced using the 2013 data and 10 using the 2018 data (approximately 23 on average). Even if a precautionary mortality rate of 10% is applied, this equates to a maximum mortality of 4 individuals. Even using NE's advised displacement rate and displacement distance (from 100% in the windfarm to 0% at 12km, derived from their review of the London Array monitoring), the range of mortalities predicted for East Anglia ONE North would be no more than 4 to 13 individuals.

57. Furthermore, the actual strength of the windfarm effect is very small (***Appendix 1***,***Figure 9)***, with the most marked effect (within the windfarm boundaries) being a reduction in diver density of 0.6 birds per km^2 (represented in ***Figure 9*** as -0.15 individuals per 0.25km^2 at zero distance)

58. Even in the most extreme case yet reported of red-throated diver displacement from offshore windfarms, in the German Bight during spring, Vilela et al. (2020) estimated that red-throated divers lost an area of foraging habitat (described as *'theoretical habitat loss'*) of 5km beyond the edge of offshore windfarms in the northern sub-area of the German Bight, but lost an area of foraging habitat of 2km beyond the edge of offshore windfarms in the southern sub-area of the German Bight. Vilela et al. (2020) found less clear evidence of displacement

during winter in these areas, probably because red-throated diver densities in the German Bight were much lower in winter than in spring. This German research is therefore consistent with the original recommendation of Natural England to employ a buffer of 4km in order to be precautionary when assessing displacement of red-throated divers.

59. The *effective* area of the SPA which would be subject to displacement can be found as the product of the area of each windfarm and their sequential 1km buffers and the predicted displacement percentages presented in ***Table 1*** to ***Table 4***. For example, in the case of the London Array windfarm, the windfarm itself covers an area of 122.2km^2. The estimated 2013 and 2018 displacement percentages in the windfarms were 33.2% and 32.6% respectively. Multiplying these together, the effective ~~habitat~~ area ~~losses~~of the SPA subject to displacement are 40.6km^2 and 39.8km^2. This calculation has been undertaken for London Array, Kentish Flats, Gunfleet Sands and East Anglia ONE North and the results are provided in ***Table 6*** to ***Table 9***.

Table 6 Effective ~~habitat loss~~area of the SPA subject to displacement for the London Array windfarm calculated using the 2013 and 2018 displacement percentages and area overlaps with the windfarms and buffers. The rates advised by NE are also included (i.e. from 100% in the windfarm to 0% in the 11-12km buffer).

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
Windfarm	122.2	33.2%	40.6	32.6%	39.8	100%	122.2
0-1km	40.9	31.8%	13.0	31.0%	12.7	100%	40.9
1-2km	45.5	28.7%	13.1	27.9%	12.7	91%	41.4
2-3km	50.9	25.2%	12.8	24.4%	12.4	82%	41.7
3-4km	55.2	20.9%	11.5	20.1%	11.1	73%	40.3
4-5km	57.6	15.5%	8.9	14.7%	8.5	64%	36.8
5-6km	58.3	8.9%	5.2	7.9%	4.6	55%	32.1
6-7km	60.5	0.8%	0.5	-0.3%	-0.2	46%	27.8
7-8km	63.5	n/a	n/a	n/a	n/a	37%	23.5

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
8-9km	66.1	n/a	n/a	n/a	n/a	28%	18.5
9-10km	68.8	n/a	n/a	n/a	n/a	19%	13.1
10-11km	73.9	n/a	n/a	n/a	n/a	10%	7.4
11-12km	79.2	n/a	n/a	n/a	n/a	0%	0
Total (km^2)	491.0 (842.5)		105.6		101.8		445.7
% of SPA (SPA total area = 3924km^2			2.7		2.6		11.4

Table 7 Effective ~~habitat loss~~area of the SPA subject to displacement for the Kentish Flats and Kentish Flats Extension windfarms calculated using the 2013 and 2018 displacement percentages and area overlaps with the windfarms and buffers. The rates advised by NE are also included (i.e. from 100% in the windfarm to 0% in the 11-12km buffer).

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
Windfarm	18.2	33.2%	6.1	32.6%	5.9	100%	18.2
0-1km	21.5	31.8%	6.8	31.0%	6.7	100%	21.5
1-2km	27.7	28.7%	7.9	27.9%	7.7	91%	25.2
2-3km	33.8	25.2%	8.5	24.4%	8.3	82%	27.7
3-4km	40.0	20.9%	8.4	20.1%	8.0	73%	29.2
4-5km	46.2	15.5%	7.2	14.7%	6.8	64%	29.6
5-6km	52.4	8.9%	4.7	7.9%	4.1	55%	28.8

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
6-7km	58.5	0.8%	0.5	-0.3%	n/a	46%	26.9
7-8km	61.9	n/a	n/a	n/a	n/a	37%	22.9
8-9km	59.01	n/a	n/a	n/a	n/a	28%	16.5
9-10km	60.8	n/a	n/a	n/a	n/a	19%	11.6
10-11km	58.2	n/a	n/a	n/a	n/a	10%	5.8
11-12km	58.5	n/a	n/a	n/a	n/a	0%	0
Total (km^2)	298.3 (596.9)		50.0		47.6		264.0
% of SPA (SPA total area = 3924km^2)			1.3		1.2		6.7

Table 8 Effective ~~habitat loss~~area of the SPA subject to displacement for the Gunfleet Sands I, II and III windfarms calculated using the 2013 and 2018 displacement percentages and area overlaps with the windfarms and buffers. The rates advised by NE are also included (i.e. from 100% in the windfarm to 0% in the 11-12km buffer).

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
Windfarm	18.4	33.2%	6.1	32.6%	6.0	100%	18.4
0-1km	27.5	31.8%	8.8	31.0%	8.5	100%	27.5
1-2km	30.1	28.7%	8.6	27.9%	8.4	91%	27.4
2-3km	31.5	25.2%	7.9	24.4%	7.7	82%	25.8
3-4km	34.8	20.9%	7.3	20.1%	7.0	73%	25.4

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
4-5km	36.8	15.5%	5.7	14.7%	5.4	64%	23.6
5-6km	38.1	8.9%	3.4	7.9%	3.0	55%	20.9
6-7km	42.4	0.8%	0.3	-0.3%	n/a	46%	19.5
7-8km	48.7	n/a	n/a	n/a	n/a	37%	18.0
8-9km	53.5	n/a	n/a	n/a	n/a	28%	15.0
9-10km	57.9	n/a	n/a	n/a	n/a	19%	11.0
10-11km	61.6	n/a	n/a	n/a	n/a	10%	6.2
11-12km	63.5	n/a	n/a	n/a	n/a	0%	0.0
Total (km^2)	259.5 (544.7)		48.1		46.0		238.6
% of SPA (SPA total area = 3924km^2)			1.2		1.2		6.1

Table 9 Effective ~~habitat loss~~area of the SPA subject to displacement for the East Anglia ONE North windfarm calculated using the 2013 and 2018 displacement percentages and area overlaps with the windfarms and buffers. The rates advised by NE are also included (i.e. from 100% in the windfarm to 0% in the 11-12km buffer).

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
Windfarm	0	42.2%	0.0	44.2%	0	100	0
0-1km	0	40.7%	0.0	43.0%	0	100	0
1-2km	0	38.2%	0.0	40.4%	0	91	0

Area	Area of OWF / buffer within SPA (km^2)	Estimated from best-fit spatial model (2013)		Estimated from best-fit spatial model (2018)		NE advised rates	
		Percentage reduction	Effective area of displacement (km2)	Percentage reduction	Effective area of displacement (km^2)	Percentage reduction	Effective area of displacement (km^2)
2-3km	8.7	35.1%	3.1	37.5%	3.3	82	7.1
3-4km	13.1	31.4%	4.1	34.0%	4.4	73	9.6
4-5km	13.7	26.8%	3.7	29.5%	4.0	64	8.8
5-6km	13.4	20.9%	2.8	23.8%	3.2	55	7.4
6-7km	13.7	13.9%	1.9	17.1%	2.3	46	6.3
7-8km	14.3	6.2%	0.9	9.5%	1.4	37	5.3
8-9km	14.9	-1.3%	n/a	2.2%	0.3	28	4.2
9-10km	17.5	n/a	n/a	n/a	n/a	19	3.3
10-11km	22.6	n/a	n/a	n/a	n/a	10	2.3
11-12km	26.1	n/a	n/a	n/a	n/a	1	0.3
Total (km^2)	91.7 (131.9)		16.4		19.0		51.4
% of SPA (SPA total area = 3924km^2)			0.4		0.5		1.4

60. The total *effective* area of the SPA estimated to be subject to displacement due to the operational windfarms for red-throated diver is 204km^2 using the 2013 predictions and 196km^2 using the 2018 predictions, and using NE's advised precautionary method is 948km^2[3]. Using the spatial modelling results, these equate to 5.0% to 5.2% of the SPA, while using NE's precautionary rate this represents 24.2% (of the total area of 3,294km^2). East Anglia ONE North adds between 16km^2 and 19km^2 to the total area (model results) or 54km^2 (NE

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[3] Note that this total double counts the area of overlap of the buffers of the London Array and Gunfleet Sands projects which is approximately 200km^2. Given that this is a simplistic model for illustration, we have not attempted to determine how the displacement effects between the two windfarms would be expressed. There is no overlap between the buffers of Kentish Flats and the other projects using NE's approach.

approach), which equates to an additional 0.4% to 0.5% (model results) or 1.4% (NE approach) of the total SPA area.

3 Ecological consequences of displacement

61. In order for an individual bird to be affected negatively as a consequence of being displaced by a windfarm there needs to be a cost to that individual (in terms of energy) that it would not have otherwise experienced. If displacement incurs no additional costs (in terms of a change to the individual's survival or reproduction prospects) then arguably the displacement is of no consequence. However, it is possible in the latter case that, while the displaced individual does not experience an additional cost, there is a knock-on effect on one or more other individuals due to the presence of the displaced individual, and those individuals have raised costs. It is through such interactions between individuals that the potential for an effect on the population may occur.

62. For wintering seabirds, such as red-throated divers in the southern North Sea, additional costs as a result of displacement might be expected due to:

- Exclusion from preferred foraging areas (i.e. ones with preferred prey species, or higher densities of prey);
- Increased densities in areas outside windfarms resulting in elevated competition in those locations for finite prey resources; or
- Increased vigilance due to higher densities or displacement into regions subject to other sources of displacement (e.g. shipping lanes) resulting in reduced time available for foraging.

63. Nonbreeding red-throated divers tend to occur at relatively low densities (typically less than 4 birds/km^2) and not in large aggregations (Dierschke et al. 2017). Therefore, in the absence of highly aggregated regions for this species, it appears unlikely that existing or planned windfarms occupy sites of particular importance for this species (i.e. red-throated diver distributions do not indicate the existence of sites of particular importance, evidenced by the fact that the coastline from Yorkshire to Kent is designated as SPAs for this species). Hence, the first mechanism above (exclusion from preferred foraging areas) is not considered to be applicable. It should also be noted that when foraging, red-throated divers show a clear preference for sea depths less than 20m (Duckworth e al. 2020), while the part of the SPA adjacent to East Anglia ONE North consists of depths between 30m and 50m. Therefore, the area of current focus would appear to be of low value as foraging habitat.

64. During the nonbreeding period, red-throated divers are highly mobile (Dorsch et al., 2020; Duckworth et al., 2020). In some instances, home ranges of many

thousands of square kilometres have been demonstrated (Nehls et al., 2018). This implies that following displacement, red-throated divers will be able to find alternative foraging sites, in some cases distant from the original area of displacement, which may be part of their existing non-breeding season range. Therefore, it appears that individuals of this species would be able to respond to increased competition and resultant reduced prey intake (if it occurred) by moving to alternative locations, thereby ameliorating the effect. In addition, a wide range of fish are preyed upon, including sandeel, sprat, flatfish, herring and members of the cod family (McGovern et al., 2016, Guse et al., 2009) Hence, it is considered that the second mechanism above (elevated densities leading to increased competition) also does not apply.

65. The final mechanism (increased vigilance leading to lower food intake and raised energy expenditure) rests on the premise that nonbreeding red-throated divers are operating close to a sustainable threshold. That is, the birds need to spend a significant part of each day during the winter foraging in order to obtain enough prey to maintain themselves and retain sufficient reserves for migration and breeding. A project combining geolocator tags and time-depth recorders (TDR) on this species is underway which aims to shed light on these questions (O’Brien et al. 2018). Preliminary outputs from this work have found that tagged birds spent 3-5 hours foraging per day during the non-breeding season (Duckworth et al. 2020). Although this has not yet been translated into energetic costs, these results do strongly indicate that red-throated divers have time available to increase foraging effort should their prey intake rate be reduced following displacement.

66. There is evidence that seabirds tend to be heavier in winter than during the breeding season (e.g. Coulson et al. 1983). It is reasonable to infer from this that most seabirds have relatively little difficulty in finding enough food during the nonbreeding season so can achieve higher body condition that buffers against short periods of adverse weather conditions. For example, puffins are 20-30% heavier in winter than in summer as a result of storing fat during the nonbreeding season, and the same is true of guillemots (Anker-Nilssen et al. 2018). If the same pattern occurs in red-throated divers, which is likely given their ecology and is supported by the tagging work to date (Duckworth et al. 2020), an implication is that their body condition would not be greatly affected by plausible levels of displacement or disturbance, since (as noted above) their time budgets do not appear to be constrained during this period.

67. The annual mortality of adult red-throated divers is around 16% per annum (Horswill and Robinson 2015) and this will include mortality (if any) caused by human disturbance in marine environments that has been occurring for decades. The amount of general ship traffic has increased up to the present time, but has

been high since the 1950s (IMO, Oskin 2014), while numbers of fishing vessels increased during the early 20th century but have decreased slightly in recent decades (Uberoi 2017). It is known that red-throated divers often tend to fly off when an approaching ship is about 1-2km away (Schwemmer et al. 2011). There is a case to be made that the net energy costs of flying away from approaching ships (and consequent loss of foraging time and opportunity) is likely to be considerably greater than the energy cost of avoiding static structures such as offshore wind turbines.

68. All offshore windfarms in UK North Sea waters combined, represent an extremely small fraction of potential foraging habitat of red-throated divers within UK North Sea waters. Therefore, it would seem appropriate to assess the plausible additional mortality caused by offshore windfarm displacement, barrier effects and associated increases in shipping traffic (both during construction and operation) as also being extremely small in relation to the existing total annual mortality (also given that this total annual mortality already includes any impact of existing (baseline) ship disturbance impacts: in 2012 an average of 86 vessel transits were identified by Automated Identification System data per day[4] in the waters off East Anglia; MMO 2014).

69. In this context, to suggest that displacement from an offshore windfarm might add up to 10% to the baseline mortality for all individuals that are displaced (the upper value advised by Natural England) is inconsistent with a total annual mortality of red-throated diver adults of only 16%.

70. The potential for displacement to result in a population level effect on migrant species such as red-throated diver depends on the relative degree of regulation on the breeding and nonbreeding area. The population will be constrained by whichever area imposes the stronger regulation.

71. The evidence strongly indicates that red-throated divers are limited by competition for safe breeding sites within range of foraging waters (Merrie 1978, Nummi et al. 2013, Rizzolo et al. 2014, Dahlen and Eriksson 2016), but they are unlikely to be in competition for resources during the nonbreeding season (Dierschke et al. 2012, 2017). Therefore, the population will only be regulated by effects in the nonbreeding areas if habitat ~~loss~~subject to displacement was so extensive, and the nonbreeding population density increased so much, that interference competition or prey depletion became a driving factor which exceeded that due to limited breeding habitat.

72. The most likely consequence is that displacement of red-throated divers will have effects which are too small to detect, as they are unlikely to be subject to density-

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[4] Note these data excluded commercial vessels less than 300 tonnes, recreational vessels, fishing vessels and military and government vessels on deployment.

dependent competition for resources during the nonbreeding season (Dierschke et al. 2017). Even though there are now many offshore windfarms in the southern North Sea and in the Baltic, the total area of these represents a very small fraction of the habitat used by nonbreeding red-throated divers throughout the southern North Sea and Baltic, so that the cumulative ~~habitat loss~~area of the SPA subject to displacement for red-throated divers is very small. The increase in density of red-throated divers caused by displacement away from offshore windfarms will therefore be extremely slight at the regional or biogeographic scale. However, the proportion of habitat ~~lost~~subject to displacement may be much higher over certain small areas. For example, Mendel et al. (2019) estimated that displacement from offshore windfarms in the German Bight results in ~~the~~an effective ~~loss~~area subject to displacement of 8.8% of the Eastern German Bight SPA habitat for these birds. However, it is important to note that while the Eastern German Bight SPA boundary reflects historical distributions of red-throated divers, it does not necessarily follow that this represents the actual extent of suitable habitat in the area, and this applies equally to other red-throated diver SPAs including the Outer Thames Estuary SPA. So, displacement may move a proportion of birds out of the SPA, but this does not necessarily mean they will no longer be able to forage successfully and that there will be a resultant population level effect.

73. The available evidence suggests that the most likely result of displacement is that there will be little or no impact on adult survival, and that any impact would probably be undetectable at the population level. Indeed, there is very little evidence to support the upper range of mortality effects for displaced birds advised by Natural England (e.g. up to 10%), and on the basis of a review of the studies (Vattenfall 2019), even an additional mortality rate of 1% is considered precautionary.

4 Legal protections afforded to the Outer Thames Estuary SPA

4.1 Basis of the legal protections

74. The Outer Thames Estuary SPA has been designated as a SPA in line with the Birds Directive. The relevant legal protections are set out in the Habitats Directive and the Birds Directive.

75. Article 6(2) of the Habitats Directive obliges the EU Member States to take steps to protect designated sites such as the Outer Thames Estuary SPA. In the Natura 2000 sites, the EU Member States are obliged to:

- Avoid the deterioration of natural habitats and the habitats of species for which the site has been designated; as well as
- Avoid the disturbance of the species for which the site has been designated, in so far as such disturbance could be significant in relation to the objectives of the Directive (as opposed to the conservation objectives for a particular site - the importance of this distinction is discussed below).

76. The objective of the Habitats Directive and the Birds Directive is to achieve a favourable conservation status for all the habitat types and species they protect across their entire range within the EU. The objective of the Birds Directive is formulated slightly differently, but the ambition is the same.

77. Article 6(3) of the Habitats Directive governs the legal protections applicable to the consent procedure for the consideration of plans and projects which are not directly connected with or necessary to the management of a protected site. This Article obliges the 'competent authority' to consider a two-staged assessment when determining whether to agree to a plan or project:

- Initially, it is necessary to consider whether the plan or project is likely to have a significant effect on a Natura 2000 site, either individually or in combination with other plans or projects. If it is determined that a significant effect on a Natura 2000 site is likely, the plan or project requires to be subject to "appropriate assessment" of its implications for the site in view of that site's conservation objectives.
- In the light of the conclusions of the appropriate assessment and subject to the provisions of Article 6(4), the consent for a plan or project should be granted only once the 'competent authority' ascertains that the particular plan or project will not adversely affect the integrity of a Natura 2000 site.

78. The conservation objectives for the Outer Thames Estuary SPA[5] are:

With regard to the SPA and the individual species and/or assemblage of species for which the site has been classified (the 'Qualifying Features' listed below), and subject to natural change;

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

a. the extent and distribution of the habitats of the qualifying features;
b. the structure and function of the habitats of the qualifying features;
c. the supporting processes on which the habitats of the qualifying features rely;
d. the populations of each of the qualifying features; and
e. the distribution of qualifying features within the site.

4.2 Baseline for assessment of effects of the Projects on the Outer Thames Estuary SPA

79. The tests prescribed in Article 6(3) of the Habitats Directive (as transposed in the UK by domestic legislation[6]) have to be considered based on an appropriate baseline for the assessment. The appropriate baseline should provide a description of the affected environment as it currently is, as well as how it could be expected to develop if the Projects were not to proceed. In other words, the assessment of baseline should be based on the identification of data about the existing environment, taking account of available sources of information. Amongst others, it should take account of recent analysis of the status of qualifying features of the protected site under consideration. This baseline should then inform the assessment of effects of the Projects.

80. The baseline for assessment of effects of the Projects on the Outer Thames Estuary SPA should take account of existing plans and projects which are reflected in the results of the relevant baseline surveys (i.e. projects that were already constructed and operational when the baseline surveys were undertaken). The relevant projects are listed in ***Table 10***. The baseline for assessment should also take account of the recent ~~analysis acknowledging~~

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[5] https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9020309&HasCA=1&NumMarineSeasonality=3&SiteNameDisplay=Outer%20Thames%20Estuary%20SPA#hlco

[6] In the context of the Applications, the Habitats Directive is transposed by the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (together "the Habitats Regulations").

~~favourable status~~reporting showing robust population counts of the non-breeding population of red-throated diver in the Outer Thames Estuary SPA.

81. The Applicants are of the opinion that some or all of the existing projects listed in ***Table 10*** (Gunfleet Sands, Kentish Flats and London Array) form part of the baseline and should not be included in the in-combination assessment of effects of the Projects. However, in light of Natural England's position on the matter an assessment including these projects in the in-combination assessment has been undertaken for illustrative purposes, using the methodology noted in ***section 5.3***. The conclusions of this illustrative assessment are noted in ***Table 11***.

4.3 Assessment of effects of the Projects on the Outer Thames Estuary SPA

82. The conservation objectives for the Outer Thames Estuary SPA include the objective to ensure that the integrity of the site is maintained or restored as appropriate, and to ensure that the site contributes to achieving the aims of the Birds Directive, by maintaining or restoring the population of each of the qualifying features (objective (d)); and the distribution of the qualifying features within the site (objective (e)). The qualifying features include red-throated diver.

83. It is necessary to determine whether the Projects will adversely affect the integrity of the Outer Thames Estuary SPA by appropriately assessing their implications for the site in view of the site's conservation objectives. The fact that a conservation objective of the Outer Thames Estuary SPA has been affected may mean that an appropriate assessment is required, but it does not necessarily mean that the integrity of the site has been adversely affected.

84. The Supplementary Advice on Conservation Objectives (Natural England, 2019) for the Outer Thames Estuary SPA notes a range of attributes which are considered to describe the site's ecological integrity. One of the attributes of red-throated diver is "Disturbance caused by human activity". The target associated with this attribute is to "*Reduce the frequency, duration and / or intensity of disturbance affecting roosting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed*". In this context, it is necessary to consider the significance of disturbance to red-throated diver resulting from the Projects.

85. "Significance" of disturbance in the context of the objectives of the Directive should be considered by reference to the objectives for the whole region or an EU Member State. The objectives of the Directive have to be distinguished from the conservation objectives of a particular site. A failure to meet a conservation objective of a particular site may not necessarily result in that disturbance being significant when that "significance" is considered by reference to the objectives of the Directive~~ as a whole~~.

86. The Supplementary Advice on Conservation Objectives (Natural England, 2019) for the Outer Thames Estuary SPA notes that 'Significant Disturbance' is defined by the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA, 2016). This definition sets out circumstances in which disturbance is likely to be significant, and indicates that this is only where there are impacts on populations of species. The definition states that this is a pre-requisite to significant disturbance.

87. Considerations of "disturbance" and "significance" have to be based on the degree of effect in question. "Significance" of "disturbance" should be considered by taking account of the conservation status of the red-throated diver, and the nature of the impact of the Projects by reference to the objectives of the Directive. For example, the significance of the disturbance will depend on factors such as the current number of members of the species being disturbed. Where a species faces possible extinction in the near future, any disturbance would be likely to be more significant. Other factors impacting on significance of disturbance could include the effects that particular disturbance has on the species' ability to reproduce, or on the life span of members of the species.

88. Recent analysis acknowledged ~~favourable status~~that there had been a significant increase of the non-breeding population of red-throated diver in the Outer Thames Estuary SPA, as reflected in the revision of the population estimate[7]. Assessment of effects on red-throated diver resulting from the Projects should take appropriate account of this~~ conclusion~~, focusing on the Outer Thames Estuary SPA's conservation objective to maintain (rather than restore) this species.

89. The Applicants' assessment and conclusion regarding the likely effects of the Projects are set out below.

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[7] See the reference to conservation objective to "maintain or enhance" (rather than restore) favourable condition of red-throated diver in the Outer Thames Estuary SPA as noted by JNCC at https://jncc.gov.uk/our-work/outer-thames-estuary-spa/#site. Also see the references to 'maintaining' (rather than restoring) red-throated diver in the Outer Thames Estuary SPA as noted in the Supplementary Advice on Conservation Objectives (see the Attribute for Non-breeding population abundance and associated target) (Natural England, 2019) at https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK9020309&SiteName=outer+thames&SiteNameDisplay=Outer+Thames+Estuary+SPA&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=3.

5 Assessment

90. The analysis and discussion above have considered the evidence of displacement of red-throated diver from operational windfarms in the Outer Thames Estuary SPA and the potential ecological consequences of that displacement. This section presents those finding in relation to the conservation objectives for the Outer Thames Estuary SPA.

5.1 Project Alone Assessment East Anglia ONE North

91. As detailed in the Information to Support Appropriate Assessment (APP-043), the construction of the Projects will not have an effect on objectives (a) to (c) which relate to the physical state of the habitats of the qualifying features. Effects upon the supporting features are discussed in relevant chapters of the Environmental Statement (as summarised in ***Applicant's Comments on Relevant Representations - Appendix 5: Outer Thames Estuary Cabling Note*** (AS-042) and assessed again in the clarification note, ***Effects on Outer Thames Estuary SPA Supporting Habitats*** (to be submitted at Deadline 3, document reference ExA.AS-13.D3.V1).

92. There is potential for a very small effect on the population of red-throated diver (objective d), however as noted in the results of the modelling presented here, the magnitude of this effect at worst (4 mortalities) would increase the natural mortality rate by less than 0.1%, which would be undetectable, therefore this objective will not be affected. The fact that during the period when the Kentish Flats, Gunfleet Sands and London Array windfarms were constructed in the SPA, the estimated red-throated diver SPA population has increased from approximately 6,000 (in 2005) to 18,000 (in 2018), further supports the prediction that there will be no effect on the population due to the construction of the East Anglia ONE North windfarm. Over the survey period the population estimates have shown a more or less straight-line increase. It must be acknowledged that this population increase may in part be due to improved survey methods, with the original estimate derived from visual aerial surveys and the latter two from digital aerial surveys. However, while this change from observers to digital imagery could potentially account for the increase from 6,000 (in 2005) to 14000 (in 2013), it is rather less likely that methodological differences would account for the subsequent increase to over 18,000 (2018) since the 2013 and 2018 surveys were both undertaken using digital survey methods. Therefore, at the very least, while the windfarms were constructed in the SPA the population must be considered to have remained stable, and has very likely increased to some degree.

93. With respect to the distribution of the qualifying features within the SPA (objective e), in NE's advice to the Applicants (Appendix A4 to the Natural England Deadline 1 Submission (REP1-172), it was stated that areas of the Outer Thames Estuary SPA within 10km of windfarms would be subject to some degree of displacement. With respect to East Anglia ONE North this equates to 2.8% of the SPA by area. The current analysis has found that the 10km distance, as derived from studies conducted in the German Bight, is not applicable to the Outer Thames region and that a maximum of 9km (as estimated for East Anglia ONE North with the 2018 predictions) is a more appropriate maximum distance to consider (for East Anglia ONE North), which equates to 2.3% of the SPA by area. However, it is important to consider the magnitude of displacement within the region of the disturbance effect. Hence, the 2.3% value (based just on the complete area of overlap between the East Anglia ONE North 9km buffer and the SPA) needs to be considered alongside the difference in the estimated abundance of red-throated diver in the SPA within the overlap of the 9km windfarm buffer, derived from the model predictions calculated with and without windfarms. Adjusting the SPA overlap area within each buffer (from 2km to 9km) by the respective displacement percentage provides the *effective* ~~habitat loss~~area of the SPA subject to displacement, which is 0.4-0.5% of the SPA (***Table 9***), an area almost 5 times smaller than the simple overlap of 2.3%.

94. Using the 2013 results, this difference (i.e. the number of birds predicted to be displaced) was 34 and using the 2018 results this was 9. These represent approximately 0.05-0.2% of the SPA population. In other words, by undertaking the analysis requested by NE (modelling the distribution of birds from the survey data and using these models to investigate how windfarms have affected the distributions), it can be seen that between 11 and 46 times fewer birds (2.3% divided by 0.05-0.2%) are predicted to be at risk of displacement within 9km and 15 to 56 times fewer birds (2.8% divided by 0.05-0.2%) are predicted to be at risk within NE's proposed 10km buffer than would be the case if area alone was used as the metric for assessing the effect.

95. As noted above, the displacement of birds from the section of SPA which overlaps with the 9km buffer from East Anglia ONE North may result in a redistribution of up to 34 individuals (0.2% of the population) within the SPA. Even if the worst case mortality rate of 10%, advised by Natural England, is applied, this amounts to only 3 birds at risk of mortality due to displacement, from a population of approximately 20,000 individuals. In addition, as discussed in ***section 3*** above, the part of the Outer Thames Estuary SPA within the windfarm buffer zone is not characterised by features known to be associated with preferred foraging habitat (i.e. water depths of less than 20m), and therefore the consequence of displacement is expected to be at the lower end of the range of

potential impacts (i.e. 1% mortality at most, equivalent to less than one mortality every two years).

96. On the basis that only one of the conservation objectives is predicted to be affected, and the magnitude of that effect has been demonstrated to be very small, the Applicants consider that an adverse effect on the integrity of the SPA can be ruled out due to East Anglia ONE North alone.

5.2 Project Alone Assessment East Anglia TWO

97. The East Anglia TWO windfarm site is 8.3km from the Outer Thames Estuary SPA boundary. Given this distance, on the basis of the modelling presented in this report and the finding that displacement declines to zero by 7km, it is considered that there will be no disturbance upon the red-throated diver population of the SPA due to East Anglia TWO and there will therefore be no displacement effect and resultant change in distribution.

98. The Applicants consider that an adverse effect on the integrity of the SPA can be ruled out due to East Anglia TWO alone.

5.3 In-Combination Assessment

99. Several of the windfarms suggested by NE as sources of displacement were in operation prior to designation of the SPA (in August 2010), or were operational before the 2018 surveys for the revised population estimate for the SPA were conducted (see ***Table 10***). Furthermore, Kentish Flats, Gunfleet Sands, Thanet and Greater Gabbard were also fully operational prior to the surveys conducted in 2013 (***Table 10***).

Table 10 Windfarms within or in close proximity to the Outer Thames Estuary SPA

Within SPA	Outwith SPA
Pre-designation of SPA	
Kentish Flats operational (2005)	Thanet operational (2010) approx. 8km from boundary
Gunfleet Sands I & II operational (2010)	Greater Gabbard (construction from 2008, operational 2012) approx. 8km from boundary
London Array (consented 2006, construction 2011, operational 2013)	
Post designation of SPA	
Kentish Flats Extension (construction 2014, operational 2015)	Galloper (construction 2016, operational 2018) approx. 10km from boundary
Gunfleet III is two turbines (operational 2013)	

100. Given the project alone conclusion for East Anglia TWO, this project is not included in the in-combination assessment. In addition, given the distances of Thanet, Greater Gabbard and Galloper Offshore Wind Farms from the Outer Thames Estuary SPA (see ***Table 10***), it is also considered that there will be no disturbance upon the red-throated diver population of the SPA and no displacement effect and resultant change in distribution. These projects are therefore too far away to affect the SPA and consequently there is no basis for including them in the in-combination assessment.

101. With respect to the remaining projects, the Applicants therefore consider that several, if not all, of these projects should actually be considered as part of the baseline irrespective of any displacement effect they may be causing. This is due to the fact that they were either operational prior to the designation of the SPA in 2010, or they became operational in the period during which the revised baseline population figure was determined by NE (Natural England, 2019).

102. Notwithstanding this last point, the Applicants have undertaken the following in-combination assessment on the basis that effects from Gunfleet Sands (I, II and III), Kentish Flats, Kentish Flats Extension and London Array are included.

103. With respect to the distribution of the qualifying features within the SPA (objective e), in NE's advice to the Applicants (Appendix A4 to the Natural England Deadline 1 Submission (REP1-172), it was stated that areas of the Outer Thames Estuary SPA within 10km of the existing windfarms would be subject to some degree of displacement and that this equates to 47% of the SPA by area. As noted above, the current analysis has found that 7km is a more appropriate maximum distance to consider. This distance includes 31% of the SPA by area.

104. This is clearly still a significant part of the SPA~~,~~ however it is equally important to consider the magnitude of predicted displacement within this region. Hence, the 31% value (based just on the area of overlap between windfarm buffers and the SPA) needs to be considered in the context of the difference in the estimated abundance of red-throated diver within 7km of the windfarm locations, derived from the model predictions calculated with and without windfarms. Using the 2013 results this difference (i.e. the number of birds predicted to be displaced) was 1,218 and using the 2018 results this was 1,393. These represent approximately 6-7% of the SPA population. In other words, by undertaking the analysis requested by NE (modelling the distribution of birds from the survey data and using these models to investigate how windfarms have affected the distributions), it can be seen that 4 to 5 times fewer birds (31% divided by 6-7%) are predicted to be at risk of displacement within 7km, and 7 to 8 times fewer (47% divided by 6-7%) within NE's proposed buffer of 10km than would be the case if area alone was used as the metric.

105. The potential effect can also be considered in terms of the *effective* area over which displacement could occur. To estimate this, the overlaps between the buffers and the SPA were multiplied by the percentage of predicted displacement for each of the windfarms included in the assessment (***Table 6*** to ***Table 9***). This provides a measure of the area of the SPA affected, adjusted to account for the degree of displacement, and indicates that the *effective* area of in-combination ~~habitat loss~~displacement for the operational windfarms (London Array, Kentish Flats and Gunfleet Sands) is between 5.0% and 5.2% of the SPA, to which East Anglia ONE North will add 0.4% to 0.5%. Compared with the simple area overlap of windfarms and their 7km buffers, the *effective* area of in-combination ~~habitat loss~~displacement, (taking into account the results of the modelling presented here and the decline in effect with distance) is 6 times smaller.

106. This conclusion applies to the existing windfarms within the Outer Thames Estuary SPA, while for the East Anglia ONE North windfarm, the total number of birds predicted to be displaced is no more than 34 individuals. Adding this to the worst case for existing windfarms (1,393) gives an in-combination total of 1,427 individuals at risk of displacement, and at 10% mortality, a total of 143 individuals which equates to 0.7% of the SPA population.

107. However, as discussed in ***section 3*** above, a mortality rate of 1% is considered more realistic and precautionary for this species and impact (see Vattenfall 2019 for a discussion of evidence for red-throated diver displacement mortality), which would result in less than 0.1% of the population at risk of in-combination displacement mortality.

108. As discussed above, the fact that the red-throated diver population has either remained stable, or as seems more probable, increased, over the period that windfarms have been constructed within the SPA, is strongly indicative that displacement has not had any detrimental effects on the population. To illustrate, it is informative to consider the alternative situation which would be expected if displacement had occurred in the manner proposed by NE. With 47% of the SPA within 10km of the operational windfarms, and assuming a linear decrease in displacement from 100% in the windfarms to 0% at 10km, the effective area of 100% impact would be 23.5% of the SPA[8] (i.e. half of 47%). Combined with a 10% mortality rate, this would indicate annual mortality of 2.4% of the SPA population due to displacement. From an initial population of approximately 6,000 prior to the windfarms' construction, after a decade the population would decline to around 4,800. In contrast the monitoring surveys have found that the population has either remained stable (and survey methods have markedly improved) or has increased by up to 13% per year. It would seem apparent that

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[8] Note that ***Table 6*** to ***Table 9*** provide these figures out to 12km, which equates to an in-combination total of 24.2% of the SPA

it is simply not feasible that both NE's predicted displacement effect and the increased or stable population are compatible, and given current evidence, more weight should be given to the monitoring data.

109. On this basis, the Applicants do not consider there to be an existing in-combination adverse effect on the SPA integrity as a result of displacement, and the small addition from the East Anglia ONE North project will not change this. Therefore, the Projects will not result in an adverse effect on the integrity of the Outer Thames Estuary SPA either alone or in-combination with other plans and projects. This is summarised in ***Table 11***.

Table 11 Summary of assessment of potential effects on the red-throated diver feature of the Outer Thames Estuary SPA conservation objectives.

Conservation objective	Summary of assessment	Conclusion		
		East Anglia ONE North alone	East Anglia TWO	In-combination
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:				
a) the extent and distribution of the habitats of the qualifying features	The Projects are outside the SPA therefore this objective is unaffected	No AEOI	No AEOI	No AEOI
b) the structure and function of the habitats of the qualifying features	The Projects are outside the SPA therefore this objective is unaffected	No AEOI	No AEOI	No AEOI
c) the supporting processes on which the habitats of the qualifying features rely	The Projects are outside the SPA therefore this objective is unaffected	No AEOI	No AEOI	No AEOI
d) the populations of each of the qualifying features	Very small magnitude of impact for East Anglia ONE North (max. mortality is 4). No effect due to East Anglia TWO as located beyond extent of predicted displacement extent. In-combination effect almost exclusively due to existing windfarms within SPA, but even these do not appear to have had a significant effect since the population has shown no indication of decline following construction.	No AEOI	No AEOI	No AEOI

Conservation objective	Summary of assessment	Conclusion		
		East Anglia ONE North alone	**East Anglia TWO**	**In-combination**
Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:				
e) the distribution of qualifying features within the site	There is potential for a small redistribution effect, but even in-combination this will only affect 5% of the SPA (derived as area x displacement percentage) and there is evidence that divers already avoided location of largest contributor to overall effect (London Array) prior to its construction so this is not a complete redistribution.	No AEOI	No AEOI	No AEOI

6 References

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O'Brien, S.H., Webb, A., Brewer, M.J. and 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.

Vattenfall (2019) Norfolk Vanguard Offshore Wind Farm The Applicant Responses to First Written Questions Appendix 3.1 - Red-throated diver displacement (https://infrastructure.planninginspectorate.gov.uk/wpcontent/ipc/uploads/projects/EN010079/EN010079-002249-Womble%20Bond%20Dickinson%20on%20Behalf%20of%20Norfolk%20Vanguard%20-%20Appendices%20to%20written%20Questions-%20Email%204.pdf)

Vilela, R., Burger, C., Diederichs, A., Nehls, G., Bachl, F., Szostek, L., Freund, A., Braasch, A., Bellebaum, J., Beckers, B., Piper, W. (2020). Final Report: Divers (Gavia spp.) in the German North Sea: Changes in Abundance and Effects of Offshore Wind Farms. A study into diver abundance and distribution based on aerial survey data in the German North Sea. BioConsult Report prepared for Bundesverband der Windparkbetreiber Offshore e.V.

Appendix 1

Modelling the displacement effects of windfarms on red throated divers *Gavia stellata* in the Thames Estuary area from 2003 to 2018

Table of Contents

1 Objectives

1) Model of spatial-temporal abundance
2) Control for confounders
3) Detect the effect of distance from windfarm
4) Quantify the shape of this relationship
5) Examine proportion of population affected (including uncertainty)

2 Methods

2.1 Environmental Data

1. We used three static and one time-dependent environmental variables. The static variables were Distance from coast, Bathymetry and Shipping traffic (**Figure 2** a b and c). The time-dependent variable was Distance to windfarm, which changes as new windfarms have come into operation (e.g. **Figure 2** d and e). We decided against truncation of the distance covariates, even though features may be visually imperceptible at greater-than-horizon distances. Nevertheless, we also examined versions of the model (not presented here) with truncation, to confirm that our results would be robust to such effects. The results presented here had effectively no truncation (we set the distance truncation value to 50km for computational reasons). We found very few differences in the results of models with and without truncation of distances. Below, we present only the results without truncation.

2.2 Survey Data

2. We collated all the years of data from different platforms conducted before, during and after the construction of the existing windfarms. These are visually summarised in **Figure 3**. The count data generated from these surveys were analysed in their raw form, but the effective strip area corresponding to each count was passed to the models as a proxy of relative effort (a model offset). This allowed the different surveys to be combined under a single analysis.

2.3 Analytical Approach

3. The nature of the problem is fundamentally spatio-temporal. We need to account for four types of change that occur through time. First, the effect of dynamic covariates such as the positions of windfarms coming into operation. Second, intrinsic distributional processes that are either the result of density dependence (autocovariates) or extrinsic variables for which we have no data (missing covariates). Third, shifts in the location and methodology of surveys (variable effort). Fourth, the effect of windfarm construction that happened after the

surveys had begun. We have used a statistical modelling approach (Generalised Additive Models (Wood 2006, 2013) within the R library MGCV), which accounted for confounding variables on the effect of windfarms. The model permitted the estimation of a flexible curve describing spatial utilisation by red throated divers at increasing distances from the windfarms (Points within the windfarm boundary were assigned a distance of zero).

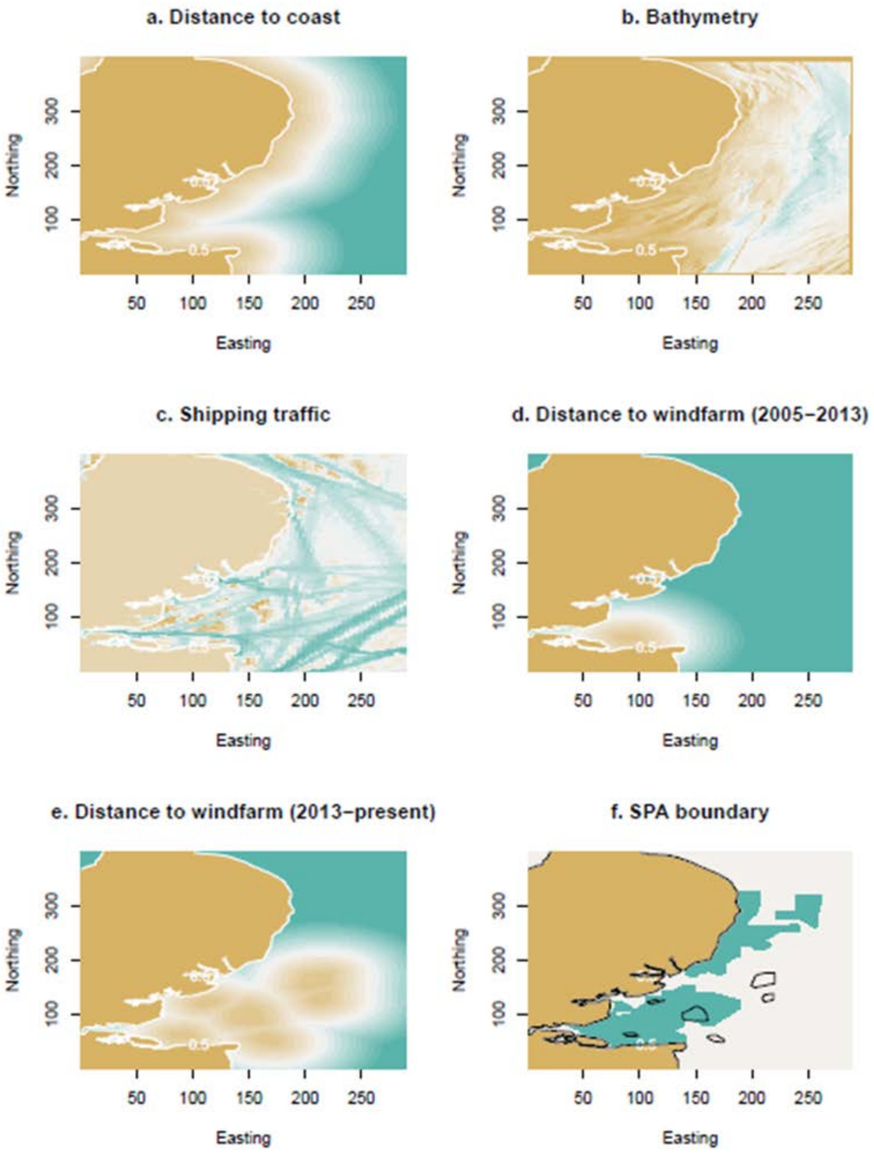


Figure 2: The different spatial layers used for modelling. The SPA boundary (shown as a turquoise area in plate f) was used purely for usage calculations and not as an explanatory variable in the statistical modelling. The black polygons in plate f represent the extent of existing windfarms

Figure 3 Survey effort at three different periods of the windfarm development

2.4 Treatment of Covariates

4. During model fitting, the survey counts were matched with contemporaneous covariate data (for the dynamic covariates). The continuous variable *Year*, was included as a fixed effect to account for trends in the overall abundance of red throated divers.

2.5 Treatment of Response

5. By default, the stochastic component of the response variable would be taken to be Poisson, but the possibility of overdispersion in the model residuals would also need to be considered. For this reason, we examined two more stochastic components, a Tweedie distribution and a negative binomial. Both were implemented with the ability to estimate overdispersion parameters during model fitting (i.e. overdispersion parameters were not hard-wired by the user).

2.6 Treatment of Spatiotemporal Autocorrelation

6. Three versions of the models were considered. The first did not contain specific spatio-temporal references. The implicit assumption in this model was that all variability not explained by the habitat covariates was spatially and temporally independent. The second contained an isotropic smooth in Easting and Northing. This assumed that there was a spatially autocorrelated structure in the data that remained constant from one year to the next. The third model structure implemented an interaction term between the year (treated as a factor) and the isotropic spatial smooth. This allowed the residual spatial structure to change

each year, hence accommodating other dynamic covariates that may not be known to us.

2.7 Model Selection

7. The combination of the three different stochastic components for the response, and the three different spatiotemporal structures, led to nine models in total. We compared those using the AIC, as described in Wood (2006, 2013). From that point on, to ensure parsimonious models we investigated two further extensions for the model with the lowest AIC. First, we increased the penalisation of flexibility in the modelled responses, using a sample-size dependent penalty, much like the one used by BIC. Second, we implemented the smooth components with a shrinkage tendency to achieve a more automatic approach to model selection. Both of these approaches are unsupervised, so we compared them with the best model from the original selection.

2.8 Outputs Produced

8. In addition to the outcome of the model selection comparison and the summary statistics for the prevailing model, to explore the direction and shape of the relationships of bird abundance with the explanatory variables, we generated partial plots of the fitted smooths. To visualise their collective effect on bird distribution we created reconstructions of expected distribution before (2002, 2006) and after (2013, 2018) windfarm construction. We also generated counterfactual scenarios for 2013 and 2018, which looked at the expected distribution of birds under the hypothetical scenario of the windfarms being absent. We calculated what percentage of the total number of birds in each plot was expected to be found inside the area of the windfarms in all 6 of those scenarios. Indicatively, these numbers were calculated as percentages of the usage enclosed in the designated SPA. Finally, to examine displacement in greater detail we generated comparison plots between 2013 and 2013 counterfactual, and again for 2018 and 2018 counterfactual. These plots looked directly at the estimated change (reduction or increase) of red-throated diver usage at different distances from the windfarm boundaries. Post-hoc analysis of these results was conducted using a univariate GAM of usage change as a function of distance from windfarms.

3 Results

9. The models evaluated initially were the following nine (made up of combinations of the three stochastic families and the three combinations of the spatiotemporal treatment). These were compared on the basis of their AIC, as well as standard diagnostics for the residuals. Quality of fit (measured as the proportion of deviance explained ranged from 19% for the simplest model 1_1, to 44% for the most complicated model 3_3. Given the very limited set of environmental covariates this higher value of 44% was satisfactory, particularly given that the comparatively high explanatory power of that model was not rejected by the model-selection procedure. A comparison of explanatory power (deviance explained) between model 3_1 and model 3_3 indicates that approx. 20% of the best model's explained deviance was owed to the spatiotemporal term included in the latter model. This term has no biological interpretation, but it merely indicates the existence of detectable spatial patterns that did not appear to remain constant over time. Therefore, future predictive models that aim to capture as much as possible of the residual variability should focus on dynamical covariates that present strong interannual variation.

Table 1 Summary model results

Model	Deviance Explained	Degrees of Freedom	AIC
1_1 Poisson, no space-time	20	34	2.3681474×10^4
1_2 Poisson, space, no time	23	63	2.3016959×10^4
1_3 Poisson, space-time	41	215	1.9024022×10^4
2_1 Tweedie, no space-time	21	30	2.9428778×10^4
2_2 Tweedie, space, no time	24	52	2.9341626×10^4
2_3 Tweedie, space-time	40	162	2.8762102×10^4
3_1 Neg Bin, no space-time	25	29	1.5738826×10^4
3_2 Neg Bin, space, no time	29	50	1.5555325×10^4

Model	Deviance Explained	Degrees of Freedom	AIC
3_3 Neg Bin, space-time	44	151	1.4497402×10^4
3_3_1 Neg Bin, space-time, penalised	37	66	1.4904213×10^4
3_3_2 Neg Bin, space-time, shrinkage	43	137	1.4546341×10^4

10. The best-performing model (model 3_3) had a fully spatial and temporal structure combined with a negative binomial likelihood. The automatic penalisation and shrinkage extensions of this model (models 3.3.1 and 3.3.2 in ***Table 1***) did not improve the AIC. Plotting some of the partial responses for this variable (**Figure 4**) shows the effects of depth (deep waters are avoided), distance from coast (greater distances are preferred) and shipping (ships are avoided) in the distribution of the birds. Clearing up the observed variability to the best possible extent allowed by these confounding variables, we see a clear inflection point in the avoidance of windfarms by red throated divers, at distances smaller than 10km. Fluctuations of the curve at distances beyond 10km are also apparent with very broad confidence intervals. Distance effects are examined in more detail by the aggregate plots later in the report.

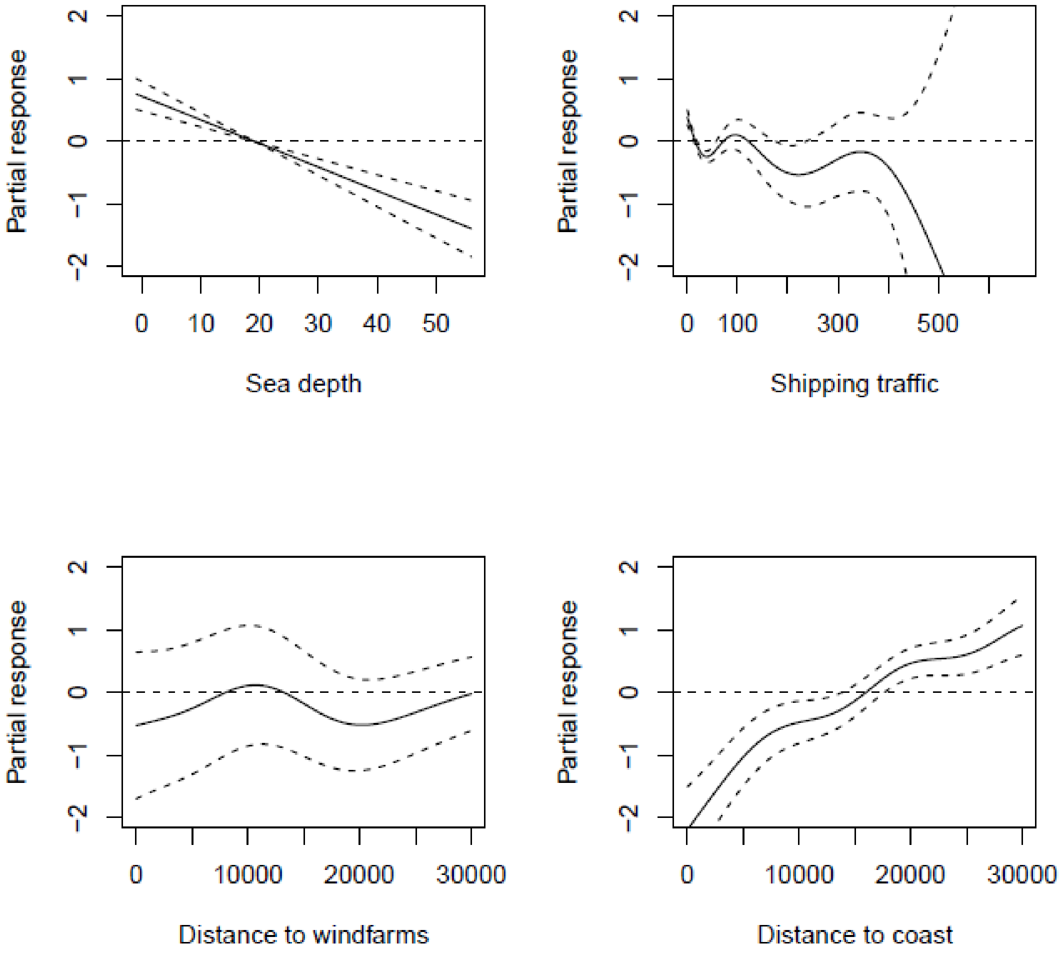


Figure 4 Partial plots of smooth covariates

11. Investigation of the spatiotemporal terms in the model (**Figure 5**), indicated some consistent features (namely a decline in usage away from the coast that was not exactly captured by the distance from coast covariate), but also considerable variability in usage from one year to the next (a result consistent with previous findings elsewhere).

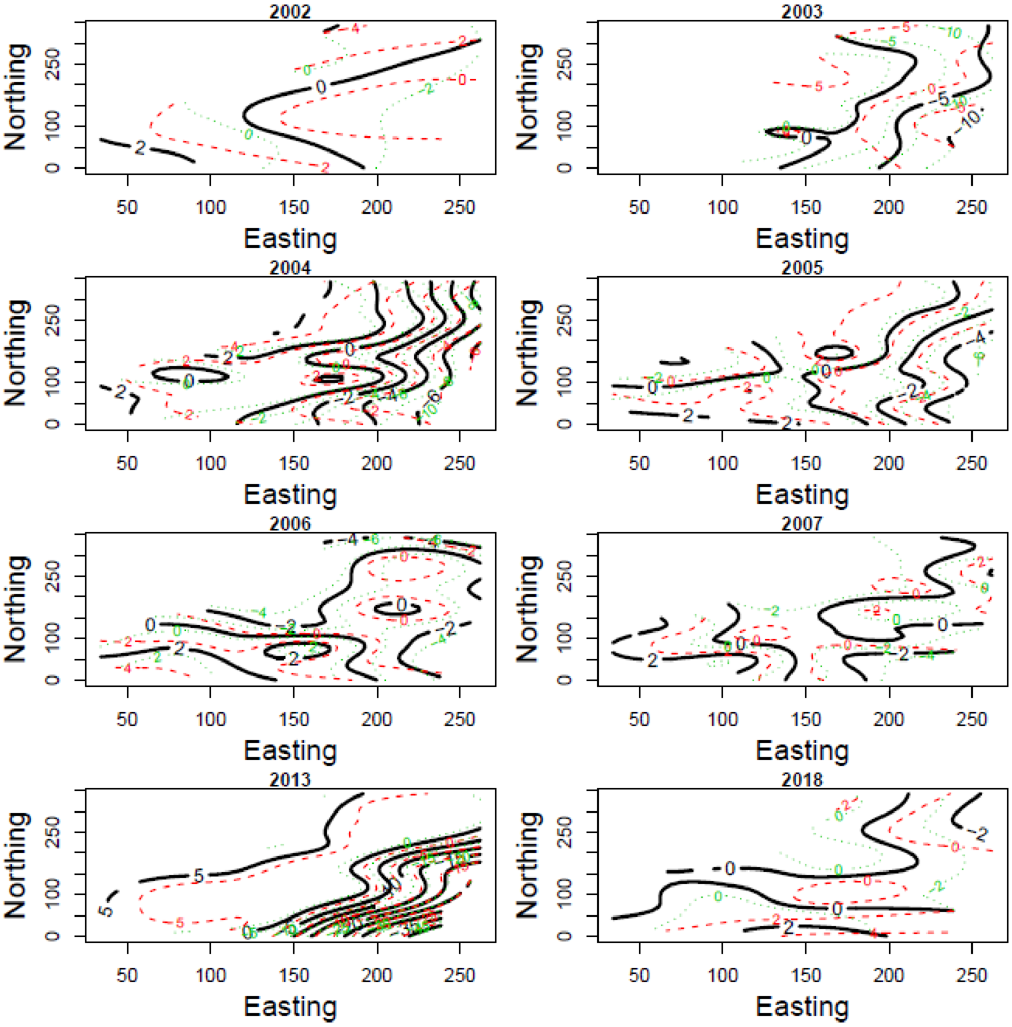


Figure 5 Spatial terms included in the model for different years

12. In **Figure 6** the total proportion of usage within the boundaries of the windfarms (i.e. before the farms were installed), was estimated as 4% in 2002 and 10% in 2006. After the installation of the windfarms (***Figure 7*a** & **Figure 8a**), that amount was estimated as 3% in 2013 and 2018. The counterfactuals presented in

13. **Figure** 7**b** & **Figure 8b** are also amenable to this calculation. Therefore, had the windfarms not been constructed, it is estimated that usage within the windfarms would have been 4% in 2013 and 5% in 2018.

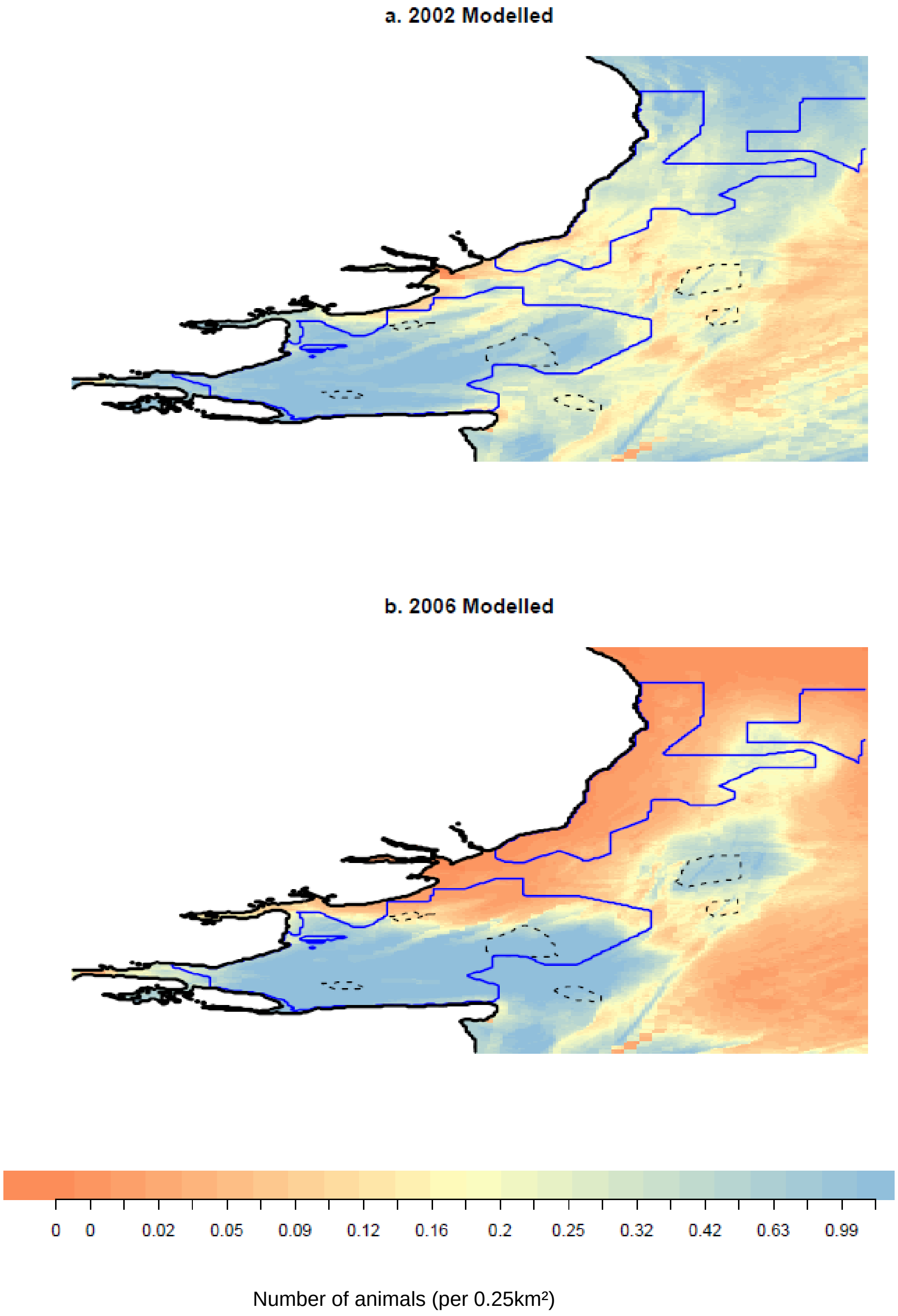
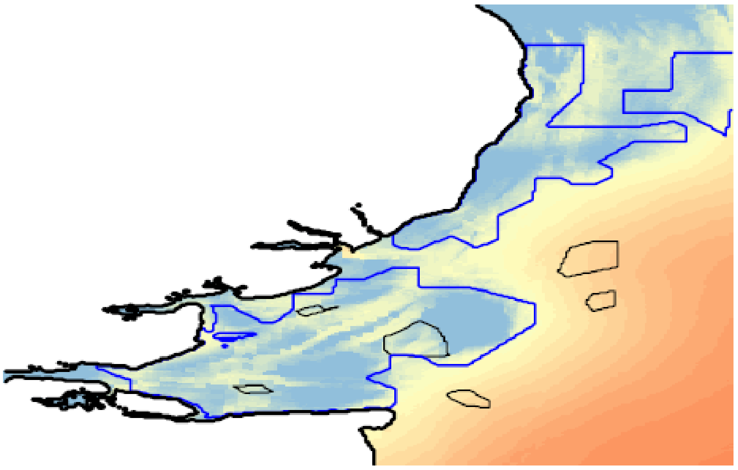


Figure 6 Modelled distribution of red throated divers for years preceding windfarm construction. This is purely in order to provide interpretable numbers for the colour scale used in the maps and should not be seen as an accurate estimation of absolute population densities

a. 2013 Modelled, with WF



b. 2013 Modelled, no WF

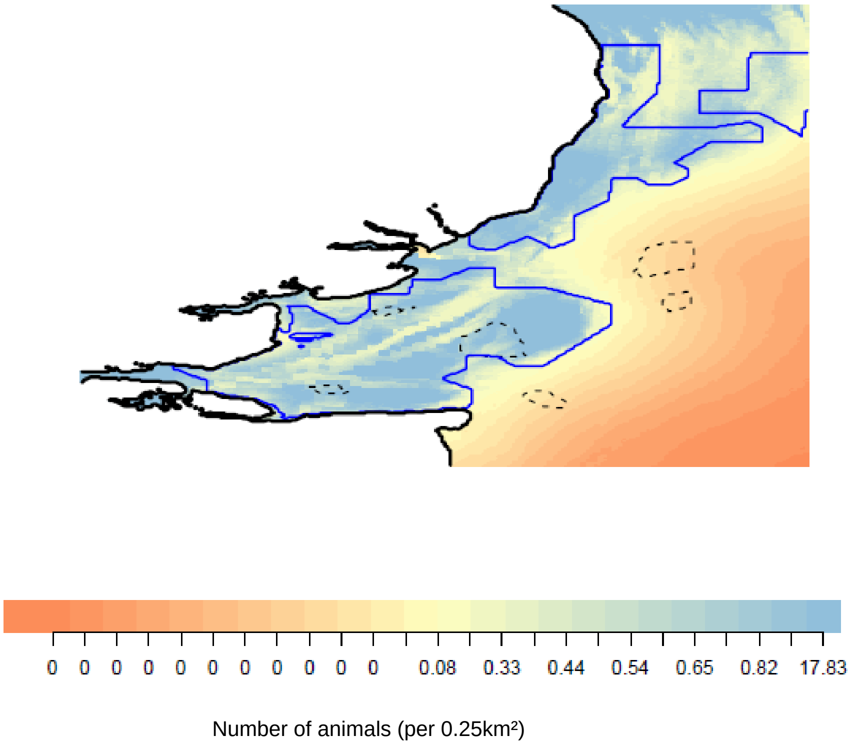


Figure 7 Modelled distribution of red throated divers, with and without windfarms (indicated by dashed and solid boundaries) for 2013. Blue line indicates the boundary of the SPA. For these illustrative plots, all predictions or relative densities are standardised to an estimated population of 20,000. This is purely in order to provide interpretable numbers for the colour scale used in the maps and should not be seen as an accurate estimation of absolute population densities

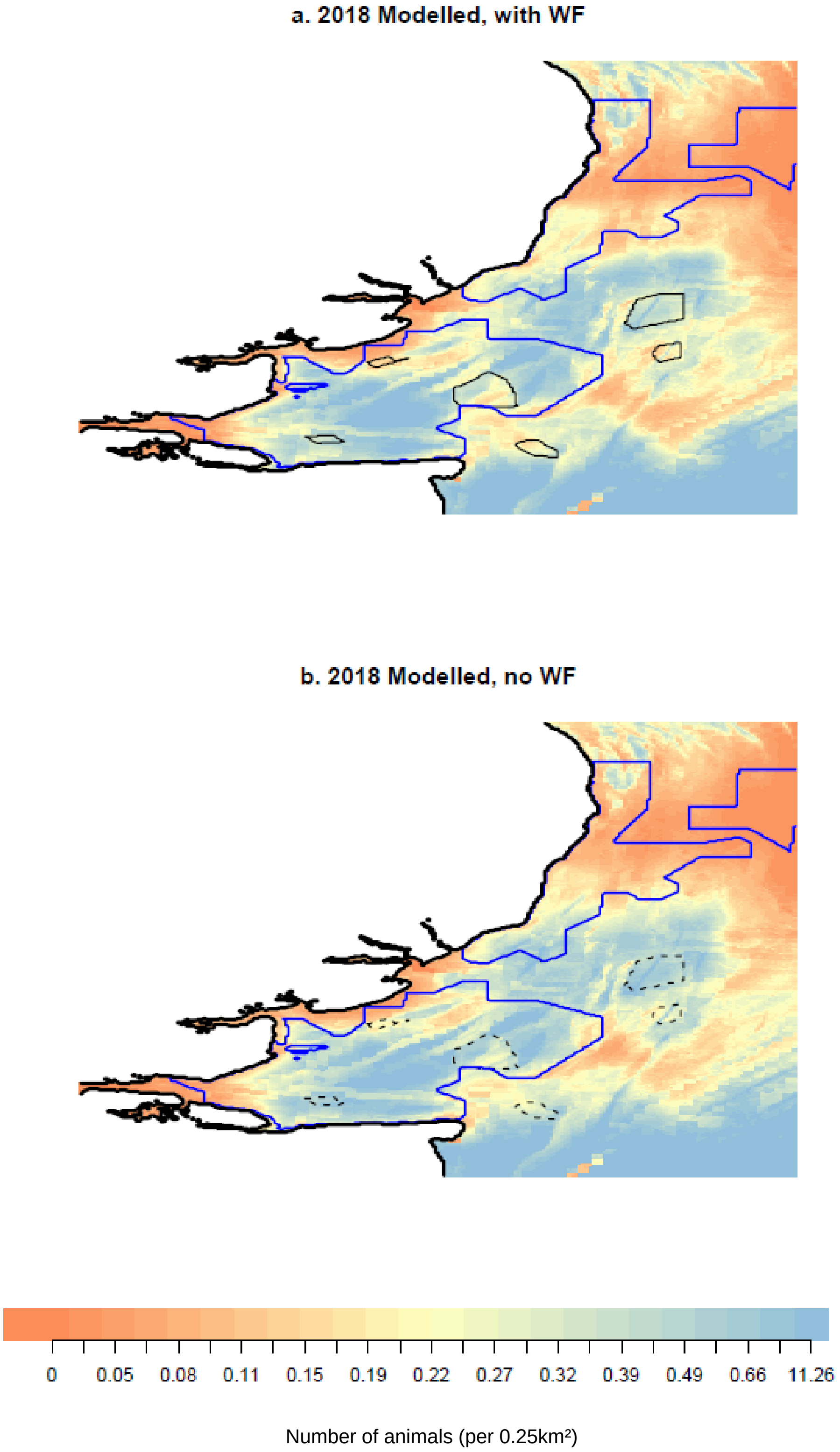


Figure 8 Modelled distribution of red throated divers, with and without windfarms (indicated by dashed and solid boundaries) for 2018. Blue line indicates the boundary of the SPA. For these illustrative plots, all predictions or relative densities are standardised to an estimated population of 20,000. This is purely in order to provide interpretable numbers for the colour scale used in the maps and should not be seen as an accurate estimation of absolute population densities

14. The aggregate effects of distance from windfarms on the final distribution of the birds were examined as follows. We first calculated the normalised map of predicted usage. We then examined a counterfactual predicting the normalised distribution of the birds, assuming the windfarms were not there. Finally, we looked at the difference between those and plotted those values against distance from windfarms. We carried out these calculations for 2013 **(Figure 9a)**, 2018 **(Figure 9b)** and the pooled data set of predictions from both of those years (**Figure 9c)**. All three plots indicated avoidance within a range of ~7km and apparent spillover aggregations in the range 7-15km.

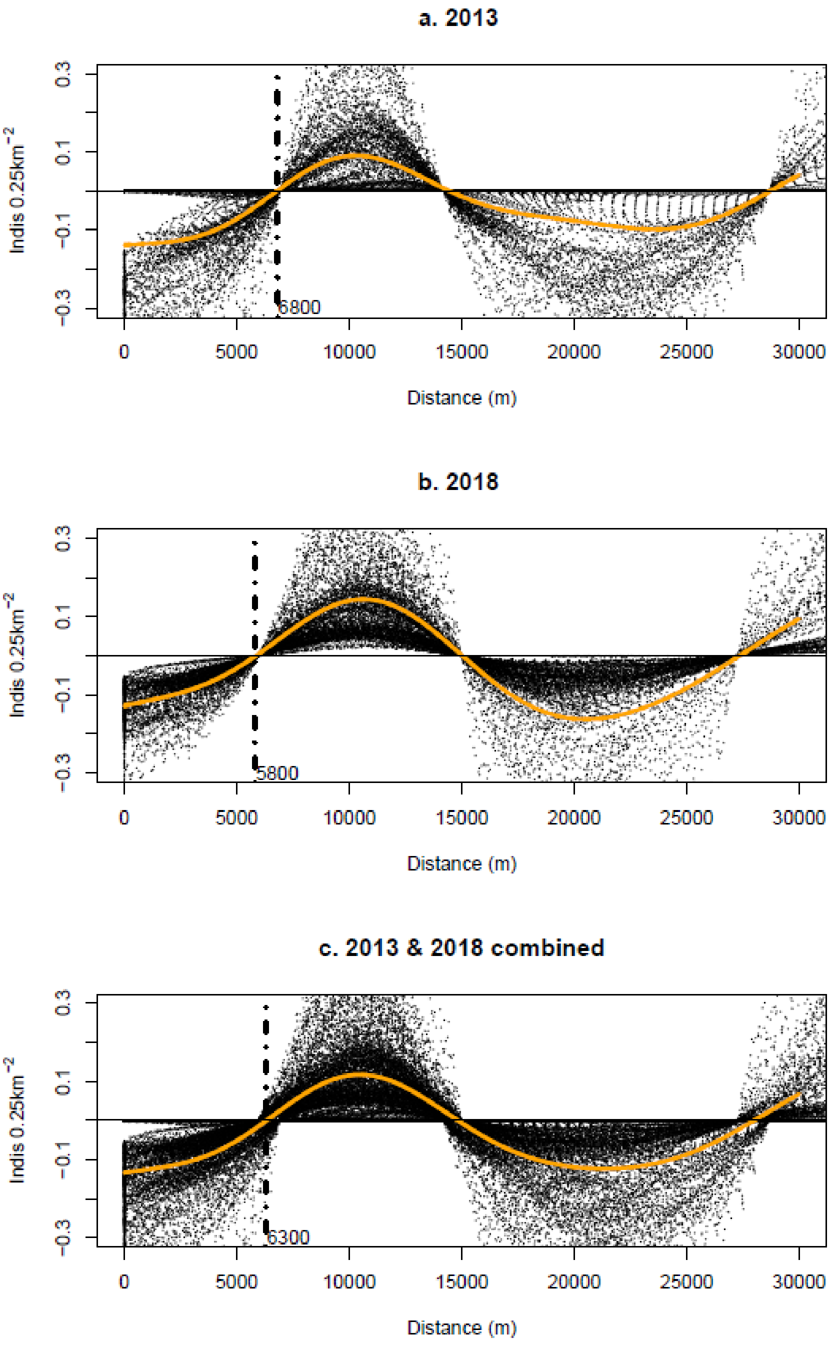


Figure 9 Differences in usage between true 2018 distribution and counterfactual, assuming the non-existence of windfarms. The values on the y axis indicate the estimated number of birds lost or gained at that distance from the windfarm per 0.25km². For example, a value of -0.2 indicates that, on average, 0.2 fewer birds are to be found in each 0.25km² as a result of the windfarms being there. The numbers are once again generated by standardising the predicted densities by an illustrative total population size of 20,000 individuals.

15. Finally, the total impact of the windfarms at different distance buffers from the windfarm was evaluated by looking at the modelled change in usage **(Figure 10)**. We used all the model results from 2013 and 2018. We found that the maximum amount of total displacement (equivalent to ~500 birds across the study area, out of a population of 20,000[9]; note the study area used for this calculation was the entire mapped area and not just the areas within the SPA) occurred within the range of 6km. In greater buffer areas that effect was over compensated, so that at distances of 15km, the number of birds within the buffer was greater than what would be expected in the absence of the windfarms.

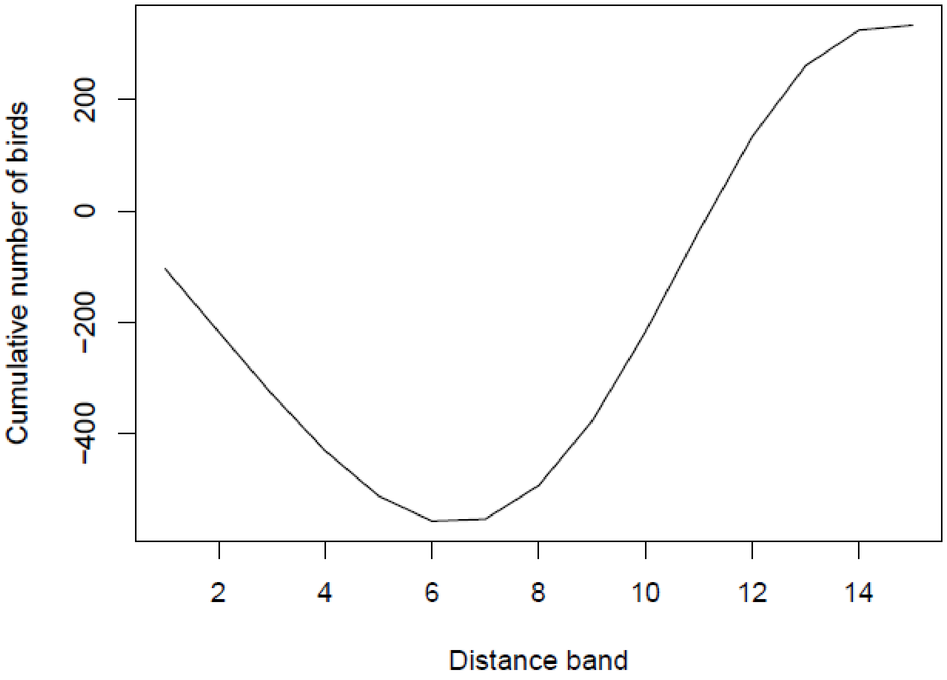


Figure 10 Total number of birds displaced or attracted to windfarms within particular buffers of distance.

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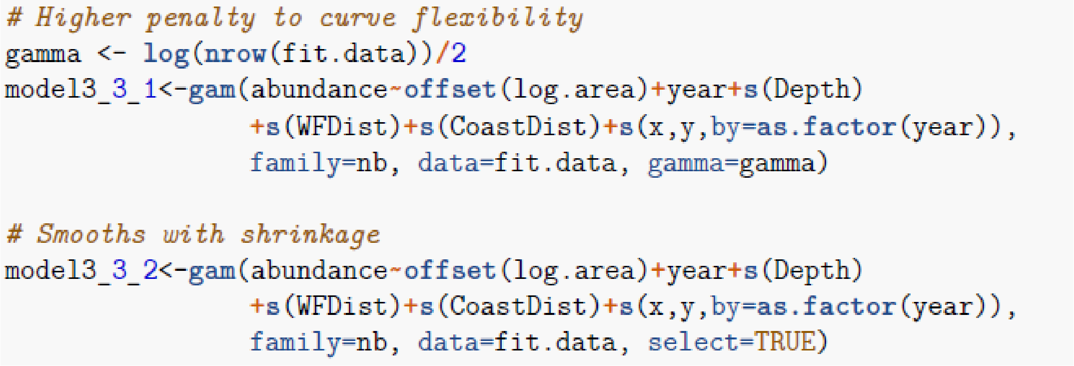
[9] Note the study area used for this calculation was the entire mapped area and not just the areas within the SPA

5 References

Wood, Simon. 2013. “mgcv: GAMs in R.” https://doi.org/10.1162/089892903770007416.
Wood, Simon N. 2006. Generalized Additive Models: An Introduction with R. Chapman & Hall/CRC.

6 Model definitions

```
model1_1<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist), family=poisson, data=fit.data)

model1_2<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist)+s(x,y), family=poisson,
              data=fit.data)

model1_3<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist)+s(x,y,by=as.factor(year)),
              family=poisson, data=fit.data)

model2_1<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist),
              family=tw(theta = NULL, link ="log",a=1.01,b=1.99),
              data=fit.data)

model2_2<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist)+s(x,y),
              family=tw(theta = NULL, link ="log",a=1.01,b=1.99),
              data=fit.data)

model2_3<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist)+s(x,y,by=as.factor(year)),
              family=tw(theta = NULL, link ="log",a=1.01,b=1.99),
              data=fit.data)

model3_1<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist), family=nb, data=fit.data)

model3_2<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist)+s(x,y), family=nb, data=fit.data)

model3_3<-gam(abundance~offset(log.area)+year+s(Depth)+s(ship)
              +s(WFDist)+s(CoastDist)+s(x,y,by=as.factor(year)),
              family=nb, data=fit.data)
```



```
# Higher penalty to curve flexibility
gamma <- log(nrow(fit.data))/2
model3_3_1<-gam(abundance~offset(log.area)+year+s(Depth)
                +s(WFDist)+s(CoastDist)+s(x,y,by=as.factor(year)),
                family=nb, data=fit.data, gamma=gamma)

# Smooths with shrinkage
model3_3_2<-gam(abundance~offset(log.area)+year+s(Depth)
                +s(WFDist)+s(CoastDist)+s(x,y,by=as.factor(year)),
                family=nb, data=fit.data, select=TRUE)
```

Appendix 2

Literature Review of Potential Red-Throated Diver Displacement

Table of contents

Glossary of Acronyms

DCO	Development Consent Order
DML	Deemed Marine Licence
EIA	Environmental Impact Assessment
DWR	Deep Water Route
EA1N	East Anglia ONE North
EA2	East Anglia TWO
ES	Environmental Statement
ETG	Expert Topic Group
HRA	Habitat Regulation Assesment
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
NE	Natural England
OWF	Offshore Windfarm
PINS	Planning Inspectorate
SoCG	Statement of Common Ground
SPR	Scottish Power Renewables

1 Existing Literature

1.1 Red-throated Divers and Displacement by Operational OWFs

16. Available literature has been reviewed to provide information on specific examples of studies where red-throated diver displacement by OWFs has been considered. ***Table 1.1*** provides a summary of information provided by available studies that have described red-throated diver displacement by OWFs. The final column provides observations by the authors of this report.

Table 1.1 Review of existing studies relating to displacement of red-throated divers from OWFs

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
Vilela et al (2020) Divers (Gavia spp.) in the German North Sea: Changes in Abundance and Effects of Offshore Wind Farms	German North Sea	For spring, 16 years of data were available, for winter, 17 years were available (aerial survey data only	Not discussed	The results showed different displacement depending on season (spring/winter) and area (north/south). In spring, a displacement distance (gradient) of 10.2 km was reported In winter, large differences in the displacement distance were reported between the northern and southern sub-area (maximum 3.3 km to 23.1km), potentially due to the considerably lower diver densities and the resulting greater uncertainties in the analyses.	No connection was found between diver abundance and the development of offshore wind in the German North Sea.	These differences show that seasonal and spatial factors may play a role in the specific response of divers to offshore windfarms. The authors caution that results are therefore not directly transferable to areas other than those considered in this study.
Dorsch et al. (2020): DIVER: German tracking study	German North Sea	Satellite transmitters used to track birds captured in 2015/16/17 for up to	Clear, near total avoidance of OWFs.	Modelling results indicate a large-scale displacement response following a	Home ranges of red-throated divers in the German North Sea are generally large (up to	The dataset used is considered to be relatively large in spatial terms, and

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
of seabirds in areas of planned Offshore Wind Farms at the example of divers		two years, in addition to assessment of digital aerial survey data from an area consisting of several thousand square km. Home ranges for individual birds were calculated separately using both datasets, and statistical analysis relating to whether overlap of home ranges with OWFs leads to changes in usage patterns was carried out.		gradient of reduced densities extending from OWFs. Displacement was very high within 5km of OWFs, and a significant effect could be detected up to 10 to 15km away from OWFs. Whilst modelled 95% home ranges frequently overlapped with OWFs, investigations of the tracking data showed larger daily movements when birds were close to OWFs.	several thousand square km), and show high individual variability; in some cases, individual home ranges contain several ‘hot spots’, indicating a patchy habitat use in space and time. During weather conditions indicating poor visibility, red-throated divers were located closer to OWFs than during good visibility. Divers kept longer distances to OWFs at night, when wind turbines are illuminated with aviation lights and navigation lights.	moderately sized in temporal terms. It is important to note that the survey data used were also used by Mendel et al. (2019) and hence this study and Mendel at al. (2019) are not two independent studies, but alternative analyses of the same data.
Mendel et al. (2019): Operational OWFs and associated ship	German North Sea	Large study area encompassing multiple OWFs and undeveloped sea between them,	Near total displacement within OWFs.	Near total displacement up to 3km from OWFs. Responses were observed up to 20km	None.	No detail presented on how ‘significance’ was defined, and how it was demonstrated, nor what the actual

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
traffic cause profound changes in distribution patterns of Loons (***Gavia*** spp.)		including the Eastern German Bight SPA. 13 years of pre-construction data and three years of operational phase data, both collected in spring. Different survey methods deployed during the two periods, so relative comparisons of distribution were made between the two periods using a range of statistical methods. OWF displacement and the synergistic effect of ship displacement was investigated.		from OWFs, significant changes to densities at 16.5km, with greatest changes within 10km. Displacement responses to ships were detectable at up to 5km, and shipping activity could account for around 14% of total displacement effect recorded. This suggests that reviewing the effect of multiple displacement sources and assessing together is important.		recorded densities or number of birds displaced is/was, though presumed to be reasonably high since the study area includes a red-throated diver SPA. Effects were observed after construction and in early operation of the OWFs, and are not what could be considered long term, though further work is ongoing. Despite this, the dataset used is considered to be relatively large both in spatial and temporal terms. It is important to note that the survey data used were also used by Dorsch et al. (2020) and hence this study and Dorsch et al.

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
						(2020) are not two independent studies, but alternative analyses of the same data.
Gill et al. (2018): Operational and Construction Monitoring and Analysis of Nine Years of Ornithological Data at Greater Gabbard Offshore Wind Farm Elston et al. (2016): Analysis of ornithological data for Greater Gabbard Offshore Wind	Outer Thames Estuary, UK	Three years of pre-construction, three years of construction and three years of operational data were available to conduct a statistical comparison of bird densities in different reporting regions within and adjacent to the Greater Gabbard OWF. Consistent survey methods throughout the study enabled direct comparisons of density to be carried out.	Compared to the 0-4km buffer around the OWF, red-throated diver densities within the OWF declined 83% between pre-construction and construction. There was weaker evidence of displacement from the OWF during the operational phase relative to the buffer zones of the survey area.	No data presented	None.	The survey area was relatively small compared with other studies, covering the OWF and a 4km buffer, however, in temporal terms the dataset is moderate in size relative to other studies. Despite this, red-throated divers were not recorded in large numbers at any point, presenting difficulties with regard to the detection of changes between project phases.

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
Farm to August 2015						
Heinänen and Skov (2018): Offshore Wind Farm Eneco Luchterduinen Ecological Monitoring of Seabirds T3 (Final) Report	Dutch North Sea	27 boat-based surveys of three OWFs, plus a larger wider area. This included baseline, construction and operational phases for all three OWFs.	The results indicate that very few red-throated divers occurred in areas of the OWFs prior to their construction, and those that do occur are displaced by the construction and operation of the OWFs.	The displacement effect detected in the OWFs was also apparent in their 0-2km buffers.	There was an increased probability of presence of red-throated divers in areas where water depths were <20m, where the water is less saline and the mean current speed and shipping intensity are lower. Increasing density (when present) was further explained by decreasing current speed and low shipping intensity.	The dataset used is considered to be relatively small in temporal terms, but the size of the study area (particularly considering boat-based surveys were used) is relatively large.
Hi Def Aerial Surveying (2017): Lincs Wind Farm Third annual post-construction aerial	Greater Wash, UK	The dataset consisted of seven years of pre-construction data, three years of construction data and five years of operational phase survey data. Potential	The abundance of red-throated divers within the OWFs as a percentage of the study area abundance estimate declined significantly during the operational phase	When abundance in different distance bands from OWFs was presented as a percentage of the abundance in the study area, a very strong pattern was	The numbers of birds displaced were relatively small compared to the apparently natural fluctuations in numbers between the	The dataset used is considered to be relatively large both in spatial and temporal terms.

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
ornithological monitoring report		effects were investigated using several statistical approaches. The study area consisted of the OWF, plus a large area of the wider Greater Wash, extending >10km to the east of the OWF. Whilst there were differences between survey methods in different phases, a calibration exercise carried out in Germany suggested that for red-throated diver, no significant differences were present in the abundances derived from both survey methods.	compared to the pre-construction phase, and to a lesser extent between the construction phase and the operational phase.	evident showing significantly lower percentage of red-throated divers close to the OWFs during the operational phase compared to the baseline phase. There was no such pattern between the baseline and the construction phase. The distance from the OWFs in which this pattern was no longer significantly different from the baseline varied between 5km and 9km depending on the year.	project phases outside the OWFs. There was some evidence to support that most, if not all of the displaced red-throated divers would have remained within the study area. This suggests that in spite of there being a measurable effect, it is considered by the authors highly unlikely that a biologically significant impact at the population level has occurred.	

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
Percival and Ford (2017): Kentish Flats Offshore Wind Farm Extension: Ornithological survey annual report, October 2016 - March 2017 (post-construction year 2)	Thames Estuary, UK	Three years of data (one year of pre-construction and two years of operation) statistically compared for changes in red-throated diver distribution and abundance.	The mean encounter rate within the OWF dropped from 0.55 birds/km prior to construction, to 0.03 in the first operational year and 0.13 in the second operational year. This was equivalent to reductions of 95% and 76% on the pre-construction baseline.	Compared to the pre-construction year, data from the first operational year demonstrated a statistically significant difference in encounter rate between the OWF and 500m buffer, where it was lower than the 1km, 3km and 4km buffers, which did not differ significantly from each other. The trend for the second operational year was consistent with the previous year's results, but higher variability in the data meant that the result was not statistically significant.	Some comparisons of relationships between red-throated diver distribution relative to distance from shore, water depth, distance to shipping lanes and substrate were carried out, but the results showed high variability with no definitive conclusions possible.	Temporal and spatial coverage for this study considered to be relatively small compared to other studies.
McGovern et al. (2016): Assessment of	Thames Estuary, UK	The study seeks to quantitatively (where possible) compare	The proportion of red-throated divers found within the OWF	The proportion of red-throated divers found within the various	Due to the nature of analysis, and apparent variation in red-	This paper details an effect seen in early operation of the OWF

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
displacement impacts of offshore windfarms and other human activities on red-throated divers and alcids		red-throated diver distribution during the pre-construction, construction and first two years of operation at and around the London Array OWF.	relative to the study area was lower during construction than pre-construction or operation, but no significance in the difference was noted.	buffer zones within 10km of the OWF relative to the study area was lower during construction than pre-construction or operation, but no significance in the difference was noted. With respect to percentage changes in proportions of red-throated divers across the study area, an increase in the proportion of red-throated divers within 4.5km of the OWF was observed during operation compared to pre-construction and construction, with differences largest in the construction versus operation comparison.	throated diver numbers across the wider Thames Estuary area comparisons between years was considered somewhat problematic by the authors of this study. Therefore, comment on the actual numbers of birds involved (and the potential for population level effects) was not possible.	only, and is not what could be considered long term. Due to the focus on a single OWF, the overall study area is moderately sized in spatial terms compared to other studies. Temporal coverage is also considered to be moderate relative to other studies, though comparisons between years is difficult due to the apparent background variability in the population size.

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
Welcker and Nehls (2016): Displacement of seabirds by an offshore wind farm in the North Sea	German North Sea	77 boat-based surveys were carried out in the operational phase only of the Alpha Ventus OWF over a three year period. A small number of transects (only one passing through the OWF) were used, with comparisons made between this transect and four others outside the OWF, which were located no more than 5km from the OWF.	A 90% difference in red-throated diver abundance between the OWF and areas outside it was observed.	Diver abundance reached an undisturbed level of about 2.5 birds per 300m at a distance of 1.5km to 2km from the outermost turbines. However, model uncertainty was large.	None.	Whilst the survey was repeated many times, the overall time period over which the work was conducted means that the temporal scale is still considered relatively low. The small size of the study area means that the same is true of the spatial scale.
NIRAS Consulting (2016): Gunfleet Sands 1&2 Offshore Wind Farms Ornithology Statistical Analysis Annex	Thames Estuary, UK	One year of pre-construction, one year of construction and three years of operational phase data were available for statistical analysis to assess possible	Survey results indicated a 90% reduction in recorded abundance of divers within the OWF between pre-construction and construction/operation.	Survey results indicated a 65% reduction in recorded abundance of divers within the 0-1km buffer of the OWF between pre-construction and operation, and 90% between pre-construction and	None.	Temporal and spatial coverage for this study considered to be relatively small compared to other studies. This can lead to studies lacking statistical power to

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
		impacts on red-throated diver. The study consisted of the OWF and a 2km buffer.	Statistical analysis indicated the difference between years was significant.	construction. In the 1-2km buffer the difference was around 20% between pre-construction and other phases. Statistical analysis indicated the differences between years was not significant.		resolve differences in bird distribution between project phases.
Percival (2014): Kentish Flats Offshore Wind Farm: Diver Surveys 2011-12 and 2012-13	Thames Estuary, UK	Assessment of seven years of operational monitoring, with comparisons undertaken with three years of pre-construction data.	Displacement of red-throated divers from within the OWF was apparent in all seven years of operational monitoring. The magnitude of this effect was calculated to be between 89% and 94% depending on the comparisons undertaken.	Comparisons of the proportional distribution of red-throated divers across the study area suggested that the 0-500m buffer consistently held substantially lower numbers of birds during the operational phase, with more minor differences reported up to 1km from the OWF. No declines were	None.	Spatial coverage for this study considered to be relatively small compared to other studies, whilst temporal coverage is moderate.

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
				apparent beyond this distance.		
Petersen et al. (2014): Post-construction evaluation of bird abundances and distributions in the Horns Rev 2 offshore wind farm area, 2011 and 2012	Danish North Sea	Statistical comparisons between ten visual aerial surveys collected during the operational phase of the Horns Rev 1 and 2 OWFs, and ten pre-construction surveys.	The reduction in overall mean diver abundances within the Horns Rev 2 OWF was 16.8 birds. It was not clear from the report how many birds were calculated to be present in the OWF during pre-construction.	The reduction in overall mean diver abundances within 2km of the Horns Rev 2 OWF was 31.3 birds during operation (calculated by subtracting numbers lost from the OWF from the 2km buffer), whilst a reduction of 55.1 birds occurred within the 2-4km buffer. It is not clear from the report what proportion of the original population this represented. Reduced abundance of red-throated divers was recorded out to approximately 10km from the Horns Rev 2 OWF, but a displacement distance	The overall abundance of red-throated divers in the study area was similar during the pre-construction and operational periods, so it was concluded that the observed changes in distribution could not be related to changes in overall abundance. This could suggest that population level effects have not occurred, though a redistribution of birds due to OWF operation has occurred. It was noted that no comment could be made on whether	The overall study area is relatively large in spatial terms compared to other studies. Temporal coverage is moderate relative to other studies.

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
				of 5km to 6km was considered likely.	changes in diver density across the area was partially caused by changes in food availability.	
Percival (2013): Thanet Offshore Wind Farm Ornithological Report 2012-13	Thames Estuary, UK	Assessment of three years of operational data (boat-based surveys) versus pre-construction.	Compared to the pre-construction phase, within the OWF an 82% decline in red-throated diver abundance was recorded during construction, and 73% during operation.	Outside the OWF, no evidence of changes in abundance was apparent of any reduction from the pre-construction level.	None.	Both temporal and spatial coverage considered to be relatively small compared with other studies.
Petersen et al. (2006): Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark	Danish North Sea	At the Horns Rev OWF, 16 surveys were carried out during pre-construction, and 15 during operation, between 1999 and 2005. At the Nysted OWF, 21 surveys were undertaken during pre-construction, with	Red-throated divers in the Horns Rev OWF study area showed significant avoidance responses to the OWF.	Red-throated divers in the Horns Rev OWF study area showed significant avoidance responses to the OWF. This avoidance effect was observed out to a distance of 2km from the OWF.	At the Nysted study area divers were less abundant, and the available dataset from this site did not show statistically significant differences between the pre- and the post-construction datasets, though the data indicated that results	Both study areas encompassed the OWFs with relatively large buffers extending >10km in most directions, meaning that relative to other studies, the study areas were moderately sized. Temporal coverage was also moderate.

Study	Location	Description of Methodology and Dataset	Reported Effects on Red-throated Divers Within OWFs	Reported Effects on Red-throated Divers Near OWFs	Other Relevant Findings	Observations
		eight carried out during operation.			were similar to the findings at Horns Rev.	

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Appendix 3

Spatial Modelling Assessment Results Prior to the Reduction in the Order Limits of the East Anglia ONE North Project

1 Introduction

1. This Appendix presents the results of the analysis equivalent to that presented in the main body of this report but for the East Anglia ONE North boundary before it was amended to accommodate the 2km SPA buffer mitigation commitment (see ***Figure 1***).

2 Pre-Mitigation Commitment Results

2. The predicted abundance within the windfarms inside the SPA (London Array, Kentish Flats and Gunfleet Sands) and sequential 1km buffers, obtained from the 2013 and 2018 model predictions and derived with and without the windfarm effect are provided in ***Table 2*** and ***Table 3***. The percentage reduction in each spatial area, calculated as the 'with windfarm' abundance divided by the 'without windfarm' abundance, is also presented.

3. Only the buffer regions within the SPA were included in the calculations (i.e. the buffers around London Array to the south which lie outside the SPA boundary were not included in the calculations).

Table 2 Comparison of modelled abundance and densities in all windfarms within the SPA and sequential 1km buffers, estimated using the 2013 model predictions calculated with and without the windfarm effect

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarms	553	828	275	33.2%	-100.9: 80.9	-835	670
0-1km	366	536	170	31.8%	-105.4: 80.5	-565	431
1-2km	471	660	189	28.7%	-114.7: 79.6	-757	525
2-3km	551	736	185	25.2%	-125.1: 78.6	-921	578
3-4km	644	814	170	20.9%	-138: 77.4	-1123	630
4-5km	756	894	139	15.5%	-154.2: 75.8	-1378	678
5-6km	838	920	82	8.9%	-174.2: 73.9	-1603	680
6-7km	944	952	8	0.8%	-198.6: 71.6	-1891	682

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
7-8km	988	913	-76	-8.3%	-225.8: 69	-2062	630
8-9km	1055	902	-154	-17.1%	-252.1: 66.5	-2274	600
9-10km	1136	918	-218	-23.7%	-272.3: 64.6	-2499	593
10-11km	1148	906	-242	-26.7%	-281.1: 63.7	-2547	578
11-12km	1071	856	-215	-25.1%	-276.3: 64.2	-2365	550
12-13km	928	778	-150	-19.3%	-258.8: 65.9	-2014	512
13-14km	632	573	-59	-10.3%	-231.5: 68.5	-1326	392
14-15km	374	375	0	0.1%	-199.7: 71.5	-749	268

Table 3 Comparison of modelled abundance and densities in all windfarms within the SPA and sequential 1km buffers, estimated using the 2018 model predictions calculated with and without the windfarm effect

Region	2018 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarms	685	1017	331	32.6%	-25.9: 64.6	-263	657
0-1km	440	639	198	31.0%	-28.7: 63.8	-184	408
1-2km	555	770	215	27.9%	-34.6: 62.2	-266	479
2-3km	637	843	206	24.4%	-41.1: 60.3	-347	509
3-4km	759	950	191	20.1%	-49.1: 58.1	-466	552
4-5km	924	1083	159	14.7%	-59.3: 55.2	-642	598
5-6km	1064	1156	91	7.9%	-71.9: 51.7	-832	597
6-7km	1212	1209	-3	-0.3%	-87.2: 47.4	-1054	573
7-8km	1296	1185	-113	-9.5%	-104.4: 42.6	-1237	504

Region	2018 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
8-9km	1399	1184	-215	-18.2%	-120.6: 38	-1428	450
9-10km	1513	1211	-302	-24.9%	-133.2: 34.5	-1613	417
10-11km	1576	1232	-344	-27.9%	-138.8: 32.9	-1710	405
11-12km	1503	1190	-313	-26.3%	-135.7: 33.8	-1615	402
12-13km	1296	1075	-218	-20.3%	-124.6: 36.9	-1339	397
13-14km	815	730	-81	-11.1%	-107.4: 41.7	-784	304
14-15km	466	462	-3	-0.5%	-87.7: 47.3	-405	218

4. Positive percentage values indicate a lower abundance in the ‘with windfarm’ scenario compared to the ‘without windfarm’ scenario, while negative values indicate the opposite (i.e. higher values in the ‘with windfarm’ outputs). In both years a maximum reduction in abundance of 33% was estimated within the windfarms themselves, declining to a zero reduction in abundance in the 6-7 km buffer. Beyond 6-7 km the predicted abundances are higher with the windfarm effect included, indicating the shift in distribution caused by the reduced numbers in closer proximity to the windfarms.

5. These observations are similar to those reported for London Array windfarm (APEM 2018). From a comparison of pre- and post-construction densities, the estimated displacement within the London Array site was 55% and within 11km of the windfarm densities were lower post-construction compared with pre-construction, following a slope of displacement from 55% to 0% by 11km. It should be noted that this distribution was not a wholesale change from that observed prior to windfarm construction which showed similar densities (within up to 9km). Therefore, while the windfarm does appear to have reduced densities, the windfarm appears to have amplified the existing distribution of high and low densities rather than changed it overall. As with the results of the current analysis, divers were not completely displaced from any parts of the study area, including London Array itself.

6. The difference between the summed predicted abundance within 7km, with windfarms and without, was 1,218 and 1,393 in 2013 and 2018, respectively. This represents approximately 6-7% of the SPA population.

7. Further evidence for different behaviour and habitat preference between UK southern North Sea and German Bight can be seen in the estimated relationship with depth (***Appendix 1***, ***Figure 4***). In the current study, the relationship with depth is a straight line with all depths less than 20m preferred. In Dorsch et al. (2019) a peak in depth preference was found at 25m, with both shallower (<10m) and deeper regions depths avoided. This may reflect differing prey preferences which influence foraging behaviour.

8. The 2013 and 2018 model predictions have also been used to predict the potential displacement effect in the SPA caused by East Anglia ONE North (***Table 4*** and ***Table 5***). The East Anglia ONE North windfarm site does not overlap the SPA, but the buffer zone does. The estimated diver abundance in the windfarm site itself using the 2013 model predictions was 7 individuals and using the 2018 model predictions was 38 individuals. The respective estimates without the wind farm effect were 13 and 69 individuals.

Table 4 Comparison of modelled abundance and densities in East Anglia ONE North and sequential 1 km buffers, estimated using the 2013 model predictions calculated with and without the windfarm effect

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarms	7.5	13	6	42.4%	-169: 88.8	-22	12
0-1km	0.6	1	0	41.0%	-175.5: 88.6	-2	1
1-2km	4	6.4	2	38.3%	-188.1: 88.1	-12	6
2-3km	7.8	12	4	35.3%	-201.9: 87.5	-24	10
3-4km	13.8	20.2	6	31.6%	-219.1: 86.8	-44	18
4-5km	20.3	27.8	8	27.0%	-240.6: 85.9	-67	24
5-6km	27.7	35.2	7	21.2%	-267.5: 84.8	-94	30
6-7km	36.4	42.5	6	14.1%	-300.9: 83.4	-128	35
7-8km	39.1	41.7	3	6.3%	-337. : 81.9	-141	34
8-9km	44.4	43.9	0	-1.1%	-371.8: 80.4	-163	35
9-10km	57.1	53.4	-4	-6.8%	-398.6: 79.3	-213	42
10-11km	77.2	70.6	-7	-9.4%	-410.4: 78.8	-290	56

Region	2013 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
11-12km	93.8	86.8	-7	-8.0%	-403.9: 79.1	-351	69
12-13km	102.4	99.7	-3	-2.7%	-379.3: 80.1	-378	80
13-14km	95.5	100.6	5	5.1%	-342.7: 81.6	-345	82
14-15km	98.3	114.4	16	14.1%	-301.1: 83.4	-344	95

Table 5 Comparison of modelled abundance and densities in East Anglia ONE North and sequential 1 km buffers, estimated using the 2018 model predictions calculated with and without the windfarm effect

Region	2018 Modelled abundance						
	With wind farms	Without wind farms	Difference	Percentage reduction	Lwr-upr 95% confidence range	Lower 95% difference	Upper 95% difference
Windfarms	38.3	68.8	30	44.3%	84.5: -97.9	58	-67
0-1km	0.2	0.3	0	43.1%	84.2: -102.1	0	0
1-2km	1.3	2.1	1	40.5%	83.5: -111.5	2	-2
2-3km	2.3	3.7	1	37.6%	82.7: -121.7	3	-5
3-4km	3.9	5.8	2	34.1%	81.7: -134.2	5	-8
4-5km	4.7	6.7	2	29.6%	80.5: -150.1	5	-10
5-6km	5.3	7.0	2	23.9%	78.9: -170.2	6	-12
6-7km	6.1	7.4	1	17.1%	77: -194.3	6	-14
7-8km	6.0	6.6	1	9.5%	74.9: -221.3	5	-15
8-9km	6.6	6.7	0	2.3%	72.9: -247	5	-17
9-10km	9.0	8.7	0	-3.2%	71.3: -266.6	6	-23
10-11km	13.6	12.9	-1	-5.7%	70.7: -275.5	9	-36
11-12km	16.8	16.1	-1	-4.4%	71: -270.7	11	-44
12-13km	18.1	18.3	0	0.6%	72.4: -253	13	-46

Region	**2018 Modelled abundance**						
	With wind farms	**Without wind farms**	**Difference**	**Percentage reduction**	**Lwr-upr 95% confidence range**	**Lower 95% difference**	**Upper 95% difference**
13-14km	17.1	18.7	2	8.2%	74.5: -226	14	-42
14-15km	18.0	21.6	4	16.9%	76.9: -195.2	17	-42

9. Using both prediction years, the maximum reduction in abundance in the windfarm was 42-44% declining to a zero reduction in abundance in the 8-9 km buffer using 2013 data and the 9-10 km buffer using the 2018 data. While the predicted distance over which the displacement effect extends is slightly further for East Anglia ONE North, the actual number of individuals involved is much smaller than for the windfarms within the SPA: two orders of magnitude smaller using the 2013 data and three orders of magnitude smaller using the 2018 data. Thus, the sum of individuals in the overlap of the SPA and the windfarm buffers up to 9 km with the windfarm is 150, compared to the without windfarm total of 187, indicating that even using the higher predictions, only 37 individuals would be displaced[10]. The 2018 equivalents (up to 8km) are 36 with the windfarm and 46 without, indicating that 10 individuals would be displaced[2].

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[10] The shaded cells in ***Table 3 & 4***