DBS Offshore Wind

RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Reduction in Kittiwake Breeding Seasons Prior to Artificial Nesting Structure Installation

(Revision 2) (Tracked)

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Revision Change Log			
Rev No.	**Page**	**Section**	**Description**
02	8	2	Inclusion of detail with regard to the Memorandum of Understanding with Outer Dowsing Offshore Wind (ODOW)
02	10	3	Clarification of wording
02	9-10	3	Additional detail provided with regard to rational for reducing breeding seasons with a focus on ANS delivery programme.
02	10-11	3	Clarification of wording.
02	11	3	Additional text added on the programme requirements for delivery four seasons in advance of operation.
02	12	4	Updates regarding additional productivity scenario used in calculations, and implications of calculation updates.
02	12	4	Introduction of tables demonstrating colonisation scenarios using the upper 95% confidence interval.
02	13	4	Inclusion of detail with regard to adaptive management
02	13	4	Updated figures for earliest compensation delivery provided.
02	13	4	Inclusion of detail with regard to the Projects' onshore ANS at Gateshead.
02	14	4	New references to Table 4-1 to 4-4, as well as onshore ANS.

Contents

Tables

Glossary

Term	Definition
Concurrent Scenario	A potential construction scenario for the Projects where DBS East and DBS West are both constructed at the same time.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).
Development Scenario	Description of how the DBS East and / or DBS West Projects would be constructed either in isolation, sequentially or concurrently.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Habitats Regulations Assessment (HRA)	The process that determines whether or not a plan or project may have an adverse effect on the integrity of a European Site or European Offshore Marine Site.
Statutory Nature Conservation Bodies	Comprised of JNCC, Natural Resources Wales, Department of Agriculture, Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage, these agencies provide advice in relation to nature conservation to government.
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).
Wind Turbine	Power generating device that is driven by the kinetic energy of the wind.

Acronyms

Acronym	Definition
ANS	Artificial Nesting Structures
DBS	Dogger Bank South
DCO	Development Consent Order
HRA	Habitats Regulations Assessment
FFC	Flamborough and Filey Coast
FID	Final Investment Decision
KCSG	Kittiwake Compensation Steering Group
KSCP	Kittiwake Strategic Compensation Plan
ODOW	Outer Dowsing Offshore Wind
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area

1 Introduction

1. The Dogger Bank South (DBS) Offshore Wind Farms ('the Projects') have proposed the installation of offshore artificial nesting structures (ANS) as compensation for predicted kittiwake mortality for birds associated with the Flamborough and Filey Coast (FFC) Special Protection Area (SPA).
2. At the point of Development Consent Order (DCO) submission in June 2024, the expectation from historic precedent and The Crown Estate's Plan Level Habitats Regulations Assessment (HRA) **Round 4 Kittiwake Strategic Compensation Plan [APP-060]** (KSCP) was that ANS should be in place three to four full breeding seasons before an offshore wind farm is operational. This is to allow sufficient time for the recruitment of juveniles to the adult population given that kittiwake are known to start breeding on average at four years old (Horswill and Robinson, 2015) although a proportion of kittiwakes (26.5%) breed for the first time at three years old (Coulson, 2011).
3. At the point of application, the Applicants committed to installing a project developed ANS three breeding seasons in advance of operation and delivering a collaborative ANS to be installed by another developer four years ahead of operation. This timing was based upon precedent for other offshore wind projects at the time. However, recent decisions to accept non-material changes for Hornsea 3 and Hornsea 4 offshore wind farms have reduced this time period to two years in advance of operation. Outer Dowsing Offshore Wind (ODOW) has followed the Hornsea projects approach and has submitted a change request to amend their DCO wording to reduce the number of breeding seasons ahead of operation from three to two. This change request was accepted into the examination process on 11th February 2025.
4. This report outlines the implications of the existing expectations in relation to timelines for ANS installation ahead of turbine operation and assesses the suitability and practicality of these.

2 Compensation Requirements

5. The compensation requirements for the Projects are provided in **Appendix 1 - Project-Level Kittiwake Compensation Plan (Revision 3) [AS-087]**. Table 4-1 of this document states that the worst-case annual mortality for the Projects would be between 104 (mean) and 377 (upper 95% confidence interval) individuals. Table 5-1 of the same document states the level of compensation required in terms of nesting pairs and compensation quantum as presented in the **KSCP [APP-060]**. The KSCP considers that between 2,500 and 5,500 nesting spaces are required to compensate for Round 4 projects concluding adverse effects on integrity for the FFC SPA kittiwake population (the Projects plus ODOW).

6. The Applicants, in collaboration with ODOW propose to deliver two offshore ANS via the following mechanisms:

   - A single ANS developed and installed by the Applicants.
   - A single ANS developed and installed by ODOW.

7. A Memorandum of Understanding (MoU) for a collaboration agreement in relation to the development, construction, operation and decommissioning of ANS sites in the North Sea between the Applicants and ODOW has been signed by both parties. This document sets out the terms for collaboration, and each party's commitment to sharing nesting spaces and compensation benefits attached to each occupied space. The MoU also sets out both parties' interests in collaborating in the design, development and implementation of respective ANSs which has facilitated discussions with regard to logistic operations in connection with the construction and maintenance of the structures. ~~The Applicants and ODOW are exploring the potential for nesting space from each other's ANS to be shared between the parties to present~~This approach provides reciprocal resilience across the compensation measure ~~(a Memorandum of Understanding is currently being drafted between the two parties). This~~ and will enable both the Applicants and ODOW to deliver the strategic measure and approach in line with **the Volume 6, KSCP [APP-053],** collaboratively through the installation of individual project-led ANS.

8. The Applicants will provide sufficient quantum of compensation for kittiwake in a single ANS which they will develop. However, it is noted that collaborative delivery is one of the mechanisms proposed in **Volume 6, KSCP [APP-053]** therefore engagement with other OWF developers both through the kittiwake Steering Group and directly with other developers has been undertaken during the pre-application stage to explore opportunities for collaboration between the Applicants, ODOW and other OWF developers.

3 Reviewing Breeding Seasons Ahead of ANS Installation

9. Several factors have given the Applicants cause to re-examine timelines in regard to offshore ANS installation ahead of wind farm operation.

10. Colony formation on ANS will take time to reach the population level required to fully deliver compensation, this may mean that compensation targets are not met within the first few years following ANS construction. To reduce the accumulation of 'mortality debt' ~~and~~ (i.e. the ~~resultant~~ lag between impact and compensation), installation of ANS four years prior to operation has been recommended by Statutory Nature Conservation Bodies (SNCBs) for previous compensation schemes based upon the age at which kittiwake breed for the first time and are therefore available as 'replacements' to an impacted colony.

11. As outlined in section 1, at the point of DCO application, the Applicants committed to installing a project developed ANS three breeding seasons in advance of operation and delivering a collaborative ANS to be installed by another developer four years ahead of operation.

12. In March 2024, Orsted's Hornsea Three Offshore Windfarm was granted a non-material change (NMC) to reduce the amount of time that ANS were required to be in place from four to two full kittiwake breeding seasons for two of their proposed ANS, and from four to three breeding seasons for another two ANS (DESNZ, 2024a). Orsted were also granted an NMC ~~a second non-material change~~ in July 2024 for Hornsea Project Four to shorten the length of time their single offshore ANS needs to be in place before operation from at least four full breeding seasons to at least two full breeding seasons (DESNZ, 2024b). As well as providing evidence that ANS will still deliver sufficient compensation over their life expectancy, the Hornsea cases have provided precedent for consent on the basis of installing two years in advance of operation.

13. ODOW has followed the Hornsea projects approach and has submitted a change request to amend their DCO wording to reduce the number of breeding seasons between installation of ANS and wind farm ~~ahead of~~ operation from three to two. This change request was accepted into the examination process on 11th February 2025.

14. There were several drivers behind the reduction in breeding seasons for the Hornsea projects and ODOW which also apply to the Applicants. The Hornsea projects required the NMCs to allow time for the construction of the ANS without impacting the programme for the operation of the development and avoiding unnecessarily delay in provision of renewable energy to the national grid.

15. Delivering an offshore ANS is a challenging task, which proportionately increases in complexity with distance offshore, and one that resulted in Hornsea 4 abandoning their offshore ANS scheme in pursuit of an onshore one. It is apparent that the implementation of this measure could present a genuine risk to overall project delivery if not done with a full understanding of consenting and supply chain risks. As such, the Applicants have undertaken a thorough and diligent process of site selection and ANS concept design in order to fully appraise the requirements. Following the latest stage of site selection work, the Applicants have examined their offshore ANS delivery programme, and it is evident that delivering on offshore ANS ahead of Q4 2027 would be highly challenging.

    Key tasks and milestones that informed this conclusion include the following:

    - Completion of the site investigation surveys to determine ground conditions
    - Identification of preferred ANS candidate site
    - Submission of marine licence application for offshore ANS
    - Detailed design phase for foundation and topside
    - Procurement of contractor for construction of foundation and topside
    - Sourcing of materials for construction
    - Construction of foundation and topside
    - Transportation
    - Installation of ANS in preferred location.

~~14.~~ The fabrication process itself is contingent upon availability of the preferred contractors and materials (primarily steel). Sourcing of materials will additionally be subject to international supply chains which are presently subject to flux due to international market uncertainty. With these factors combined, the Applicants have concluded it would be highly challenging for the reasons outlined above for the Projects to deliver an offshore ANS more than two breeding seasons ahead of operation.

~~15.~~16. In both of the Hornsea project cases, the provision of evidence to support a reduction in pre-installation breeding seasons, relied upon the calculation of the growth rates of kittiwake colonies to demonstrate the point at which the new colony at the ANS would provide sufficient recruits to offset ~~reach~~ the accumulated mortality from the project. This was based upon a number of demographic factors:

- Initial colony size (either of 1 or 20 pairs);
- Initial colony growth rate – based on logistic growth rates; and
- Productivity (chicks/pairs).

~~16.~~17. The input values differ slightly between the two Hornsea projects however, the models remain similar, and methods for calculation of colony growth rates are transparent given that they are provided in a stepwise format within respective non-material change documentation (Orsted, 2024a; Orsted, 2024b). Following a review of references, the growth rate calculation methods are also considered to be ecologically appropriate for modelling colony growth on offshore ANS. In both cases, the Hornsea growth rate models demonstrate that, subject to the growth rate assumptions made, the ANS will overcompensate for the collision mortality within the lifetime of the project. Additionally, in the wider context of kittiwake populations in the North Sea, the difference in when the break-even point occurs (i.e. when compensation exceeds impact) ~~summed across years,~~ for ANS installation four years prior to operation compared with two years is insignificant. Compensation colony growth follows the same trajectory irrespective of when the colony is initiated so, as ~~T~~the Hornsea cases demonstrate a one year delay in ~~that if~~ implementation of compensation (for example) simply ~~is~~ delay~~eds,~~ achievement of the goal by the same period~~there will be an equivalent delay in achieving its goals~~.

~~17.~~18. The ~~non-material changes~~NMC were consented for both Hornsea projects on the basis of a provision of evidence on growth rates at the ANS. Given this outcome, and the challenging programming and commercial implications of installing an offshore ANS three or four breeding seasons ahead of operation, the Applicants have modelled their impact numbers provided in **Appendix 1 - Project-Level Kittiwake Compensation Plan (Revision 4) [AS-087]** to assess the ability of offshore ANS to provide sufficient compensation within the lifetime of the project for a scenario with ~~should~~ installation ~~occur~~ two years ahead of operation.

~~18.~~19. Given that ~~the calculations~~ calculations ~~demonstrate~~ ~~that~~ the gap between ANS installation and wind farm operation ~~makes~~there ~~is~~ ~~difference to the period~~does not affect the functioning of the ANS merely the point at which ~~taken for~~ impact payback occurs~~little biological relevance to the four-year figure~~, and that ANS installation four years prior to operation significantly ~~impact~~ affects the Projects programming and would require sizeable investment decisions to be made prior to the FID for the Projects, the Applicants propose to reduce the number of breeding seasons prior to operation to two.~~.~~ ~~This~~ is to allow greater flexibility and reduce risk of delays and ensure that the Projects are contributing to UK Net Zero targets as soon as possible. Furthermore, to deliver the offshore ANS four years in advance of first possible operation (planned for 2029), the Applicants would have been required to install the structure in Q1 2025, prior to consent being granted. This was not considered feasible or reasonable in regard to financial or logistical risks.

4 Application to the Projects

~~19.~~20. To understand compensation colony growth rates t~~T~~he Hornsea 4 colony growth rate calculation method was used since this is ~~as~~ the most recently consented method~~,~~. It was also considered ~~and due to~~ ecologically appropriate ~~suitability of the approach~~ on the basis of specialist input from Natural England on logistic growth rates. Full details are provided in Orsted (2024b). The ~~outputs of the~~ calculations demonstrate that if the Projects compensation is delayed, the primary outcome is a deferment in the ~~success of the~~ compensation by the same amount of time. Given that the colonies will ~~grow~~ start from zero, even at high growth rates, it will take more than four years for the annual production to exceed annual mortality, and longer still to compensate the accrued mortality debt.

21. Following Natural England's Deadline 3 representation, **Appendix H3 Offshore Ornithology Compensation** [REP3-055] the calculations presented as graphs in the previous iteration of this document (i.e. Figure 4-1 in [REP2-060]) have been replaced with tables with input parameters more clearly indicated (see **Table 4-1** to **Table 4-4**). Juvenile survival rate is assumed to be 0.79 and adult survival rate 0.854 as used in Orsted (2024b) and Horswill and Robinson (2015). The tables are based on installation of the ANS two years prior to operation (and hence start of impact).

22. The point at which productivity exceeds mortality varies depending on the initial colony size, colony growth rate and productivity. Four productivity values (low - high) are presented in **Table 4-1** to **Table 4-4**): 0.69, 0.8, 1.025 and 1.38. The additional rate of 0.69 was added in response to Natural England's Deadline 3 representation [REP3-055] based upon the latest available UK average productivity rate (Horswill & Robinson, 2015). Multiple values are presented as a basis to predict how quickly the proposed compensation for the Projects would achieve its aims under various scenarios.

23. ~~Calculations indicate that offshore ANS would deliver the required compensation quantum within the project lifetime.~~ Modelling the data using this method demonstrates that ~~for the mean mortality rate for~~ with a single structure, an initial population of 20 pairs and using all but the worst case productivity parameters, the ANS would take between ~~14~~ 13 and ~~36~~ 37 years for productivity to exceed accrued mortality (assuming the mean collision impact) ~~(i.e. between 10 and 32 years following first DBS operation, assuming ANS in place four years prior to operation,~~(see **Table 4-2**Table 4-3~~**Figure 4-1**~~) or between 19 and 50 years (assuming the colony initially has a single pair) (see **Table 4-1**) and in this scenario the mortality debt is not reached at growth rates of <20% if productivity is <1.38. In most scenarios for the mean mortality, therefore, the offshore ANS would deliver the required compensation quantum within the Projects 30-year lifetime.

24. **Table 4-3** and **Table 4-4** illustrate the same scenarios for the upper 95% confidence interval mortality. Whilst, success takes longer, it is still achieved in most scenarios other than those with the lowest growth rates.

~~20.~~25. In the event that the ANS is colonised but there is remaining compensation debt after 30 years of operation (the Projects' lifespan); to reduce the risk of compensation deficit the Applicant retains the option to maintain and monitor the ANS beyond the Projects' operational duration. This additional responsibility could be implemented as adaptive management, to be reviewed regularly with oversight from the Kittiwake Compensation Steering Group (KCSG). The option to provide additional commitment to ensuring the success of the offshore ANS provides confidence that the measure will deliver the compensation requirement for the Projects, even if beyond the Projects' operational lifespan.

~~21. The point at which productivity exceeds mortality is variable depending on the initial colony size, colony growth rate and productivity. Three productivity values (low, medium and high) are presented in **Figure 4-1**: 0.8, 1.025 and 1.38. Multiple values are presented as a basis to predict how quickly the proposed compensation for the Projects would achieve its aims under various scenarios.~~

~~22.~~26. Given a likely compensation ratio of 2:1 the compensation would be provided by the ~~second structure~~ODOW offshore ANS within the same timescales. It follows that if ANS installation occurs two full years prior to operation, full compensation would be achieved ~~between 16 and 36~~from 13 years following first generation (dependent upon the scenario).

~~23. In addition, there are other~~Another considerations~~s~~ that would affect the timescales at which the ANS would ~~be~~ match~~ing~~ mortality with productivity and at which the overall accumulated mortality would be compensated for (assuming that the compensation functions as expected and there are no extreme events which affect productivity) is~~:~~

~~24. ODOW provide their project led ANS in 2025. This would mean that 50% of the compensation would be delivering earlier than the DBS alone ANS (assuming both ANS identical).~~ that the Projects will become

~~25.~~27. ~~DBS beco ming~~ operational in phases. ~~u~~Under a concurrent scenario, ~~would mean that~~ mortality would not reach the full worst-case numbers until construction is complete and~~.~~ ~~T~~the sequential development of either Dogger Bank South East, or West would result in a staggering of predicted impacts.

28. Given the long timescales required to compensate fully~~, early delivery of the ODOW ANS and~~ DBS becoming operational in phases would not materially affect the point at which the ANS would be matching mortality with productivity and at which the overall accumulated mortality would be compensated for.

~~26.~~29. Furthermore, the Applicants would like to emphasise the value of the onshore ANS that has already been delivered by the Projects. This structure was installed ahead of the **Round 4 Kittiwake Strategic Compensation Plan** [APP-053] publication and was delivered in good faith with the intention that this structure could contribute to compensation and avoid the accrual of mortality debt well in advance of any impacts associated with operation. The onshore ANS was constructed in February 2023, a full seven breeding seasons ahead of first possible operation for the Projects.

~~27.~~30. In conclusion**, Table 4-1** to **Table 4-4**~~The graphs in **Figure 4-1**~~ demonstrate that, even at low colonisation rates and low productivity, the ANS would adequately compensate the lifetime collision mortality of the Projects, in ~~all but one scenario (Graph D)~~most scenarios. ~~Under this scenario~~In the worst-case scenarios, the ANS would be unlikely to compensate for the lifetime collision mortality as calculated, whether the structure is installed either two, or four years in advance of wind farm operation.

31. Given that most scenarios show the measure adequately compensating, as well as the presence of the onshore tower, and the potential option for adaptive management, the Applicants are confident that a reduction in breeding seasons from four to two ahead of operation does not materially affect the delivery of the compensation requirement and furthermore, is necessary to ensure the security of the Projects.

Table 4-1 Cumulative Adult production, initial colony size of 1, mean annual mortality (191) (yellow indicates 100% accrued mortality & green 200% accrued mortality).

Breeding season of an ANS (i)	Accumulated mortality MEAN	Mortality Scenario	Mean (191); 2500 LGR model											
		Initial colony growth rate (α)	20%	20%	20%	20%	50%	50%	50%	50%	80%	80%	80%	80%
		Initial colony size (breeding pairs)	1	1	1	1	1	1	1	1	1	1	1	1
		Productivity (fledglings / nest) (f	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38
1	0		0	0	0	0	0	0	0	0	0	0	0	0
2	0		0	0	0	0	0	0	0	0	0	0	0	0
3	191		0	0	0	0	0	0	0	0	0	0	0	0
4	382		0	0	0	0	0	0	0	0	0	0	0	0
5	573		1	1	1	1	1	1	1	1	1	1	1	1
6	764		1	1	2	2	1	1	2	2	1	2	2	2
7	955		2	2	2	3	2	2	3	4	3	3	4	5
8	1146		2	3	3	4	3	4	5	6	5	5	6	9
9	1337		3	3	4	6	5	6	7	9	8	9	12	16
10	1528		4	4	6	7	8	9	11	15	14	17	21	28
11	1719		5	6	7	9	11	13	17	22	26	30	38	51
12	1910		6	7	9	12	17	20	25	34	46	54	69	92
13	2101		8	9	11	15	26	30	38	51	83	96	123	165
14	2292		9	11	14	18	39	45	57	77	147	171	219	294
15	2483		11	13	17	22	58	67	86	116	260	301	385	519
16	2674		14	16	20	27	87	100	129	173	450	521	668	899
17	2865		17	20	25	33	129	150	192	258	758	878	1125	1515
18	3056		21	24	30	41	192	223	285	384	1223	1417	1816	2445
19	3247		25	29	37	49	284	329	422	567	1856	2152	2756	3711
20	3438		30	35	44	60	417	483	619	833	2618	3035	3888	5235
21	3629		36	42	54	72	606	702	900	1211	3442	3990	5113	6883
22	3820		44	51	65	87	868	1006	1289	1735	4285	4968	6365	8570
23	4011		53	61	78	105	1221	1415	1813	2441	5133	5951	7625	10265
24	4202		64	74	94	127	1677	1944	2491	3353	5981	6935	8885	11962
25	4393		76	88	113	152	2238	2595	3325	4476	6830	7919	10146	13660
26	4584		92	106	136	183	2895	3356	4300	5789	7679	8903	11407	15357
27	4775		110	128	163	220	3626	4204	5386	7251	8528	9887	12668	17055
28	4966		132	153	196	264	4407	5110	6547	8814	9376	10871	13928	18752
29	5157		158	184	235	316	5220	6052	7754	10439	10225	11855	15189	20450
30	5348		190	220	282	379	6050	7014	8987	12099	11074	12839	16450	22147
31	5539		227	263	337	454	6889	7987	10233	13777	11923	13823	17711	23845
32	5730		272	315	404	543	7733	8966	11487	15465	12771	14807	18972	25542
33	5921		325	377	483	649	8579	9947	12744	17158	13620	15791	20233	27240
34	6112		388	450	576	775	9427	10929	14003	18853	14469	16776	21494	28937
35	6303		463	536	687	925	10275	11913	15263	20549	15318	17760	22754	30635
36	6494		551	639	818	1101	11123	12896	16523	22246	16167	18744	24015	32333
37	6685		655	759	973	1310	11972	13880	17784	23943	17015	19728	25276	34030
38	6876		777	901	1155	1554	12821	14864	19045	25641	17864	20712	26537	35728
39	7067		921	1067	1368	1841	13669	15848	20306	27338	18713	21696	27798	37425
40	7258		1088	1261	1616	2175	14518	16832	21566	29036	19562	22680	29059	39123
41	7449		1282	1486	1904	2563	15367	17817	22827	30733	20410	23664	30319	40820
42	7640		1506	1746	2237	3011	16216	18801	24088	32431	21259	24648	31580	42518
43	7831		1763	2044	2618	3525	17064	19785	25349	34128	22108	25632	32841	44215
44	8022		2055	2383	3053	4110	17913	20769	26610	35826	22957	26616	34102	45913
45	8213		2386	2767	3545	4772	18762	21753	27871	37523	23805	27600	35363	47610
46	8404		2758	3198	4097	5515	19611	22737	29132	39221	24654	28585	36624	49308
47	8595		3171	3677	4711	6342	20459	23721	30392	40918	25503	29569	37885	51005
48	8786		3627	4205	5387	7253	21308	24705	31653	42616	26352	30553	39145	52703
49	8977		4125	4782	6127	8249	22157	25689	32914	44313	27201	31537	40406	54401
50	9168		4664	5407	6928	9327	23006	26673	34175	46011	28049	32521	41667	56098

Table 4-2 Cumulative Adult production, initial colony size of 20, mean annual mortality (191) (yellow indicates 100% accrued mortality & green 200% accrued mortality)

Breeding season of an ANS (t)	Accumulated mortality	Growth Rate Model Nest Capacity	Base: 2500											
		Initial colony growth rate (α)	20%	20%	20%	20%	50%	50%	50%	50%	80%	80%	80%	80%
		Initial colony size (breeding pairs)	20	20	20	20	20	20	20	20	20	20	20	20
		Productivity (fledglings / nest) (f	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38
1	0		0	0	0	0	0	0	0	0	0	0	0	0
2	0		0	0	0	0	0	0	0	0	0	0	0	0
3	191		0	0	0	0	0	0	0	0	0	0	0	0
4	382		0	0	0	0	0	0	0	0	0	0	0	0
5	573		7	8	11	14	7	8	11	14	7	8	11	14
6	764		15	18	23	30	17	20	26	34	19	22	29	38
7	955		25	29	37	50	33	38	48	65	41	48	61	82
8	1146		37	43	55	73	55	64	82	110	80	93	119	160
9	1337		51	59	75	101	89	103	132	177	148	172	220	296
10	1528		68	78	100	135	139	161	206	277	267	309	396	533
11	1719		88	101	130	175	212	246	315	423	467	542	694	934
12	1910		111	129	165	222	319	369	473	637	790	916	1173	1579
13	2101		140	162	208	280	472	547	701	943	1273	1475	1890	2545
14	2292		174	202	258	348	688	798	1022	1376	1922	2228	2855	3843
15	2483		215	249	319	429	985	1142	1463	1969	2693	3122	4001	5386
16	2674		263	305	391	526	1378	1598	2047	2755	3521	4082	5230	7041
17	2865		321	372	476	641	1877	2176	2788	3753	4365	5061	6484	8729
18	3056		389	451	577	777	2478	2873	3681	4956	5213	6044	7743	10425
19	3247		470	544	697	939	3167	3672	4705	6334	6061	7028	9004	12122
20	3438		565	655	839	1129	3921	4546	5825	7842	6910	8012	10265	13820
21	3629		677	785	1006	1354	4717	5469	7008	9434	7759	8996	11526	15517
22	3820		809	938	1202	1618	5538	6421	8227	11076	8608	9980	12786	17215
23	4011		963	1117	1430	1926	6373	7388	9466	12745	9456	10964	14047	18912
24	4202		1142	1324	1697	2284	7214	8364	10716	14427	10305	11948	15308	20610
25	4393		1350	1565	2005	2699	8059	9344	11971	16117	11154	12932	16569	22307
26	4584		1589	1842	2360	3177	8906	10326	13230	17811	12003	13916	17830	24005
27	4775		1862	2159	2766	3724	9754	11309	14489	19507	12851	14900	19091	25702
28	4966		2172	2519	3227	4344	10602	12292	15749	21204	13700	15884	20352	27400
29	5157		2522	2924	3746	5044	11451	13276	17010	22901	14549	16868	21612	29098
30	5348		2913	3377	4327	5825	12299	14260	18270	24598	15398	17852	22873	30795
31	5539		3346	3879	4970	6691	13148	15244	19531	26295	16247	18837	24134	32493
32	5730		3821	4430	5676	7642	13997	16228	20792	27993	17095	19821	25395	34190
33	5921		4338	5030	6445	8676	14845	17212	22053	29690	17944	20805	26656	35888
34	6112		4896	5676	7273	9792	15694	18196	23314	31388	18793	21789	27917	37585
35	6303		5492	6367	8158	10983	16543	19180	24574	33085	19642	22773	29178	39283
36	6494		6123	7099	9096	12246	17392	20164	25835	34783	20490	23757	30438	40980
37	6685		6787	7869	10082	13574	18240	21148	27096	36480	21339	24741	31699	42678
38	6876		7480	8672	11111	14959	19089	22132	28357	38178	22188	25725	32960	44375
39	7067		8198	9505	12178	16395	19938	23116	29618	39876	23037	26709	34221	46073
40	7258		8938	10363	13277	17876	20787	24101	30879	41573	23885	27693	35482	47770
41	7449		9697	11243	14405	19394	21636	25085	32140	43271	24734	28677	36743	49468
42	7640		10472	12142	15557	20944	22484	26069	33400	44968	25583	29661	38004	51166
43	7831		11261	13056	16728	22522	23333	27053	34661	46666	26432	30645	39264	52863
44	8022		12061	13984	17916	24121	24182	28037	35922	48363	27281	31630	40525	54561
45	8213		12870	14922	19118	25739	25031	29021	37183	50061	28129	32614	41786	56258
46	8404		13687	15868	20331	27373	25879	30005	38444	51758	28978	33598	43047	57956
47	8595		14509	16822	21554	29018	26728	30989	39705	53456	29827	34582	44308	59653
48	8786		15337	17782	22783	30674	27577	31973	40966	55153	30676	35566	45569	61351
49	8977		16169	18747	24019	32338	28426	32957	42226	56851	31524	36550	46830	63048
50	9168		17004	19715	25260	34008	29275	33941	43487	58549	32373	37534	48090	64746

Table 4-3 Cumulative Adult production, initial colony size of 1, 95% UCI annual mortality (377) (yellow indicates 100% accrued mortality & green 200% accrued mortality)

Breeding season of an ANS (i)	Accumulated mortality UCI	Mortality Scenario	UCI (377); 2500 LGR model											
		Initial colony growth rate (α)	20%	20%	20%	20%	50%	50%	50%	50%	80%	80%	80%	80%
		Initial colony size (breeding pairs)	1	1	1	1	1	1	1	1	1	1	1	1
		Productivity (fledglings / nest) (f)	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38
1	0		0	0	0	0	0	0	0	0	0	0	0	0
2	0		0	0	0	0	0	0	0	0	0	0	0	0
3	377		0	0	0	0	0	0	0	0	0	0	0	0
4	754		0	0	0	0	0	0	0	0	0	0	0	0
5	1131		1	1	1	1	1	1	1	1	1	1	1	1
6	1508		1	1	2	2	1	1	2	2	1	2	2	2
7	1885		2	2	2	3	2	2	3	4	3	3	4	5
8	2262		2	3	3	4	3	4	5	6	5	5	6	9
9	2639		3	3	4	6	5	6	7	9	8	9	12	16
10	3016		4	4	6	7	8	9	11	15	14	17	21	28
11	3393		5	6	7	9	11	13	17	22	26	30	38	51
12	3770		6	7	9	12	17	20	25	34	46	54	69	92
13	4147		8	9	11	15	26	30	38	51	83	96	123	165
14	4524		9	11	14	18	39	45	57	77	147	171	219	294
15	4901		11	13	17	22	58	67	86	116	260	301	385	519
16	5278		14	16	20	27	87	100	129	173	450	521	668	899
17	5655		17	20	25	33	129	150	192	258	758	878	1125	1515
18	6032		21	24	30	41	192	223	285	384	1223	1417	1816	2445
19	6409		25	29	37	49	284	329	422	567	1856	2152	2756	3711
20	6786		30	35	44	60	417	483	619	833	2618	3035	3888	5235
21	7163		36	42	54	72	606	702	900	1211	3442	3990	5113	6883
22	7540		44	51	65	87	868	1006	1289	1735	4285	4968	6365	8570
23	7917		53	61	78	105	1221	1415	1813	2441	5133	5951	7625	10265
24	8294		64	74	94	127	1677	1944	2491	3353	5981	6935	8885	11962
25	8671		76	88	113	152	2238	2595	3325	4476	6830	7919	10146	13660
26	9048		92	106	136	183	2895	3356	4300	5789	7679	8903	11407	15357
27	9425		110	128	163	220	3626	4204	5386	7251	8528	9887	12668	17055
28	9802		132	153	196	264	4407	5110	6547	8814	9376	10871	13928	18752
29	10179		158	184	235	316	5220	6052	7754	10439	10225	11855	15189	20450
30	10556		190	220	282	379	6050	7014	8987	12099	11074	12839	16450	22147
31	10933		227	263	337	454	6889	7987	10233	13777	11923	13823	17711	23845
32	11310		272	315	404	543	7733	8966	11487	15465	12771	14807	18972	25542
33	11687		325	377	483	649	8579	9947	12744	17158	13620	15791	20233	27240
34	12064		388	450	576	775	9427	10929	14003	18853	14469	16776	21494	28937
35	12441		463	536	687	925	10275	11913	15263	20549	15318	17760	22754	30635
36	12818		551	639	818	1101	11123	12896	16523	22246	16167	18744	24015	32333
37	13195		655	759	973	1310	11972	13880	17784	23943	17015	19728	25276	34030
38	13572		777	901	1155	1554	12821	14864	19045	25641	17864	20712	26537	35728
39	13949		921	1067	1368	1841	13669	15848	20306	27338	18713	21696	27798	37425
40	14326		1088	1261	1616	2175	14518	16832	21566	29036	19562	22680	29059	39123
41	14703		1282	1486	1904	2563	15367	17817	22827	30733	20410	23664	30319	40820
42	15080		1506	1746	2237	3011	16216	18801	24088	32431	21259	24648	31580	42518
43	15457		1763	2044	2618	3525	17064	19785	25349	34128	22108	25632	32841	44215
44	15834		2055	2383	3053	4110	17913	20769	26610	35826	22957	26616	34102	45913
45	16211		2386	2767	3545	4772	18762	21753	27871	37523	23805	27600	35363	47610
46	16588		2758	3198	4097	5515	19611	22737	29132	39221	24654	28585	36624	49308
47	16965		3171	3677	4711	6342	20459	23721	30392	40918	25503	29569	37885	51005
48	17342		3627	4205	5387	7253	21308	24705	31653	42616	26352	30553	39145	52703
49	17719		4125	4782	6127	8249	22157	25689	32914	44313	27201	31537	40406	54401
50	18096		4664	5407	6928	9327	23006	26673	34175	46011	28049	32521	41667	56098

~~Figure 4- 1 Graphs illustrating ANS colonisation rates by kittiwake across a range of growth scenarios~~

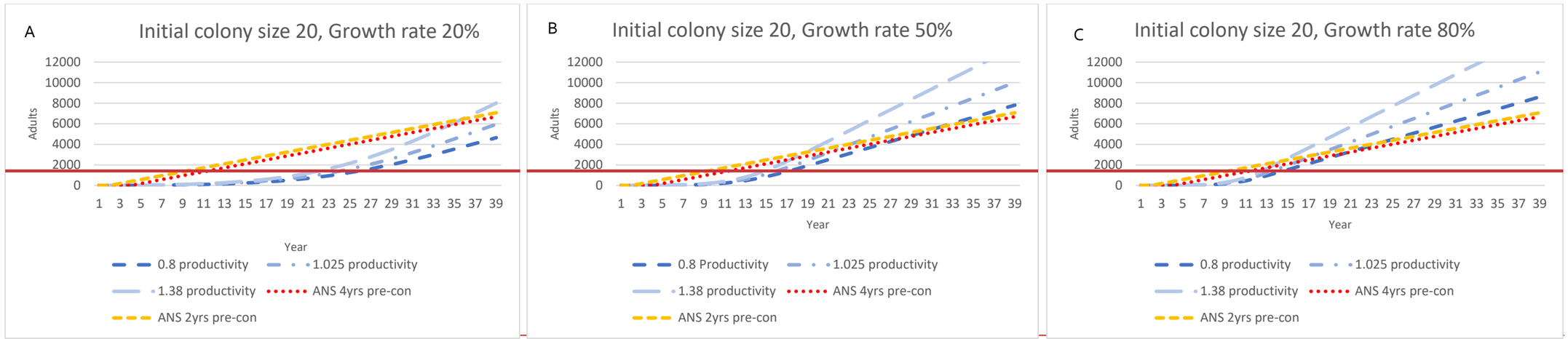

Table 4-4 Cumulative Adult production, initial colony size of 20, 95% UCI annual mortality (377) (yellow indicates 100% accrued mortality & green 200% accrued mortality)

Breeding season of an ANS (t)	Accumulated mortality	Motality Scenario	Upper: 2500											
		Initial colony growth rate (r)	20%	20%	20%	20%	50%	50%	50%	50%	80%	80%	80%	80%
		Initial colony size (breeding pairs)	20	20	20	20	20	20	20	20	20	20	20	20
		Productivity (fledglings / nest) (f)	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38	0.69	0.8	1.025	1.38
1	0		0	0	0	0	0	0	0	0	0	0	0	0
2	0		0	0	0	0	0	0	0	0	0	0	0	0
3	377		0	0	0	0	0	0	0	0	0	0	0	0
4	754		0	0	0	0	0	0	0	0	0	0	0	0
5	1131		7	8	11	14	7	8	11	14	7	8	11	14
6	1508		15	18	23	30	17	20	26	34	19	22	29	38
7	1885		25	29	37	50	33	38	48	65	41	48	61	82
8	2262		37	43	55	73	55	64	82	110	80	93	119	160
9	2639		51	59	75	101	89	103	132	177	148	172	220	296
10	3016		68	78	100	135	139	161	206	277	267	309	396	533
11	3393		88	101	130	175	212	246	315	423	467	542	694	934
12	3770		111	129	165	222	319	369	473	637	790	916	1173	1579
13	4147		140	162	208	280	472	547	701	943	1273	1475	1890	2545
14	4524		174	202	258	348	688	798	1022	1376	1922	2228	2855	3843
15	4901		215	249	319	429	985	1142	1463	1969	2693	3122	4001	5386
16	5278		263	305	391	526	1378	1598	2047	2755	3521	4082	5230	7041
17	5655		321	372	476	641	1877	2176	2788	3753	4365	5061	6484	8729
18	6032		389	451	577	777	2478	2873	3681	4956	5213	6044	7743	10425
19	6409		470	544	697	939	3167	3672	4705	6334	6061	7028	9004	12122
20	6786		565	655	839	1129	3921	4546	5825	7842	6910	8012	10265	13820
21	7163		677	785	1006	1354	4717	5469	7008	9434	7759	8996	11526	15517
22	7540		809	938	1202	1618	5538	6421	8227	11076	8608	9980	12786	17215
23	7917		963	1117	1430	1926	6373	7388	9466	12745	9456	10964	14047	18912
24	8294		1142	1324	1697	2284	7214	8364	10716	14427	10305	11948	15308	20610
25	8671		1350	1565	2005	2699	8059	9344	11971	16117	11154	12932	16569	22307
26	9048		1589	1842	2360	3177	8906	10326	13230	17811	12003	13916	17830	24005
27	9425		1862	2159	2766	3724	9754	11309	14489	19507	12851	14900	19091	25702
28	9802		2172	2519	3227	4344	10602	12292	15749	21204	13700	15884	20352	27400
29	10179		2522	2924	3746	5044	11451	13276	17010	22901	14549	16868	21612	29098
30	10556		2913	3377	4327	5825	12299	14260	18270	24598	15398	17852	22873	30795
31	10933		3346	3879	4970	6691	13148	15244	19531	26295	16247	18837	24134	32493
32	11310		3821	4430	5676	7642	13997	16228	20792	27993	17095	19821	25395	34190
33	11687		4338	5030	6445	8676	14845	17212	22053	29690	17944	20805	26656	35888
34	12064		4896	5676	7273	9792	15694	18196	23314	31388	18793	21789	27917	37585
35	12441		5492	6367	8158	10983	16543	19180	24574	33085	19642	22773	29178	39283
36	12818		6123	7099	9096	12246	17392	20164	25835	34783	20490	23757	30438	40980
37	13195		6787	7869	10082	13574	18240	21148	27096	36480	21339	24741	31699	42678
38	13572		7480	8672	11111	14959	19089	22132	28357	38178	22188	25725	32960	44375
39	13949		8198	9505	12178	16395	19938	23116	29618	39876	23037	26709	34221	46073
40	14326		8938	10363	13277	17876	20787	24101	30879	41573	23885	27693	35482	47770
41	14703		9697	11243	14405	19394	21636	25085	32140	43271	24734	28677	36743	49468
42	15080		10472	12142	15557	20944	22484	26069	33400	44968	25583	29661	38004	51166
43	15457		11261	13056	16728	22522	23333	27053	34661	46666	26432	30645	39264	52863
44	15834		12061	13984	17916	24121	24182	28037	35922	48363	27281	31630	40525	54561
45	16211		12870	14922	19118	25739	25031	29021	37183	50061	28129	32614	41786	56258
46	16588		13687	15868	20331	27373	25879	30005	38444	51758	28978	33598	43047	57956
47	16965		14509	16822	21554	29018	26728	30989	39705	53456	29827	34582	44308	59653
48	17342		15337	17782	22783	30674	27577	31973	40966	55153	30676	35566	45569	61351
49	17719		16169	18747	24019	32338	28426	32957	42226	56851	31524	36550	46830	63048
50	18096		17004	19715	25260	34008	29275	33941	43487	58549	32373	37534	48090	64746

References

Department of Energy Security and Net Zero (2024a) Proposed Non-Material Change To Hornsea Three Offshore Wind Farm Order 2020 – (S.I. 2023/459) Letter, 9th May 2024.

Department of Energy Security and Net Zero (2024b) Proposed Non-Material Change To The Hornsea Four Offshore Wind Farm Development Consent Order 2023 – (S.I. 2023/800) Letter, 17th July 2024.

Horswill, C. and Robinson, R.A. (2015). Review of seabird demographic rates and density dependence. JNCC Report No. 552. JNCC, Peterborough.

Orsted (2024a) Non-material Change – Regulation 7 Letter Application To Make A Non-Material Change To Hornsea Three Offshore Wind Farm Order 2020 (S.I. 2020/1656) As Corrected (S.I. 2021/599) and Amended (S.I. 2023/459). Pinsent Masons LLP on behalf of Orsted Hornsea Project Three.

Orsted (2024b) Non-material Change – Regulation 7 Letter – 2nd May 2024. Pinsent Masons LLP on behalf of Orsted Hornsea Project Four Limited.

Outer Dowsing Offshore Wind (2025) 21.19 The Applicant's Change Request, 3rd February 2025.

The Planning Inspectorate (2025) Planning Act 2008 and The Infrastructure Planning (Examination Procedure) Rules 2010– Rules 8(3) and 9 letter to GTR4 Limited (Trading as Outer Dowsing Offshore Wind) - Notice of variation to the Examination Timetable and Procedural Decision relating to a request for changes to the application as part of the applicant's submission for Deadline 4.

RWE Renewables UK Dogger Bank
South (West) Limited

RWE Renewables UK Dogger Bank
South (East) Limited

Windmill Business Park
Whitehill Way
Swindon
Wiltshire, SN5 6PB