THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES

2010

East Anglia TWO Offshore Wind Farm

Appendix A17 to the Natural England Deadline 6 Submission

Natural England's Comments on Displacement of Red-throated Divers in the Outer Thames Estuary SPA – Update [REP5-025]

For:

The construction and operation of East Anglia TWO Offshore Windfarm, a 900MW windfarm which could consist of up to 67 turbines, generators and associated infrastructure, located 37km from Lowestoft and 32km from Southwold.

Planning Inspectorate Reference: EN010078

24th February 2021

Natural England's Comments on Displacement of Red-throated Divers in the Outer Thames Estuary SPA – Update [REP5-025]

This document is applicable to both the East Anglia ONE North and East Anglia TWO applications, and therefore is endorsed with the yellow and blue icon used to identify materially identical documentation in accordance with the Examining Authority's (ExA) procedural decisions on document management of 23rd December 2019. Whilst for completeness of the record this document has been submitted to both Examinations, if it is read for one project submission there is no need to read it again for the other project.

1. Introduction

This document provides comments based on points raised in the following documents submitted by the Applicant at Deadline 5:

- REP5-025 Displacement of Red-Throated Divers in the Outer Thames Estuary SPA - Update

The paragraphs below summarise NE's response to the submission. Annex 1 contains our detailed technical advice on the report.

2. Summary of NE's position

1. Natural England raised a number of **fundamental** concerns on the red-throated diver (RTD) Displacement document submitted at Deadline 3 [REP3-049], these are set out in [REP4-087]. We note that the key points raised by Natural England have not been addressed, and the Applicant does not propose to re-visit the modelling to address the issue of the change in survey platform, or to carry out any further validation. **Therefore, we continue to advise that the Applicant should address these outstanding points and that our advice on displacement of SPA divers remains unchanged.**

2. Notwithstanding Natural England's ongoing concerns that the modelling approach is underestimating the level of displacement, it is important to note that **even using the Applicant's modelling outputs, which we do not accept, an adverse effect on**

integrity on the Outer Thames Estuary SPA from East Anglia ONE North alone cannot be ruled out. This conclusion is based on the assumption that if displacement extends to at least 7km from the OWF then more than 1% of the total area of supporting habitat within the SPA will no longer be able to support the same density and distribution of red throated diver in the presence of EA1N.

3. As set out in our comments on the Applicant's HRA Derogation case [REP5- 082] **we advise that full consideration is given to a revised project design to enable at least a 10km buffer between the Outer Thames Estuary SPA and the EA1N array, in order to avoid an adverse effect**.

4. In addition, impacts from EA2 also need to be taken into consideration in the assessment for the area 8-12km from the SPA boundary. We continue to advise that an adverse effect on integrity cannot be ruled out for EA2 in-combination with other plans and projects.

3. Summary of NE's position on RTD displacement modelling

5. The Applicant argues that, regardless of the points raised by Natural England, their modelling and resulting predictions of displacement are robust. However, a fundamental question remains; why does the Applicant's modelling predict a reduction of RTD density of 33% within the windfarm footprint, whereas every one of the **eight** empirical studies, including several within the Outer Thames Estuary (OTE) SPA, consistently report levels of RTD displacement within the windfarm footprint which are much higher? Although displacement of 55% has been reported at London Array, most empirical studies concerning the OTE SPA have observed higher rates of displacement from operational windfarm sites, generally between 78% and 95%. Whilst it is acknowledged that the extent of displacement outside of the array itself varies between different studies, there is consistency across all empirical studies in reporting a high level of displacement within the windfarm footprint itself. This strongly suggests there is an issue with the Applicant's modelling which remains to be resolved.

4. Use of Novel Methodologies

6. One issue arising within the report is that some of the displacement assessment methods, particularly those around the buffer zone analysis and generation of the counterfactuals, are novel as far as Natural England is aware (i.e. not in the published literature). Therefore,

the onus is on the Applicant to clearly demonstrate that the buffer zone and counterfactual methodologies are scientifically robust. These would require further sensitivity analyses or references to past work / precedence (as well as addressing other methodological concerns) before Natural England would accept the outputs of the modelling.

ANNEX 1. Detailed technical comments on [REP5-025] Displacement of Red-Throated Divers in the Outer Thames Estuary SPA - Update

1) Bootstrap replicates

7. Natural England welcomes the application of a bootstrap resampling method to calculate confidence intervals around the buffer zone analysis. However, the Applicant's use of only 100 bootstrap replicates appears to be arbitrary and potentially restrictive as bootstrap tests frequently utilise thousands of replicates. <u>We advise that testing of the appropriate number of bootstrap replicates should be carried out to properly assess this uncertainty (Davidson and MacKinnon, 2000; Andrews and Buchinsky, 2002).</u>

2) Accounting for Different Survey Methods

8. The Applicant continues to not take account of the difference survey methods (visual and digital aerial) across the data collection period. This is a major concern for Natural England and is set out in full in Appendix 12 of our Deadline 4 [REP4-087]. If it is assumed, as the Applicant asserts, that the distribution map pre- and post-construction have accurate relative proportions, the different survey platforms may not be an issue. However, it significantly undermines the outputs of the modelling if there are differences in the ability to accurately record spatial variation in relative proportions due to the survey platform.

9. One of the issues highlighted when APEM (2010) compared results obtained from visual and digital aerial surveys of the same areas conducted immediately after one another was that when considering red-throated divers alone, or all birds, the tendency for visual surveys to underestimate densities in comparison with digital aerial methods became more pronounced where digital imagery had recorded more birds. This is probably due to the ability to enumerate large numbers of birds post survey using the digital method, a procedure which is not possible for visual surveys. The assumption being made by the Applicant is that the relative abundance of birds in visual aerial surveys scale linearly with the relative abundance of birds in digital surveys (i.e. the year effect is a linear fixed effect in the model), but it is highly possible that the effect of survey platform is non-linear, as per findings in APEM (2010). Therefore, it is difficult to rule out the possibility that for the pre-construction period, largely covered by the visual aerial surveys, the highest densities

could have been disproportionately under recorded, impacting the relative spatial distribution.

10. It is the Applicant's view that this not an issue because:

"…. *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*."

Natural England continues to have outstanding concerns, however, because the process undertaken to normalise and then compare the model outputs may be sensitive to the population size used and therefore skewed. <u>Therefore, we advise that a sensitivity check is done by also using a population size of 10,000 individuals to check that the predicted percentage decrease is not sensitive to the assumed population size.</u>

3) Counterfactual approach and potential pseudo-replication

11. The Applicant has endeavoured to address some of Natural England's concerns regarding the counterfactual approach and the potential for pseudo-replication as set out in [REP4-087], but unfortunately these remain outstanding issues. Natural England's view continues to be that the counterfactual comparison is producing lower relative changes in abundance when compared to other studies. In all likelihood this is due to the distance to windfarm relationship (Figure 4 Appendix 1) being weak when compared to other parameters. It is therefore expected that by removing the weak relationship, only a weak relative change in abundance would be detected.

12. The Applicant states that they have considered this matter further by reviewing the partial plots of the time specific spatial layers (Figure 4 in Appendix 1) and found no similarity between the fitted spatial effects and the location of windfarms, and therefore assert that pseudo-replication is not an issue. However, the results of this review have not been shown in the report and therefore we are unable to agree with the Applicant's position. Furthermore, we would have expected to see a check of collinearity of the covariates, and

reporting of that process, in order to get a better understanding of the appropriateness of the variables. Provision of this information would allow the robustness of the Applicant's modelling to be better assessed, and should be submitted into the Examination.

4) Limitations of the Modelling Approach

13. Natural England has commented, on several occasions, that the results showing only ~33% of birds being displaced from the windfarms is much lower than other studies. This is related to the fact that other studies use methods like MRSea or Bayesian point process models, both of which have more sophisticated methods of dealing with the spatial structure in the data. For example, Bayesian point process models have a similar spatial component as an intrinsic stochastic process, while a Generalised Additive Modelling (GAMs) approach, as used by the Applicant, incorporates the spatial structure as a deterministic smooth function. Paradinas et al. (2017) outlines more explicitly why a stochastic approach is better for quantifying spatial relationships. A more sophisticated approach for capturing the spatial structure in the predictions might be more appropriate.

14. In paragraph 13 of the Applicant's report it states that their modelling is similar to that used in the studies in the German Bight. However, this statement is not true. The only similarities are that the data were collected by aerial surveys and some of the same environmental parameters are included in the modelling. However, the GAM approach used by the Applicant and Bayesian methods used in the German Bight study are very different. It is possible that the spatial smoother that the Applicant has used is not as sophisticated as the one applied with MRSea by London Array (APEM 2020), or with Bayesian point process models used in the German Bight (Vilela et al, 2020), and so the predictions are being driven almost entirely by bathymetry and distance to coast. It seems entirely possible that GAMs are over-generalizing the relationship compared to other methods that were used in other studies and as such, they under-estimating the percentage decline in RTD abundance. Natural England notes that the only way to test that would be to apply the same Bayesian point process models as Vilela et al. (2020).

15. The Applicant acknowledges that 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. Natural England notes that the same possibility must therefore also exist when considering direct effects of windfarms on

the birds which likewise do not necessarily radiate symmetrically from them. This introduces a further source of uncertainty regarding the modelled outputs which a more sophisticated modelling approach might have addressed. This emphasises the need for validation of the model's outputs (see below).

5) Validation of model predictions

16. It is disappointing that the Applicant has again not provided the necessary validation of the model outputs through comparisons of the model predictions with survey results recorded in and around windfarms, and through formal cross-validation, as advised by Natural England at deadline 4 [REP4-087].

17. We advise that cross-validation is defined as a method of evaluating and comparing learning algorithms by splitting data into 'training' and 'validation' datasets and is commonly applied in spatial modelling exercises. It can be used for model selection, but for it to be applied appropriately, the cross-validation 'folds' need to be independent. In this instance the Applicant has separated cross-validation and independent validation when they are the same procedure, which NE advises is inappropriate (Refaeilzadeh et al. 2009; Arlot and Celisse 2010).

18. Natural England disagrees with the Applicant that by using their chosen statistical software, which they assert replaces impractical methods with considerably more expedient ones such as maximum likelihood (in the case of model fitting) and penalised likelihood criteria such as the Akaike Information Criterion (AIC) (for model selection), our concerns are addressed. Our concerns remain outstanding. We advise that the cross-validation methods have not been replaced and are far from impractical, particularly with new R packages being rapidly developed. For example, in Allen and Kim (2020) a spatial blocking system is used for cross validation. Another recent example from Clairbaux et al. (2020) demonstrates cross validation for a large spatial data set using 80/20 data splits. The spatial blocking technique would be particularly relevant here as it could demonstrate which areas of spatial distribution are being predicted better than others, and clarify the performance of the model and therefore the weight that can be given to its outputs.

19. We note that the Applicant is correct in a broad sense that there is a level of subjectivity in assessing what is a 'good' or 'bad' model, as it depends on the data. However, a blocked cross-validation could display data relatively and spatially and would allow for an

assessment of the spatial areas which have the most relatively robust predictions. We recommend that the Applicant considers the use of a blocked cross-validation to increase the level of confidence in the model.

20. We note that the Applicant is of the view that for the current models and size of dataset the time-scale for cross validation analysis could be in the order of years. However, we request that further clarity is provided on what is meant by this e.g. does the Applicant mean it would take years to analyse or more years of data to perform? Arguably neither of those would be true, as cross-validation is a well-documented procedure with packages available in R to carry this out. Regarding data quantity, it is true that temporally there is a limited data set available; however, spatially and numerically there are sufficient data to generate a model, thus it would be possible to do a cross-validation assessment, even with the caveat that temporally there are limitations.

21. **Therefore, for the reasons set out above we continue to advise that some form of validation be carried out by the Applicant in order to demonstrate that the modelling is robust and suitable for use in assessing displacement impacts.**

6) Model assumptions and model selection

22. Whilst the Applicant's view is that there can be confidence in the selected best fit model, which is defined by the use of penalised AIC, which is appropriate for GAMs; Natural England notes that no model assumptions have been provided to ensure that GAMs have been applied appropriately. For example, this could have involved plotting the standardized residuals against fitted values to examine issues with mean-variance, or checking the residuals for violation of independence using correlograms/variograms. The output from the GAM check in R would also help to ensure that the degrees of freedom chosen by the algorithm were appropriate as well.

23. The Applicants also do not present any sort of check of correlation between variables by way of the variable inflation factor or similar assessments. This relates to the counterfactuals as well in that an assessment of cross-correlation between variables could help identify if the signals are being confounded. These matters require further consideration in order to demonstrate the model assumptions and selection are robust.

7) Results

24. We note that Table 1 & 2 legends state modelled abundance and densities, but only abundance is shown.

25. We welcome that Table 5 has been added to include the percentage predicted to be displaced in each 1km buffer when calculated as a straight-line relationship (from 100% at 0km to 0% at 12km).

26. We note that the displacement within the East Anglia ONE North buffers from 2km to 8km estimated using the spatial models provided by the Applicant equated to a total 34 individuals, and that using the NE advised outputs, across the 2km to 12km buffers, the estimate is of 127 displaced individuals. However, as stated in REP1-172 and REP4-087 the mortality rate as a result of any displacement is not the main concern. To reiterate NE's position, our primary concern in this case is maintaining the ability of supporting habitat within the SPA to continue to support the same density and distribution of RTD following the construction of EA1N.

8) Implications

27. We have previously commented on the implications of displacement in relation to the need to consider the full suite of Conservation Objectives on pages 10 to 12 of [REP4-087]. **Even when using the Applicant's modelling approach, which we do not agree with, more than 1% of the total area of the SPA is subject to displacement effects. Natural England's advice is that a reduction of 1% or more of the supporting habitat is an adverse effect on the integrity on the Outer Thames Estuary SPA from EA1N alone.**

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