



# Hornsea Project Four: Additional Application Information

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## F2.19: Outline Ornithological Monitoring Plan

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## Glossary

Term	Definition
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Hornsea Project Four Offshore Wind Farm	The term covers all elements of the project (i.e. both the offshore and onshore). Hornsea Four infrastructure will include offshore generating stations (wind turbines), electrical export cables to landfall, and connection to the electricity transmission network. Hereafter referred to as Hornsea Four.
Impact	Change that is caused by an action; for example, land clearing (action) during construction which results in habitat loss (impact).
Mean High Water Spring (MHWS)	The height of MHWS is the average throughout the year (when the average maximum declination of the moon is 23.5°) of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
Mitigation	A term used interchangeably with Commitment(s) by Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, Preliminary Environmental Information Report (PEIR), or ES).
Orsted Hornsea Project Four Ltd	The Applicant for the proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).

## Acronyms

Acronym	Definition
AfL	Agreement for Lease
CfD	Contracts for Difference
CRM	Collision Risk Modelling
DCO	Development Consent Order
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
DML	Deemed Marine Licence
EIA	Environmental Impact Assessment
EP	Evidence Plan
ES	Environmental Statement
FFC	Flamborough and Filey Coast
FID	Final Investment Decision
GPS	Global Positioning System
HRA	Habitats Regulations Assessment
JNCC	Joint Nature Conservation Committee
LSE	Likely Significant Effect
MHWS	Mean High Water Springs

Acronym	Definition
MMO	Marine Management Organisation
MSL	Mean Sea Level
OOMP	Outline Ornithological Monitoring Plan
OMP	Ornithological Monitoring Plan
ORJIP	Offshore Renewables Joint Industry Programme
OWEER	Offshore Wind Environmental Evidence Register
OWF	Offshore Wind Farm
OWSMRF	Offshore Wind Strategic Monitoring Research Forum
PEIR	Preliminary Environmental Information Report
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
UK	United Kingdom
WTG	Wind Turbine Generator

## Units

Unit	Definition
km	Kilometre
km <sup>2</sup>	Kilometre squared
m	Metres
μ	Mean

## Scientific Bird Names

English Name	Scientific Name
Gannet	<i>Morus bassanus</i>
Kittiwake	<i>Rissa tridactyla</i>
Guillemot	<i>Uria aalge</i>
Lesser black-backed gull	<i>Larus fuscus</i>
Herring gull	<i>Larus argentatus</i>
Razorbill	<i>Alca torda</i>
Puffin	<i>Fratercula arctica</i>

## 1 Introduction

### 1.1 Overview of the Outline Ornithological Monitoring Plan (OOMP)

- 1.1.1.1 Orsted Hornsea Project Four Ltd. (hereafter the Applicant) is proposing to develop the Hornsea Project Four Offshore Wind Farm (hereafter Hornsea Four) which will be located approximately 69 km from the East Riding of Yorkshire in the Southern North Sea with the array area covering an area of approximately 468 km<sup>2</sup> and will be the fourth project to be developed in the former Hornsea Zone. Hornsea Four will include both offshore and onshore infrastructure including an offshore generating station (wind farm), export cables to landfall, and connection to the electricity transmission network (see [Volume A1, Chapter 4: Project Description](#) for full details on the Project Design).
- 1.1.1.2 The Hornsea Four Agreement for Lease (AfL) area was 846 km<sup>2</sup> at the Scoping phase of project development. In the spirit of keeping with Hornsea Four's approach to Proportionate Environmental Impact Assessment (EIA), the project has due consideration to the size and location (within the existing AfL area) of the final project that is being taken forward to Development Consent Order (DCO) application. This consideration is captured internally as the "Developable Area Process", which includes Physical, Biological and Human constraints in refining the developable area, balancing consenting and commercial considerations with technical feasibility for construction.
- 1.1.1.3 The combination of Hornsea Four's Proportionality in EIA and Developable Area Process has resulted in a marked reduction in the array area taken forward at the point of DCO application. Hornsea Four adopted a major site reduction from the array area presented at Scoping (846 km<sup>2</sup>) to the Preliminary Environmental Information Report (PEIR) boundary (600 km<sup>2</sup>), with a further reduction adopted for the Environmental Statement (ES) and DCO application (468 km<sup>2</sup>) due to the results of the PEIR, technical considerations and stakeholder feedback. The evolution of the Hornsea Four Order Limits is detailed in [Volume A1, Chapter 3: Site Selection and Consideration of Alternatives](#) and [Volume A4, Annex 3.2: Selection and Refinement of the Offshore Infrastructure](#), whilst [Figure 2](#) illustrates the reductions to the array area throughout this process.
- 1.1.1.4 Hornsea Four has produced this Outline Ornithological Monitoring Plan (OOMP) in order to outline the proposed approach and objectives of any ornithological monitoring required by the Deemed Marine Licences (DMLs) prior to the granting of development consent. In doing so, it is the intention that this will enable all relevant parties to have clarity on the rationale associated with relevant ornithological monitoring requirements and focus from the outset and provide greater certainty on the limitations and deliverability of any monitoring. It is important to note that this OOMP relates to offshore ornithological monitoring only. For the purposes of this OOMP, 'offshore' refers to areas seaward of Mean High-Water Springs (MHWS). This OOMP should be read in conjunction with [F2.7: Outline Marine Monitoring Plan](#).
- 1.1.1.5 It is the intention of the Applicant to consult on this OOMP with the Marine Management Organisation (MMO) and its statutory nature conservation advisor (Natural England) prior to the start of the Hornsea Four Examination process. This document therefore represents an outline plan to form the basis of discussion during the post-Application and the Examination phases.
- 1.1.1.6 The OOMP sets out the outline monitoring proposals for offshore ornithology, encompassing the DML for the Generation assets, the relevant conditions of which are set out in Schedule 11 of [C1.1 Draft Development Consent Order](#).

1.1.1.7 The primary aims of this document are to:

- Identify relevant offshore ornithological monitoring as required by the conditions of the draft DML;
- Establish the objectives of such monitoring, noting the limitations and deliverability of any monitoring; and
- Set out the guiding principles and framework for delivering any monitoring measures as secured by the conditions within the draft DML.

## 1.2 Requirement for OOMP

1.2.1.1 A number of potential impacts on offshore ornithology have been identified, as detailed in [Volume A2, Chapter 5: Offshore and Intertidal Ornithology](#). The potential impacts being considered in this OOMP relate to disturbance and displacement, and collision risk. The assessment for Hornsea Four alone concluded that for all of the potential impacts considered, resulting effects would be of **neutral, slight** or **minor** adverse significance, which are not significant in EIA terms ([Volume A2, Chapter 5: Offshore and Intertidal Ornithology](#)).

1.2.1.2 Whilst the assessment for Hornsea Four alone did not predict any significant effects, it is recognised that uncertainties exist, generically, within the ornithological assessment process relating to, for example, flight heights, demographics, apportioning of populations from Special Protection Areas (SPAs), foraging ranges and avoidance rates<sup>1</sup>. In order to address these uncertainties, precautionary approaches have been taken to assessments with a range of parameters often used (e.g. within the Collision Risk Modelling (CRM)) to account for these uncertainties.

1.2.1.3 This OOMP has been submitted as part of the DCO Application and contains details of the proposed outline monitoring approach to ornithological monitoring and associated justification for this approach. It is important to note that this OOMP relates to EIA-related monitoring only. Any monitoring related to potential compensation is considered separately ([B2.5: Without Prejudice Derogation Case](#)).

1.2.1.4 As detailed in Schedule 11 (Generation Assets), Part 2, Condition 13(1)(k) of [C1.1 Draft Development Consent Order](#) requires that, prior to relevant works being undertaken, *“an ornithological monitoring plan setting out the circumstances in which ornithological monitoring will be required and the monitoring to be carried out in such circumstances.”*

1.2.1.5 The final Ornithological Monitoring Plan (OMP) will be based on the principles adopted in this OOMP, with the aim of addressing uncertainty, where it is possible and reasonable for those uncertainties to be monitored at Hornsea Four. It is, for the avoidance of doubt, not the intention of the DML condition or the outline proposals to provide an exhaustive monitoring exercise to address all of the uncertainties alluded to in [paragraph 1.2.1.2](#).

1.2.1.6 It should be noted that the final OMP will not be produced until closer to the time that the actual work will be undertaken (following detailed scheme design), and as such this OOMP will not include details such as timings and detailed methodologies. The final OMP will be drafted in the post-consent phase to ensure it remains appropriate to the final design of the scheme and the relevant uncertainties. The final OMP will subsequently be provided for agreement with the MMO (as

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<sup>1</sup> It is also recognised that at project and strategic levels, there are and will be a number of studies underway aimed at addressing aspects of these generic uncertainties and that the outcomes of these studies and the resulting body of evidence will need to be taken into account when designing the final Hornsea Four OMP.

required by the conditions of the draft DML) in consultation with their statutory advisors, where necessary, in order to discharge the conditions of the corresponding final DML.

## 2 General Principles and Guidance

### 2.1 Guidance

2.1.1.1 There are a number of guidance documents and reviews to draw on when considering overarching principles in marine environmental monitoring. Of particular relevance to offshore wind farms is the independent review of post-consent environmental monitoring data undertaken by Fugro EMU Ltd on behalf of the MMO (MMO 2014a) and the MMO's subsequent recommendations (MMO 2014b) – see [Section 2.3](#) for further detail on the recommendations.

2.1.1.2 The MMO (2014b) note that the purpose of monitoring requirements that are incorporated into licence conditions are to:

- a) Validate, or reduce uncertainty in predictions on environmental impacts recorded in supporting EIAs;
- b) Provide evidence on the effectiveness of mitigation measures; and
- c) Allow identification of any unforeseen impacts.

### 2.2 Commitments and Mitigation

2.2.1.1 Hornsea Four has adopted commitments (primary design principles inherent as part of Hornsea Four, installation techniques and engineering designs/modifications) as part of the pre-application phase, to eliminate and/or reduce the Likely Significant Effects (LSEs) arising from a number of impacts (as far as possible). The two most significant design changes incorporated for the purpose of reducing potential impacts on offshore ornithology include;

- Raising the air gap between the sea surface and the lowest swept area of wind turbines to 40 m above Mean Sea Level (MSL); and
- Reducing the overall extent of the project through the Developable Area Process, reviewing data on where higher densities of key species (including gannet, kittiwake and guillemot) reside within the original AfL and re-shaping the array area to avoid those areas with greatest risk.

2.2.1.2 Further commitments (adoption of best practice guidance), referred to as tertiary commitments are embedded as an inherent aspect of the EIA process. Secondary commitments are incorporated to reduce LSE to environmentally acceptable levels following initial assessment i.e., so that residual effects are reduced to environmentally acceptable levels. These commitments are outlined in [Volume A4, Annex 5.2 Commitments Register](#).

2.2.1.3 Options for monitoring are appropriate to consider where significant residual effects (following mitigation) have been identified through the EIA process, or where there is a significant degree of uncertainty in the assessment conclusions relating to a particularly sensitive feature. As noted in [paragraph 1.2.1.2](#) uncertainties generically exist within ornithological assessments.

### 2.3 Principles

2.3.1.1 The guiding principles which apply to the outline monitoring approaches in this OOMP are as follows:

- All consent conditions (including those for monitoring) should be “necessary, relevant to planning and to the development to be permitted, enforceable, precise and reasonable in all other respects” (set out in paragraph 55 of the National Planning Policy Framework, Ministry of Housing, Communities and Local Government 2019);
- Monitoring should have a clear purpose and be designed to provide answers to specific questions where significant environmental impacts have been identified (Cefas 2012; Glasson et al. 2011; OSPAR 2008). As such (and in-line with the MMO’s recommendations for targeted monitoring (MMO 2014b)), monitoring proposals should have an identified frequency (and/ or duration) and confirmed outputs, which provide statistically robust datasets designed to address the hypothesis being tested;
- The presence of a significant impact identified in the EIA (whilst necessitating mitigation) should not, in itself, necessarily lead to a requirement for monitoring. Monitoring should address significant evidence gaps or uncertainty relevant to Hornsea Four, where it is realistic for those gaps to be filled or uncertainty reduced significantly. Monitoring should also be targeted at those features considered to be particularly sensitive to the impacts of the development, especially where these features are of economic or environmental importance. MMO (2014b) advise that the greatest focus should be placed on impacts of concern for which the highest uncertainty remains. Such targeted monitoring is more likely to answer key uncertainties than broad scale / generic monitoring approaches;
- Proposals for monitoring should be based, where relevant, on the best practice and outcomes of the latest review of environmental data (i.e., best available evidence) associated with post-consent monitoring of licence conditions of offshore wind farms (MMO 2014b);
- An iterative approach should be taken whereby the scope and design of any new monitoring work should be based on a review of the findings of any preceding phases of monitoring or relevant survey work, including surveys carried out in support of the EIA for Hornsea Four. It is acknowledged that the MMO may require amendments to individual monitoring programmes if the evidence indicates the existing monitoring programme is not fit for purpose and/or impacts are not as predicted;
- Where site-specific monitoring is undertaken pre- and post-construction it may be relevant to consider undertaking monitoring over non-consecutive years (for example post construction monitoring at years one, three and five following completion, or years one, five and ten) to explore the potential for longer term trends; and
- Under certain circumstances for addressing specific uncertainties it may be more appropriate to adopt a strategic approach to the monitoring (for example the Offshore Renewables Joint Industry Programme (ORJIP)<sup>2</sup> bird collision assessment (Skov et al. (2018)), or the consequence of harbour porpoise disturbance that Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS<sup>3</sup>) is addressing). Strategic work (potentially outside the boundary of Hornsea Four) may be considered where contributing to the answering of a broader question (that is still linked to the relevant Hornsea Four receptors) is likely to offer a greater ability to address key questions than any site-specific monitoring may achieve. Such strategic work may need to be de-coupled from any specific phase of the development (i.e., not specifically related to a comparison between pre-construction and post-construction data).

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<sup>2</sup> ORJIP is a UK-wide collaborative programme of environmental research with the aim of reducing consenting risks for offshore wind and marine energy projects. Currently there are two ORJIP streams: Offshore Wind and Ocean Energy

<sup>3</sup> DEPONS is a collaborative project between industry and academia to enhance the knowledge of the consequence of disturbance to harbour porpoise when exposed to underwater noise.



## 2.4 Consultation

2.4.1.1 Consultation with statutory authorities, including Natural England and the MMO, is fundamental to agreeing that the ornithological monitoring adopted for Hornsea Four is proportionate, effective, and secured. As previously described, this document is intended to form a framework for engagement going forward following the submission of the Hornsea Four DCO Application and during the Examination phase.

2.4.1.2 The exact dates for agreement and refinement of the OOMP and production of the final OMP cannot be determined at this stage since this relies on detailed consent, procurement and construction timescales, however, key milestones have been outlined in [Table 1](#) to signpost the likely development of the OOMP/OMP from the point of the DCO Application through to the start of offshore construction.

**Table 1: Anticipated review and revision process for the OOMP/OMP.**

Development Stage	Indicative Date(s)	Applicant Actions	Relevant Statutory Authority/Advisor(s)
Post-application review of the OOMP by Natural England and the MMO	Q4 2021 – Q1 2022	Provide consultees with OOMP post DCO Application. Review OOMP and identify (where necessary) any areas for revisions/updates.	Natural England and the MMO
Post-application review of the OOMP through Relevant Representations and DCO Examination	Q4 2021 – Q1 2022	Review OOMP and identify (where necessary) any areas for revisions/updates.	The Examining Authority. Consultation with any other relevant interested parties.
Consent decision and Appropriate Assessment	Q4 2022	Review final DCO requirements relating to monitoring.	N/A
Design optimisation	Pre-construction	Review the Outline OOMP and agreed monitoring approaches in light of the refined project design information and scheduling, taking into account any refinements that may be required as a result of the confirmation of design details.	N/A
First draft of the final OMP	Following Contracts for Difference (CfD) award/Final Investment Decision (FID)	Based on the final design optimisation, the Applicant will draft the final OMP and submit to the MMO for approval.	MMO and in consultation with Natural England.
Finalisation and sign-off of the final OMP	Prior to commencement of the relevant licensed activities	Update monitoring detail having due regard to consultee comments.	MMO to approve the final OMP.

## 3 Proposed content for the final OMP

3.1.1.1 It is proposed that the following types of information will be contained within the Hornsea Four OMP:

- Background - This section will provide context to the OMP, confirming the reason for its need, its aims and objectives, and the latest project status and programme;
- Consultation - This section will summarise all relevant consultation that has taken place during the development of the OMP, including key decisions, agreements, and outstanding issues under discussion; and
- Proposed project specific methodology for pre-construction and post-construction ornithological monitoring and its reporting requirements or details of strategic monitoring (which will generate data of benefit to the offshore wind industry as a whole).

## 4 Conclusions from the Environmental Statement and Key Uncertainties

4.1.1.1 The potential impacts being considered in this OOMP relate to disturbance and displacement, and collision risk.

### 4.2 Displacement

4.2.1.1 The activities within an array area associated within the construction, operation and decommissioning of Wind Turbine Generators (WTGs) has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where Hornsea Four is proposed to be developed. This in effect represents indirect habitat loss, potentially reducing the area available to seabirds for foraging and maintenance behaviours. Over time, displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could theoretically lead to the mortality of individuals (Searle et al. 2018).

4.2.1.2 Potential effects of disturbance and displacement were assessed for four species in **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**, as agreed through the Evidence Plan (EP) process: gannet, guillemot, razorbill and puffin. For each of the four species considered, a review was undertaken of current knowledge regarding displacement rates, in order to inform an evidence-led approach to assessment. A range of displacement and mortality rates were presented following best practice guidance (Statutory Nature Conservation Bodies (SNCBs) 2017), with the following, evidence-led rates taken forward for assessment:

- Gannet: a displacement rate of 60-80% out to 2 km from the array, with 1% mortality.
- Guillemot: a displacement rate of 50% out to 2 km from the array, with 1% mortality.
- Razorbill: a displacement rate of 50% out to 2 km from the array, with 1% mortality.
- Puffin: a displacement rate of 50% out to 2 km from the array, with 1% mortality.

4.2.1.3 It was concluded that for Hornsea Four alone, potential disturbance and displacement for all four species, across all development phases, would be of negligible magnitude and not significant in EIA terms. At a cumulative level, disturbance and displacement was considered to be of minor magnitude (not significant) for guillemot and razorbill during operation, and negligible magnitude (not significant) for the remaining species and development phases.

4.2.1.4 Key uncertainties remain regarding realised displacement rates for these species, and the potential impacts of displacement on species designated at the Flamborough and Filey Coast (FFC) SPA in terms of fitness consequences.

## 4.3 Collision Risk

- 4.3.1.1 There is potential risk to birds from operational offshore wind farms (OWFs) through collision with WTGs, resulting in injury or fatality. This may occur when birds fly through the Hornsea Four array area whilst foraging for food, commuting between breeding sites and foraging areas, or during migration.
- 4.3.1.2 Potential effects of collision were assessed for five species in [Volume A2, Chapter 5: Offshore and Intertidal Ornithology](#), as agreed through the Evidence Plan (EP) process: gannet, kittiwake, lesser black-backed gull, herring gull and great black-backed gull. For each of the five species considered, the assessment was based upon recommendations made by Natural England. The following avoidance rates were applied, based on Joint Nature Conservation Committee (JNCC) et al. (2014) which draws from Cook et al. (2014):
- Gannet: 98.9% using Band Option 2.
  - Kittiwake: 98.9% using Band Option 2.
  - Large gull species: 99.5% using Band Option 2 or 98.9% using Band Option 3.
- 4.3.1.3 It was concluded that for Hornsea Four alone, potential collision risk for all five species would be of negligible magnitude and not significant in EIA terms. At a cumulative level, collision risk was considered to be of negligible or minor magnitude (not significant) for all five species.
- 4.3.1.4 However, a number of elements of additional precaution were included in the input parameters for the CRM, including considering a range of nocturnal activity factors and lower avoidance rates than those currently predicted from the latest scientific evidence.
- 4.3.1.5 The nature of such precaution is evidenced through the findings of the Bird Collision Avoidance Study funded by ORJIP, which aimed to understand seabird flight behaviour within and surrounding an offshore wind farm. Skov et al. (2018) present the findings of the study, including updated values for both nocturnal activity and avoidance behaviour for use in CRM. They also reported that only six birds (all gull species) collided with WTGs from over 12,000 records during the two-year study period.
- 4.3.1.6 Bowgen and Cook (2018) provide further analyses of the Skov et al. (2018) data, with the aim of updating current advice on avoidance rates (98.9% for gannet and kittiwake; Cook et al. 2014). They recommend that higher avoidance rates of 99.5% for gannet and 99.0% for kittiwake would be more appropriate given the findings of Skov et al. (2018). They considered that precaution remained within the estimated number of collisions even at these higher avoidance rates.
- 4.3.1.7 A recent analysis of nocturnal gannet behaviour extracted from tagged individuals was undertaken by Furness et al. (2018) that provides evidence to suggest that they spend considerably less time in flight at sea during the evening and night-time, with ongoing analyses by the same author suggesting similar results for kittiwake (Furness, in prep). The use of a nocturnal activity rates of 25% to 50% across all months considered in the collision risk models for these species would therefore appear to be over precautionary ([Volume A2, Chapter 5: Offshore and Intertidal Ornithology](#)).
- 4.3.1.8 Key uncertainties therefore remain regarding realised collision avoidance and nocturnal activity rates and for these species, together with any subsequent impacts on species designated at the FFC SPA in terms of fitness consequences.

## 5 Outline Proposals for Monitoring

### 5.1 Background

5.1.1.1 Hornsea Four will be the fourth project to be developed in the former Hornsea Zone and, as such, a suite of strategic monitoring in relation to offshore ornithology is either currently underway or proposed. Many of the key uncertainties remaining for Hornsea Four are similar to, or the same as those encountered for other projects within both the Hornsea Zone and across the wider region of the Southern North Sea.

5.1.1.2 To ensure that the monitoring taken forward for Hornsea Four is not replicating work already in progress, an outline of existing monitoring both within the Hornsea Zone and across the wider region is provided below.

### 5.1.2 Hornsea Zone

5.1.2.1 The Ornithological Monitoring Survey Proposal for the Hornsea Zone is focused on improving understanding of the populations of gannet, kittiwake and auks at the FFC SPA and their dependence on the Hornsea Zone. The intention of this proposal is that each Hornsea project will, as it comes forward, agree to a strategic monitoring programme which contributes to this aim. The objectives of the Hornsea Zone strategic programme were to improve understanding, through the collection and analysis of robust data, regarding:

- Trends in population abundance for those key species designated at the FFC SPA. This would be achieved through contributions to whole colony counts, ensuring that these are comprehensive and undertaken regularly;
- Understanding population processes, including the collection of additional data on the productivity and survivorship of key species breeding at the FFC SPA; and
- Understanding connectivity between FFC SPA populations and the Hornsea Zone, through techniques such as tagging, which can reveal the movements of individuals between the colony and the Hornsea projects within the wider Hornsea Zone.

### 5.1.3 Hornsea Project One

5.1.3.1 The OMP for Hornsea Project One focusses on three key objectives which are to:

- Objective 1: Quantify flight height behaviour of gannet and kittiwake in the project area during the post-construction phase, including consideration of seasonal and inter-annual variation in flight height behaviour;
- Objective 2: Collect digital aerial survey data on auk species (guillemot, razorbill and puffin), kittiwake and gannet within the wind farm site and buffer zone. Raw survey data is to be provided to the MMO and Natural England; and
- Objective 3: Carry out a programme of at colony GPS tagging and tracking primarily of kittiwake and also Gannet at FFC SPA, with an aim to undertake tagging and tracking in the same years as the offshore surveys (2020, 2023, 2026, 2029). The data collected will be provided to MMO and Natural England.

5.1.3.2 Objectives 2 and 3 do not encompass objectives that lead to testable hypotheses. Rather, these objectives involve the commitment to the collection of data that will inform wider strategic studies which will be directly relevant to the ornithological assessment uncertainties identified for Hornsea Project One. The wider study will therefore be informed by core components of this OMP including both abundance data from aerial survey and tracking data from at-colony tagging of individual seabirds.

## 5.1.4 Hornsea Project Two

5.1.4.1 The OMP for Hornsea Project Two has been formulated so as to define objectives that seek to address, where possible, uncertainties associated with the assessments presented in the ES and RIAA, consisting of three objectives which are to:

- Objective 1: Collect digital aerial survey data on gannet, kittiwake, lesser black-backed gull, great black-backed gull and auk species (guillemot, razorbill and puffin) during the post-construction phase within the wind farm site and buffer zone and to provide the data to the MMO and Natural England;
- Objective 2: Conduct a study which seeks to trial the deployment and use of a camera system (DTBird®) at Hornsea Project Two to test the use of this technology at an offshore wind farm site approximately 90 km offshore whilst looking at the practicalities of installation, maintenance, and data collection, retrieval and analysis;
- Objective 3: Collaborate with relevant stakeholders via the [FFC Seabird Monitoring Group \(SMG\)](#), and provide funding or procure directly for a defined time period, for specified demographic monitoring studies of key species at the FFC SPA. This will start once the project moves into operation and will involve determination of adult survival rates (kittiwake only) and productivity monitoring (kittiwake and gannet only) carried out annually for five years once the project enters operation and three cycles of whole-colony counts (one count every five years).

5.1.4.2 Objective 1 does not encompass aims that lead to testable hypotheses. Rather, this objective commits to the collection of data that will inform wider strategic studies which will be directly relevant to the ornithological assessment uncertainties (i.e. apportioning birds to FFC SPA) identified for Hornsea Project Two. This objective will also provide data for Hornsea Project Two consistent with that being collected as part of the post-construction monitoring programme at Hornsea Project One thus providing a dataset covering larger spatial and temporal scales. No data analysis or interpretation as part of this objective is proposed in this OMP.

5.1.4.3 Objective 2 aims to deploy DTBird® systems at two turbine locations for two years at Hornsea Project Two to trial the deployment of the technology at a site approximately 90 km offshore. The objective of the trial will be to investigate and demonstrate the practicalities of installation and maintenance and trial the reliability of collecting and retrieving suitable data over two full years. This will include the analysis, where suitable data is retrieved, of data aimed at answering questions in relation to species detection and identification and how these may vary or are affected by other parameters (e.g. weather conditions, time of year, time of day). The Objective has two aims, with the second of these aims (data acquisition to determine data quality and evidence of collision events) contingent on the success of the first (establish if the deployment and operation of DTBird® at Hornsea Project Two is practical and feasible).

5.1.4.4 The demographic studies described in Objective 3 will occur outside of the Hornsea Two OMP as part of the strategic workstreams within FFC SMG, however Hornsea Project Two will collaborate with relevant stakeholders and provide funding where necessary or directly procure surveys to facilitate the continuation of existing demographic studies of key species at the FFC SPA. This will include three cycles of colony counts (one count every five years) with studies for other demographic studies (productivity and survival) occurring annually for five years starting once the project enters operation.

## 5.1.5 Hornsea Three

5.1.5.1 In-principle monitoring for Hornsea Three in relation to offshore ornithology is focussed on the following potential effects on key species breeding at FFC SPA:

- Pre-construction: the impact of displacement from an area around turbines and other ancillary structures during the operational phase of the development may result in effective habitat loss and reduction in survival or fitness rates;
- Pre-construction: the impact of collisions with rotating turbine blades may result in direct mortality of individuals; and
- Post-construction: direct disturbance to birds including displacement from important foraging and habitat.

5.1.5.2 An OMP is to be developed in order to meet the following objectives:

- Pre-construction: to establish a baseline to test key predictions or address specific areas of uncertainty relating to key receptors as identified in the ES and RIAA; and
- Post-construction: to establish any significant change from baseline conditions to test key predictions or address specific areas of uncertainty relating to key receptors in the ES and RIAA.

5.1.5.3 Monitoring approaches to achieve these objectives will be set out in detail in the final OMP which will be drafted following FID.

## 5.1.6 Strategic Monitoring

5.1.6.1 The final Hornsea Four OMP will also be cognisant of wider strategic monitoring in the region (e.g. through the recently published Offshore Wind Environmental Evidence Register (OWEER) together with forums such as OWSMRF (Offshore Wind Strategic Monitoring and Research Forum)). The detailed focus, requirements and methodologies for future monitoring for Hornsea Four may therefore differ, to some extent, from the outline approach presented in this document.

## 5.2 Approach

5.2.1.1 The following section sets out the outline monitoring proposals for implementing the monitoring DML condition for Hornsea Four, in cognisance of the monitoring set out above. For the proposed monitoring, [Table 2](#) details the potential effects (alongside the Impact ID that is used in [Volume A4, Annex 5.1: Impacts Register](#) and within [Volume A2, Chapter 5: Offshore and Intertidal Ornithology](#)) and relevant receptor(s) for which monitoring is considered necessary. Links are also provided to the relevant DML conditions that set out monitoring conditions ([C1.1 Draft DCO indulging Draft DML](#)) and, where relevant, requirements for submission of related plans.

5.2.1.2 This OOMP outlines the rationale behind the proposed monitoring, with a view to providing a common understanding of the aims, objectives and approaches to guide the approval of the final OMP for approval by the MMO in the post-consent phase.

5.2.1.3 Following an iterative approach, it should be recognised that increased knowledge and understanding based on survey outcomes, but also the final detailed design of Hornsea Four, may influence the detailed design of the subsequent ornithological monitoring work following an Adaptive Management Framework (Copping & Bennett. 2016). The detailed focus, requirements and methodologies for future monitoring for Hornsea Four may therefore differ, to some extent,

from the outline approach presented in this document. Any such future modifications to monitoring approaches will be the subject of consultation between the Applicant, the MMO and its advisors.

- 5.2.1.4 As detailed in [Section 4](#), uncertainties within the assessments relate to estimates of displacement and collision, and the consequences of these impacts on SPA populations. Proposed monitoring is therefore aimed at addressing these key uncertainties where possible and is described in [Table 2](#).
- 5.2.1.5 It should be noted that whilst monitoring is set out in a pre- and post-construction monitoring format within [Table 2](#), flexibility may be sought to ensure that the monitoring taken forward is done in the most appropriate way, in line with Copping & Bennett (2016). The proposed monitoring may therefore be decoupled from this prescribed approach if it is deemed (and agreed with the MMO) that a more appropriate monitoring schedule is merited.

**Table 2: Potential Offshore ornithology monitoring approaches.**

Impact ID	Receptor(s)	Objective and monitoring approach	Options of securing monitoring
<i>Pre- construction and construction monitoring</i>			
Disturbance & Displacement (ORN-0-5) and Collision risk (ORN-O-6)	Guillemots, razorbills and puffins	<p><b>Objective:</b> to determine the at-sea distribution of auk species designated at the FFC SPA during the extended breeding season, prior to and during construction of Hornsea Four.</p> <p><b>Monitoring approach:</b> abundance, distribution, and behavioural data to be collected between the FFC SPA out to the Hornsea Four array and buffer. There is currently uncertainty regarding the importance of Hornsea Four to auk species during the extended breeding season. The aim of gathering these data would be threefold: 1) to establish which areas of sea relative to Hornsea Four are important to auk species during the extended breeding season, 2) to provide a suitable baseline dataset against which any effects from construction of operation could be compared and 3) to provide additional raw data to that already being collected across Hornsea Project One and Hornsea Project Two for strategic monitoring purposes. It is recommended that a power analysis is undertaken in advance of designing surveys to determine the level of effort required to detect a statistically significant change in species abundance and distribution post-construction.</p>	Aerial digital surveys
<i>Post-construction monitoring</i>			
Disturbance & Displacement (ORN-0-5) and Collision Risk (ORN-O-6)	Guillemots, razorbills and puffins	<p><b>Objective:</b> to determine the at-sea distribution of auk species designated at the FFC SPA during the extended breeding season during the post-construction period.</p> <p><b>Monitoring approach:</b> abundance, distribution, and behavioural data to be collected between the FFC SPA out to and beyond the Hornsea Four array, utilising the same survey design as used for pre-construction and construction. The aim of gathering these data would be threefold: 1) to determine whether important areas of sea for auks change post-construction 2) to determine if predicted displacement effects on auks are valid and 3) to provide additional raw data to that already being collected across Hornsea One and Two for strategic monitoring purposes. Post-construction monitoring typically extends over a three-year period, which is often insufficient for detecting statistically significant evidence of any potential habituation. It is recommended that monitoring continues to cover at least five years in line with the longest post-</p>	Aerial digital surveys



Impact ID	Receptor(s)	Objective and monitoring approach	Options of securing monitoring
		<p>construction monitoring programme undertaken to date in the UK (Vallejo et al. 2017). This will provide greater confidence in any conclusions drawn.</p>	
Collision Risk (ORN-0-6)	Gannets and kittiwakes	<p><b>Objective:</b> to determine rates of macro-, meso- and micro-avoidance of gannets and kittiwakes within and surrounding Hornsea Four</p> <p><b>Monitoring approach 1:</b> in order to build upon Objective 2 of the Hornsea Project Two OMP, multi-sensor systems should be explored to determine their suitability for detecting and measuring macro-, meso- and micro-avoidance of Hornsea Four. The aim being to validate the applicability of avoidance rates presented in Skov et al. (2018) in the offshore environment. The requirements of such a system should be considered at the pre-construction stage in order to determine feasibility.</p> <p><b>Monitoring approach 2:</b> investigate and compare methods to collect supplementary data on species flight heights within and surrounding the operational Hornsea Four e.g. latest GPS trackers fitted with altimeters.</p>	<p>Multi-sensor systems</p> <p>Tagging</p>
SPA connectivity	Guillemots, razorbills and puffins	<p><b>Objective:</b> to determine if auk species present within and surrounding Hornsea Four during the breeding season are attributable to the FFC SPA</p> <p><b>Monitoring approach:</b> where possible, new tagging studies should be initiated, or existing studies extended, for birds breeding within the FFC SPA. Such data would provide direct evidence of how SPA birds interact with Hornsea Four. Given the logistical difficulties associated with obtaining large sample sizes from tagging studies, additional methods should be considered to supplement these data.</p>	<p>Tagging</p> <p>Aerial Digital Surveys</p>
SPA connectivity	Guillemots and razorbills	<p><b>Objective:</b> to determine if birds present within and surrounding Hornsea Four during post-breeding dispersal are attributable to the FFC SPA</p> <p><b>Monitoring approach 1:</b> where possible, methods for tagging auks at sea should be explored in order to determine the relative contribution of FFC SPA birds to those guillemots and razorbills present in the vicinity of Hornsea Four.</p> <p><b>Monitoring approach 2:</b> supplementary, or alternate to this, contributing to ongoing PhD programmes which examine the post-breeding and winter distribution of guillemots and</p>	<p>Tagging</p> <p>PhD Research</p>

Impact ID	Receptor(s)	Objective and monitoring approach	Options of securing monitoring
		razorbills from multiple SPA colonies would also be of benefit in apportioning impacts to FFC SPA.	
SPA connectivity	Guillemots and razorbills	<p><b>Objective:</b> to determine the age structure of birds present during post-breeding dispersal.</p> <p><b>Monitoring approach:</b> the ratio of adults to chicks could be determined from surveys designed to collect abundance and distribution data between FFC SPA out to and beyond Hornsea Four.</p>	Aerial digital surveys
Measuring impacts	Gannets, kittiwakes and guillemots, razorbills and puffins	<p><b>Objective:</b> to determine if the potential impacts of displacement and collision affect the productivity of FFC SPA birds.</p> <p><b>Monitoring approach:</b> supporting any existing annual colony counts at FFC SPA and determine if any additional methods could be used to increase precision in productivity estimates.</p>	Human observers Aerial digital surveys Boat-based surveys
Measuring impacts	Guillemots, razorbills and puffins	<p><b>Objective:</b> to determine if the potential impacts of displacement affect the productivity and survival of FFC SPA auk species.</p> <p><b>Monitoring approach:</b> support or procure long-term ring-resighting and productivity studies at FFC SPA for auk species.</p>	Ringling Human observers

5.2.1.6 The detailed requirements and methodologies for any of the project specific or strategic monitoring secured within the final OMP would be subject to further consultation with Natural England and the MMO.

### **5.3 Pre-construction monitoring**

5.3.1.1 For pre-construction, such details would be available for Natural England and the MMO for approval at least six months before any pre-construction surveys and plans evidenced through the use of power analysis, where appropriate.

### **5.4 Post-construction monitoring**

5.4.1.1 For post-construction, such details would be available for Natural England and the MMO for approval at least six months before completion of construction.

### **5.5 Strategic approach to the monitoring**

5.5.1.1 In line with the strategic monitoring objectives set out for Hornsea Project One and Hornsea Project Two, raw data regarding species abundance and distribution collected as part of the Hornsea Four OMP would be submitted to the MMO and Natural England. This would therefore extend both the spatial and temporal extent of the datasets currently being collected across the Hornsea Zone, with addressing key uncertainties within ornithological assessment. objective will also provide data for Hornsea Project Two consistent with that being collected as part of the post-construction monitoring programme at Hornsea Project One thus providing a dataset covering larger spatial and temporal scales.

5.5.1.2 The outline monitoring objectives set out in [Table 2](#) would also complement a number of strategic initiatives set out in The Crown Estate's OWEER, namely in relation to supplementing existing auk tagging and monitoring programmes within the North Sea, adding to the understanding of flight behaviour and avoidance in the offshore environment, and in improving current understanding of seabird behaviour at sea.

## **6 Summary**

6.1.1.1 The overall purpose of this OOMP is to propose methods to address impacts, evidence gaps or uncertainty of most relevance to Hornsea Four with respect to key seabirds (gannet, kittiwake and guillemot). The broad aims of the final OMP would be to validate potential displacement of gannet and guillemot through understanding their abundance and distribution, validating collision risk to gannet and kittiwake and understanding the connectivity to the nearest seabird colony at Flamborough and Filey Coast SPA.

6.1.1.2 Following previous monitoring programmes and commitments for Hornsea Project One, Hornsea Project Two and Hornsea Three, it would be the intension of Hornsea Four to widen such studies, where appropriate, to incorporate Hornsea Four also. Hornsea Four also recognise that if there is a requirement to implement compensatory measures as a result of a Habitats Regulations Assessment (HRA) Derogation, then monitoring may be a necessary part of those proposals.

6.1.1.3 This OOMP outlines the rationale behind the proposed monitoring, with a view to providing a common understanding of the aims, objectives and approaches to guide the approval of the final OMP for approval by the MMO and Natural England in the post-consent phase. The final OMP will be based on the principles adopted in the OOMP, with the aim of addressing uncertainty inherent to ornithological assessments, where it is possible and reasonable for those uncertainties to be monitored at Hornsea Four.

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