THE PLANNING ACT 2008

THE INFRASTRUCTURE PLANNING (EXAMINATION PROCEDURE) RULES 2010

Natural England review of G2.10 MRSea Baseline Sensitivity Report (Gannet) - Revision: 02 [REP3-029]

For:
The construction and operation of Hornsea Project Four Offshore Wind Farm, located approximately 69 km from the East Riding of Yorkshire in the Southern North Sea, covering an area of approximately 468 km^2.

Planning Inspectorate Reference EN010098

10th May 2022

Natural England's advice on the MRSea v2 modelling [REP3-029]

Natural England welcome the additional work undertaken by the Applicant to address concerns with the baseline characterisation data derived from the application of the MRSea modelling tool and used in the assessment presented in the DCO Application. This is a novel approach to deriving the baseline for ornithological impact assessments, which NE supports the use of, so we are grateful for the Applicant's attempts made to address the issues that have arisen.

Following discussions with Natural England (17th February 2022) and consultation with the Centre for Research into Ecological and Environmental Modelling (CREEM) who developed the modelling tool, the Applicant has conducted an initial reanalysis of the data for Northern gannet (*Morus bassanus*, gannet hereafter), a species subject to potential impacts arising from displacement and collision risk.

Natural England consider the results and information presented in this report fully justifies the concerns set out in our Relevant Representations [RR-029], and our recommendation to revise the modelling that underpins key elements of the ornithological impact assessment for EIA and HRA. In contrast to the original model, the revised model appears statistically sound and provides a superior fit to the raw data, with the spatial distribution of birds now more closely aligned with observed patterns, rather than having a fixed distribution across the entire survey period. This has resulted in notable changes to the predicted distributions and abundance estimates for gannet in some months.

The Applicant asserts that these changes in abundance estimates will have minimal impact on the assessment, however the comparison presented is not based on like-for-like results owing to changes in the structure of the outputs produced (discussed further below) so we do not agree that this conclusion can be drawn. We also consider the differences described for gannet may not be representative of potential changes in abundance estimates of other, often more abundant species, which may exhibit greater variation in spatial distribution or abundance. Critically, Natural England highlight that the values used in the Application's impact assessment have been shown to be based on a sub-standard modelling approach. **We therefore advise that the original model-based estimates are not fit-for-purpose and cannot be reliably used to inform the assessment of impacts within the EIA and RIAA; potential compensation requirements, or future cumulative or in-combination assessments.**

In relation to the new model outputs (MRSea_v2), Natural England had not expected or agreed that these would be presented as 12 mean monthly estimates, rather than the 24 individual survey estimates required to capture the differences in the timing of the peak abundance of birds in each season used in displacement assessments. This means that whilst the outputs could be used for collision risk modelling, they are not compatible for use in displacement assessments based on Statutory Nature Conservation Body (SNCB) guidance (SNCBs 2022).

Natural England understand that this approach was taken following advice from CREEM, to enable the best model fit owing to several surveys having low counts of gannet. Further, we understand that the model was successfully trialled with survey (year/month), providing outputs in the required format for displacement analysis as in the original modelling, but that it was not selected due to lower model fit (Hornsea 4 pers. comm., 20th April 2022). Whilst it is understandable that the Applicant wanted to select the best fitting model, it is unfortunate that the data requirements for the displacement assessment were not taken into consideration as this has significantly impaired the utility of the outputs presented. We consider that this could be rectified for all relevant species by constraining the model parameters considered to ensure that the selected model/s do provide estimates for each survey.

The Applicant has suggested that they are now able to undertake revisions to the model-based analyses relatively quickly for other species (Hornsea 4 pers. comm., 20th April 2022). However, we are mindful that these outputs would then need to be incorporated into updated modelling and analysis (i.e. Collision Risk Modelling, Displacement Analysis etc) before any conclusions in relation to EIA and HRA level impacts can be drawn and the requirement for compensatory measures established. **To ensure that sufficient progression is made on these matters prior to the close of Examination, we consider that the baseline would need to be agreed for key species and associated assessments redone for submission into Examination at Deadline 5.** This would include collision risk modelling (CRM) for kittiwake and gannet and displacement assessment for gannet, guillemot and razorbill, which would then inform the range of impacts assessed within the Population Viability Analysis (PVA) for assessment in the ES/RIAA. (N.B. updated assessments for puffin (displacement), great black backed gull (collision) and the number of Northern fulmar (*Fulmarus glacialis)* would also need to be submitted into examination as soon as possible, but these could be accepted later than Deadline 5 if necessary).

Natural England accepts that in order to achieve this, the baseline data issues need to be resolved to a satisfactory level as quickly as possible. As a result, Natural England provides the following options for a way forward and recommends that the Applicant selects the route that will enable the submission of the updated assessments listed above at Deadline 5.

1. The Applicant should provide design-based estimates for all species where model-based analyses have been used in the current assessment. We note that this should not require any significant additional resource from the Applicant. This is to i) allow comparison with model-based outputs, and ii) to provide a fallback option where modelling is not possible due to time constraints.
2. For gannet, revise the modelling to include 'survey' or 'year/month' as the only possible temporal variables. This would provide individual survey estimates that can be used in both displacement and collision risk assessments. Alternatively, if this is not possible in time to provide updated assessments at Deadline 5, we would recommend the use of the MRSea_v2 estimates for the collision risk assessment and design-based estimates for displacement.
3. In order of priority, for kittiwake, common guillemot (*Uria aalge*) and razorbill (*Alca torda*), provide updated model-based estimates using the revised approach set out in 2. Alternatively, if this is not possible in time to provide updated assessments at Deadline 5, we would recommend the use of design-based estimates for the collision risk and displacement assessments respectively.
4. For completeness, use design-based estimates for all other species where the MRSea_v1 model-based estimates have been used.

To ensure that the outputs of updated analyses are presented in line with SNCB advice and to avoid any additional requests for further information, we would request that a copy of the template provided in Annex III is populated and submitted at Deadline 5.

Natural England would be pleased to work through these recommendations with the Applicant to identify the best way forward in the time available.

We also request that the Applicant should provide the following in any revised submissions:

- Provide a clearer narrative on the modelling process, diagnostics and form of the final selected model.

- Density estimates (design-based and model-based) for birds in flight within the wind farm array area for species subject to collision risk modelling. This is applicable to gannet, kittiwake and great black-backed gull (*Larus marinus*).
- Coefficients of variation (CVs) associated with all abundance estimates (design-based and model-based), to aid interpretation of the relative precision of the estimates.

Annex I: Detailed advice on G2.10 MRSea Baseline Sensitivity Report [Gannet] Revision 02

The submitted report is split into three parts: 1) the Applicant's response to comments from Natural England and CREEM on the original modelling, 2) the results of the revised analysis for gannet, and 3) a comparison between the DCO MRSea results, revised MRSea results and simple design-based abundance estimates (used in all historic impact assessments). In this section, we provide comments on the three parts of the report and present our recommendations for the work required to provide a set of appropriate baseline data for the assessment.

1. <u>Detailed comments</u>

Part 1 – Consultation and Agreed Actions

Natural England notes the Applicant's repeated claim that we have reversed our position of agreement on the outputs from the MRSea modelling being used to define the baseline. Natural England respectfully disagrees with this claim, noting that whilst we agreed in principle to the use of the MRSea tool as a method for deriving abundance estimates for the assessment, we had outstanding concerns and had requested additional information prior to the DCO Application which the Applicant did not address. We also highlight that the modelling has gone through several iterations, and the issues identified only appear to have arisen with the modelling work which was conducted in 2020 to reflect changes to the project's proposed Developable Area. Given the significance of baseline characterisation for the impact assessment, our outstanding concerns and it being a novel approach for generating the baseline we sought the advice of CREEM, the developer of the MRSea package and authority on its application, which informed our advice in RR-029. We highlight that CREEM's views supported our concerns, and we consider that this submission provides a revised, much improved application of the tool. We have subsequently shared CREEM's advice with the Applicant and would be happy to provide it into the examination pending agreement with CREEM, however it should be noted that it represents CREEM's, rather than Natural England's, opinion.

The responses to our comments in Table 1 of the report address a number of our concerns with the modelling approach and outputs. However, we note that the Applicant has not provided the requested CVs, which are necessary to judge the precision of abundance estimates (see comment NE3 in the report). Further, this report does not provide density estimates and associated confidence limits based on either design-based or model-based (MRSea_v2) methods. These are required to undertake collision risk modelling. A clear description of how these are calculated should also be provided by the Applicant

Natural England cannot comment directly on the Applicant's response to the specific issues raised by CREEM in Table 2, however CREEM have reviewed the report independently and have provided further advice to Natural England which has informed our position and is provided in Annex II.

Part 2 – Revised MRSea Results

Natural England welcome that the Applicant has consulted with CREEM during the revised modelling, providing greater confidence in the application of the MRSea tool and outputs. In particular, the presentation of the spatial distribution data clearly identifies the shortcomings of the previous modelling approach that did not include a spatial-temporal interaction. The fitted surfaces now much more closely match the underlying raw observations (see Figure 1 below for an example).

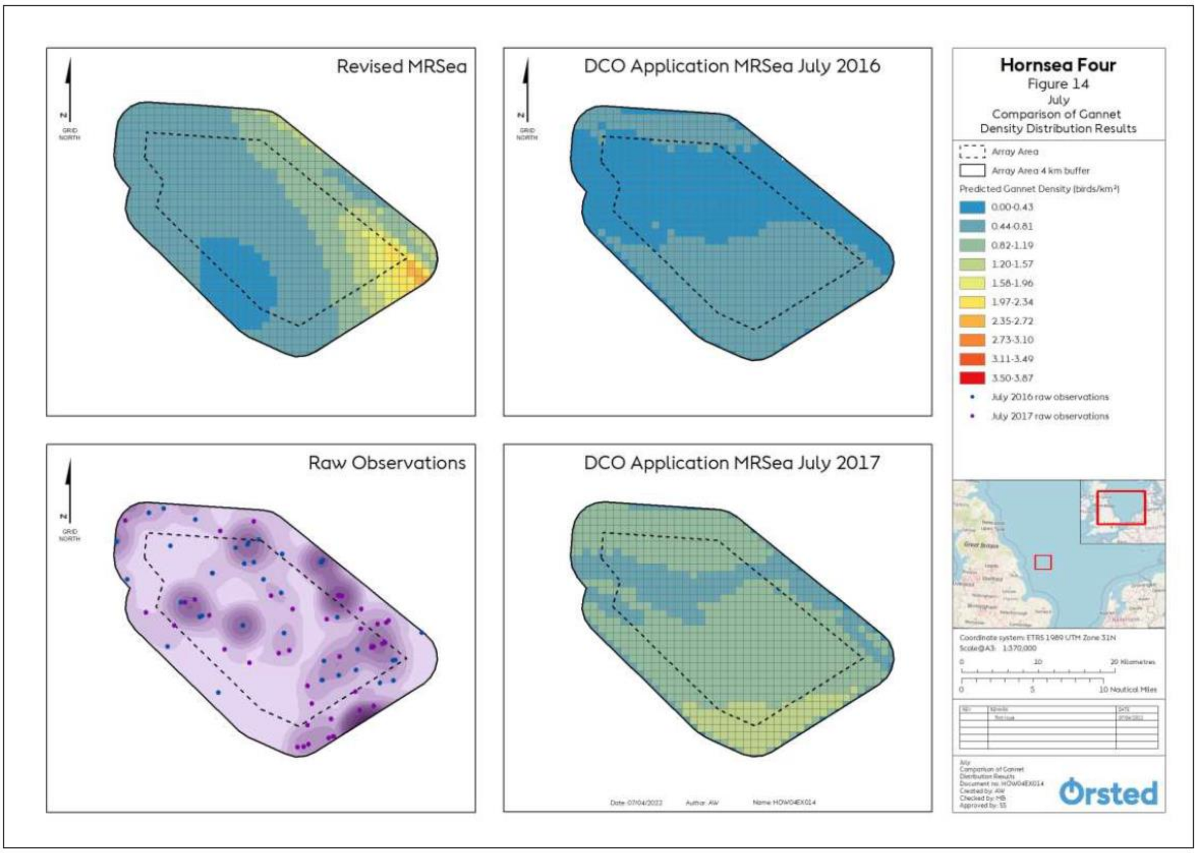

Figure 1: Comparison between predicted gannet distributions form the revised MRSea model (MRSea_v2) and original model underpinning the assessment (MRSea_v1) for July presented in the Applicant's MRSea Baseline Sensitivity Report (Gannet). Underlying raw observations are pooled over both years.

The outputs provided in Part 2 of the report, Annex A, and Annex B, are generally in line with our expectations with the following exceptions:

<u>Suitability of outputs for displacement assessments</u>

Critically, the model framework now includes "month" (12 months) or "bio-season" (3 periods), rather than survey (24 surveys), as the temporal explanatory variables in the model. This reflects a significant change from the previous modelling (MRSea_v1) that underpinned the assessment in the DCO Application. This newly adopted approach effectively pools surveys in the same months, or bio-seasons, under the assumption that there is no significant variation between months in different survey years. The selected model, including "month" as the temporal term, therefore produces a single prediction for each calendar month, rather than for each individual survey as in the former modelling. Unfortunately, this has resulted in a fundamental mismatch between the model outputs and data requirements for the displacement assessment as set out in SNCB guidance. The displacement assessment requires the use of individual survey estimates, rather than combined monthly ones, to capture interannual variability in the timing and magnitude of peaks in the abundance of species within discrete seasons.

The use of combined monthly estimates could result in a significant underestimation of impacts if the timing of peaks varies between years, and it would also be inconsistent with SNCB guidance and the approach taken for all other offshore wind farm assessments to date. To demonstrate the potential implications of this on the number of gannet subject to displacement impacts, we can use the design-based estimates provided in the report to illustrate the potential differences resulting from the use of individual surveys versus combined months (see Table 1 and Table 2). Following SNCB guidance, a total of 2,196 birds would be subject to displacement. Using the mean monthly data (a proxy for the pooled monthly model data), a total of 1,790 birds would be subject to displacement. As shown in Table 2, this represents an 18% reduction in the estimates used for the assessment.

Table 1: Design-based estimates for the abundance of all gannet in the wind farm array and 2 km buffer. Cells highlighted in yellow represent the peak abundance estimates in a given season in each year. Those highlighted in orange are the peak values from the mean monthly estimates.

NE seasons	**Pre-breeding**			**Breeding**							**Post-breeding**	
Year	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**
1	**369**	0	30	320	30	580	**1,431**	440	200	260	**860**	539
2	**421**	70	10	130	70	90	100	0	**591**	0	230	**720**
Mean	**395**	35	20	225	50	335	**765.5**	220	395.5	130	545	**629.5**

Table 2: Comparison of seasonal abundance estimates that would be adopted for displacement assessment following SNCB guidance (i.e. the average of the peak abundance estimates in a given season over two years) and using the mean monthly data (a proxy for the pooled monthly model estimates) using the design-based abundance estimates for gannet presented in Table 1.

Method	Pre-breeding	Breeding	Post-breeding	Total
Following SNCB guidance	395	1,011	790	2,196
Using mean monthly data (proxy for MRSea_V2 Approach)	395	765.5	629.5	1,790

Natural England had not expected or agreed this modification to the approach and understand that it was implemented following advice from CREEM to enable the best model fit, owing to several surveys having low counts of gannet. As modellers CREEM were not likely to be aware of the requirements of the displacement assessments, so it is unfortunate that they were not apprised of the necessary model outputs. We understand the model was successfully trialled with 'survey' or 'year/month' as the temporal covariates, providing outputs in the required format for the displacement assessment, but that it was not selected due to a poorer model fit (Hornsea 4 pers. comm., 20th April 2022). Details of these model runs are not provided in the report so we cannot comment on the validity of this choice. We do not consider that surveys having low counts of gannet should prohibit the advised approach being pursued, as alternative options are available to deal with low data which would allow the required outputs to be produced.

Whilst incompatible with displacement analyses, the provision of pooled monthly estimates from the new modelling approach does not preclude the use of the results for collision risk modelling, as this uses single monthly averages of flying bird densities in the array which the new model effectively provides. Thus, Natural England consider the provided model results for gannet could be used for collision risk modelling if time constraints necessitate this.

<u>Other outstanding concerns with the model outputs</u>

- Additional narrative around the model selection process, diagnostics provided, and results would help clarify interpretation of the provided outputs.

- The final selected 'best' model is not fully described, including the selected variables and how they were entered (smooth, linear, discrete etc) and there has been no mention of how effort was included.
- Natural England note that the Applicant continues to provide outputs according to their defined "bio-seasons", rather than the Natural England advised seasonal definitions for gannet. Outputs should be provided in line with Natural England's approach for gannet (alongside those of the Applicant) as seasonal definitions may influence the estimated impacts. This should also be carried out for other species as required.
- The Applicant describes the values presented in Table 4 of the report as "mean peak abundances" in section 6.1.1.1, when these are in fact simply peak abundances, as no averaging can be carried out based on single estimates for each calendar months.
- In Table 7 some of the results are to be confirmed (TBC). We would welcome clarity regarding whether this part of the analysis has not yet been completed, and if not when the analysis will be submitted.

Part 3 – Comparison of DCO Application and MRSea_v2 Results

The report makes it clear that a like-for-like comparison between the DCO Application MRSea_v1 results and the new MRSea_v2 outputs is not possible due to the way the new model has been parameterised. We agree with the Applicant regarding this. Nevertheless, in Part 3 the Applicant has provided a proxy comparison based on the SNCB advised approach from design-based and MRSea_v1 estimates within their defined seasons for gannet, against the pooled monthly outputs from the new MRSea_v2. As a result of this, the Applicant's position is that the difference in outputs of the two approaches is minor and that the application values are therefore appropriate for use. Natural England strongly disagrees with this. In addition to the inappropriateness of the comparison, the original values have been shown to be based on sub-standard modelling and therefore we cannot have confidence in their use within the assessments.

Furthermore, according to the baseline characterisation report, gannet are generally present in lower numbers than kittiwake, guillemot and razorbill in the Hornsea 4 array. This is particularly evident for guillemot which were present in very large numbers during August and September. We therefore consider the potential for larger discrepancies between the existing and new modelling for these species to be high, owing to the much-improved fit to the raw data which better captures variations in the spatial distributions of these species, which in turn will influence the abundance estimates.

2. <u>Natural England's recommendations</u>

Natural England consider it critical that, if model-based estimates are to be used for the assessment, all stakeholders and decision-makers have confidence in the application of the MRSea tool. The revised modelling approach presented in the report provides a much-improved analysis and has addressed several of the concerns expressed by Natural England in our Relevant Representations, which we welcome. However, changes to the way the model is now parameterised have resulted in a mismatch between the outputs and requirements for the displacement assessment, which significantly limits their utility.

The Applicant has suggested that they are now able to undertake revisions to the model-based analyses relatively quickly for other species (Hornsea 4 pers. comm., 20th April 2022). However, we are mindful that these outputs would then need to be incorporated into updated modelling and analysis (i.e. Collision Risk Modelling, Displacement Analysis etc) before any conclusions in relation to EIA and HRA level impacts can be drawn and the requirement for compensatory measures established. To ensure that sufficient progression is made on these matters prior to the close of Examination, we consider that the baseline would need to be agreed for key species and associated assessments redone for submission into Examination at Deadline 5.

Natural England accepts that in order to achieve this, the baseline data issues need to be resolved to a satisfactory level as quickly as possible. As a result, Natural England provides the following options for a way forward and recommends that the Applicant selects the route that will enable the submission of the updated assessments listed above at Deadline 5.

1. **Provide Natural England with design-based estimates or all species where the MRSea_v1 model-based estimates have been used to underpin the assessment.**

   We do not anticipate this request would require significant additional resource from the Applicant. The aim of this is to i) allow comparison with model-based outputs, and ii) to provide a fallback option where modelling is not possible due to time constraints. Whilst we are hopeful that the Applicant will be able to provide further revised model-based estimates, we consider design-based estimates could readily be used where necessary. Design-based estimates have been used to inform all other recent offshore wind farm assessments.

2. **Depending on time constraints, revise the modelling for gannet. If this is not possible in time to provide updated assessments at Deadline 5, use the MRSea_v2 outputs for collision risk assessment and design-based estimates for the assessment of displacement.**

   We suggest that if it is possible to provide a revised model that results in individual survey estimates, this should be used to inform both displacement and collision risk assessments for gannet. This could be achieved by constraining the temporal explanatory variables to either 'survey' or 'year/month' combination and ensuring that any other model parameters are adjusted accordingly (e.g. blocking structure). The Applicant has stated that they have already trialled such a model for gannet (Hornsea 4 pers. comm., 20th April 2022) which we hope will reduce the time needed to address this.

3. **Depending on time constraints, revise the modelling for, in order of priority, kittiwake, guillemot and razorbill. If this is not possible in time to provide updated assessments at Deadline 5, use design-based estimated to inform the assessments of collision risk and displacement for respective species.**

   Given the importance of these species within the Examination, we consider the re-analysis of these species should be undertaken if the Applicant considers it feasible within the time constraints of the examination. They are generally more abundant than gannet and lend themselves to the modelling approach. Again, we request that any revised models ensure that individual survey estimates are produced as outputs.

4. **For completeness, use design-based estimates to update the assessments for all other species where the MRSa_v1 model-based estimates have been used. This includes Atlantic puffin (*Fratercula arctica*), great black-backed gull (*Larus marinus*) and fulmar.**

   These species are generally present in low numbers within the project area, which means modelling may prove more problematic. Thus, we suggest that, in the interest of efficiency, design-based estimates should be used to ensure the outcomes of the relevant assessments are based on a standard approach and can be used where necessary for any future cumulative and in-combination assessments.

We suggest design-based estimates (abundance and densities), associated CIs and CVs should be provided in a standalone report. Results of any revised models could be reported in a similar manner to the gannet report Appendices. This should include details of the model selection process, details of the final model, relevant diagnostics, maps of derived spatial distributions and abundance estimates. These reports should also include the following to address outstanding concerns:

- We request the Applicant provides a description and interpretation of the model code, model diagnostics and outputs. This would be useful to understand what they are showing and whether they are content with, and trust, the model outputs and results.
- Please ensure the final model is clearly defined in the results, including what variables have been included, how they have been entered (e.g. smooth, linear, discrete etc) and how survey effort has been included.
- A minimum of density estimates for birds in flight within the wind farm array area for species subject to collision risk modelling. This is applicable to gannet, kittiwake and great black-backed gull (*Larus marinus*).
- CVs associated with all abundance estimates, to aid interpretation of the relative precision of the estimates.
- Where defined seasons are used to produce comparative estimates for gannet and kittiwake, comparable estimates, based on Natural England advised seasonal definitions, should be provided to illustrate differences or similarities.

These outputs would then need to be incorporated into updated modelling and analysis (i.e. Collision Risk Modelling, Displacement Analysis, Population Viability Analysis etc) as required. To ensure that the outputs of updated analyses are presented in line with SNCB advice and to avoid any additional requests for further information, we would request that a copy of the template provided in Annex III is populated and submitted at Deadline 5.

Results of revised analyses could be provided to Natural England in an iterative fashion. We would work to agree these as soon as possible to expedite the process and allow the values to quickly be used in revised assessments.

We welcome further consultation with the Applicant throughout, to help ensure any questions or issues that may arise during any further work are addressed at the earliest possible time.

References

SNCBs (2022) Joint SNCB Interim Displacement Advice Note. Joint SNCB Interim Displacement Advice Note | JNCC Resource Hub

Annex II: CREEM review of G2.10 MRSea Baseline Sensitivity Report (Gannet) - Revision: 02 [REP3-029]

Dr L Scott-Hayward
CREEM, University of St Andrews

Statistical Review of EN010098-001325 Hornsea Project four:

G2.10 MRSea Baseline Sensitivity Report Gannet

Summary

The aim of this review was to determine the validity of the statistical content of the report. In my opinion, the statistical analysis seems sound and the model results trustworthy. Many of the comments below relate to reporting which, whilst not strictly in the remit of this review, are fundamental to being able to assess the statistical approach. I would hope that these are taken on board in the future.

It has, however, become apparent since the submission of this report that NE would prefer abundance estimates and associated uncertainties for each of the 24 months separately for input into a secondary process.

The models fitted here appear to be sufficient statistically but do not meet this requirement from NE. Some options going forward might be to:

1) Provide the spatial distribution outputs as is – the best model showing spatial distribution and use potentially inferior design based estimates for inputs to NE's process.
2) Re model with the 24 months in mind and think of ways to ensure this is achieved. Perhaps fitting models to each bioseason separately. Start with the most complex (e.g. with a spatial interaction of some kind) and reduce till models work/converge. If models are not possible (e.g. for a bioseason with very few sightings) then as a last resort, present the design based estimates for these months. Year-month could remain in the models even if the cross validation scores are not sufficient to retain it, the downside being that the uncertainty of these could be quite large.

It is difficult to suggest a concise solution as it may be different for each species and the analyst should familiarise themselves with the data to make informed choices about the models to be fitted.

Care should be taken in future to ensure that necessary outputs are identified and justified (especially if in contravention to natural modelling outputs) so that all involved may work toward the same goals.

General Comments:

I think there is some misunderstanding about what MRSea actually is. Principally, MRSea is an R package for fitting spatially adaptive regression splines in a generalised additive model framework. It was developed to examine animal survey data for signs of changes in animal abundance and distribution following marine renewables development. However, the methods are suitable for a wide range of applications. The methods included are SALSA 1D and 2D and CReSS smoothing for the spatial smooth. In addition, there are various helper functions for diagnostics which the user may choose to employ or use other techniques perhaps more familiar to them. It is not a model and there are any number of models that could be fitted using this framework and the structure of these are the responsibility of the analyst. Please refer to MRSea as a package both here and throughout the report and reference it appropriately.

Additionally, the models fitted here are not particularly complex, as stated in the report, and the vignette provided with the package (referenced as Scott-Hayward *et al* 2017) describes the basic functionality of the package. It assumes the analyst has prior knowledge of general modelling techniques and is not a "recipe" for all analyses. In particular, the checking of model assumptions is ubiquitous across all statistical methods. The vignette for MRSea v1.3 has been available since March 2021.

It would have been nice to see a proper methods section to show that the analysts are able to describe what they have done rather than step by step with R code. There is also a lack of interpretation or description of some of the outputs. For example, if you show a diagnostic, what does it mean, are you happy with the results and trust in the model outputs? If you show R code/output, what is it helping show/explain and what do you want the reader to take away from it?

Detailed comments:

After each comment the letter in brackets denotes the following: R, reporting issue; C, comment and M, Modelling.

2.1.1.1 - "not routinely saved". This may be so in this case but it is good practice to ensure analyses are repeatable and information retained/at hand such that routine enquiries on review can be quickly dismissed. Not every detail of an analysis need be submitted/reported but it is good practice to keep your own log book of decisions/results that an be called upon if needed. [C]

3.1.1.1 - methods developer not model developer [R]

- bullet points seem to be a repeat from earlier [R]

CREEM4 – "interpreting the P value produced to ensure a non-significant value." You can't interpret a p-value to *ensure* anything. The interpretation depends entirely on its value. [R]

- P-value less than 0.05 – presumably this is only for the best gannet model. It will need to be checked for all species. [C]
- "…the absence of documentation". These are standard tests for residual correlation and not specific to MRSea even though there is some functionality for them within the package. The vignette is not a course on statistical modelling. [C]
- "…not having prior knowledge of which outputs would be required". These sorts of outputs are an absolute requirement for assessing one of the critical model assumptions for any kind of modelling in an LM, GLM or GAM framework and being able to justify any results produced. If they are not mentioned in a report, potential violation of assumptions may be questioned. [R]
- "stochastic nature". Hopefully in future these models will be run with a seed set so that they are reproducible. [C]
- In the Actions column, it states survey ID was used as a block structure. I believe this to be incorrect, it was unique transect ID. [R]

CREEM9 – good to see summary but it needs to be in the methods section. Also I don't think the max knots was 5 for the 2D smooth but I may be wrong. Default radial basis is Gaussian. [R]

6.1.1.1 - final modelling code was not shared with CREEM. A draft code file was seen which was heavily edited by CREEM. The final version was not seen or commented on. [C]

- please report details of the final model in the results. What variables and how they entered (smooth, linear, discrete etc). No mention of the inclusion of effort anywhere. [R]

Figure 1 - not sure I understand the use of the heatmap. There is no inclusion of zero segments, how was the bandwidth chosen and how are observations of size >1 shown? [R]

- Seems that mostly the numerous figures in the results could be replaced with the ones in the appendix (point est, lower and upper ci). Much more concise. [R]
- Following on, unless requested by NE, the month by month comparison of all the surfaces seems unnecessary. The previous models have been shown to be not valid statistically and so any outputs were untrustworthy rendering comparison irrelevant.

Part 3 – checking the new estimates against the old MRSea estimates seems redundant given the previous results have been shown to be untrustworthy. One can compare the design based and new estimates but again this seems redundant. Model based estimates are much better (if they can be attained) as they take into account environmental variables and the patchy nature of some species. [R]

8.1.1.2 - more professional to use Dr Scott-Hayward (and then you don't have to remember the spelling). [R]

- transect ID not survey ID in the blocking structure. [R]

- As stated earlier, Scott-Hayward *et al* 2017 is a vignette for the package and not guidance. Variables and how they are included is at the discretion of the analyst. [C]

8.1.2.1 – it would be better to translate the R output into tables [R]

8.1.2.3 – no need to include this R code [R]

8.1.3.1 – not sure what this model is in aid of. It does not need to be reported. The initial model for SALSA only includes factor variables. [R]

8.1.3.2 – the runs test and all following diagnostics need only be carried out/reported on the best model. These outputs are meaningless as the variables do not enter the model in the way they will ultimately. [R]

8.1.4.1 – 1D salsa routine does not allow a SPATIAL interaction to be fitted. [R]

Figure 32 – the code shows only depth variable, what happened to other 1d candidates? Additionally, please write up the parameterisation using words/tables. R-code is usually reserved for analysts eyes only. [R]

Figure 33 – no need to show output from 1D model – unless of course it turns out to be the best one. Only show the necessary details from the final one – e.g. final model specification with degrees of freedom for any smooths. [R]

8.1.4.3 – "… is lower and therefore" the addition of s(depth) improves model fit sufficiently to continue with this model. [R]

- not sure what you mean by GLM, is this the initial model? [R]

Figure 35 – max knots states 20, not 5 as specified earlier. Again, put parameterisation in text/tables which a statistician not familiar with MRSea coding would understand. [R]

Figure 37 – tedious amount of output – if you must, the ANOVA output would be more concise. [C]

Figure 39 – just state this in the text, unnecessary figure. Would be most useful to show table of scores. [R]

8.1.5.4 – this paragraph and the table should probably come before the description of the best model. [R]

Table 7 – Would be more concise and easier to understand if each line was a single model (not three) and the best score given. For example, the first line would be:

	CV Score
s(depth) + month + s(x,y,month)	0.491806
s(depth) + s(distFFC) + bioseason_year + s(x, y, bioyear)	0.4919532
s(depth) + bioseason + s(x, y, bioseason)	0.492040
Month	0.4927862
Month	0.4939167
etc	

[R]

- Not sure why the two month scores are different. Did you use a different seed for the CV score? [M]

- Also, did you try using a smooth of month or month24? [M]

Figure 40 – you need to order the months! Use the relevel function in R to change the order of the factor levels so that the graphic makes more sense. [R]

8.1.5.5 – there is no description of the outputs or any indication of areas which the analyst is happy/unhappy with the results. [R]

8.1.5.6 – maximum likelihood PARAMETER estimates and ESTIMATED VARIANCE-COVARIANCE MATRIX. [R]

- 95 percentile based CIs [R]

8.1.5.7 – odd way to present it, using coefficient of variation would be better. There is also no description of this plot. Is the analyst happy with the wide ranges in places? Hint: wider intervals where you have higher fitted values is a natural result from using the Poisson distribution. The variance of your predicted values increases as the mean increases. The dispersion parameter of your model has not yet been reported. In this case, your variance increases at a rate 2.79 times that of the mean. A mean-variance relationship plot (the coding for which was given to the analyst but I do not see here) would indicate if this is a reasonable assumption. [RC]

8.1.6 – great to see the diagnostics but there is no interpretation by the analyst. Are they happy with the results? [R]

- as mentioned above, no evidence of checking the mean-variance relationship (is the quasipoisson appropriate?) or checking for spatial bias (spatial residual plot). [M]

Annex III: Natural England template for presenting data for ornithological impact assessments

Natural England template for presenting data for ornithological impact assessments

Applicants submit their assessment of predicted impacts on receptor species in their ES documents prior to the examination stage. However, there is not currently a consistently used, standardised format for data presentation and use in these assessments, which can result in projects being assessed using different parameters without a clear audit trail or justification for doing so. This in turn results in further requests for information during the examination process, meaning discussions focus on assessment updates rather than considering the impacts of the project on key receptors and ways to address them.

Following the initial submission, over the course of the six-month examination period, there may be several iterations of the assessment that result in the production of different estimates of predicted impact. These reassessments occur for various reasons, including advice from statutory advisers regarding the use and interpretation of the data, models, model parameters and analysis methods to use, or because developers incorporate new data, models or methods based on new evidence that becomes available during the examination period. Additionally, developers may change the physical design of their development (for example alter turbine specifications) resulting in changes to the predicted magnitude of impacts.

As a result of this evolving assessment of impacts throughout the examination stage there are typically multiple impact scenarios presented. This may be further complicated if the applicant, examining authority and stakeholders have alternative positions regarding the assessment process, as this can result in multiple versions of impact predictions being presented alongside each other, or in different documents.

At the end of the examination there is often no clear summary or presentation of the final impacts predicted (or whose position these figures represent), and a lack of information about the data, models, parameters, analysis etc. that have been used to derive the specific impact values.

This presents a particular problem for subsequent projects entering into examinations, as these need to use the impact figures from earlier projects in their cumulative and in-combination assessments. On occasions, subsequent projects have needed to use data from the original submissions even though the assessment and/or project parameters have changed.

This document sets out a generic template for the information that needs to be presented at the beginning and close of any offshore wind farm examination to ensure that these data are available in a standard format that enable subsequent projects to undertake their cumulative and in-combination assessments. If there are further changes to the assessment and/or project parameters following the examination, the template should also be updated after the consent decision.

The data and parameters used to populate this template should reflect the design parameters that are set out in the draft DCO for the project. It is recognised that the parameters specified in the DCO do not always provide all the information needed to establish the worst-case scenario parameters within the development envelope needed for the ornithological assessments. Therefore, these parameters should be set out in this template – and should reflect the worst-case scenario for each receptor and impact within the Rochdale Envelope defined by the draft DCO. The data within the template should be fully integrated into the relevant sections of the ES.

It is recognised that different parties may not agree on the details of all the data, parameters or impacts at the start and close of the examination. The parameters and data requested in this template represent those that Natural England considers should be used for the assessment of ornithological impacts. However, the template is designed such that the information presented can easily be adjusted to reflect alternative positions on, and interpretations of the underpinning data. If required the template can be used to present alternative parameters and data (for example to reflect the developer rather than Natural England position), but in this case we request that a) the alternative data are presented using the same tables and layout as per this template; and b) these data are presented in a separate version of this template to the version representing Natural England's position, which should be submitted irrespective of whether the developer has an alternative position.

The template can be updated following consenting decisions to reflect any changes to the licence condition or design parameters in the final DCO.

1.1 Project-specific parameter information required

The following parameters and data should initially be presented by the developer at the application submission stage. An updated version should then be presented at the final deadline of the examination as a final statement of the information underpinning the predicted impacts on ornithology receptors.

Where 'source' or 'reference' is specified in the tables below, this should be a reference or link to the published document where the parameter is defined.

Please note that tables with orange-coloured headers are those where consultation with Natural England is required to agree some of the parameter values for the specific project.

Where multiple table templates are required, each table should be clearly labelled within the application, e.g. Table 8a, 8b, 8c etc.

1.1.1 Wind farm and turbine parameters

Wind farm and turbine parameters should represent the worst-case scenario for collision and/or displacement predictions (as applicable) within the project envelope parameters defined within the DCO. If the worst-case scenario parameters differ between species and/or impacts, multiple tables would be needed to reflect this.

Parameter	Parameter Value	Source/document references
Latitude (degrees)		
Wind farm Footprint Area[1] (km^2)		
OWF + 2km buffer area (km^2)		
OWF + 4km buffer area (km^2)		
OWF +10km buffer area (km^2)		
Width of wind farm footprint (km)		
Number of years that Wind farm will be operational		

Table 1. Wind farm parameters. These should represent the worst-case scenario parameters in terms of collision and/or displacement impacts within the DCO design, timescale and layout parameters. Use separate tables for collision and displacement if the worst-case scenario parameters differ.

Parameter	Parameter Value (SDs in parentheses)	Source/document references
Number of turbines		
Number of blades		
Max blade width (m)		
Average blade pitch and SD (degrees)		
Rotor radius (m)		
Average rotation speed and SD (rpm)		
Hub height relative to HAT (m)		
Air gap at HAT (m)		
Tidal offset (HAT-MSL) (m) (Plus indicate whether Tidal Offset applied to CRM calculations)		
Turbine model information (MW, name etc.) [It is recognised that a generic turbine may be specified but any project specific detail that can be provided is helpful]		

Table 2. Turbine parameters used in collision risk modelling (CRM), or stochastic CRM (sCRM), using final turbine specifications as presented in DCO. These should represent the worst-case scenario parameters in terms of collision impacts within the DCO design, timescale and layout parameters. Use separate tables for each species if the worst-case scenario parameters differ.
HAT = Highest Astronomical Tide. MSL = Mean Sea Level. MW = megawatt.

[1] This should relate to the Offshore Order Limits area.

Model	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Source
Band	Prop. of time operational (%)													
sCRM	Wind availability (%)													
	Mean downtime (%)													
	SD downtime													

Table 3. Monthly operational time for wind farm used in the Band model or sCRM.

1.1.2 Bird data and parameters for collision risk modelling

Present data that relate to the assessment of collision impacts using the Natural England advised approach in the tables below (Tables 4 to 6).

Tables have been pre-populated where data are available from published documentation, and to reflect Natural England's position on generic parameters that should apply to all projects. Applicants should check with Natural England whether they are using the latest version of the template, to ensure any updates to Natural England's generic advice are incorporated. Where any amendments are made to the suggested values, these should be clearly signposted and justified with annotations.

Densities of birds in flight should include apportioning of unidentified birds based on survey ratios where appropriate. If species- and site-specific flight height data are used, the proportions at collision height (PCH) should be presented by month (with standard deviations and confidence intervals where possible) and as an overall (Table .6). Flight height distribution data used in basic sCRM should be provided as separate files. Where the basic sCRM is used, densities of birds in flight should be provided with standard deviations or a file should be provided with the distribution reference points or distribution samples used. Also note that NE suggests the basic sCRM should be run using the NE parameters stipulated in Table 4, including each Nocturnal Activity Factor (NAF), with a standard deviation of 0, separately.

Parameter	Gannet	Kittiwake	Lesser black-backed gull	Herring gull	Greater black-backed gull	Little gull	Sandwich tern	Position	Source Refs
Bird length (m) SD for sCRM in parentheses	0.94 (0.0325)	0.39 (0.005)	0.58 (0.03)	0.6 (0.0225)	0.71 (0.035)	0.26 (0.005)	0.38 (0.005)	Accepted by NE	BTO Bird Facts data (Robinson, 2005). These are the same data used in Cook *et al.* 2014
Wingspan (m) SD for sCRM in parentheses	1.72 (0.0375)	1.08 (0.0625)	1.42 (0.0375)	1.44 (0.03)	1.58 (0.0375)	0.78 (0.0125)	1.00 (0.04)	Accepted by NE	BTO Bird Facts data (Robinson, 2005). These are the same data used in Cook *et al* 2014.
Flight speed (m/s) SD for sCRM in parentheses	14.9 (0)	13.1 (0.40)	13.1 (1.90)	12.8 (1.80)	13.7 (1.20)	11.5 (TBC with NE)	10.3 (3.4)	Accepted by NE	Pennycuick (1987,1997) and Alerstam *et al.* (2007) and used in Cook *et al.* (2014).
NAF for deterministic model (1-5 as per Band 2012) and/or proportion for sCRM Convert percentages to proportions and use SD of 0 for sCRM. Run model twice where two values considered.	1-2 = 0.10 & 0.20	2-3 = 0.25 & 0.50	2-3 = 0.25 & 0.50	2-3 = 0.25 & 0.50	2-3 = 0.25 & 0.50	2-3 = 0.25 & 0.50	Please consult NE for latest advice	SNCB advice	Garthe & Hüppop (2004) Furness *et al.* (2018) for Gannet
Flight Type (Flapping or Gliding)	Gliding	Flapping	Flapping	Flapping	Flapping	Flapping	Flapping	SNCB advice	
Proportion of flights upwind (%)	50	50	50	50	50	50	50	Accepted by NE	Band (2012)
Avoidance Rate (%) (± 2SD) for basic Band and basic sCRM	98.9 (98.7-99.1)	98.9 (98.7-99.1)	99.5 (99.4-99.6)	99.5 (99.4-99.6)	99.5 (99.4-99.6)	99.2 (99.0-99.4)	98.0	SNCB advice	JNCC (2014)

Avoidance Rate (%) (± 2SD) for extended Band		NA	NA	98.9 (98.7-99.1)	99.0 (98.9-99.1)	98.0 (97.8-98.2)	NA	NA	SNCB advice	JNCC (2014)
CRM model		Band (2012)	Band (2012)	Band (2012)	Band (2012)	Band (2012)	Band (2012) using Migrant Collision Risk tab	Band (2012) or Band (2012) using Migrant Collision Risk tab (season/site dependent)	NE	Current NE advice to Projects
Options to present within CRM	Option 1	YES if Natural England agrees that there are robust site specific PCH data							NE	JNCC (2014)
	Option 2	YES	YES	YES	YES	YES	YES	YES	NE	JNCC (2014)
	Option 3	NO	NO	YES if densities from boat based surveys	YES if densities from boat based surveys	YES if densities from boat based surveys	NO	NO	NE	JNCC (2014); Johnston & Cook (2016)
	Option 4	NO	NO	NO	NO	NO	NO	NO	NE	JNCC (2014)
Flight Height Data	Option 1	Site specific PCH data (see above caveat under CRM Options)							NE	
	Option 2	Use generic species-specific flight distribution in Johnston *et al.* (2014a; 2014b) (maximum likelihood distribution) including upper and lower 95% Confidence Intervals (CIs)							NE	
	Option 3	N/A	N/A	Use generic species-specific flight distribution in Johnston *et al.* (2014a; 2014b) (max likelihood distribution) including upper and lower 95% Cis			N/A	N/A	NE	

Table 4. Bird parameters.[2]

[2] Note that additional species present in project areas may be at risk from collisions and therefore need to be included in CRM, including but not limited to common tern, little tern, Arctic tern, Mediterranean gull. If there is a requirement to include these species for a project's assessment, Natural England will provide information on the advised parameters to use.

Species: [xx]; Calendar Years for surveys: [Month xxx, Year xxxx – Month xxx, Year xxxx]; Birds in flight, densities derived from wind farm footprint with no buffer													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Source**
Calendar Year 1 Mean Density (birds in flight, footprint with no buffer) (birds/km^2)													
Calendar Year 1 UCL (97.5%)													
Calendar Year 1 LCL (2.5%)													
Calendar Year 2 Mean Density (birds in flight, footprint with no buffer) (birds/km^2)													
Calendar Year 2 UCL (97.5%)													
Calendar Year 2 LCL (2.5%)													
Calendar Year 3 Mean Density (birds in flight, footprint with no buffer) (birds/km^2)													
Calendar Year 3 UCL (97.5%)													
Calendar Year 3 LCL (2.5%)													
Mean Bird density in OWF across all years surveyed (birds in flight, footprint with no buffer) (birds/km^2)													
UCL density (97.5%)													
LCL density (2.5%)													
SD (for sCRM)													

Table 5. Bird density[3] data for CRM (add separate table for each species subject to CRM[4]) and sCRM (inclusion of standard deviations) – this should specify that it relates to density of birds in flight in the wind farm footprint[5] (i.e. with no buffer). Specify calendar years that survey data relate to, and first and last month of data collection.

[3] Note that for species where the Migrant Collision Risk tab in Band (2012) is used e.g. little gull, the monthly data should be entered as “Migration passages” which is the number of birds migrating through the migration corridor. This data might only apply to certain months. Additionally, the width of the migration corridor needs to be specified.
[4] Number Tables for each species as 5a, 5b etc
[5] Footprint = “Offshore Order Limits”

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Overall
PCH													
SD													
CI													

Table 6. Site-specific proportions of birds at Collision Height (PCH).
SD = Standard Deviation. CI = Confidence Intervals.

1.1.3 Seabird seasonal and apportioning parameters

This section provides a template for providing seasonal and apportioning parameters within an application for the completion of CRM and displacement assessments.

Species	Pre-breeding season/spring migration	Breeding season	Post-breeding season/autumn migration	Non-breeding/winter season

Table 7. Seasonal definitions used for each species (seasons as applicable – noting not all seasons are relevant to all species). Add seasons applicable to both collision and displacement assessments. If different seasonal definitions are used for different assessment components for a species (e.g. EIA versus HRA, or for different SPAs under HRA), include a separate table for each species/population scale to show the seasons used, with clear headers. Advice should be sought from Natural England on the appropriate species and seasonal definitions to use for particular SPAs and population scales.

SPA: [insert name]				
Species	**Apportioning pre-breeding season / spring migration (%)**	**Apportioning breeding Season (%)**	**Apportioning post breeding season / autumn migration (%)**	**Apportioning non-breeding / winter season (%)**

Table 8. Seasonal apportioning to each SPA subject to Appropriate Assessment in HRA for each species. Not all seasons will apply to all species.[6] Advice should be sought from Natural England on the apportioning values to use for each species and SPAs.

If any non-adult birds were apportioned to the colony in the breeding season provide details as a separate table.

[6] Tables should be numbered for each SPA (e.g. Tables 8a, 8b etc.)

1.1.4 Project collision figures for all receptor species

This section should be populated with the predicted collision figures for each species, calculated using the parameters and data set out in Sections 1.1.2 and 1.1.3. It is recognised that these predicted impacts may not represent the agreed impact levels of all parties, however the data provided in Sections 1.1.2 and 1.1.3 will allow impact levels to be calculated using alternative approaches if required by other parties. Presentation of these figures does not preclude Natural England or any other party updating these figures if assessment data or parameters change in the future. The intention is that the data provided in this document will allow these updates to be made transparently, providing a clear audit trail to the original data and figures from each project's examination.

If collision figures are calculated using the Band Model (Band 2012), there should be separate sets of tables (as per below) presented for each species, model option and NAF combination used (if applicable). If the stochastic model is used, then results should also be provided for each relevant species, model option and NAF combination.

1.1.4.1 Collisions with no apportioning to SPAs

Tables 9 and 10 (or 11 if applicable) should be populated for all relevant species included in Table 4 (and any additional species where relevant).[7]

Data should be presented based on the parameters in the tables 1 to 8 above. If using the Band Model (Band 2012) multiple tables will be required for each species, model option and NAF level used. If using sCRM, we request any input and output files are provided and Table 11 should be populated for each species, model option, and NAF value combination explored.

We also request that Excel Band Model Spreadsheets are provided for all model runs. Actual spreadsheets to be provided (not screenshots).

AR % [Specify in boxes below]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Total**
Density = LCL													
AR (-2SD)													
AR (Mean)													
AR (+2SD)													
Density = Mean													
AR (-2SD)													
AR (Mean)													
AR (+2SD)													
Density = UCL													
AR (-2SD)													

[7] All tables should be clearly numbered (e.g. Table 9a, 9b, 9c).

AR (Mean)													
AR (+2SD)													

Table 9. Collisions predicted by month – variability in densities. All Birds. Band Option [X]. Flight height distribution = maximum likelihood distribution. NAF = [XX].
AR = Avoidance Rate. UCL = Upper Confidence Limit. LCL = Lower Confidence Limit.

AR % [Specify in boxes below]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
LCL Flight Height Distribution													
AR (-2SD)													
AR(Mean)													
AR (+2SD)													
max likelihood Flight Height Distribution													
AR (-2SD)													
AR(Mean)													
AR (+2SD)													
UCL Flight Height Distribution													
AR (-2SD)													
AR(Mean)													
AR (+2SD)													

Table 10. Collisions predicted by month – variability in flight heights. All Birds.
Band Option 2. NAF = [XX].

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Overall
Mean													
SD													
CV													
Median													
2.5%													
25.0%													
75.0%													
97.5%													

Table 11. Collisions predicted by month – sCRM outputs. All Birds. Band Option [X]. NAF = [XX].

1.1.4.2 Collisions with apportioning to SPAs

Tables 9 and 10 (or 11 if applicable) should be populated for all relevant species included in Table 14.4 (and any additional species where relevant). Each table should be clearly numbered.

Data should be presented based on the parameters in the Tables 1 to 8 above. If using the Band Model (Band 2012) multiple tables will be required for each species, model option and NAF level used. If using sCRM, we request any input and output files are provided and Table 11 should be populated for each species, model option, and NAF value combination explored.

We also request that Excel Band Model Spreadsheets are provided for all model runs. Actual spreadsheets to be provided (not screenshots).

Species: [xx]; SPA: [insert name]; Band Option [X]; NAF [xx] **Specify actual AR value and +/- 2SD values used in rows below**			
Avoidance Rate	**Annual collisions based on:**		
	LCI	**Mean density**	**UCI**
AR (-2SD) (insert value used)			
AR(Mean) (insert value used)			
AR (+2SD) (insert value used)			
Avoidance Rate	**LCI**	**Max likelihood flight height**	**UCI**
AR (-2SD) (insert value used)			
AR(Mean) (insert value used)			
AR (+2SD) (insert value used)			

Table 12. Annual collisions (birds apportioned to SPA - adults)

1.1.5 Bird data for displacement assessments

Data should be provided for all species subject to displacement. All data should follow seasons and apportioning as per Tables 7 & 8 above.

Bird abundance data (Table 13[8]) should specify that it relates to the population estimate of birds (all age classes) on the water and in flight combined in the wind farm and appropriate buffer (stipulate in table. Where appropriate, birds on the water should either include distance corrections (if boat-based) or account for availability bias[9] where appropriate. Unidentified species should also be apportioned according to ratios present in survey where necessary. Colour code seasons and indicate in bold the peak figure for each season in the table.

[8] Number Tables 13a, 13b etc
[9] Please indicate the availability correction that has been employed for each species

Species: XXXXX; Buffer: X km (species specific); on water availability bias used [xx]; on water distance correction [xx]; unidentified birds apportioned [xx].													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Data Source Ref.**
Calendar Year 1 Mean Population estimate													
Calendar Year 1 UCL (97.5%)	ND	ND	ND										
Calendar Year 1 LCL (2.5%)													
Calendar Year 2 Mean Population estimate													
Calendar Year 2 UCL (97.5%)													
Calendar Year 2 LCL (2.5%)													
Calendar Year 3 Mean Population estimate													
Calendar Year 3 UCL (97.5%)				ND	ND	ND	ND	ND	ND	ND	ND	ND	
Calendar Year 3 LCL (2.5%)													

Table 13. Example table for presentation of abundance data for displacement assessments (add colour coding for seasons as per Table 6). Illustrated here is an example with two years of baseline survey data collected April-March spread over 3 calendar years, for a species with two defined seasons: March-July and August-February. ND = No Data.

1.1.6 Project displacement figures for all receptor species

This section provides templates for recording displacement figures for all receptors, using parameters set out above. Please provide data in the following sections for each species to be used for EIA (section 1.1.6.1) and each species/SPA considered for the HRA (1.1.6.2).

1.1.6.1 Displacement assessment with no apportioning to SPAs

Table 14 should be completed for each species considered within the assessment.

Species: [xx]; Buffer: [xx – species specific]; Calendar Years for surveys: [Month xxx, Year xxxx – Month xxx, Year xxxx];					
Abundance	**Season**				
	Pre-Breeding	**Breeding**	**Post – breeding**	**Non-breeding**	**TOTAL**
Mean of peak					
UCL					
LCL					

Table 14. Mean peak abundance - this should be the mean of the peak values per season (as indicated in the seasonal definitions in Table 7 above) as tabulated in the relevant versions of Table 13, noting that some seasons will need to include data from multiple calendar years.

In the tables below (15 to 17[10]), applications should present the displacement matrix based on values in TOTAL column of Table 14 with no apportioning.

Species [x] mortality figures. All Birds.		**% Mortality**												
Mean of peak population estimates.		1	2	5	10	20	30	40	50	60	70	80	90	100
% Displacement	10													
	20													
	30													
	40													
	50													
	60													
	70													
	80													
	90													
	100													

Table 15. Predicted annual displacement mortalities based on sum of **mean** abundance values in each season.

[10] Number tables 15-17 with a, b, c etc

Species [x] mortality figures. All Birds. **LCL of population estimates.**		% Mortality												
		1	2	5	10	20	30	40	50	60	70	80	90	100
% Displacement	10													
	20													
	30													
	40													
	50													
	60													
	70													
	80													
	90													
	100													

Table 16. Predicted annual displacement mortalities based on **LCL** of abundance values.

Species [x] mortality figures. All Birds. **UCL of population estimates.**		% Mortality												
		1	2	5	10	20	30	40	50	60	70	80	90	100
% Displacement	10													
	20													
	30													
	40													
	50													
	60													
	70													
	80													
	90													
	100													

Table 17. Predicted annual displacement mortalities based on **UCL** of abundance values.

1.1.6.2 Displacement with apportioning to SPAs

Applications should provide Table 18[11] for each species and SPA combination considered in the assessment.

Species: [xx]; SPA: [insert name]; Buffer: [xx]; Calendar Years for surveys: [Month xxx, Year xxxx – Month xxx, Year xxxx]; [adults only/all birds];					
Abundance	**Season**				
	Pre-Breeding	**Breeding**	**Post - breeding**	**Non-breeding**	**TOTAL**
Mean of peak					
UCL					
LCL					

Table 18. Mean Peak abundance apportioned to each SPA using the seasonal definitions in Table 7, and the apportioning percentages in Table 8. Not all seasons may be relevant to all species. For each table, specify whether the figures refer to adults only or all birds (delete below as appropriate).

In the tables below (19 to 21[12]), present displacement matrix for total annual mortalities (using values in TOTAL column of Table 18) with apportioning as per Table 8 for all relevant species SPAs combinations.

Species [x] mortality figures. **[XXX] SPA [adults only/all birds]; Mean peak population estimate**		**% Mortality**												
		1	2	5	10	20	30	40	50	60	70	80	90	100
% Displacement	10													
	20													
	30													
	40													
	50													
	60													
	70													
	80													
	90													
	100													

Table 19. Predicted annual displacement mortalities apportioned to SPA [XXX] based on **mean peak** abundance values in each season. For each table, specify whether the figures apply to adults only or all birds (delete below as appropriate).

[11] Number tables 18a, 18b etc
[12] Number tables 19-21 with a, b, c etc

Species [x] mortality figures. **[XXX] SPA [adults only / all birds]; LCL of population estimate**		**% Mortality**												
		1	2	5	10	20	30	40	50	60	70	80	90	100
% Displacement	10													
	20													
	30													
	40													
	50													
	60													
	70													
	80													
	90													
	100													

Table 20. Predicted annual displacement mortalities apportioned to [XXX] SPA based on **LCL** of abundance values. For each table, specify whether the figures apply to adults only or all birds (delete below as appropriate).

Species [x] mortality figures. **[XXX] SPA [adults only / all birds]; UCL of population estimates**		**% Mortality**												
		1	2	5	10	20	30	40	50	60	70	80	90	100
% Displacement	10													
	20													
	30													
	40													
	50													
	60													

	70													
	80													
	90													
	100													

Table 21. Predicted annual displacement mortalities apportioned to [XXX] SPA based on **UCL** of abundance values. For each table, specify whether the figures apply to adults only or all birds (delete as appropriate).

1.2 References

Alerstam, T., Rosén, M., Bäckman, J., Ericson, P.G.P., Hellgren, O. (2007) Flight speeds among bird species: allometric and phylogenetic effects. *PLoS Biology* 5(8): 1656-1662.

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Cook, A.S.C.P., Humphries, E.M., Masden, E.A., and Burton, N.H.K. (2014). The avoidance rates of collision between birds and offshore turbines. BTO research Report No. 656 to Marine Scotland Science.

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