An Coimisiún Pleanála

Schedule of Further Information

1. Northern Gannet - Saltee Islands SPA

1.1 Appendix H Addendum Offshore Ornithology – Supporting Information of the NIS is noted. Table 6A-16 of this document presents the estimated annual mortality of adult Northern Gannets apportioned to the Saltee Islands SPA arising from the combined effects of disturbance/displacement and collision from the proposed development together with other relevant offshore wind farm projects. The NIS predicts 21.91 additional adult Northern Gannet deaths/year for Saltee Islands SPA, equivalent to a 2.86% increase in baseline mortality.

1.2 The NIS also includes an assessment of the Ailsa Craig SPA in terms of estimated annual mortality of Northern Gannet from disturbance and displacement and collisions. Of the 24 in-combination projects identified, 16 of the UK windfarm projects attribute the same breeding mortality values to both Ailsa Craig SPA and Saltee Islands SPA. This gives rise to concern as to whether it is correct to use the same values, given that both SPAs are different and support different breeding colonies. Therefore, the use of identical breeding mortality values for two different breeding colonies raises questions as to how the values were derived and apportioned to the relevant SPAs.

1.3 The applicant is therefore requested to submit the following further information to facilitate the completion of the Article 6(3) Appropriate Assessment for the proposed development -

a) Re-examine the Northern Gannet breeding mortality values attributed to the Saltee Islands SPA to ensure that they have been apportioned correctly to that SPA, and/or provide clear details as to why the same values are attributed to Ailsa Craig SPA.

b) Re-calculate the annual in-combination Northern Gannet mortality estimate and associated increase in baseline mortality based on any updated in how effects are apportioned to the Saltee Island SPA.

c) Re-analyse and present the Saltee Islands SPA Northern Gannet Population Viability Assessment (PVA)

d) It is further requested that the PVA outputs be considered within the context of the Saltee Islands SPA site population and growth trends to robustly assess the potential consequences for the population model predictions on the conservation objectives of the site.

e) Provide sourcing and references to all cumulative and in-combination values used within the relevant assessments for Northern Gannet.

2. Auks & Gulls – Ireland's Eye SPA & Lambay Island SPA - Common Guillemot & Razorbill & European Herring Gull; & Skerries Island SPA -Herring Gull

It has not been possible to conclude, without reasonable scientific doubt, that there will not be an Adverse Effects on Site Integrity (AEOSI) with regard to the Conservation Objectives for the Special Conservation Interests of the following SPAs. -

2.1 **Auks** (Common Guillemot & Razorbill) at **Ireland's Eye SPA and Lambay Island SPA**.

2.1.1 While the NIS has assessed a range of displacement rates (up to 70% displacement and 10% mortality) for the assessment of the proposed development alone, with the highest rates representing a <0.5% increase in baseline mortality, the recommended displacement rates (60% displacement with 5% mortality in the breeding season and 3% in the non-breeding season) in the in-combination assessment have not been assessed. The upper range of NatureScot's mortality rates are recommended for the in-combination assessment as the magnitude of displacement from multiple areas of habitat within foraging range (i.e. several offshore wind developments) is greater than displacement from a single location.

2.1.2 Further, the applicant has screened in additional SPAs for these SCIs, including Rathlin Island, Howth Head Coast and Wicklow Head SPAs. Auks are not SCIs of Howth Head Coast or Wicklow Head SPA, and all three SPAs are outside the mean maximum plus 1 standard deviation foraging ranges (excluding data for Northern

Isles) for Common Guillemot and Razorbill. The applicant appears to have used the extended foraging ranges recommended for the Northern Isles, off the north coast of Scotland, rather than the standard foraging ranges which should be applied to this area as per NatureScot Guidance Note 3[1]. This results in a reduced level of impact being apportioned to the Ireland's Eye and Lambay Island SPAs. Therefore, it is considered that there is an underestimation of the impacts on the Ireland's Eye SPA and the Lambay Island SPA.

2.1.3 As such, insufficient evidence has been provided by the applicant, and it is considered that there is a potential underestimation of the impacts. As the impact has not been fully assessed, potential adverse impacts on the qualifying interests and conservation objectives of the above Natura 2000 sites cannot be ruled out.

f) The applicant is therefore requested to address the inconsistencies identified in the NIS such that the effects to the SCIs of the relevant Natura sites concerned are precisely identified in order to enable the Commission to complete an appropriate assessment.

2.2 **European Herring Gull** at the **Lambay Island SPA** and **Ireland's Eye SPA**.

Lambay Island SPA

2.2.1 The collision risk model outputs estimate an increase in baseline mortality for the project alone of 0.63% in the breeding season and 0.16% in the non-breeding season, resulting in an annual increase of 0.79%. As this is less than a 1% increase in baseline mortality the impacts are unlikely to be detectable at a population level for the Oriel proposed development alone.

2.2.2 The in-combination effects on European Herring Gull results in a 3.31% increase in mortality at Lambay Island SPA. The applicant undertook Population Viability Analysis (PVA) to assess population-level effects, with outputs suggesting a growth

[1] Guidance Note 3: Guidance to support Offshore Wind applications: Marine Birds - Identifying theoretical connectivity with breeding site Special Protection Areas using breeding season foraging ranges | NatureScot

rate 0.7% lower than the unimpacted (baseline) scenario and a population size 22.3% smaller after 40 years of impact (2025 to 2065).

Ireland's Eye SPA.

2.2.3 The collision risk model outputs estimate a worst-case increase in baseline mortality for the project alone of 0.46% in the breeding season and 0.16% in the non-breeding season, resulting in an annual increase of 0.62%. As this is less than a 1% increase in baseline mortality, the impacts are unlikely to be detectable at a population level for the Oriel proposal alone.

2.2.4 The in-combination effects on European Herring Gull results in a 4.41% increase in mortality. The applicant undertook PVA to assess population-level effects, with outputs suggesting a growth rate 0.9% lower than the unimpacted (baseline) scenario and a population size 28.2% smaller after 40 years of impact (2025 to 2065).

2.2.5 The in-combination impacts apportioned to the Lambay Island SPA and Ireland's Eye SPA represent a >1% increase in baseline mortality at both populations, with population-level effects that are outside the range of natural variation (i.e. a >0.5% decrease in population growth rate and / or a >10% smaller population size when compared with the unimpacted scenario in a 40-year model). These thresholds are considered appropriate in the context of the Lambay Island SPA and Ireland's Eye SPA European Herring Gull populations as the Conservation Objectives for both are "*to restore the Favourable conservation condition of Herring Gull*".

2.2.6 The Commission notes that due to the timing of the applications and subsequent FI responses, the values used by Oriel for their in-combination assessment with other Phase 1 projects may not reflect the most up-to-date information used by the other Phase 1 applicants for their project-alone assessments, particularly where significant additional information has been compiled on the colony counts for these SPAs and/or where changes to project design have been proposed. For example, the applicant has attributed different mortality rates for the NISA proposed development than NISA has used themselves, as presented in their response to the request for FI dated 29th June 2026.

g) The applicant is therefore requested to update the in-combination and PVA assessments using the most up-to-date colony counts and population trends and the most recent project-alone estimates published for the other four Phase 1 projects.

h) The applicant is also requested to provide sourcing and references to all new information used and to cumulative and in-combination values used within the relevant Phase 1 assessments for all species at Lambay Island SPA and Ireland's Eye SPA.

2.3 **European Herring Gull** at the Skerries Island SPA.

2.3.1 The Skerries Island SPA had a small population of 20 breeding individuals in 2010, with a baseline mortality of 6 birds per year. The colony count has been updated in recent years which could change the assessment outputs.

2.3.2 Despite the increase in baseline mortality exceeding 1%, the applicant has not assessed population-level effects and has not assessed in combination impacts on the population. The Conservation Objective for the site is "*to restore the favourable conservation condition of Herring Gull"*, and the target for breeding population size is "*long term SPA population trend is stable or increasing*".

i) With regard to the SPA population figures, the applicant is requested to update the EIAR and NIS with the latest SPA colony counts, including recent Bird Watch Ireland surveys. This may have implications for assessment of baseline mortality, potential mortality from the project and population effects, both alone and in combination.

j) The applicant is requested to undertake a PVA on the project alone effects on the Herring Gull from Skerries Island SPA.

k) In terms of the in-combination effects, the timing of the applications and subsequent Further Information responses from the other Phase 1 applications, any updates in colony count and population trends for Skerries Island SPA Herring Gull, together with any changes to the assessment of effects on Herring Gull from the Oriel project alone assessment, should be used as input to the in-combination effects assessment. Should there be no change to the conclusions, the results of these assessments, together with other factors effecting the European Herring Gull from Skerries Island SPA,

should provide further context and justification for the applicant arriving at these conclusions.

l) The applicant is also requested to provide sourcing and references to all new information use and to cumulative and in-combination values used within the assessments for all species at Skerries Island SPA.

These issues identified in the NIS and FI response are required to be addressed and the effects to the relevant sites concerned must be precisely identified in order to conclude an Article 6(3) determination.

3. <u>Sea Ducks and Diving Birds -</u> <u>Common Scoter, Red-throated Diver and Great Northern Diver</u>

3.1 The surveys used to inform the baseline environment include 19 boat-based surveys (in the period May 2018-May 2020) and 6 months of Digital Aerial Surveys (DAS) from April-September 2020. The requirement for collecting data to inform the baseline environment is set out in the Department of Communications, Climate Action and Environment (DCCAE) 2018 '*Guidance on Marine Baseline Ecological Assessments & Monitoring Activities for Offshore Renewable Energy Projects. Parts I and II*'[2]. The Guidance Part 1 recommends that three years of ornithological baseline surveys should be undertaken where no previous data exists, or a reduced period of two years where such data are available.

3.2 This is in line with NatureScot guidance[3], which further highlights that the survey design is to be informed by consideration of likely species to be encountered. While boat-based surveys are an appropriate methodology for surveying birds in the marine environment, the NatureScot guidance states that if sensitive species such as sea ducks and divers are likely to be present, a buffer of 10km will be required.

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[2] Guidance Documents for Offshore Renewable Energy Developers

[3] Guidance Note 2: Guidance to support Offshore Wind Applications: Advice for Marine Ornithology Baseline Characterisation Surveys and Reporting | NatureScot

The Joint Nature Conservation Committee (JNCC)[4] has highlighted that aerial surveys were deemed to be the most suitable method in cases where species are prone to disturbance by boat (Schwemmer et al., 2011), and NatureScot, in their Research Report 1281 - Approaches to monitoring wintering waterfowl in Marine Protected Areas - Moray Firth pilot study winter 2019/20[5], support this approach noting that '….*digital aerial surveys are increasingly accepted as the best method for providing snapshot estimates of numbers and distributions of birds at sea*'. In addition, this Research Report notes that '*boat-based surveys are associated with a high disturbance rate, markedly reducing detection of some species such as divers and red-breasted merganser (Mendel et al., 2008; Jarrett et al., 2018), which results in low population estimates for such species'*. Sensitive species include divers and certain sea ducks and therefore, boat-based surveys may underestimate sensitive species such as Red-throated Diver, Great Northern Diver or Common Scoter, which are SCIs for the proximate SPAs.

3.3 One breeding season of DAS was undertaken by the applicant. The Commission, in its request for FI, highlighted the sensitivity of Red-throated diver and other North-west Irish Sea SPA SCI species including Great Northern Diver and Common Scoter, to displacement and disturbance during the construction and operational phases of the proposed development.

3.4 While the applicant's justification for the methodology employed in the response to the further information request is acknowledged, sufficient evidence has not been provided to address the concerns relating to the gap in information raised therein, particularly with regard to the winter season survey data.

3.5 Diver species and the Common Scoter are known to be susceptible to vessel-related disturbance and therefore the baseline data used to inform the applicant's assessment are not sufficient for characterising distribution and abundance of these SCIs for the Dundalk Bay SPA or the North-west Irish Sea SPA. On this basis, the

[4] Supporting information for aerial survey data (All site data (Database) version)
[5] NatureScot Research Report 1281 - Approaches to monitoring wintering waterfowl in Marine Protected Areas - Moray Firth pilot study winter 2019/20 | NatureScot

Commission is not satisfied that the project alone or the in-combination effects have been assessed adequately in the NIS. The applicant has not demonstrated satisfactorily that no significant residual effects will remain post the application of mitigation measures for the identified SCIs in relation to displacement. Adverse effects on site integrity cannot be excluded, and scientific doubt remains as to the absence of such effects based on the available data and analysis presented by the applicant.

3.6 Further information is therefore required to resolve these uncertainties. Options that could provide the detail needed to adequately inform the Appropriate Assessment include the following -

Option 1: Further survey effort targeting the presence of diver and scoter species using DAS methodology including 2 full winter periods, or

Option 2: In the alternative, the applicant shall submit 1 years' worth of DAS covering one full winter period, and undertake an additional species habitat mapping and/or modelling technical assessment to improve the ecological inference given to the species usage, and therefore provide sufficient confidence as to the potential disturbance or displacement, from and within the SPA sites. The data provided under this option should be capable of allowing the Commission to carry out a robust Appropriate Assessment of the implications of the project (including in combination effects) on conservation objectives of local SPAs without the need for additional surveys.

3.7. More up to date information on species distribution for divers and scoters, using a robust survey methodology that will cause limited disturbance to the species surveyed (i.e. DAS) should improve confidence in the long-term implications for protected species within and nearby the Oriel array area, and resolve the outstanding concerns regarding potential impacts on local SPA conservation objectives. Option 2 is provided without prejudice to the Commission potentially requiring 2 full winter periods of surveys under Option 1, if Option 2 does not provide sufficient confidence for concluding the Appropriate Assessment.

3.8 Information provided under Option 2 in terms of additional species habitat mapping and/or modelling technical assessment, should describe the distribution of key environmental variables, it should combine known environmental habitat variables which explain species distribution to show a constraints map of where the species are and aren't likely to be (both inside and outside the SPAs), how the constraints map that is subsequently produced, compares to current available species presence data (summarised in Appendix 1) and how this combined information may describe the species distribution. All the above considerations should be visualised on a monthly basis to represent as close to a standard baseline characterisation dataset as possible. Further scientific approaches for Option 2, with key reference material highlighted, is included within Appendix 2 of this FI.

3.9 The applicant is requested to provide sourcing and references for all data used, or utilised, within the analysis. It is important that any R or similar software code used to process, analyse and present the data should be described sufficiently so that the assessment methodology can be fully understood, including any assumptions made.

3.10 The applicant is therefore requested to submit the following further information to facilitate the completion of the Article 6(3) Appropriate Assessment for the proposed development within the context of assessing Red-throated Diver, Great Northern Diver and Common Scoter:

m) For the three species referred to, a description and justification of the methods used by the applicant. The methods highlighted with Appendix 2 of this FI Schedule may inform the method selection. The outputs of the assessment to be submitted should include:

i. Habitat mapping of environmental variables which are known to explain the distribution of the species referenced above. These should be presented individually and monthly to show temporal variability and cover the area shown in Figure 6 below.

ii. Habitat modelling combining the environmental variables which are known to explain the distribution of the three species. The covariates should be modelled together based on known species ecology to show where the species distribution may be naturally constrained in space

and time in the absence of the array, where and to what extent the presence of the Oriel array (and other projects and on-going activities acting in-combination) may change these constraints given known displacement behaviours, and how these constraints may have consequences for the assessment of the Conservation Objectives for the species of the North-west Irish Sea SPA and Dundalk Bay SPA.

iii. Both the habitat maps (i) and constraints maps derived from habitat modelling (ii) should have species presence data overlayed on top.

iv. Species distribution modelling using the best available data from all available data sources including but not limited to the applicant's own surveys, Clogherhead surveys, ObSERVE I+II surveys, and Marine Institute coastal surveys using the environmental variables as covariate within the models.

v. The applicant shall provide full justification for the scientific approach taken in responding to this further information request.

With regards iv), acknowledging the previous conclusions of the data reviews, it is accepted that it may be concluded that the data available are unsuitable for informing a robust species distribution model. In this case, full justification must be presented, together with the data available presented on a monthly basis against the relevant habitat and/or constraint maps and species distribution maps to enable qualitative assessment.

n) Following the updated assessment, updates to the relevant EIAR and NIS sections should be provided to update the assessment of the proposed development's potential impacts on these species taking into account factors such as, but not limited to, availability and accessibility of equivalent habitat, distance displaced, routes to and from foraging/resting areas, and barrier or energetic effects and having regard to other pressures on that habitat. This should include cumulative or in-combination considerations.

As set out above, based on the data currently available and the analysis as presented in the NIS and FI response, it is not possible to complete an Appropriate

Assessment as to whether any reasonable scientific doubt remains as to effects of the proposed development on the integrity of the Natura 2000 sites. Accordingly, the applicant is requested to provide the information sought in points a) to n) to enable the appropriate assessment to be completed.

Without prejudice to the Commission reaching a final Article 6(3) determination, the Commission is also conscious of the objectives of the REDIII Directive, its obligations under section 15 of the Climate Action and Low Carbon Development Act 2015 (as amended) and the requirement to determine this application as expeditiously as possible. It is also noted that renewable energy projects are presumed to have Imperative Reasons of Overriding Public Interest (IROPI) for the purposes of Article 6(4) of the Habitats Directive. The issues identified in this request relating to the NIS and FI response are required to be addressed and the potential effects to the relevant sites concerned must be precisely identified in order to conclude an Article 6(3) determination.

If adverse effects on the integrity of one or more of the SPAs described above cannot ultimately be avoided or reasonable scientific doubts remain as to the absence of such effects, the Commission is accordingly open to considering any information submitted with the response that would facilitate the consideration as to whether Article 6(4) should be invoked at this point (including the precise identification/quantification of damage to a site if it were to occur for the purposes of compensatory measures). However, again, in the absence of knowledge of the implications for a Natura site, the application of the derogation provisions under Article 6(4) cannot be assessed, and in order to determine the nature of any compensatory measures, the damage to the site must be precisely identified. The applicant is invited to consider this in their response to this request.

Appendix 1 –

Publicly available data analysed by ACP to address gap in information relating to divers and sea ducks.

The following figures depict previous surveys spatial coverage -

1. The applicant's;
2. Marine Institute (2019);
3. ObSERVE I (2015-2016);
4. NISA's;
5. Applicant provided Clogherhead survey information (not publicly available).

It is clear that while there is some overlap, the individual identified datasets are insufficient in terms of spatial coverage, effort density and temporal coverage. In addition, the Commission's consultant concluded that only the Marine Institute Aerial surveys and ObSERVE I data are useful for a comparison, with ObSERVE II raw data being unavailable for review, though the available information does not have appropriate transect design to resolve the uncertainties identified.

1. The applicant's DAS survey is included for comparison purposes.

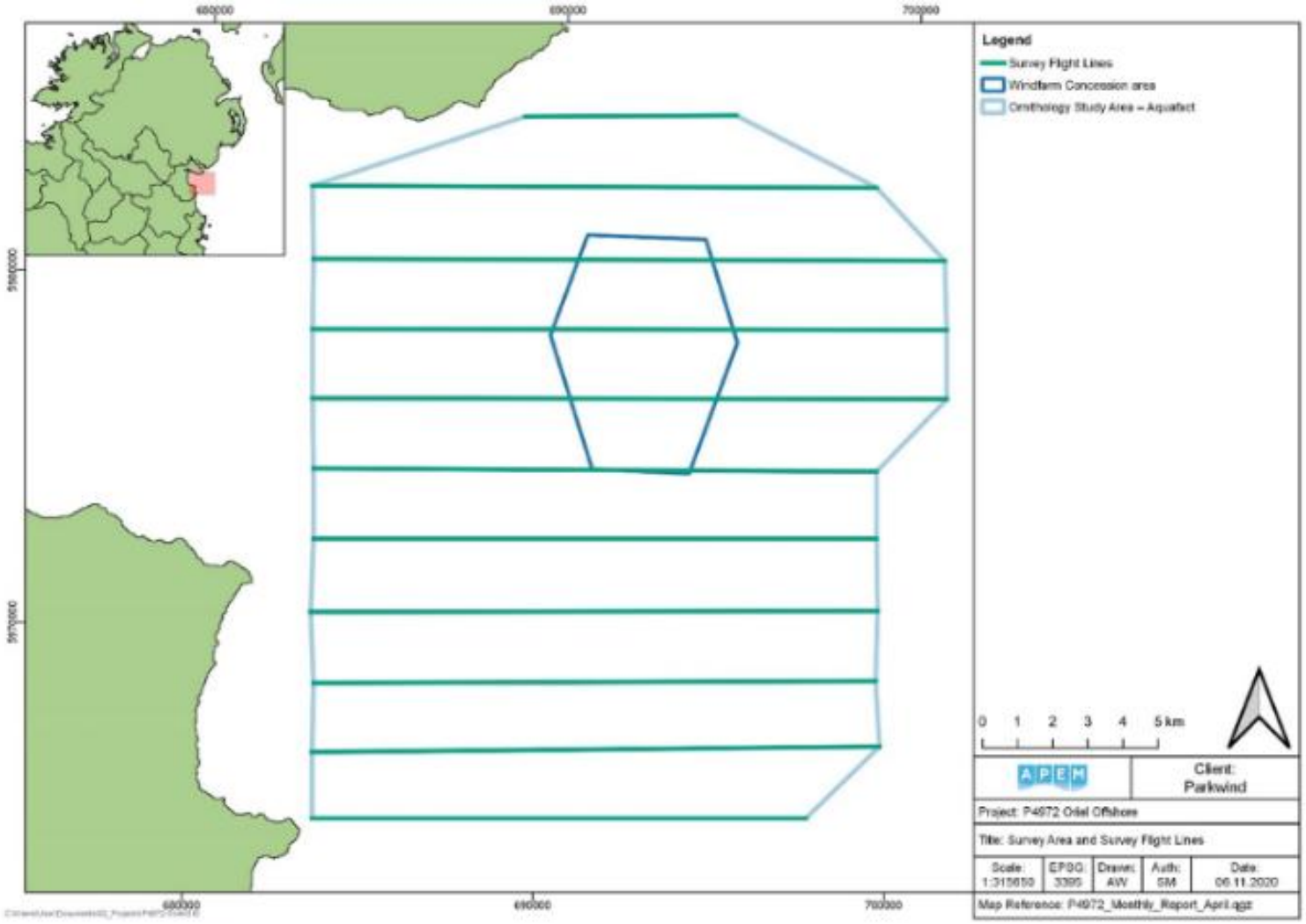


FIGURE 1: DIGITAL AERIAL SURVEY BASELINE SURVEYS PRESENTED BY THE APPLICANT FOR REFERENCE.
APPENDIX 11-2: ORNITHOLOGICAL AND MARINE MEGAFAUNA AERIAL SURVEY RESULTS

2. MI data

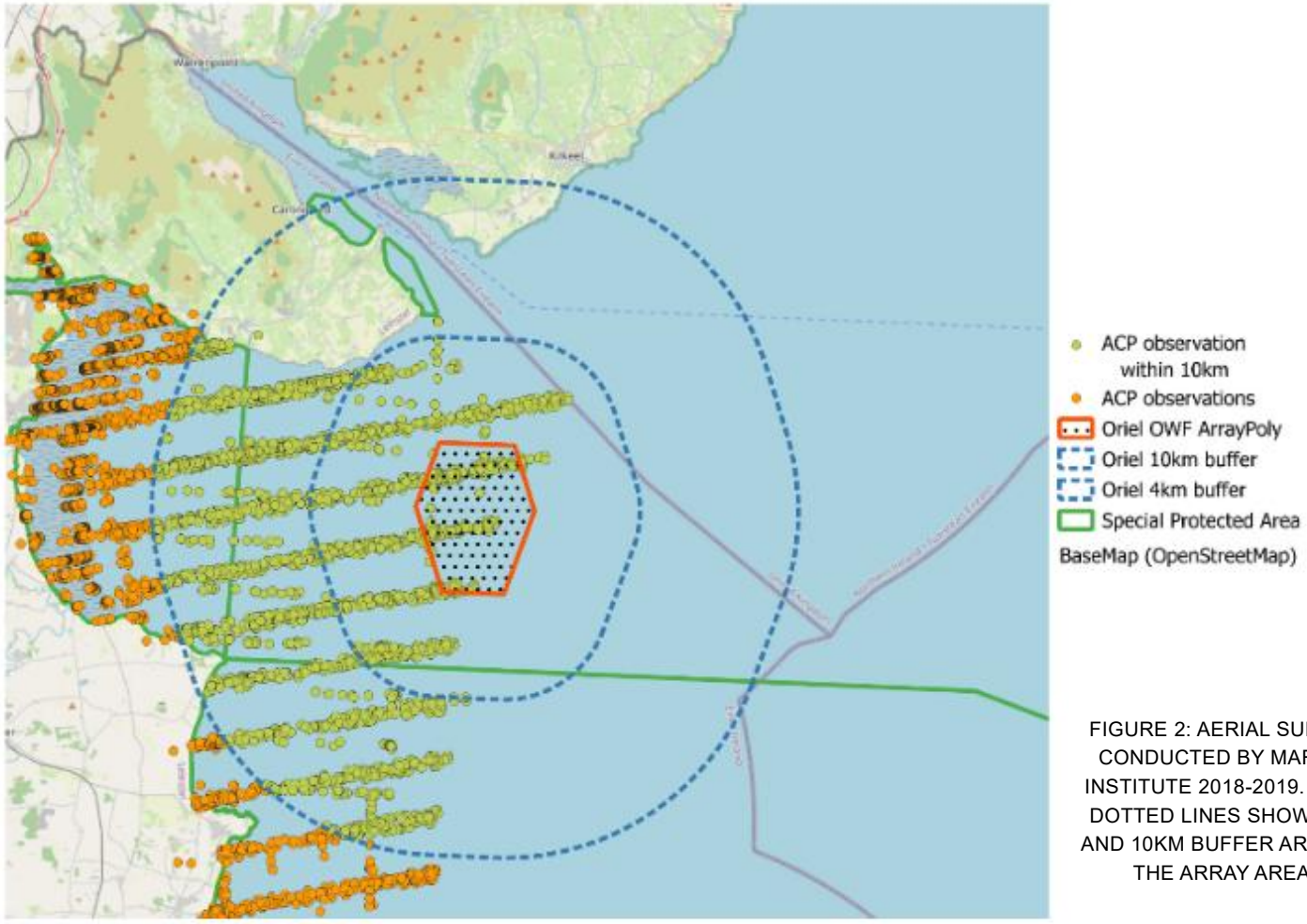


FIGURE 2: AERIAL SURVEY CONDUCTED BY MARINE INSTITUTE 2018-2019. BLUE DOTTED LINES SHOW 5KM AND 10KM BUFFER AROUND THE ARRAY AREA.

While the MI data offer the best spatial coverage, it is limited temporally with no overlap with the comparable applicant DAS data. The surveys did not cover the full array area, but allows for proxy comparisons of species usage of the area.

3. ObSERVE Data

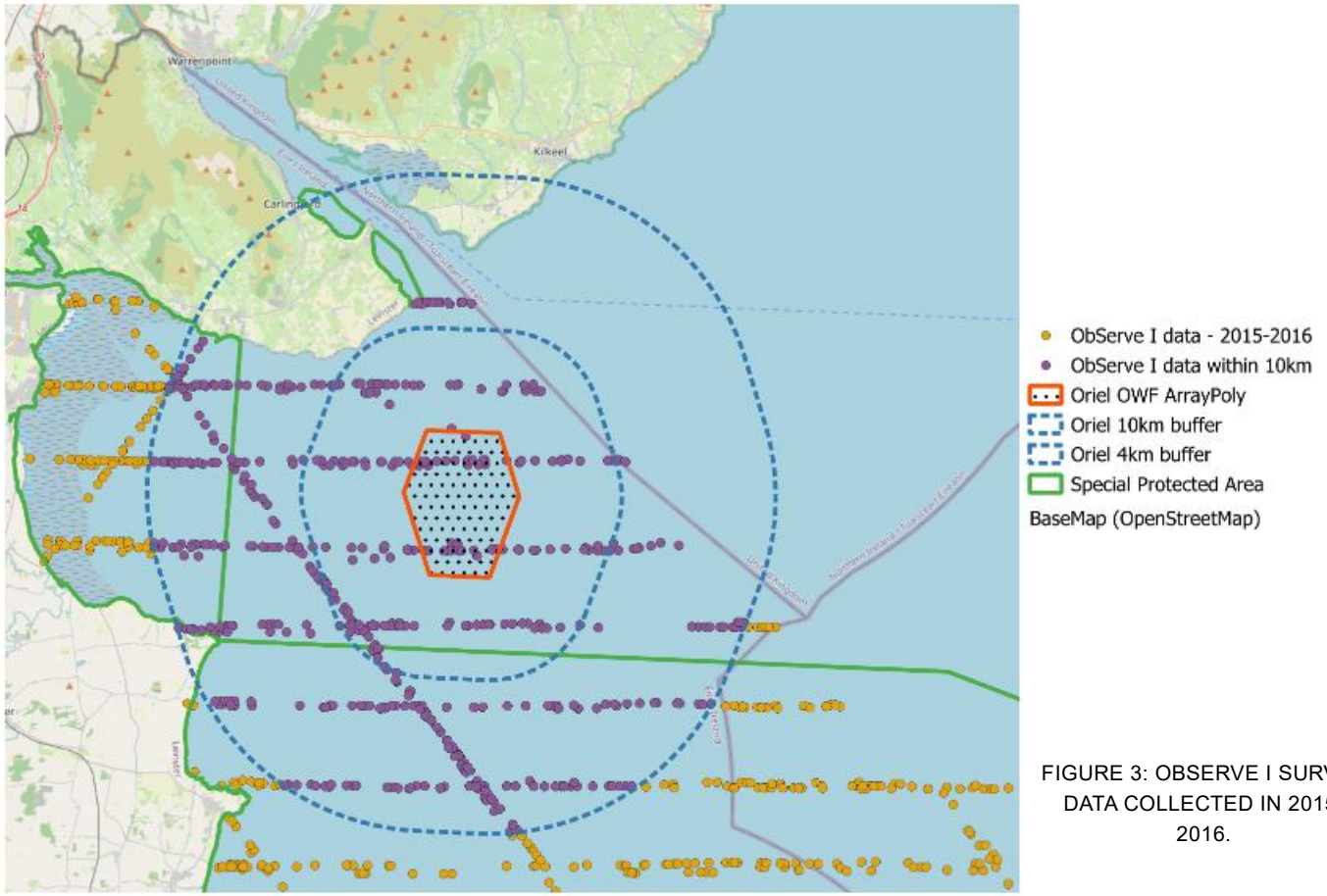


FIGURE 3: OBSERVE I SURVEY DATA COLLECTED IN 2015-2016.

ObSERVE I + II provide a robust full coastline assessment for marine ornithology and marine mammal species. However, due to its scope targeting the wider Ireland coastline, the density of transects is lower than would be typically utilised for offshore wind farm assessments. While only ObSERVE I can be compared against the applicant data and the MI surveys, it presents a lower array coverage than these two datasets.

4. NISA data

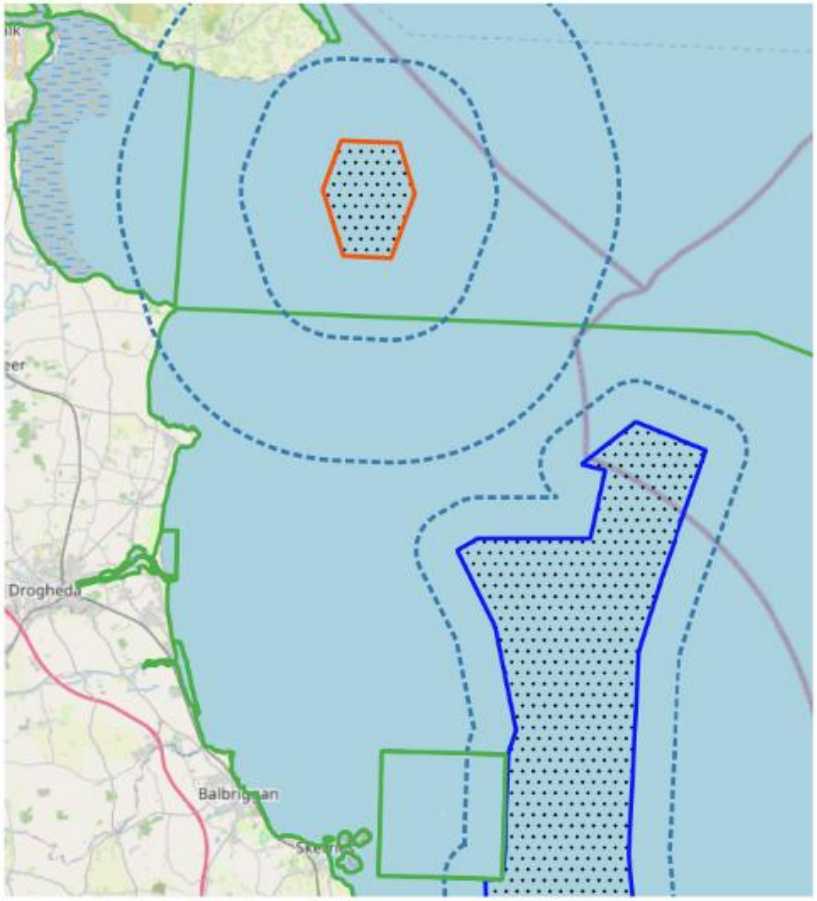


FIGURE 4: COMPARISON OF LOCATION OF ORIEL (RED) AND NISA (BLUE) ARRAY AREAS, INCLUDING 4KM BUFFER FOR BOTH SITES, AND A 10KM BUFFER FOR ORIEL

The NISA application data is noted to be of appropriate survey design. Therefore, if there was spatial overlap, densities could in theory be extracted to inform further analysis. There is, however, no spatial overlap, and therefore it is unsuitable to extrapolate species usage through species distribution modelling methods.

5. Clogherhead DAS Area

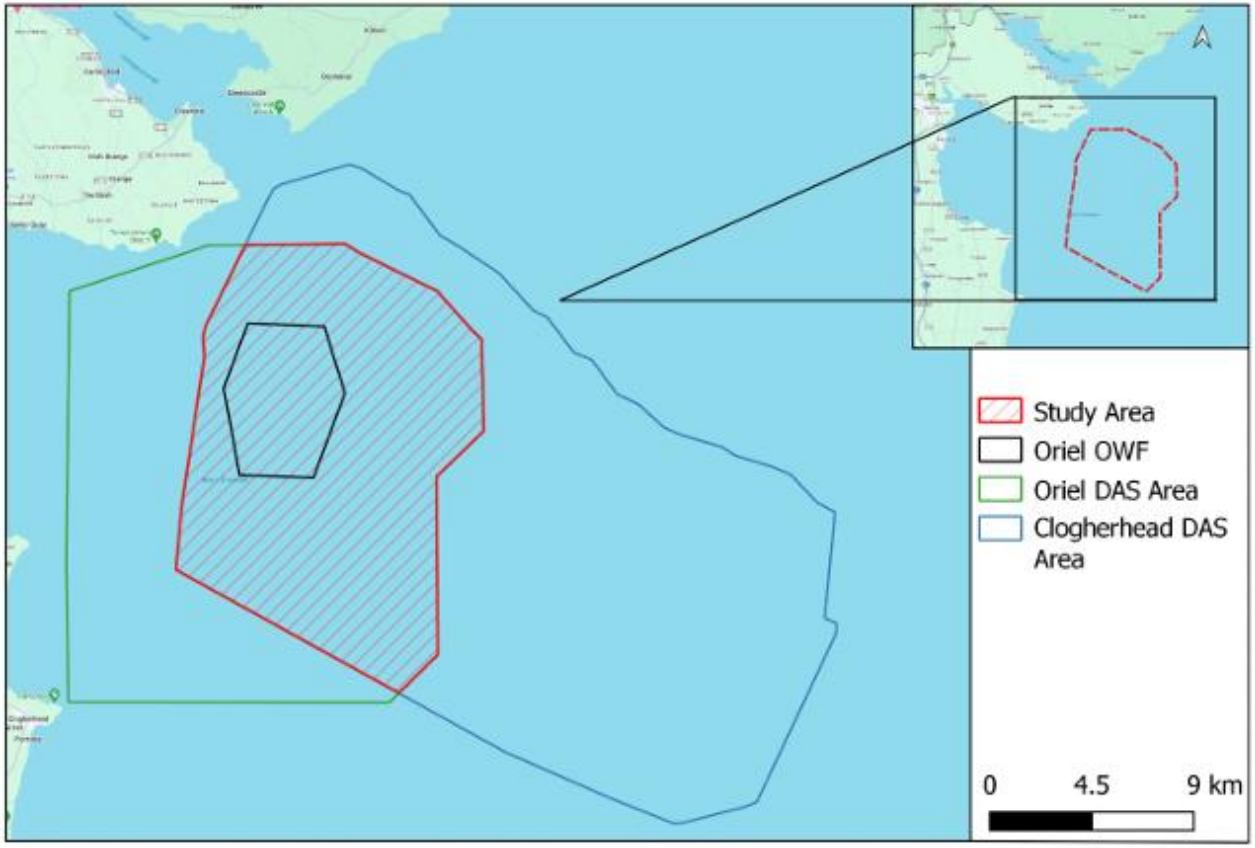


Figure 2.1: Study Area consisting of the overlapping area between the Oriel DAS Area and the Clogherhead DAS Area.

Figure 5 Oriel DAS Area and Clogherhead DAS area from Oriel EIAR Addendum 11-8 Aerial survey data comparison

NB: The data for this survey was not available to the Commission or its consultants for analysis and is only presented in applicant submissions

Appendix 2 –

Approaches for consideration for presenting habitat mapping, modelling and species distribution modelling for Red-throated Diver, Great Northern Diver and Common Scoter

This Appendix contains validated scientific approaches to describing the likely use of the sea area within and close to the Oriel Array Area by Red-throated Diver, Great Northern Diver and Common Scoter. These species are known to be associated (positive and negatively) with certain environmental and anthropogenic covariates which can be used to provide informative mapping and modelling which has the potential to better inform the Appropriate Assessment.

The Appropriate Assessment requires consideration of potential contraventions of the Conservation Objectives of local SPAs. Of particular note is the Conservation Objective for the North-west Irish Sea SPA regarding *Barriers to connectivity and site use* –

> *"Access to ecologically important sites outside the SPA must also be considered as a single SPA may not satisfy all the ecological requirements of the non-breeding population…".*

This therefore requires the consideration of habitat distribution and their spatial use by species within and outside the SPA that species may use. The objective of Option 2, and the additional species habitat mapping and/or modelling technical assessment, is to satisfy this requirement. The response should consider including the following:

- mapping of relevant habitats,
- habitat modelling showing areas likely used by each species (i.e. and environmental constraints map)
- Habitat modelling showing areas likely used by each species in the absence of the Oriel array (i.e. an environmental constraints map), habitat modelling highlighting areas where displacement may occur due to the presence of the Oriel array; and also, other projects and on-going activities that may act in combination

- Visual presentation of all available species data showing where individuals have been observed across all available surveys, and
- Species distribution modelling based on available species data and the environmental habitat covariates using best modelling practises to describe distribution and associated uncertainty.

The summary below highlights potential options and information sources within each step.

It is highlighted that the information presented within this FI Memo and Appendix is not a prescriptive methodology, and the applicant is welcome to develop their own approach. However, the items listed above for consideration are required to be addressed within the response.

The spatial extent of the information provided should cover the area indicated by the red rectangle in Figure 6. This is to enable capturing of suitable habitat available within and outside the SPA including those areas adjacent to the Oriel array area.

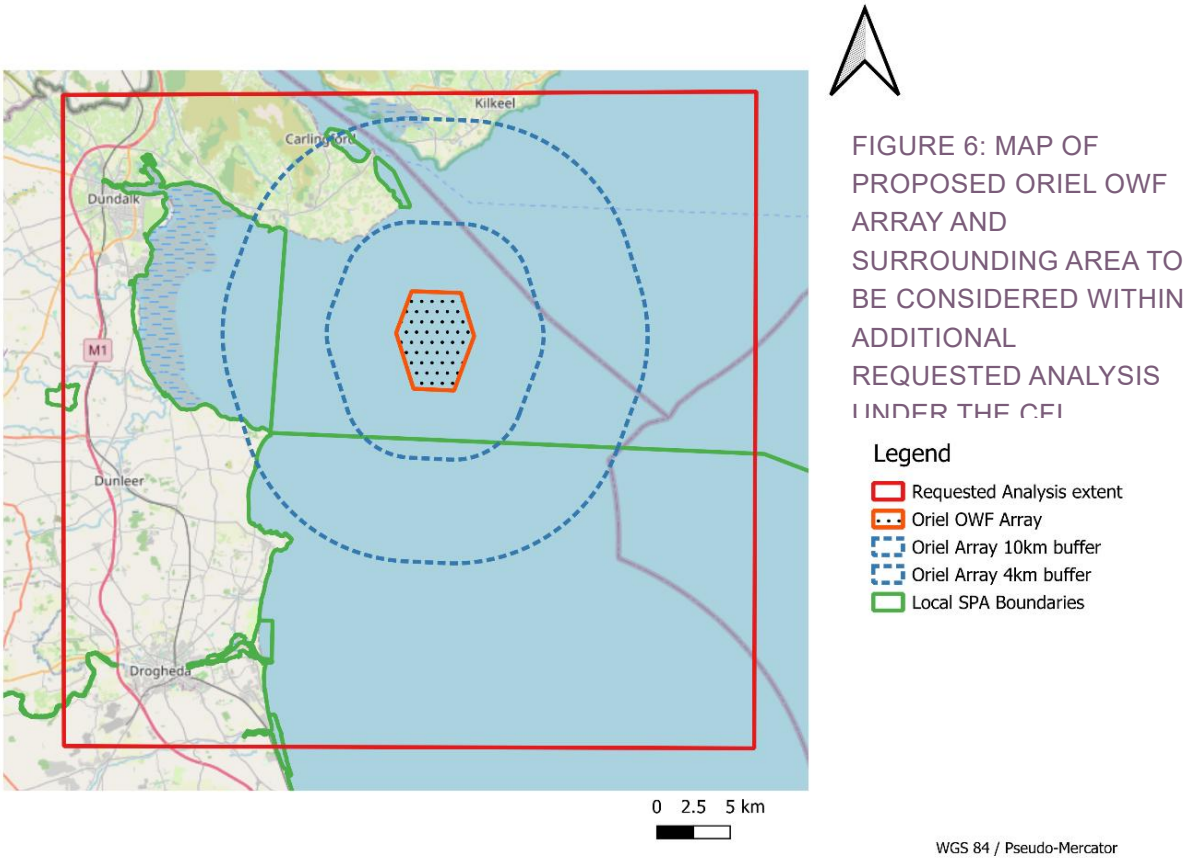


FIGURE 6: MAP OF PROPOSED ORIEL OWF ARRAY AND SURROUNDING AREA TO BE CONSIDERED WITHIN ADDITIONAL REQUESTED ANALYSIS UNDER THE CEI

Candidate covariates

The environmental covariates listed below are based on available information from the Dundalk Bay SPA and North-west Irish Sea SPA region, as well as other known key regions used by the three species such as Greater Thames, Outer Wash, and Liverpool Bay/Bae Lerpwl (**Error! Reference source not found.**).

The environmental covariates listed below should be considered for informing the likely species use of the area, the environmental constraints which currently exist in terms of access to habitats preferred by the species, and the potential changes to access to these habitats due to the presence of the array area and the known behavioural impacts it may cause on the usage of the surrounding area (i.e. displacement and known gradients). This assessment should also consider how other projects and on-going activities may act in-combination with the array. Environmental covariates that should be considered are listed in Table 1 but those that should potentially be prioritised are:

- Bathymetry;
- Distance to coast;
- Seabed slope, aspect and complexity;
- Boundary zones between open and estuarine waters;
- Chlorophyll-a;
- Mean sea surface temperature;
- Wave metrics.
- Other users such as fishing and shipping.

There are numerous online databases which can provide the above information on the appropriate spatial scales for informing the mapping and modelling. These include INFOMAR, EMODnet, Marine Data Exchange, Admiralty Bathymetric Data Service, OceanColour-CCI, CMEMS Satellite Derived Sea Surface Temperature, and other similar online environmental and species data online depositories. Examples of environmental and anthropogenic variables and how previous modelling

studies have used these are presented in Table 1. The evidence presented in the papers and reports cited within Table 1 are expected to be considered for inclusion where equivalency is available and appropriate for red rectangle area identified in Figure 6.

Potential space use mapping and/or modelling

The above candidate variables, along with any others the applicant may deem suitable which may explain diver and/or scoter species occurrence, should be presented individually to visually present, their distribution across the region and monthly for temporal variability.

Additionally, the covariates should be modelled together based on known species ecology to show where the species distribution may be naturally constrained, where the presence of the Oriel array may change these constraints, and how these constraints may have consequences for the assessment of the Conservation Objectives for the species on the North-west Irish Sea and Dundalk Bay SPAs. Habitat variables should be combined to show the areas most likely used for foraging. For example, the Conservation Objectives points out that, during the non-breeding period divers (primarily Great Northern and Red-throated Divers) in the western Irish Sea are known to concentrate in the shallower coastal areas, with a clear preference for waters of 5-20m[6]. Red-throated Diver are known to forage within 15 km of the coastline in depths typically no greater than 15 metres. A habitat constraints map would therefore show the depth contours present which are less than 15 metres depth within 15 km of the coastline, with observed individuals overlayed.

This second stage should be presented as in terms of a constraints map, showing where the individuals are able to forage without the array present, and the potential change in usage of area caused by the Oriel array, taking into account in-

[6] NPWS (2023) Conservation Objectives: North-west Irish Sea SPA 004236. Version 1. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage.

combination effects, and the displacement decay effects (Joint SNCB, 2022). Both the habitat and constraints mapping should have the most appropriate species presence data overlayed on top to visualise how individuals may be using the region.

Species distribution modelling

Species distribution models are the preferred output, if possible, from the technical report, as the output would best represent the number of individuals theoretically impacted within the different areas within and around the SPAs. The modelling approach used should follow statistical modelling standard methods to incorporate spatiotemporal variation from the best fitted variables to robustly inform on uncertainty in the estimates produced. Various modelling approaches may be utilised, ranging from GLM, GAM(M), MaxEnt or INLA approaches as deemed appropriate and practical with the information available. The comparisons presented within Oppel et al. (2012) should be used for guidance on appropriate techniques.

It is however acknowledged that the data reviewed to date, and likely available to the client, that the spatial and temporal coverage of the data is highly variable, and combining different data sources together is not a simple task. It is therefore left to the applicant to decide on the best approach for this, however non-presentation of a species distribution model, even a simplified approach with significant assumptions, should be robustly justified within the response. Spatial interpolation models (i.e. kriging, Kernal Density Estimation (KDE)) should also be considered as a simple way of presenting the species-only spatial information that the applicant may hold for the three species, however it is recommended that this approach is presented with sufficient information on parameterisation to enable a full understanding of how a spatial map of densities without any environmental habitat covariates may be interpreted.

Table 1 Summary of environmental and anthropogenic variables used in previous red-throated diver Gavia stellata and seabird modelling studies which should be used as examples to consider replicating (Source: Burt et al., 2022)

Variable	Examples
Spatiotemporal Considerations	
Geographical location (coordinates, in relation to specific area such as Special Protection Area)	Petersen, 2007; Petersen *et al.*, 2011; Petersen and Nielsen, 2011; APEM, 2013; Natural Power, 2014; Burger *et al.*, 2016; Skov *et al.*, 2016; Dorsch *et al.*, 2019; Burt *et al.*, 2022.
Time of year (month, season, date)	Maclean *et al.*, 2006; Natural Power, 2014, Jarrett *et al.*, 2018; Dorsch *et al.*, 2019.
Time of day	Natural Power, 2014; Jarrett *et al.*, 2018; Dorsch *et al.*, 2019.
Environmental Variables	
Sunshine (duration of sunshine, cloud cover, angle)	Dorsch *et al.*, 2019.
Atmospheric conditions (air temperature, pressure, wind speed, vapour, precipitation)	Dorsch *et al.*, 2019.
Coastal physiography	Black *et al.*, 2015.
Distance to coastline	Maclean *et al.*, 2006; Petersen, 2007; Skov *et al.*, 2008; Petersen and Nielsen, 2011; Oppel *et al.*, 2012; APEM, 2013; Natural Power, 2014; Black *et al.*, 2015; Hostetter *et al.*, 2015; APEM, 2016; Skov *et al.*, 2016; Jarrett *et al.*, 2018; Mendel *et al.*, 2019; MacArthur Green and Royal HaskoningDHV, 2020.

Distance to shallow water (<10 m water depth)	Maclean *et al.*, 2006.
Bathymetry (water depth)	Maclean *et al.*, 2006; Skov *et al.*, 2008; Petersen, 2007; Petersen *et al.*, 2011; Petersen and Nielsen, 2011; Oppel *et al.*, 2012; APEM, 2013; Natural Power, 2014; Black *et al.*, 2015; APEM, 2016; Burger *et al.*, 2016; Heinänen, 2016; Žydelis *et al.*, 2016; Nehls *et al.*, 2017; Dorsch *et al.*, 2019; Mendel *et al.*, 2019; Heinänen, 2020; MacArthur Green and Royal HaskoningDHV, 2020; Burt *et al.*, 2022.
Seabed complexity (slope, aspect, relief)	Maclean *et al.*, 2006; Skov *et al.*, 2008; Oppel *et al.*, 2012; APEM, 2013; Black *et al.*, 2015; Hostetter *et al.*, 2015; APEM, 2016; Skov *et al.*, 2016.
Seabed sediment characteristics (type, substratum, grain size)	Natural Power, 2014; Black *et al.*, 2015; Hostetter *et al.*, 2015.
Currents (speed, gradient)	Skov *et al.*, 2008; Skov *et al.*, 2016; APEM, 2016; Heinänen, 2016; Skov *et al.*, 2016; Žydelis *et al.*, 2016.
Probability of fronts	Oppel *et al.*, 2012; Black *et al.*, 2015; APEM, 2016; Nehls *et al.*, 2017.
Vorticity (vertical water velocity, upwelling)	Skov *et al.*, 2016.
Tidal base (tidal force)	APEM, 2013.
Sea surface height (e.g. tidal state)	Oppel *et al.*, 2012; Jarrett *et al.*, 2018.
Water level/tidal bed stress	Black *et al.*, 2015; APEM, 2016; Skov *et al.*, 2016.
Wave base (as wave length)	APEM, 2013; Black *et al.*, 2015; APEM, 2016.

Shear stress (waves)	APEM, 2016.
Water density	Heinänen, 2016.
Sea state	Petersen, 2007; Petersen *et al.*, 2011; Jarrett *et al.*, 2018; Dorsch *et al.*, 2019.
Sea temperature (sea surface temperature, average sea temperature)	Skov *et al.*, 2008; Oppel *et al.*, 2012; APEM, 2013; Black *et al.*, 2015; Hostetter *et al.*, 2015; APEM, 2016; Heinänen, 2016; Žydelis *et al.*, 2016.
Salinity	Skov *et al.*, 2008; Black *et al.*, 2015; Hostetter *et al.*, 2015; Heinänen, 2016; Žydelis *et al.*, 2016; Dorsch *et al.*, 2019; Heinänen, 2020; Burt *et al.*, 2022.
Chlorophyll-a	Oppel *et al.*, 2012; APEM, 2013; Hostetter *et al.*, 2015; APEM, 2016; Heinänen, 2016; Dorsch *et al.*, 2019; Heinänen, 2020.
Mollusc distribution	Skov *et al.*, 2011.
Subject species behaviour	Petersen *et al.*, 2011.
Number of individuals in flock	Petersen, 2007; Petersen *et al.*, 2011; Jarrett *et al.*, 2018.
Anthropogenic Variables	
Offshore wind farm (presence, distance to, period)	Petersen, 2007; Skov *et al.*, 2008; APEM, 2013; Natural Power, 2014; APEM, 2016; Heinänen, 2016; Žydelis *et al.*, 2016; Nehls *et al.*, 2017; Dorsch *et al.*, 2019; Mendel *et al.*, 2019; Heinänen, 2020; MacArthur Green and Royal HaskoningDHV, 2020; Burt *et al.*, 2022.

Dredging operations	APEM, 2013.
Vessel presence/absence	Burger *et al.*, 2016; Burt *et al.*, 2022.
Vessel count/density	APEM, 2013; APEM, 2016; Burger *et al.*, 2016; Skov *et al.*, 2016; Dorsch *et al.*, 2019; Mendel *et al.*, 2019; Heinänen, 2020; MacArthur Green and Royal HaskoningDHV, 2020; Burt *et al.*, 2022.
Distance to vessel activity (established shipping lane, navigation route/channel)	Skov *et al.*, 2008; Burt *et al.*, 2022.
Delay between vessel activity and red-throated diver presence/absence	Burger *et al.*, 2016.
Vessel characteristics (speed, length, type)	Burger *et al.*, 2016; Dorsch *et al.*, 2019; Burt *et al.*, 2022.

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