BY E-MAIL

Secretary of State for Energy Security and Net Zero
Energy and Infrastructure Planning
1 Victoria Street
London
SW1H 0ET

For the Attention of:
Energy Infrastructure Planning Team

2 May 2024

Dear Energy and Infrastructure Planning Team

REGULATION 4 OF THE INFRASTRUCTURE PLANNING (CHANGES TO, AND REVOCATION OF, DEVELOPMENT CONSENT ORDERS) REGULATIONS 2011

APPLICATION TO MAKE A NON-MATERIAL CHANGE TO HORNSEA FOUR OFFSHORE WIND FARM ORDER 2023 (S.I. 2023/800) AS CORRECTED (S.I. 2024/117)

1. **Introduction and Background**

1.1 Orsted Hornsea Project Four Limited ("**Orsted**") (company number 08584182) of registered office 5 Howick Place, London, England, SW1P 1WG is the undertaker with the benefit of the Hornsea Four Offshore Wind Farm Order 2023, which was granted by the Secretary of State for Energy Security and Net Zero on 12 July 2023 (S.I. 2023 No. 800) as corrected by the Hornsea Four Offshore Wind Farm (Correction) Order 2024 (S.I. 2024 No. 117) following an application made by Orsted (the "**Order**").

1.2 The Order includes provision authorising the construction, operation, maintenance and decommissioning of the Hornsea Project Four offshore wind farm together with associated offshore and onshore infrastructure and all associated development ("**Hornsea Four**"), on land approximately 69 kilometres from the East Riding of Yorkshire in the Southern North Sea, covering an area of approximately 600 square kilometres. Hornsea Four comprises the following key elements: up to 180 wind turbine generators; offshore transformer substations; offshore convertor substations (High Voltage Direct Current system only); up to one offshore accommodation platform to house operations and maintenance staff; boosters stations (High Voltage Alternating Current system only); subsea inter-array cables linking wind turbines to each other and to offshore substations; subsea interconnector cables linking the offshore substations to one another; subsea export cables to connect the wind farm to landfall; and cable protection.

1.3 The Order requires Orsted to construct an artificial nesting structure ("**ANS**") for kittiwake, as a compensation measure for the potential impacts of Hornsea Four. Paragraph 3(d) of Part 2 of Schedule 16 of the Order requires the ANS to be in place four full breeding seasons before Hornsea Four becomes operational.

1.4 Orsted proposes a non-material change to the Order, which seeks to shorten the length of time the ANS needs to be in place before operation. This non-material change (the "**NMC**") is required to allow time for necessary rights for the construction of the ANS to be obtained without impacting the programme for the operation of Hornsea Four and its provision of renewable energy to the National Grid.

1.5 Discussions on the NMC have been held with the Marine Management Organisation ("**MMO**"), Natural England ("**NE**") and the Royal Society for the Protection of Birds ("**RSPB**") at the Offshore Ornithological Engagement Group ("**OOEG**") Steering Group meeting held on 24 November 2023 and no objections were raised with regards to the wording of the NMC detailed at paragraph 3.1 of Appendix 1 to this letter.

1.6 As a result of the above, some minor consequential changes are required to the Order. These changes are needed to ensure that the appropriate and agreed kittiwake compensation measures are reflected in the Order, in order that construction and implementation of the Order is in accordance with its conditions. The proposed changes will not give rise to any materially new or materially different environmental effects from those considered in the Secretary of State's Habitats Regulation Assessment ("**HRA**") as part of the original application for the Order. Orsted has produced a new Environmental and HRA report in support of this statement, the conclusions of which are summarised at paragraph 3.3 of the NMC application at Appendix 1 of this letter and which is appended in full at Appendix 2.

2. **Supporting documentation**

2.1 Orsted is applying to the Secretary of State pursuant to section 153 and paragraph 2 of Schedule 6 to the Planning Act 2008 to make changes to the Order that are not material. This application is subject to the Infrastructure Planning (Changes to, and Revocation of, Development Consent Orders) Regulations 2011. As such, the following documents are included to support the application for the NMC:

(a) NMC application (included as the first Appendix to this letter);

(b) Environmental and HRA report (included as the second Appendix to this letter);

(c) Hornsea Four Artificial Nesting Structures: Growth Scenarios report (Niras 2024) (included as the third Appendix to this letter);

(d) Regulation 6 Notice;

(e) Draft amendment Order (Word and PDF version); and

(f) Email confirming successful validation of the draft amendment Order.

2.2 Please do contact Amy Stirling (Amy.Stirling@pinsentmasons.com) or Alex Tresadern (Alex.Tresadern@pinsentmasons.com) should you have any further questions.

Yours sincerely

Pinsent Masons LLP
(This letter has been sent electronically and so is unsigned)

APPENDIX 1

NON-MATERIAL CHANGE APPLICATION REPORT

1. INTRODUCTION

1.1 Orsted Hornsea Project Four Limited ("**Orsted**") (company number 08584182) of registered office 5 Howick Place, London, England, SW1P 1WG is the undertaker with the benefit of the Hornsea Four Offshore Wind Farm Order 2023, which was granted by the Secretary of State for Energy Security and Net Zero on 12 July 2023 (S.I. 2023 No. 800) (the "**Order**") as corrected by the Hornsea Four Offshore Wind Farm (Correction) Order 2024 (S.I. 2024 No. 117) following an application made by Orsted (the "**Order**").

1.2 The Order includes provision authorising the construction, operation, maintenance and decommissioning of the Hornsea Project Four offshore wind farm together with associated offshore and onshore infrastructure and all associated development ("**Hornsea Four**"), on land approximately 69 kilometres from the East Riding of Yorkshire in the Southern North Sea, covering an area of approximately 600 square kilometres. Hornsea Four comprises the following key elements: up to 180 wind turbine generators; offshore transformer substations; offshore convertor substations (High Voltage Direct Current system only); up to one offshore accommodation platform to house operations and maintenance staff; boosters stations (High Voltage Alternating Current system only); subsea inter-array cables linking wind turbines to each other and to offshore substations; subsea interconnector cables linking the offshore substations to one another; subsea export cables to connect the wind farm to landfall; and cable protection.

1.3 The Order requires Orsted to construct an artificial nesting structure ("**ANS**") for kittiwake, as a compensation measure for the potential impacts of Hornsea Four. Paragraph 3(d) of Part 2 of Schedule 16 of the Order requires the ANS to be in place four full breeding seasons before Hornsea Four becomes operational.

1.4 Orsted proposes a non-material change to the Order, which seeks to shorten the length of time the ANS needs to be in place before operation. This non-material change (the "**NMC**") is required to allow time for the construction of the ANS without impacting the programme for the operation of Hornsea Four and its provision of renewable energy to the National Grid.

1.5 Discussions on the NMC have been held with the Marine Management Organisation ("**MMO**"), Natural England ("**NE**") and the Royal Society for the Protection of Birds ("**RSPB**") at the Offshore Ornithological Engagement Group ("**OOEG**") Steering Group meeting held on 24 November 2023 and no objections were raised with regards to the wording of the NMC detailed at paragraph 3.1 of Appendix 1 to this letter. The changes are needed to ensure that the appropriate and agreed kittiwake compensation measures are reflected in the Order, in order that construction and implementation of the Order is in accordance with its conditions. The changes required comprise changes to paragraphs 3(d) and 4 of Part 2 of Schedule 16 of the Order, as set out at section 3 below.

1.6 The Applicant remains committed to delivering the most ecologically suitable ANS for the purposes of its habitats compensation. To achieve this aim, the Applicant requires flexibility in timing of delivery of the ANS to avoid unnecessarily delaying the provision of renewable energy from Hornsea Four.

1.7 The Applicant is seeking the amendments proposed in this NMC application to provide necessary contingency in the Hornsea Four programme to deliver the ANS.

1.8 The proposed changes would not require additional compulsory acquisition of land, nor would they have new or different effects on local residents or businesses or any additional implications in respect of habitats regulation assessment. They are simply required to ensure that the appropriate and agreed kittiwake compensation measures are reflected in the Order, in order that construction and implementation is in accordance with its conditions.

1.9 Orsted hereby applies to the Secretary of State pursuant to section 153 and paragraph 2 of Schedule 6 of the 2008 Act to make changes to the Order that are not material (referred to hereafter as the "**NMC Application**"). The NMC Application is subject to the Infrastructure Planning (Changes to, and Revocation of, Development Consent Orders) Regulations 2011 (the "**2011 Regulations**"). This NMC Application has been prepared with reference to the Department of Communities and Local Government document 'Guidance on Changes to Development Consent Orders' (December 2015).

1.10 This document sets out the proposed NMC to the Order sought by Orsted and the rationale for doing so and details of the consultation process undertaken. It also sets out why the changes sought in the NMC Application will not result in any materially new or materially different environmental effects, given that the changes proposed are technical and would not result in any development beyond that already consented through the Order, which has already been subject to Environmental Impact Assessment.

2. CONSULTATION PROCESS

Background

2.1 Under the 2011 Regulations, on making an NMC Application the applicant must notify and consult those persons specified in the Regulations, this being all those who were notified (in accordance with section 56 of the Planning Act 2008) when the application for the original development consent order was accepted by the Secretary of State, as well as any other person who may be directly affected by the changes proposed in the application.

2.2 Regulation 7(3) of the 2011 Regulations also provides that an applicant need not consult a person or authority specified in the Regulations if they have the written consent of the Secretary of State not to do so.

2.3 A letter of 06 February 2024 from Pinsent Masons to the Secretary of State requested written consent from the Secretary of State under regulation 7(3) of the 2011 Regulations that only the MMO, NE, the RSPB, The Crown Estate and the Joint Nature Conservation Committee (the "**JNCC**") (together, the "**Proposed Consultees**") should be consulted on the NMC Application, because the Proposed Consultees have played an active role in developing the ANS including its location, design, monitoring and adaptive management. The MMO, NE and the RSPB are active members of the OOEG, with whom Orsted has already liaised with and no objections have been raised to the NMC Application. In addition, Orsted has been in regular discussions with The Crown Estate, who have played an active role both from a strategic and project specific perspective in the site selection and have been kept informed of Orsted's approach to the implementation of compensation – in particular, Orsted notes that it holds an agreement for lease with The Crown Estate in relation to the offshore ANS option, further explaining the ongoing discussions between the parties. The JNCC are the authority for offshore nature conservation, working closely with NE.

2.4 On 19 February 2024, the Secretary of State confirmed that the consultee list should include the Proposed Consultees, but that the Wildlife Trusts (the "**Additional**

Consultee") should also be directly consulted on the NMC Application, given the nature of the proposed changes.

2.5 The Secretary of State agreed that all other parties need not be consulted as they are not directly affected by the NMC Application, either because the changes proposed will not affect their interests or because their interests relate to a different part of the scheme.

2.6 Accordingly, the Secretary of State gave written consent, under regulation 7(3) of the 2011 Regulations, that only the Proposed Consultees and the Additional Consultee (together, the "**Consultees**") need be consulted on the NMC Application. No other parties who may be directly affected by the changes proposed in the NMC Application have been identified.

Overview

2.7 Regulations 6 and 7 of the 2011 Regulations set out the process for publicising and consulting respectively on an NMC Application. Pursuant to Regulation 7A of the 2011 Regulations, Orsted will submit a separate Consultation and Publicity Statement confirming its compliance with Regulations 6 and 7A of the 2011 Regulations.

2.8 In summary, the following has, or is being, undertaken by Orsted to comply with Regulations 6 and 7:

2.8.1 Orsted is publicising the NMC Application by publishing a notice in each of the Yorkshire Post, the London Gazette, the Lloyd's List and the Fishing News for two successive weeks. The notice will be published for the first time on 2 May 2024 when the NMC Application is made to the Secretary of State. A copy of the notices will be included in the Consultation and Publicity Statement;

2.8.2 the project email address HornseaProjectFour@planninginspectorate.gov.uk has been included in the notice publicising the NMC Application so that members of the public can make a formal response to PINS in relation to the NMC Application; and

2.8.3 following receipt of notice from the Secretary of State pursuant to Regulation 7(3) on 19 February 2024, the list of consultees contacted regarding the NMC Application will be the Consultees defined above.

2.9 The NMC Application will be available to view on the project website at:

https://hornseaprojects.co.uk/hornsea-project-four/documents-library

and also on PINS' website at:

https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/EN010098/documents

2.10 Hard copies of the NMC Application can be requested by contacting Orsted at HornseaProjectFour@orsted.com or on: +447826663963. Each hard copy is available at the cost of £20 per copy.

2.11 Consultees are invited to provide comments on the NMC Application until the closing date for consultation which is no less than 28 days following the date when the notice is last published.

3. PROPOSED NON-MATERIAL CHANGE TO THE ORDER

3.1 The Order consists of 49 articles and 16 Schedules. This NMC Application proposes changes only to paragraphs 3(d) and 4 of Part 2 of Schedule 16. The content of these changes is set out in the table below.

Table 1 - Proposed changes to the Order

Article of the Order	Proposed change
Schedule 16, Part 2, paragraph 3(d)	Delete the existing paragraph and insert the following new text as a new paragraph: *"an implementation timetable for delivery of the artificial nesting structure such timetable to ensure that the structure is in place to allow for at least two full kittiwake breeding seasons prior to operation of any turbine forming part of the authorised development. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September."*
Schedule 16, Part 2, paragraph 4	Delete the existing paragraph and insert the following new text as a new paragraph: *"The undertaker must implement the measures set out in the KCIMP approved by the Secretary of State, unless otherwise agreed by the Secretary of State in consultation with the relevant SNCB, MMO and the relevant local planning authority. No operation of any turbine forming part of the authorised development may begin until the KCIMP has been approved by the Secretary of State and two full breeding seasons following the implementation of the measures set out in the KCIMP have taken place. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September."*

3.2 The changes to the Order proposed are required to ensure that the appropriate and agreed kittiwake compensation measures are reflected in the Order, so that construction and implementation of the Order is in accordance with its conditions.

3.3 Orsted has produced a new Environmental and HRA report, which is appended in full at Appendix 2, in order to confirm that the proposed changes will not give rise to any materially new or materially different environmental effects from those considered in the Secretary of State's Habitats Regulation Assessment ("**HRA**") as part of the original application for the Order. The Environmental and HRA report is accompanied by a technical report (Growth Scenarios (NIRAS 2024) summarising the Applicant's existing understanding on the likely growth rate of new colonies. In summary, the conclusions of these reports are as follows:

3.3.1 the proposed delay to the availability of the ANS (or any subsequent colonisation by the kittiwake) will have no consequence on the effectiveness of the proposed compensation measure with respect to the Flamborough and Filey Coast Special Protection Area ("**FFC SPA**") population (or wider North Sea population) or coherence of the network for kittiwake;

3.3.2 a delay in installation of the ANS by two years would simply result in a delay in the time for compensation to exceed mortality i.e. pay back of the mortality debt. As the planned compensation measures will be in place over the long-

term (35+ years), any such delay would have a de minimis impact on the overall success of these measures;

3.3.3 the time it would take the total production of adults at the ANS to exceed the accrued mortality debt from predicted collisions at Hornsea Four (i.e. 43.1 kittiwakes per year x *n* years of the windfarm being operational) has been estimated at as early as the 8th breeding season from initial colonisation when applying a 2:1 compensation ratio;

3.3.4 the proposed reduction of the number of breeding seasons does not affect the overall ecological validity of the compensation measure and does not have the potential to alter the conclusions of the HRA, including from an offshore ornithology perspective; and

3.3.5 the proposed reduction in the timescale the ANS is in place prior to the operation of Hornsea Four turbines will not conflict with the objective of compensation as set out by the SoS in the HRA i.e. the potential of structures to deliver 43.1 adult kittiwakes into the FFC SPA population per year.

4. SUMMARY AND CONCLUSIONS

4.1 Orsted is proposing to change the Order so that the appropriate and agreed kittiwake compensation measures are reflected in paragraphs 3(d) and 4 of Part 2 of Schedule 16 of the Order.

4.2 No change to the other provisions in the Order, physical development or other controls regulating the construction, operation, maintenance or decommissioning of the authorised development are proposed.

4.3 The proposed changes would not require additional compulsory acquisition of land, nor would they have new or different effects on local residents or businesses or any additional implications in respect of habitats regulation assessment. They are simply required to ensure that the appropriate and agreed kittiwake compensation measures are reflected in the Order, in order that construction and implementation is in accordance with its conditions.

4.4 Given the information presented in this document, as summarised above, it is considered that the proposed changes are non-material changes for the purposes of the 2011 Regulations. Accordingly, Orsted submits that the proposed changes as outlined in section 3 of this document can be granted consent by the Secretary of State as non-material changes.

APPENDIX 2

ENVIRONMENTAL AND HRA REPORT

Hornsea Project Four

Environmental and HRA Report in support of application for a non-material amendment to the Hornsea Four Development Consent Order

Prepared Elizabeth Morgan and Robin Ward, NIRAS, 08 March 2024
Checked Will Gredington, NIRAS, 08 March 2024
Accepted Felicity Le Page, Orsted, 26 March 2024
Approved Natalie Bown, Orsted, 27 March 2024

Doreco Number: 08651839

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Version History			
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24/03/2024	002	Draft	Final

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Acronyms

Term	Definition
ANS	Artificial nesting structure
DCO	Development Consent Order
DEZNEZ	Department for Energy Security and Net Zero
FFC SPA	Flamborough and Filey Coast Special Protection Area
HRA	Habitats Regulation Assessment
KCIMP	Kittiwake Compensation Implementation and Monitoring Plan
MMO	Marine Management Organisation
NMC	Non-Material Change
OOEG	Offshore Ornithology Engagement Group
RSPB	The Royal Society for the Protection of Birds
SNCB	Statutory Nature Conservation Body
SoS	Secretary of State

1 Introduction

1.1.1.1 Orsted Hornsea Project Four Limited (hereafter 'Orsted') is required to construct an artificial nesting structure (ANS) for kittiwake as a compensation measure for the potential impacts of the Hornsea Project Four Offshore Windfarm (hereafter 'Hornsea Four'). Hornsea Four's Development Consent Order (DCO) states that the timetable for delivery of the artificial nest structure should ensure that the structure is in place to allow for at least four full kittiwake breeding seasons prior to the operation of any turbine forming part of the authorised development.

1.1.1.2 This note supports the submission by Orsted for a non-material change (NMC) to the Hornsea Four DCO for amendments focused on shortening the length of time the ANS need to be in place before Hornsea Four becomes operational from at least four full breeding seasons to at least two full breeding seasons (see Figure 1.1). The wording of this non-material change was presented during the Offshore Ornithology Engagement Group (OOEG) meeting #3 on 24/11/2023 with no objections raised by OOEG members. This note provides an appraisal of the implications of a change to the number of breeding seasons as submitted in the NMC, on the conclusions of the Secretary of State's (SoS's) Habitats Regulation Assessment (hereafter, the HRA) for Hornsea Four. To provide context, the note summarises:

- The conclusions of the SoS's HRA for Hornsea Four in relation to kittiwake compensation and the number of breeding seasons required; and,
- The key points agreed by the OOEG when discussing deployment of the ANS with respect to designs, locations, monitoring techniques and adaptive management processes.

Proposed amendment to paragraph 3(d) of Part 2 of Schedule 16 of the Hornsea Four DCO: Delete existing text and insert:

*"an implementation timetable for delivery of the artificial nesting structure such timetable to ensure that the structure is in place to allow for **at least two full kittiwake breeding seasons** prior to operation of any turbine forming part of the authorised development. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September."*

Proposed amendment to paragraph 4 of Part 2 of Schedule 16 of the Hornsea Four DCO: Delete existing text and insert:

*"The undertaker must implement the measures set out in the KCIMP approved by the Secretary of State, unless otherwise agreed by the Secretary of State in consultation with the relevant SNCB, MMO and the relevant local planning authority. No operation of any turbine forming part of the authorised development may begin until the KCIMP has been approved by the Secretary of State and **two full breeding seasons following the implementation of the measures** set out in the KCIMP have taken place. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September."*

Figure 1.1 Proposed amendments to Part 2 of Schedule 16 of the Hornsea Four DCO

2 Hornsea Four HRA

2.1.1.1 Sections of the SoS HRA for Hornsea Four have been reviewed for this report and the conclusions relating to kittiwake compensation and the number of breeding seasons required are summarised below.

2.2 Required Compensation

2.2.1.1 The HRA conclusion states Section 12.1 that:

2.2.1.2 "With regards to the kittiwake feature of the Flamborough and Filey Coast SPA. The Secretary of State is satisfied that appropriate compensation measures have been identified to offset the loss of 43.1 birds per year, and that these measures can be secured in the DCO."

2.2.1.3 The HRA conclusion proceeds to describe Kittiwake compensation Section 12.1, including the measures to be addressed as conditions of the DCO, stating the contents of the Kittiwake Compensation and Implementation and Monitoring Plan (KCIMP) should include: *"iii. Details of the design of the artificial nesting structure(s) to provide nesting for at least 750 pairs of kittiwake in total; including the projected number of nests that will be accommodated on the structure…"*

2.2.1.4 The conditions set out in the HRA and DCO relevant to the proposed amendments to the timelines required for the delivery of kittiwake compensation are set out in Table 2.1 below.

2.2.2 Timescales

2.2.2.1 With respect to the timescales for the kittiwake compensation measure, relevant sections of text from Hornsea Four's HRA and DCO are summarised in Table 2.1 below.

Table 2.1 Extracts from DEZNEZ Hornsea Project Four Habitats Regulation Assessment And Marine Conservation Zone Assessment July 2023

HRA Text	DCO Text
[Section 12.1] A KCIMP must be developed by the Applicant in consultation with the H4 OOEG. The KCIMP must deliver the strategy set out in the Kittiwake Compensation Plan and be submitted to the Secretary of State for approval (in consultation with the H4 OOEG) within sufficient time to provide the agreed compensation measures **four full breeding seasons before the operation of the first wind farm generator.** [Section 12.1.] ...no operation of any turbine forming part of the authorised development may begin until the KCIMP has been approved by the Secretary of State and **until four full breeding seasons following the implementation of the measures** set out in the KCIMP have elapsed. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September.	[Schedule 16, Part 2, Para 4] The undertaker must implement the measures set out in the KCIMP approved by the Secretary of State, unless otherwise agreed by the Secretary of State in consultation with the relevant SNCB, MMO and the relevant local planning authority. No operation of any turbine forming part of the authorised development may begin until the KCIMP has been approved by the Secretary of State **and four full breeding seasons following the implementation of the measures** set out in the KCIMP have taken place. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September.
[Section 12.1] The KCIMP should include: **iii. Details of the design of the artificial nesting structure(s) to provide nesting for at least 750 pairs of kittiwake in total; including the projected number of nests that will be accommodated on the structure, and how risks from predation or other perturbations have been designed out or mitigated;** iv. An implementation timetable for delivery of the artificial nesting structure, such timetable to ensure that the structure is in place to allow for **at least four full kittiwake breeding seasons** prior to operation of any turbine forming part of the authorised development. For the purposes of this paragraph each breeding season is assumed to have commenced on 1st April in each year and ended on 30th September;	[Schedule 16, Part 2, Para 3] **The KCIMP must be based on the strategy for kittiwake compensation set out in the kittiwake compensation plan and include—** (c) details of the design of the artificial nesting structure(s) to provide nesting for at least 750 pairs of kittiwake in total; including the projected number of nests that will be accommodated on the structure, and how risks from predation and other perturbations have been designed out or mitigated; (d) an implementation timetable for delivery of the artificial nesting structure, such timetable to ensure that the structure is in place to allow for **at least four full kittiwake breeding seasons** prior to operation of any turbine forming part of the authorised development. For the purposes of this paragraph each breeding season is assumed to have commenced on 1 April in each year and ended on 30 September;
[Section 12.1] The artificial nesting structure must not be decommissioned without prior written approval of the Secretary of State in consultation with relevant SNCB. The artificial nest **structures shall be maintained beyond the operational lifetime of the authorised development** if they are colonised, and routine and adaptive management measures and monitoring must continue whilst the artificial nesting structures are in place.	[Schedule 16, Part 2, Para 7] The artificial nesting structure must not be decommissioned without prior written approval of the Secretary of State in consultation with relevant SNCB. The artificial nest **structures shall be maintained beyond the operational lifetime of the authorised development** if they are colonised, and routine and adaptive management measures and monitoring must continue whilst the artificial nesting structures are in place.

3 Implications on HRA conclusions

3.1 Introduction

3.1.1.1 The key point considered by the SoS in his decision was the number of birds for which Hornsea Four has to compensate (i.e. 43.1 birds per year at a 2:1 compensation ratio) with the conclusion that 750 nests would be a sufficient number of nests to fulfil the necessary compensation requirements.

3.1.1.2 In response to the Secretary of State's request for further information to inform the HRA, Orsted confirmed that, *"no specific timescale should be included within the DCO, but the ANS should be in place prior to operation; However, if the Secretary of State considers that a lead in time is required, the Applicant has committed to ensure the nesting structure is in place at least three full kittiwake breeding seasons prior to the operation of any turbine"* (Section 11.1.4). Whereas previously during the examination stage, Natural England had confirmed their position as being *"the ANS should be in place four breeding seasons before the operation of any turbine"* (Section 11.1.2).

3.1.1.3 The number of breeding seasons the structure should be in place prior to Hornsea Four becoming operational was based on a simple measure that reflected the average age kittiwake could recruit into the wider breeding population (as stated in the Examining Authority's conclusion; Section 11.1.3 of the HRA) and would indicate the likelihood of further colonisation of the ANS. To demonstrate that the reduction of the number of required breeding seasons from four to two would have no material implications for the HRA, a mathematical appraisal akin to that accepted in the non-material change application by Hornsea Project Three, has been developed further to the SoS decision to give greater confidence as to the likely growth rate of new colonies on the ANS. The results of these growth rate scenarios are discussed in section 3.2 below.

3.2 Growth rate scenarios

3.2.1.1 The implications of a change to the number of breeding seasons on the conclusions of the HRA will be determined by the timing of colonisation, growth rate and productivity of the kittiwake colony at each ANS. This section begins by summarising the existing understanding on the likely growth rate of new colonies, as described in the supporting technical report on growth scenarios (NIRAS 2024). An appraisal of this is then provided of the implications of a change to the number of breeding seasons on the conclusions of the HRA.

3.2.2 Potential impact of a delay on SPA populations and network coherence

3.2.2.1 Projecting the growth rate of a new artificial site is challenging as data on the colonisation of artificial structures is limited (Ørsted 2020). At natural sites, new colonies are usually created by young birds and will typically grow rapidly, but thereafter increase at a progressively lower rate (Coulson 2011, Kidlaw *et al.* 2005). Their initial growth for the first ten years or so has been found to be typically of an annual (compound) rate of increase of 50-80% amongst UK colonies (Coulson 2011). Thereafter, growth rate of the larger and older colonies having declined to around 10%–20% per annum or less (Coulson 2011, Kidlaw *et al.* 2005).

3.2.2.2 There is for all breeding populations, a range of parameter value combinations below which a colony is not self-sustaining and before which, excess productivity falls below a specified level e.g. dispersal of 43.1 breeding adults in to the wider population. What is of ecological pertinence to Hornsea Four is that the capacity of the ANS is that required to meet compensation requirements, and the agreed annual excess

productivity is attained and maintained, with the accrued debit fully compensated, at a point within the windfarm's operational lifespan.

3.2.2.3 The Growth Scenarios Technical Report (NIRAS 2024) has presented a range of colony growth scenarios that include where the colony growth rate, productivity and number of nests at initial colonisation, lie within the range of recent natural variability of these parameters at existing colonies along the east coast of England.

3.2.2.4 It is where these combinations of parameter value lie inside the range of recent natural variability along the east coast of England, that a single ANS is predicted to succeed to accumulate adult production that exceeds the accumulated mortality from collision predicted over 35 years. Under all scenarios presented it will take a number of years to pay off the accrued debt, however the debt is likely to be accrued within the operational lifetime of the windfarm. The time it would take the total production of adults at the ANS to exceed the accrued mortality debt from predicted collisions at Hornsea Four (i.e. 43.1 kittiwakes per year x *n* years of the windfarm being operational) has been estimated at as early as the 8th breeding season from initial colonisation when applying a 2:1 compensation ratio (NIRAS 2024).

3.2.3 Appraisal of implications of a change to the number of breeding seasons on the conclusions of the SoS's HRA

3.2.3.1 Whilst the ANS will have the capacity to support a minimum of 750 nesting pairs of kittiwake, proving the required compensation when using a precautionary, yet realistic, set of assumptions (NIRAS 2024), the metric of success is linked directly to the overall productivity of the ANS to deliver 43.1 kittiwakes per year at a 2:1 compensation ratio to the existing wider breeding population. Orsted is confident in high occupancy rates at the structure given that there has been a thorough site selection and careful design process.

3.2.3.2 The NMC to the Hornsea Four DCO is for amendments focused on shortening the length of time the ANS needs to be in place before Hornsea Four becomes operational. Specifically, a change from at least four full breeding seasons to at least two full breeding seasons. Colonisation could occur within the first breeding season after construction or may take a few years. However, scenarios for ANS colony growth where the controlling parameter values lie within the range of recent natural variability (NIRAS 2024), suggest any delay of up to a few years in the construction of the ANS or its colonisation by the Kittiwake, will have **no consequence on the effectiveness of the proposed compensation measure** with respect to the Flamborough and Filey Coast Special Protection Area (FFC SPA) population (or wider North Sea population) or coherence of the network for Kittiwake. Such a delay in the annual excess productivity being attained and maintained, with the accrued debit fully compensated, is proportionately small temporally and numerically in the wider context, that it will not represent any meaningful and detectable impact in the coherence of the network for Kittiwake.

3.2.3.3 The number of breeding seasons recommended by Natural England in representations to the Examining Authority was an indicative guideline based on the average age kittiwakes are likely to recruit into the breeding population. Colony formation on ANS will take time to reach the population level required to deliver compensation, this may mean that compensation targets are not met within the first few years post ANS construction. Modelled scenarios indicate the ANS is likely to pay off any debt well within the lifetime of the windfarm and any further growth would result in a surplus in future years. So a delay of two years in installation of the ANS would simply result in a delay of no greater than one year in the time for compensation to exceed mortality i.e. pay back of the mortality debt. As the planned compensation measures will be in place over the long-term (35+ years) so a delay of one to a few years would have a de minimis impact on the overall success of these measures.

3.2.3.4 Pertinent to a discussion on shortening the length of time the ANS needs to be in place before Hornsea Four becomes operational, is the behaviour of prospecting kittiwake. Whilst colonists of an ANS will not nest in a year when a structure is completed during the first half of the breeding season, the structure will still be available to birds prospecting in that year prior to breeding. Prospecting of Kittiwake peaks in the middle of chick rearing, with most individuals prospecting active colonies into which they are recruited, the year before breeding (Reed *et al.* 1999).

3.2.3.5 From these results it is clear is that the change in the number of breeding seasons will not impact the conclusion of the HRA. The proposed change to the number of breeding seasons does not affect the overall ecological validity of the compensation measure and does not have the potential to alter the conclusions of the HRA. A reduction in the timescales the ANS is in place prior to the operation of Hornsea Four turbines will not conflict with the objective of compensation as set out by the SoS in the HRA i.e. the potential of the structure to deliver 43.1 adult kittiwakes at a 2:1 compensation ratio into the FFC SPA population per year.

4 Implications on the conclusions of the offshore ornithology section of the EIA

4.1.1.1 Hornsea Four's EIA offshore and intertidal ornithology concluded with respect to potential impacts on kittiwake, that during construction and operational phases of the windfarm:

- Indirect effects, such as changes in habitat or abundance and distribution of prey will be negligible;
- The impact on mortality from collision with rotating turbine blades will be minor to negligible;
- The impact from barrier effects caused by the physical presence of turbines and ancillary structures may prevent clear transit of birds between foraging and breeding sites, or on migration, will be negligible;
- The impact of attraction to lit structures by migrating birds in particular may cause disorientation, reduction in fitness and possible mortality will be negligible; and

4.1.1.2 There is no mechanism whereby a change to the number of breeding seasons an ANS is in place prior to windfarm operations could alter any of these conclusions. Therefore, the NMC will not affect the conclusions of the offshore ornithology section of the EIA.

5 Conclusions

5.1.1.1 The kittiwake compensation measures will be achieved and secured regardless of any delay in the timing of the delivery. The proposed amendments to the length of time the ANS needs to be in place before Hornsea Four becomes operational, will not give rise to any materially new or materially different environmental effects from those considered in the HRA.

5.1.1.2 Hornsea Four will contribute significantly to the UK Government's ambition (as set out in British Energy Security Strategy) of 50 GW offshore wind capacity by 2030 and net zero carbon emissions by 2050, which are crucial in the fight against climate change. Climate change is listed in the International Black-legged Kittiwake Conservation Strategy and Action Plan as a key factor which is affecting adult mortality and breeding success. The main pathway for changing climate to impact kittiwake is likely to be through indirect trophic interactions and associated changes in the abundance and distribution of their main prey species, but also through changing patterns of extreme weather events. Accelerating the switch to renewable energies could also benefit kittiwake populations by reducing the impact of climate induced adverse effects on kittiwake.

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APPENDIX 3

GROWTH SCENARIOS REPORT (NIRAS 2024)

Hornsea Project Four Artificial Nesting Structure: Growth Scenarios

Ecological Report Supporting a Non-Material Change Application

Prepared Robin Ward, NIRAS, 8 March 2024
Checked Will Gredington, NIRAS 8 March 2024
Accepted Felicity Le Page, Orsted, 26 March 2024
Approved Natalie Bown, Orsted, 27 March 2024

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Acronyms

Term	Definition
AON	Apparently Occupied Nests
ANS	Artificial Nesting Structures
BEIS	Department for Business, Energy and Industrial Strategy
DCO	Development Consent Order
EIA	Environmental Impact Assessment
HRA	Habitats Regulation Assessment
NMC	Non-Material Change
SPA	Special Protection Area

1 Introduction

1.1.1.1 Orsted Hornsea Project Four UK Limited (hereafter 'Orsted') is required by the Development Consent Order (DCO) to construct one artificial nesting structure (ANS) for kittiwake as a compensation measure for the potential impacts of the Hornsea Project Four Offshore Windfarm (hereafter 'Hornsea Four').

1.1.1.2 This note considers a range of scenarios for colony growth, productivity and size of the starting colony at an ANS. In doing so, it identifies a range of predictions of the likely time scale within which the proposed compensation can be expected to achieve its aims.

2 Potential for colonisation

2.1.1.1 . Kittiwake are colonial nesting species so are strongly attracted to areas where other kittiwake are already nesting. In addition to this, areas where populations are increasing and breeding success is high are more attractive to birds wanting to recruit into the breeding population and are indicative of favourable environmental conditions (e.g. prey resource availability in the region). Existing colonies which are known to have growing populations (which indicate good productivity) show that prey availability is not likely to be a constraint locally.

2.1.1.2 Orsted is confident that the ANS will be populated given that there has been a thorough site selection and careful design process. By providing nesting space for at least 750 pairs, there is a high likelihood of achieving more than the target of 230 nesting pairs per year, as would be required to replenish annually the predicted 43.1 collisions of breeding adult Kittiwake apportioned to Flamborough and Filey Coast Special Protection Area (SPA) at a maximum compensation ratio of 2:1.

3 Colony Growth

3.1 Growth rate

3.1.1.1 Projecting the growth rate of a new artificial site is challenging as data on the colonisation of artificial structures is limited (Orsted 2020). At natural sites, new colonies are usually created by young birds and will typically grow rapidly, but thereafter increase at a progressively lower rate (Coulson 2011, Kidlaw *et al.* 2005). Their initial growth for the first ten years or so has been found to be typically of an annual (compound) rate of increase of 50-80% amongst UK colonies (Coulson 2011). Thereafter, growth rate of the larger and older colonies having declined to around 10%–20% per annum or less (Coulson 2011, Kidlaw *et al*. 2005).

3.2 Realistic scenario of colony growth

3.2.1 Coquet Island's kittiwake breeding population trajectory

3.2.1.1 Coquet Island (Northumberland) has been monitored from colonisation and initial breeding in 1991, so is likely to present a scenario for establishment of a new colony at a new site where birds had not bred prior. Furthermore, kittiwake had not previously bred nearby to Coquet[1], thus providing what is likely to be a precautionary scenario, this is perhaps exemplified by the colony being initiated by only one breeding pair in 1991[2] . In addition, the colony has been limited by available nesting space, running out of natural cliff

[1] Nearest colony is over 30 km away on the Farne Islands, Northumberland.
[2] In contrast to Coquet Island with no nearby colonies, all ANS will have existing breeding kittiwakes at or within 3 km.

ledges in recent years which has led to RSPB providing artificial nesting ledges from 2019 (Morrison 2021[3]). The result is a colony that has continued to expand to 512 apparently occupied nests (AON) in 2022[4].

3.2.1.2 The growth rate of the kittiwake colony at Coquet Island conforms with that described for starting colonies in general. The annual (compound) rate of increase is:

- 63% in the first ten years, declining to,
- 12% for the second ten year period (2001-2010), and
- 9% for the last ten real data years (2013-2022), and
- a modelled 0.7% for the period years 26 to 35 using the average growth rate for the five years 2018-2022, for those three years after the last real count data in 2022.

3.2.1.3 The growth rate of the kittiwake colony at Coquet Island is used in this note as the basis to predict how quickly the proposed compensation for Hornsea Four would achieve its aims following a delay in the initial colonisation of the ANS.

3.2.2 Marsden Cliff's kittiwake breeding population trajectory

3.2.2.1 Marsden Cliff (South Shields, Tyneside) has been monitored from after the first few years after colonisation that occurred between 1929 and 1931 (Coulson 2011). Following that initial colonisation, the colony increased by a similar number of nests (about 100) each year throughout the period 1932 to 1955 with the exception of a deviation between 1937 and 1953; World War II is considered a possible explanation for the latter deviation (Coulson 2011). Colony growth following the initial few years of colonisation, can be mathematically described by the equation:

$$y = 98.7(1931 + x) - 190767$$

Where x = year (where 1 = year of colonisation) and y = the number of nests.

3.2.2.2 The growth rate of the kittiwake colony at Marsden Cliff is used in this note as the basis of a second real example from the east coast of England, of how quickly the proposed compensation for Hornsea Four could achieve its aims following a delay in the initial colonisation of the ANS.

3.2.3 Logistic growth rate model

3.2.3.1 Natural England has previously stated that whilst recognising the limited data available to predict the likely growth of a generic colony, a 10% per annum growth rate would be more appropriate for the lifetime of the wind farm. This is based on Natural England's advice when commenting on a comparable kittiwake compensation project for Norfolk Boreas offshore wind farm, where they also acknowledged that a 20% growth rate may well be achieved or exceeded in the early years of the colony (Natural England 2021). To accommodate this view-point in the absence of any in-situ examples from which to inform, a logistic growth rate model (Vandermeer 2010) is presented as an alternative scenario to using the population trajectories observed at Coquet Island, Marsden Cliff and elsewhere. In logistic growth, a breeding population's per capita growth rate gets smaller and smaller as population size approaches a maximum imposed by limited resources in the environment, in the current scenario that is nesting space. For the model used in this note,

[3] https://community.rspb.org.uk/ourwork/b/natureshomemagazine/posts/handy-hammocks---getting-creative-for-kittiwakes , https://www.theambler.co.uk/2021/10/14/bumper-seabird-season-on-coquet-island/

[4] BTO/JNCC Seabird Monitoring Programme (SMP) https://www.bto.org/our-science/projects/seabird-monitoring-programme

the logistic growth curve for the breeding population commences with a 20% growth in accordance with Natural England's view on what may be achieved in the early years of the colony (Natural England 2021), together with a 50% and 80% initial growth rate in accordance with the findings of Coulson (2011).

3.3 Size of the starting colony

3.3.1.1 Kidlaw *et al*. (2005) described the growth of colonies in Alaska and record that they are typically founded by variable numbers of pioneers (23 pairs on average). Within the UK, Coulson (2011) noted that new colonies are usually formed by between three and 20 breeding pairs.

3.3.1.2 This note presents for each of the three colony growth rate models, (i.e. the logistic growth rate model and models following Coquet Island's and Marsden Cliffs kittiwake breeding population trajectories) two scenarios of differing initial colony sizes:

- Scenario One: uses a starting position of one nest in year 1, the same scenario as founded the Coquet Island colony; and
- Scenario Two: shows an alternative scenario, based on a starting colony size of 20 breeding pairs in year one.

4 Productivity

4.1.1.1 To achieve a sustainable kittiwake population, annual breeding success should be maintained at, at least 0.8 chicks per nest (Coulson 2017) when adult survival rates are that of recent years (1985-2015), with no evidence of any change since. The latter threshold approximates to the regional-specific productivity that had earlier been estimated by Horswill and Robinson (2015) for the east coast of Britain (i.e. 0.819). At a site level, between 1991-2022, 1.16 fledglings per pair were produced at the kittiwake colony at Coquet Island, and 1.27 fledglings per pair for the last five of those years (2017-2022). Whereas for the last five year period for which data is available, the number of fledglings per pair has been 0.64 at Flamborough and Filey Coast SPA (2018-2022), and 1.025 at Lowestoft (2013-2017). At the latter site, Lowestoft, productivity has been estimated as high as 1.27 fledged chicks per nest as in 2021. However, at the nearby two water intake/outflow rigs inshore at Sizewell (19 miles south of Lowestoft) productivity has been estimated as high as 1.38 fledged chicks per nest as in 2021 (NIRAS 2023).

4.1.1.2 Four productivity values (as listed 1 to 4 below) are used as a basis to predict how quickly the proposed compensation for Hornsea Four would achieve its aims:

1) the actual productivity observed for each year of growth of the kittiwake colony at Coquet Island is used as the primary source, given its unique insight into the full trajectory of kittiwake colony growth from colonisation.

To provide context, the growth rate of colony observed at the Coquet Island is also modelled using three productivity values defined as:

2) "Low" - 0.8 fledglings per nest, the threshold for a sustainable colony detailed by Coulson (2017);
3) "Medium" - 1.025 fledglings per nest, the average productivity of the last five year period (2013-2017) for which data is available at Lowestoft, being representative of the region where ANS is proposed; and
4) "High" - 1.38 fledglings per nest, the peak productivity of the last three years (2021, 2022, 2023) at Sizewell rigs.

4.1.1.3 For the logistic growth curve model and the colony growth recorded at Marsden Cliff, productivity was set at the above defined low, medium and high productivity values.

5 Survival rates and age of first breeding

5.1.1.1 Parameterisation of both models that which replicated kittiwake colonisation of Coquet Island (3.2.1), Marsden Cliff (3.2.2) and the logistic growth rate model (3.2.3) required several additional factors to be considered:

- The survival rate of kittiwake varies by age with juvenile birds typically experiencing slightly higher levels of mortality than older birds. In alignment with the review of seabird demographic rates by Horswill and Robinson (2015), the following survival rates used were:
    - Juvenile survival (0-1 years) = 0.790
    - Adult survival (≥2 years) = 0.854
- Age at which birds start to breed (age of recruitment) = four years of age (Horswill and Robinson 2015).

6 Computational steps of the models

6.1.1.1 Table 7.1 presents the stepwise progression of the computational process in each of the two models used to determine the likelihood of when the cumulative adult production from chicks fledged at the ANS, begins to exceed the accrued mortality debt from predicted collisions at Hornsea Four.

Table 7.1: Stepwise calculation of the cumulative total of the production of adults from ANS when using a model that either (a) replicates kittiwake colonisation of Coquet Island or alternatively (b) Marsden Cliff, and (c) that uses the logistic growth rate model

Successive steps of the analysis	Formulas used (using the parameters identified in first and third columns)	Value
(a) Breeding season of ANS		t
(b) Initial colony size: 1 nest		1
20 nests		20
(c) a. Initial colony logistic growth rate: Low		20%[5]
Medium		50%[6]
High		80%[6]
Or alternatively:		Colony growth rate as annually recorded at (1) Coquet Island and (2) Marsden Cliffs
b. Colony growth rate as annually recorded at:		
(1) Coquet Island (1991 - 2022)		
(2) Marsden (1932 - 1995)		
(d) Carrying capacity of ANS (i.e. no. of nesting spaces)		750
(e) Colony size (breeding pairs) in t^{th} breeding season of ANS: Logistic growth rate model	$e_{t-1} \times c \times ((d - e_{t-1})/d) + e_{t-1}$	
Or alternatively: Growth in colony size as annually recorded at: (1) Coquet Island (1991 - 2022) (2) Marsden (1932 - 1995)	(1) Coquet Island colony size (1991-2021) where 1991 is t = 1[7] (2) Marsden where 1932 is t = 1[6]	
(f) Productivity (fledglings/nest): Low		0.8[8]
Medium		1.025[9]
High		1.38[10]
Or Productivity as annually recorded at Coquet Island (1991 - 2022)		0.4-1.69[11]
(g) No. of chicks fledged in year t from ANS	e x f	
(h) Survival rate of juvenile birds		0.79[12]
(i) No. of year t cohort of fledged birds from ANS surviving first year	h x g	
(j) Survival rate of sub-adults/adults		0.854[13]
(k) No. of year t cohort of fledged birds from ANS surviving second year	j x i	
(l) No. of year t cohort of fledged birds from ANS surviving third year	j x k	
(m) No. of year t cohort of fledged birds from ANS surviving fourth year	j x l	
(n) Cumulative total of the production of adults	$\sum_{1}^{t} m$	

[5] Natural England (2021)
[6] Coulson (2011)
[7] Seabird Monitoring Programme https://app.bto.org/seabirds/public/index.jsp
[8] Coulson (2017)
[9] 5 year mean (2013-2017), Lowestoft
[10] Peak productivity in 2021 - 2023, Sizewell (NIRAS 2021, 2022, 2023)

7 Delivery

7.1 Scenario One - initial colony size of one breeding pair

7.1.1.1 Figures 7.1 and 7.2 show the cumulative production of kittiwake and accumulated kittiwake mortality from predicted collisions at Hornsea Four. Each model is based on an initial colony size of one breeding pair on the ANS at the point in time when the windfarm becomes operational. Parameters include:

- The growth rate replicating that of Coquet Island with productivity replicating that at either:
    - Coquet Island (between 0.4 - 1.7 fledglings per pair, mean of 1.1; 1991-2022); or
    - Sizewell Rigs in 2021 (1.38 fledglings per pair) defined as "High"; or
    - Lowestoft (1.025 fledglings per pair; 2015-2017) defined as "Medium"; or
    - Colonies attaining the threshold of being sustainable (0.8 fledglings per pair; Coulson 2017) defined as "Low"; or
- The growth rate replicating that of Marsden Cliffs with productivity replicating that at either:
    - Sizewell Rigs in 2021 (1.38 fledglings per pair) defined as "High"; or
    - Lowestoft (1.025 fledglings per pair; 2015-2017) defined as "Medium"; or
    - Colonies attaining the threshold of being sustainable (0.8 fledglings per pair; Coulson 2017) defined as "Low"; or
- A logistic growth rate of 50% with productivity set at 0.8 fledglings per pair.

7.1.1.2 Each figure provided is for one ANS as proposed for the Hornsea Four kittiwake compensation measure to replenish annually the predicted 43.1 collisions of breeding adult Kittiwake apportioned to Flamborough and Filey Coast SPA at a **2:1 compensation ratio**. Therefore progress should be viewed in delivering from the structure that which equates to 86.2 additional birds per annum over the lifetime of the Hornsea Four (35 years). The ANS produces 3,017 additional breeding birds contributing to the existing wider breeding population[14]) within the lifetime of the Project when productivity is comparable to the average recorded in recent years at kittiwake colonies in eastern England (2021 – 2023; NIRAS 2023), which is 200% of the total predicted mortality for kittiwake from Hornsea Four during its operational lifetime. Moreover, the cumulative adult production from chicks fledged at the ANS, begins to exceed 200% of the accrued mortality debt[15] from predicted collisions at Hornsea Four from as early as the 8th breeding season of an ANS.

7.1.1.3 The compensation measure would be delivered at a **1:1 compensation ratio** when the cumulative production of adults at the ANS attains 100% of the total predicted mortality from collisions at Hornsea Four (i.e. 1,509 additional breeding birds contributing to the existing wider breeding population). This would be achieved between the 12th and 32nd breeding season of an ANS depending on the four productivity scenarios above and including when productivity was as low as 0.8 fledglings per pair, below the average recorded in recent years at kittiwake colonies in eastern England (2021 – 2023; NIRAS 2023). Moreover, the cumulative adult production from chicks fledged at the ANS, begins to exceed 100% of the accrued mortality debt from

[11] Coquet Island from 1993 to 2022 (Seabird Monitoring Programme https://app.bto.org/seabirds/public/index.jsp)
[12] Horswill and Robinson (2015)
[13] Horswill and Robinson (2015)
[14] 200% cumulative mortality from a predicted 43.1 collision per annum over the lifetime of the Hornsea Four (35 years) equates to 3,017 birds i.e. 43.1 collisions x 35 years = 1,508.5 collisions, 200% of which is 3,017 birds.
[15] Mortality debt is the cumulative mortality incurred at that time from predicted collisions at Hornsea Four that remains after deducting the cumulative adult production from chicks fledged at the ANS.

predicted collisions at Hornsea Four from between the 7th and 29th breeding season of an ANS depending on the four productivity scenarios above.

7.1.1.4 An ANS for Hornsea Four will provide nesting opportunities for at least 750 breeding pairs of kittiwake. However, ANS generally do not reach full capacity, for example the Gateshead kittiwake Tower, South Shields, has an occupancy rate of approximately 40%[16] . The latter site's low occupancy is in itself however, a consequence of a sub-optimal design, having been installed prior to current understanding of the importance of carefully orientating artificial nest site ledges. The optimally designed ANS aims to provide a nesting ledge microclimate where the net balance between heat stress from solar irradiation, and cold stress from wind exposure is least thermoregulatory stressful for both adults and chicks.

7.1.1.5 Table 7.1 shows modelled outputs of the time taken to repay mortality debt[17] at differing rates of colony growth, productivity and initial colony size, when using the logistic growth rate model. There is no evidence to suggest that colony size will follow any of the trajectories presented here in reality; this is in part due to several external factors which the colony could be impacted by (both negatively and positively), such as severe weather events or changes in food availability. However, the model accommodates for a decreasing growth rate with time, which for the example in Figure 7.2a, declines from 50% to 23% by the 22nd breeding season of an ANS and to 1% by the 28th breeding season of an ANS, the direction and scale if not the timeline of percentage change, comparable to colonies monitored.

7.1.1.6 In the context of the scenarios mentioned above, it is pertinent to recognise their precautionary nature in colonisation being initiated by only one breeding pair, whereas three to 20 nesting pairs is typically encountered in the UK (Coulson 2011). Moreover, those scenarios parameterised with a low productivity of 0.8 fledglings per nest. lies below the average recorded in recent years at kittiwake colonies in eastern England (2021 – 2023; NIRAS 2023).

[16] A higher level of occupancy than 40% would be expected at each of the ANS on account of having optimised the location and design of the structure for nesting kittiwake.
[17] Mortality debt is the cumulative mortality incurred at that time from predicted collisions at Hornsea Four that remains after deducting the cumulative adult production from chicks fledged at the ANS.

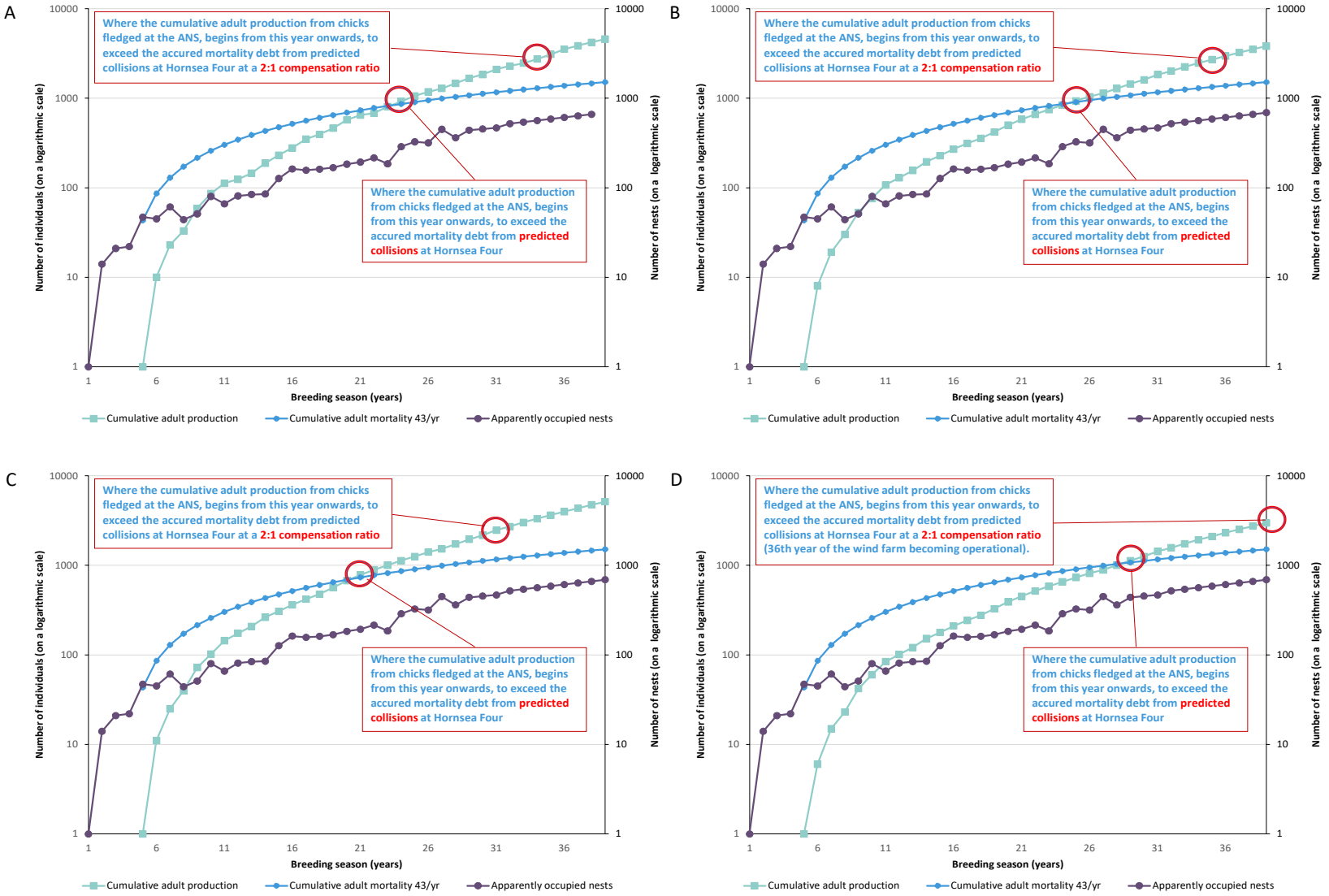

Figure 7.1 Graphs of accumulated kittiwake mortality at rate of 43.1 birds per annum and the size of a new colony with its cumulative production of adults, under the assumptions of the initial colony and growth rate being that as recorded at Coquet Island, and productivity being (A) as recorded at Coquet Island, (B) as that averaged in Lowestoft (1.025; 2013-2017), (C) as that averaged on the two Sizewell Rigs (1.38; 2021) and (D) 0.8 fledglings per pair

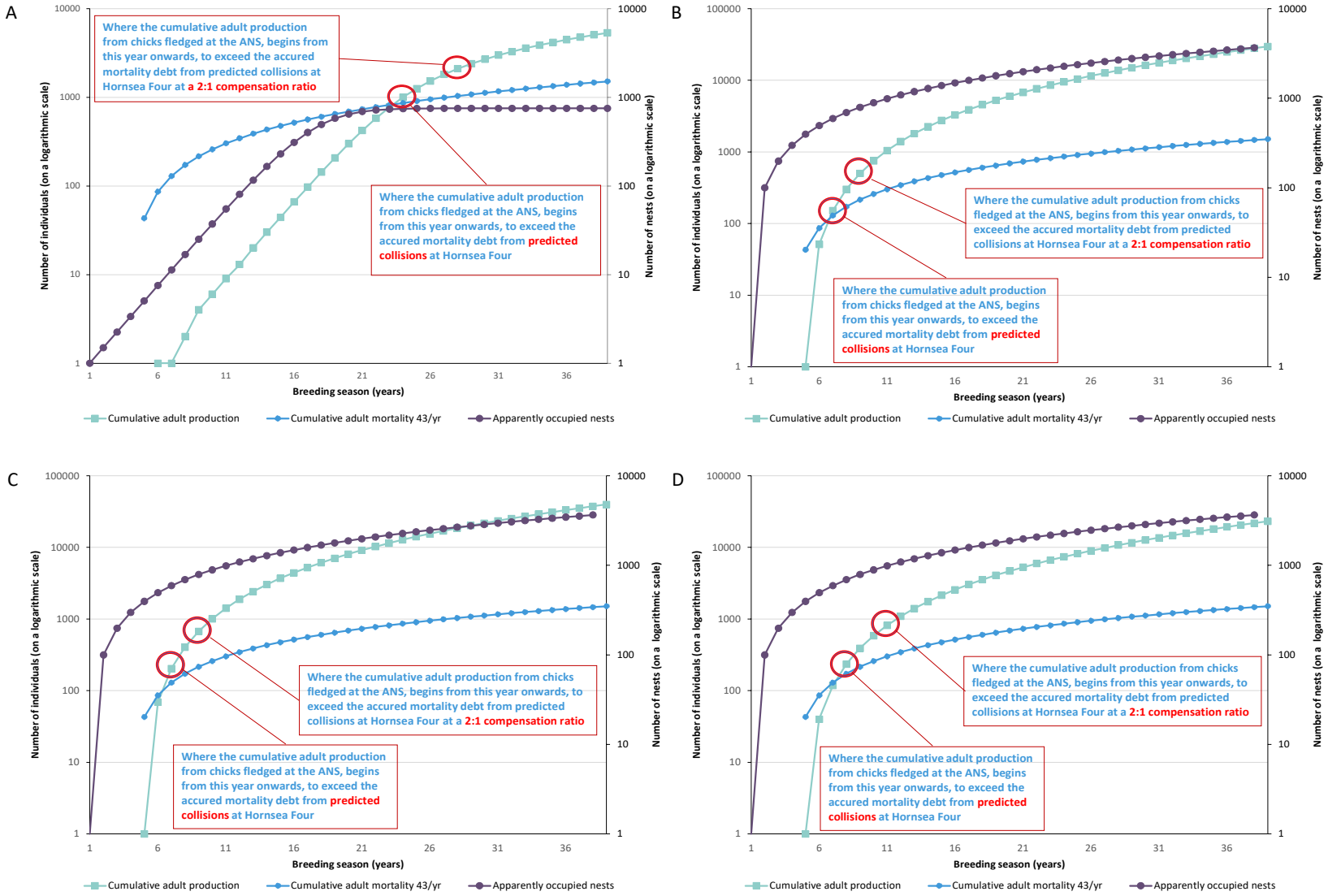

Figure 7.2 Graphs of accumulated kittiwake mortality at rate of 43.1 birds per annum and the size of a new colony with its cumulative production of adults, under the assumptions of the initial colony of one nest, (A) logistic growth rate of 50% and productivity being 0.8 fledglings per pair, or a growth rate being that as recorded at Marsden, and productivity as (B) that averaged in Lowestoft (1.025; 2013-2017), (C) as Sizewell Rigs (1.38; 2021) or (D) 0.8 fledglings per pair

Table 7.1: Modelled accumulation of collision mortality at Hornsea Four against production of adults (assuming first breeding at 4 years old) and various colony logistic growth rates, productivity assumptions, based on an initial colony size of 1 pair. Shaded cell indicates year in which cumulative adult production from chicks fledged at the ANS, begins to exceed 100% (yellow) and 200% (green) accrued mortality debt from predicted collisions at Hornsea Four.

Breeding Season of an ANS	Accumulated mortality at Hornsea Four		Cumulative total of the production of adults (colony initiation in Year 1, Hornsea Four operational from Year 5)								
		Initial colony growth rate	*20%*	*20%*	*20%*	*50%*	*50%*	*50%*	*80%*	*80%*	*80%*
		Initial colony size (breeding pairs)	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
		Productivity (fledglings/ nest)	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*
1	0		0	0	0	0	0	0	0	0	0
2	0		0	0	0	0	0	0	0	0	0
3	0		0	0	0	0	0	0	0	0	0
4	0		0	0	0	0	0	0	0	0	0
5	43.1		1	1	1	1	1	1	1	1	1
6	86.2		1	2	2	1	2	2	2	2	2
7	129.3		2	2	3	2	3	4	3	4	5
8	172.4		3	3	4	4	5	6	5	6	9
9	215.5		3	4	6	6	7	9	9	12	16
10	258.6		4	6	7	9	11	15	17	21	28
11	301.7		6	7	9	13	17	22	30	38	51
12	344.8		7	9	12	20	25	34	53	67	91
13	387.9		9	11	15	30	38	51	93	119	160
14	431		11	14	18	44	57	76	161	206	277
15	474.1		13	17	22	66	84	113	270	346	466
16	517.2		16	20	27	97	125	168	435	557	750
17	560.3		19	25	33	143	183	247	658	842	1134
18	603.4		24	30	40	208	267	359	924	1184	1594
19	646.5		29	37	49	299	382	515	1211	1552	2089
20	689.6		35	44	59	420	538	725	1505	1928	2596
21	732.7		42	53	72	578	740	997	1800	2306	3104
22	775.8		50	64	86	772	989	1332	2095	2684	3613
23	818.9		60	77	104	1000	1281	1724	2390	3062	4123
24	862		73	93	125	1253	1606	2161	2685	3441	4632
25	905.1		87	111	150	1525	1953	2630	2981	3819	5141
26	948.2		104	134	180	1807	2315	3117	3276	4197	5650
27	991.3		125	160	215	2096	2685	3615	3571	4575	6160
28	1034.4		149	191	257	2387	3059	4118	3866	4954	6669
29	1077.5		178	228	307	2681	3435	4624	4162	5332	7178
30	1120.6		212	271	365	2975	3812	5132	4457	5710	7688
31	1163.7		252	323	434	3270	4190	5640	4752	6088	8197
32	1206.8		299	383	515	3565	4568	6149	5047	6467	8706
33	1249.9		353	453	609	3860	4946	6658	5342	6845	9215

Breeding Season of an ANS	Accumulated mortality at Hornsea Four		Cumulative total of the production of adults (colony initiation in Year 1, Hornsea Four operational from Year 5)								
		Initial colony growth rate	*20%*	*20%*	*20%*	*50%*	*50%*	*50%*	*80%*	*80%*	*80%*
		Initial colony size (breeding pairs)	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
		Productivity (fledglings/ nest)	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*
34	1293		417	534	719	4155	5324	7168	5638	7223	9725
35	1336.1		491	629	846	4451	5702	7677	5933	7601	10234
36	1379.2		576	737	993	4746	6080	8186	6228	7980	10743
37	1422.3		672	861	1160	5041	6459	8695	6523	8358	11252
38	1465.4		782	1002	1349	5336	6837	9205	6819	8736	11762
39	1508.5		906	1160	1562	5631	7215	9714	7114	9114	12271

7.2 Scenario Two - initial colony size of 20 breeding pairs

7.2.1.1 Figures 7.3 and 7.4 show the cumulative production of kittiwake and accumulated kittiwake mortality from predicted collisions at Hornsea Four. Each model is based on initial colony size of 20 breeding pairs on the ANS when the windfarm becomes operational, but otherwise uses identical parameters values to the models of Scenario One (as stated in Section 7.1 above). However, the initial growth value is taken from that between the second and third breeding season of the colony i.e. 50%, when using growth rate of the kittiwake colony at Coquet Island, as opposed to the 1,300% increase noted the previous year when the colony expanded from an initial one nest to 14 nests. This precautionary approach is taken in the absence of any known examples of a colony at approximately 20 nests exhibiting a comparable or greater numerical increase the following year to 280 nests (i.e. 1,400%). As previously described (see Section 3.2.1.2 in using a ceiling of 750 breeding pairs), when using the growth rate of the kittiwake colony at Coquet Island, the average growth rate for the five years 2018-2022 is used for those three years after the last real count data in 2022.

7.2.1.2 In common to Scenario One, Figures 7.3 to 7.4 are for one ANS to replenish annually the predicted 43.1 collisions of breeding adult Kittiwake apportioned to Flamborough and Filey Coast SPA at a **2:1 compensation ratio**.. The ANS produces 3,017 additional breeding birds contributing to the existing wider breeding population within the lifetime of the Project, which is 200% of the total predicted mortality for kittiwake from Hornsea Four during its operational lifetime. Moreover, the cumulative adult production from chicks fledged at the ANS, begins to exceed 200% of the accrued mortality debt[15] from predicted collisions at Hornsea Four from as early as the 8th breeding season of an ANS.

7.2.1.3 The compensation measure would be delivered at a **1:1 compensation ratio** when the cumulative production of adults at each ANS attains 100% of the predicted mortality from collisions at Hornsea Four (i.e. 1,509 additional breeding birds contributing to the existing wider breeding population[18]). This would be achieved between the 8th and 28th breeding season of an ANS depending on the four productivity scenarios above. Moreover, the cumulative adult production from chicks fledged at the ANS, begins to exceed 100% of the accrued mortality debt[19] from predicted collisions at Hornsea Four from between the 6th and 21st breeding season of an ANS depending on the four productivity scenarios above.

7.2.1.4 Table 7.2 shows further examples to those already present in Table 7.1, of modelled outputs of the time taken to repay mortality debt at further differing rates of colony growth, productivity and initial colony size, when using the logistic growth rate model. As noted previously (see Section 7.1), this model accommodates for a decreasing growth rate with time and fluctuating productivity values, which for the example shown in Figure 7.4a, declines from 50% to 27% by the 14th breeding season of an ANS and to 1% in 21st breeding season of an ANS.

[18] 100% cumulative mortality from a predicted 43.1 collision per annum over the lifetime of the Hornsea Four (35 years) equates to 1,509 birds i.e. 73 collisions x 35 years = 1,508.5 collisions, 100% of which is 1509 birds.
[19] Mortality debt is the cumulative mortality incurred at that time from predicted collisions at Hornsea Four that remains after de-ducting the cumulative adult production from chicks fledged at the ANS.

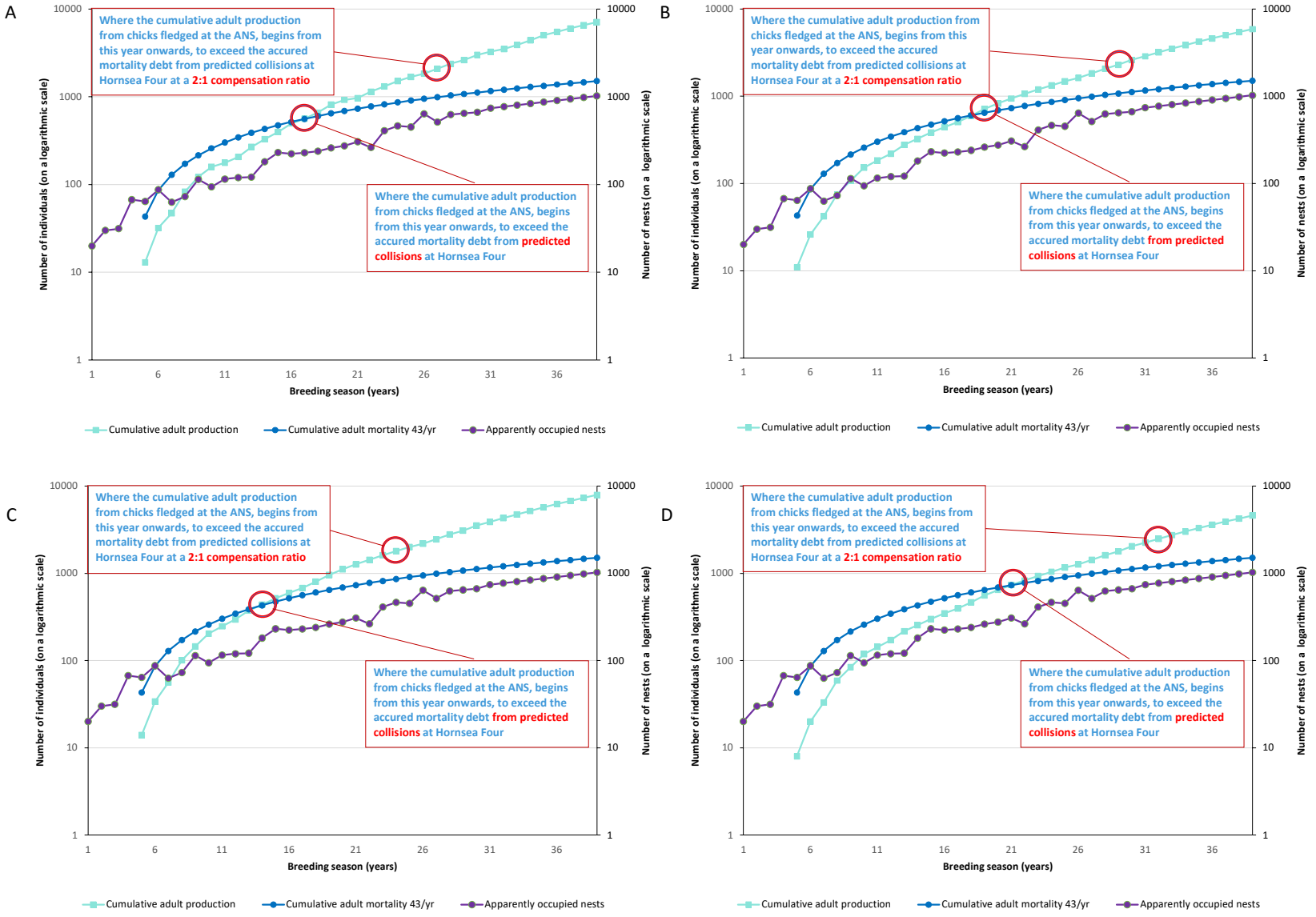

Figure 7.3 Graphs of accumulated kittiwake mortality at rate of 43.1 birds per annum and the size of a new colony with its cumulative production of adults, under the assumptions of an initial colony of 20 nests and growth rate being that as recorded at Coquet Island, and productivity being (A) as recorded at Coquet Island, (B) as that averaged in Lowestoft (1.025; 2013-2017), (C) as that averaged on the two Sizewell Rigs (1.38; 2021) and (D) 0.8 fledglings per pair

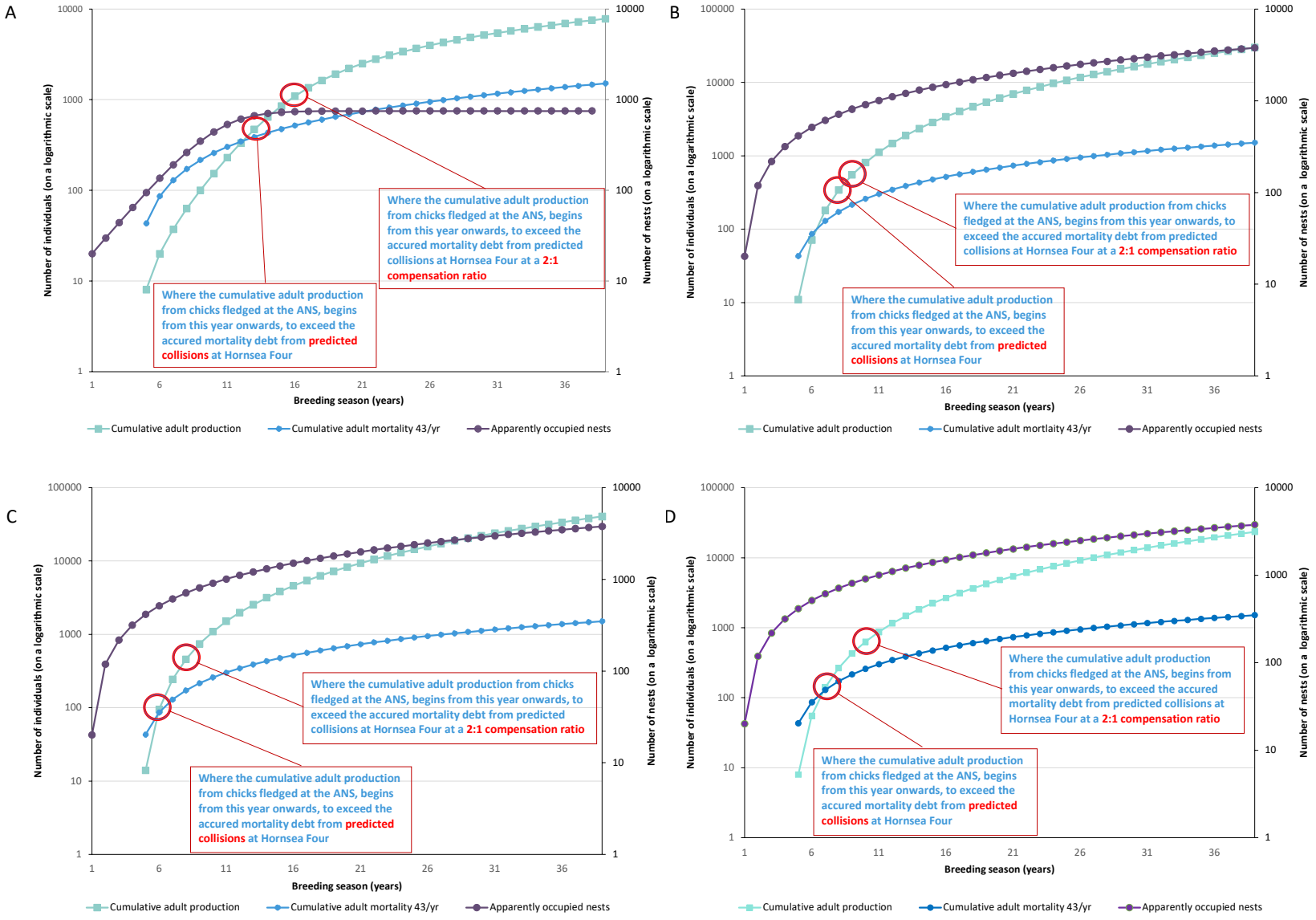

Figure 7.4 Graphs of accumulated kittiwake mortality at rate of 43.1 birds per annum and the size of a new colony with its cumulative production of adults, under the assumptions of the initial colony of 20 nests, (A) logistic growth rate of 50% and productivity being 0.8 fledglings per pair, or a growth rate being that as recorded at Marsden, and productivity as (B) that averaged in Lowestoft (1.025; 2013-2017), (C) as Sizewell Rigs (1.38; 2021) or (D) 0.8 fledglings per pair

Table 7.2 Modelled accumulation of collision mortality at Hornsea Four against production of adults (assuming first breeding at 4 years old) and various colony logistic growth rates, productivity assumptions, based on an initial colony size of 20 pairs. Shaded cell indicates year in which cumulative adult production from chicks fledged at the ANS, begins to exceed 100% (yellow) and 200% (green) accrued mortality debt from predicted collisions at Hornsea Four.

Breeding Season of an ANS	Accumulated mortality at Hornsea Four		Cumulative total of the production of adults (colony initiation in Year 1, Hornsea Four operational from Year 5)								
		Initial colony growth rate	*20%*	*20%*	*20%*	*50%*	*50%*	*50%*	*80%*	*80%*	*80%*
		Initial colony size (breeding pairs)	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*
		Productivity (fledglings/ nest)	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*
1	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
3	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
4	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
5	43.1		8	11	14	8	11	14	8	11	14
6	86.2		18	23	30	20	26	34	22	29	38
7	129.3		29	37	50	37	48	64	47	60	81
8	172.4		42	54	73	63	80	108	90	115	155
9	215.5		58	75	100	100	128	172	162	207	279
10	258.6		77	99	133	153	196	264	277	355	478
11	301.7		100	128	172	229	293	394	449	575	775
12	344.8		126	162	218	332	425	572	679	869	1170
13	387.9		158	202	272	469	600	808	949	1216	1636
14	431		195	250	336	642	822	1107	1237	1585	2134
15	474.1		239	306	412	851	1091	1468	1531	1962	2641
16	517.2		290	371	500	1091	1398	1882	1826	2339	3150
17	560.3		349	447	602	1353	1734	2334	2121	2718	3659
18	603.4		418	536	721	1630	2088	2812	2416	3096	4168
19	646.5		498	638	859	1916	2454	3304	2712	3474	4677
20	689.6		589	755	1016	2206	2826	3805	3007	3852	5186
21	732.7		693	888	1195	2499	3201	4310	3302	4231	5696
22	775.8		810	1038	1398	2792	3578	4817	3597	4609	6205
23	818.9		942	1207	1624	3087	3955	5325	3893	4987	6714
24	862		1088	1394	1876	3382	4333	5833	4188	5365	7224
25	905.1		1249	1600	2154	3677	4711	6342	4483	5744	7733
26	948.2		1424	1825	2456	3972	5089	6852	4778	6122	8242
27	991.3		1614	2068	2783	4267	5467	7361	5073	6500	8751
28	1034.4		1817	2328	3134	4563	5846	7870	5369	6878	9261
29	1077.5		2033	2605	3506	4858	6224	8379	5664	7257	9770
30	1120.6		2260	2896	3899	5153	6602	8888	5959	7635	10279
31	1163.7		2498	3201	4309	5448	6980	9398	6254	8013	10788
32	1206.8		2746	3518	4736	5743	7359	9907	6550	8391	11298

Breeding Season of an ANS	Accumulated mortality at Hornsea Four		Cumulative total of the production of adults (colony initiation in Year 1, Hornsea Four operational from Year 5)								
		Initial colony growth rate	*20%*	*20%*	*20%*	*50%*	*50%*	*50%*	*80%*	*80%*	*80%*
		Initial colony size (breeding pairs)	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*
		Productivity (fledglings/ nest)	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*	*0.8*	*1.025*	*1.38*
33	1249.9		3001	3845	5176	6039	7737	10416	6845	8770	11807
34	1293		3263	4180	5628	6334	8115	10926	7140	9148	12316
35	1336.1		3531	4524	6090	6629	8493	11435	7435	9526	12825
36	1379.2		3804	4874	6561	6924	8872	11944	7730	9905	13335
37	1422.3		4081	5229	7039	7220	9250	12453	8026	10283	13844
38	1465.4		4361	5588	7523	7515	9628	12963	8321	10661	14353
39	1508.5		4645	5951	8012	7810	10006	13472	8616	11039	14862

8 Impact of delayed colonisation

8.1.1.1 The above findings suggest that a one year delay in colonisation would result in an equivalent delay for compensation to exceed mortality (i.e. pay back of the mortality debt). This is irrespective of which scenario of growth rate, productivity or initial colony size occurs. Thereafter, every additional year to that first year of delay in initial colonisation of an ANS is no greater than another year before the ANS achieves compensation for either a 100% or 200% of the collision mortality debt. This holds true irrespective of the scenario considered for colony growth rate, productivity and number of nests at initial colonisation of those plotted in Figures 7.1 - 7.4. It is pertinent to note therefore that a reduction from four to two full kittiwake breeding seasons that the ANS is in place prior to operation of any turbine, delays the ANS achieving compensation for 200% of the collision mortality debt by no more than one year for those scenarios plotted in Figures 7.1 - 7.4.

8.2 Potential impact of a delay on SPA populations and network coherence

8.2.1.1 There is, for all breeding populations, a range of parameter value combinations below which a colony is not self-sustaining and before which excess productivity falls below a specified level (e.g. dispersal of 43.1 breeding adults into the wider population). What is of ecological pertinence to Hornsea Four is that at the ANS, the agreed annual excess productivity is attained and maintained, with the accrued debt fully compensated, at a point within the windfarm's operational lifespan. A realistic timeframe for this, when reviewing a range of predicted scenarios as in the preceding tables (Tables 7.1 and 7.2), is that captured by those scenarios whose parameter values lie within recent and known natural variation. That excess productivity of an ANS does not rise above a specified level (e.g. dispersal of 43.1 breeding adults into the wider population) within the infancy of the windfarm's operational lifespan, does not reflect failure. To identify where the cut-off lies when productivity is falling below a specified level, evitability scenarios need to be run that fail to achieve the set objective. Of the 26 scenarios presented, it is where a combination of the parameter values lie outside the range of recent natural variability (i.e. initial colony growth rate of 20%; see section 3.1), that the ANS is predicted to fail to accumulate adult production that exceeds much more than 50% of the accumulated mortality from collision predicted over 35 years.

8.2.1.2 For those scenarios where the controlling parameter values lie within the range of recent natural variability, they demonstrate any delay of up to a few years in their colonisation by kittiwake will have no consequence on the effectiveness of the proposed compensation measure with respect to the Flamborough and Filey Coast Special Protection Area population (or wider North Sea population) or coherence of the network for kittiwake. Such a delay in the agreed annual excess productivity being attained and maintained, with the accrued debt fully compensated, is proportionately small temporally and numerically in the wider context, that it will not represent any meaningful and detectable impact in the coherence of the network for kittiwake. The planned compensation measures will be in place over the long-term (35+ years) so a delay of one to a few years would have a de minimis impact on the overall success of these measures. In the context of this NMC, this buffer is sufficient for the ANS to be able to deliver the compensation requirement over the lifetime of the Hornsea Four (35 years) when it is in place for the requested change to two, rather than four breeding seasons before the operation of any turbine. In addition, Hornsea Four will be taking steps to enhance the chances of success and minimise the risk of failure in delivery of the compensation requirements, by the designing in of ecological niches and provisioning of at least 750 nesting sites at the ANS as per the Habitats Regulation Assessment.

9 References

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