Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Sandwich Tern – Quantification of Productivity Benefits Technical Note (Revision B) (Clean)

Revision B
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Glossary of Acronyms

AoS	Area of Search
CRM	Collision Risk Modelling
DAS	Discretionary Advice Service
DCO	Development Consent Order
DEL	Dudgeon Extension Limited
DEP	Dudgeon Offshore Wind Farm Extension Project
ORJIP	Offshore Renewables Joint Industry Programme
SEL	Scira Extension Limited
SEP	Sheringham Offshore Wind Farm Extension Project
SMP	Seabird Monitoring Programme
SPA	Special Protection Area

Glossary of Terms

Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the EIA and HRA for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
The Applicant	Equinor New Energy Limited. As the owners of SEP and DEP, Scira Extension Limited and Dudgeon Extension Limited are the named undertakers that have the benefit of the DCO. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of SEL and DEL as the undertakers of SEP and DEP.

1 Purpose of Document

1. This note has been prepared to address comments provided within Appendix C Offshore Ornithology Compensation of Natural England's Relevant Representation [RR-063] in relation to Equinor New Energy Limited's (the Applicant's) proposed Sandwich tern compensatory measures to provide nesting habitat improvements and restoration of lost breeding range at Scar Point, Loch Ryan (inland pool) and improved breeding success at Special Protection Area (SPA) sites other than North Norfolk Coast SPA for example, at Farne Islands SPA as part of the Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP).

2. Excerpts from Appendix C of Natural England's Relevant Representation [RR-063] which this note is intended to address include:

> *Paragraph 4: The scale of compensation is not yet clearly defined, and the methodology for determining the population required to compensate a specific level of estimated mortality has not been described.*
>
> *Detailed Comments Point 8: To provide the requisite confidence in the number of recruits that would be produced, the methodology for calculation of a reasonable target population for the compensatory measure should be fully detailed.*
>
> *It would be useful to stress test the proposed colony size in terms of its ability to deliver the required compensation under a worst-case productivity scenario.*
>
> *Detailed Comments Point 13: We note that the outline roadmap for the implementation of the habitat provision compensation measure aims to allow 2 full breeding seasons of operation prior to first power at SEP and DEP.*
>
> *Sandwich tern recruit into the breeding population in their third year, and therefore the measure could in theory be delivering adults into the wider breeding population at the point of impact. However, colonisation of habitat is highly uncertain in terms of time taken, and uptake/growth. With a 2-year lead in it is highly likely that the measure will accrue a mortality debt in the formative years. Calculations relating to the scale of the measure required to compensate a specified impact should be stress tested against mortality debt scenarios, especially when further adaptive management options are limited.*

3. In response to these comments the Applicant has provided further information within this note to explain how the measures proposed will deliver the necessary productivity benefits and therefore the level of compensation required to increase Sandwich tern numbers.

4. As the respective owners of SEP and DEP, Scira Extension Limited (SEL) and Dudgeon Extension Limited (DEL) are the named undertakers that have the benefit of the Development Consent Order (DCO). References in this document to

obligations on, or commitments by, 'the Applicant' are given on behalf of SEL and DEL as the undertakers of SEP and DEP.

2 Consultation on this Document

5. Natural England provided comments on this note at Deadline 2 [REP2-061]. These comments and the Applicant's response are provided in **Table 1**.

Table 1: Applicant's comments on Natural England's comments provided in REP2-061

ID	Natural England Comment	Applicant Comment
Detailed Comments		
1	Paragraph: 5 Excerpt: Farne Islands Comment: Please refer to Natural England's comments in our Relevant Representation [RR-063] Appendix B (summary Para 6, detailed comments 15 to 17) regarding our concerns with the measures proposed for the Farne Islands SPA. We note the National Trust's comment that they do not feel the compensation measures proposed for the Farne Islands, which the Trust manages, are appropriate [REP1-134].	See the **HRA Derogation and Compensatory Measures Update Note (Revision B)** [document reference 13.7] for an update on the Applicant's position with respect to the Farne Islands SPA.
2	Paragraph: 6 Excerpt: 'Natural England predicts a 42% increase in seabird numbers in the North Sea within 15 years of closure of the North Sea sandeel fishery (Bayes and Kharadi 2022, Natural England 2023).' Comment: While Natural England agrees that reducing fishing pressure on sandeel stocks would benefit seabirds, we do note that more recent ecosystem modelling outputs potentially indicate lower levels of benefit to seabirds.	The Applicant notes that the estimate of a 42% increase in seabirds has been published by Natural England only very recently (2023), and that the "more recent ecosystem modelling" to which Natural England refer seems not yet to have been made public so the Applicant is unable to comment on the validity of that work.
3	Paragraph: 7 Excerpt: Size of island. Comment: Please refer to comments in our Relevant Representation [RR-63] (summary paragraph 5 and detailed comments 10 and 11) on the scale of the project. We further note that there may be benefits in establishing an island large enough to allow colonisation by other species, in particular black headed gull. Schwartz et al noted colonisation probability increased if sites were used by other species.	Noted. As noted in the **HRA Derogation and Compensatory Measures Update Note (Revision B)** [document reference 13.7], the Applicant can confirm that discussions with a landowner within the preferred Area of Search (AoS) are progressing positively. Draft Heads of Terms were provided to this party in January 2023 and access granted to undertake non-intrusive surveys on this individual's land. Efforts to mature discussions with a further landowner within the preferred AoS are ongoing. Several alternative sites within the wider AoS remain under consideration.
4	Paragraph: 8	

ID	Natural England Comment	Applicant Comment
	Excerpt: If a colony of 150 pairs of Sandwich terns can be restored at Loch Ryan and these birds achieved the average breeding success of this species at Scottish colonies when the birds are not subject to mammal predation or human disturbance (about 0.8 chicks per pair per year; Short 2020, Joint Nature Conservation Committee (JNCC) 2021) this would produce an average output of about 120 fledglings per year. Comment: Natural England requests a more detailed justification is provided for the presented productivity figure of 0.8 for colonies not subject to mammalian predation or human disturbance. The JNCC report that for Sandwich tern in Scotland 'Productivity of Sandwich terns at colonies monitored in Scotland has fluctuated considerably since recording began. 2000 and 2001 were the only years on record with relatively high levels of productivity, with an average of 0.57 chicks being fledged per pair between 1986 and 2019. In 2019, Sandwich terns at Sands of Forvie again occupied a breeding colony among black-headed gulls. In 2018, productivity at this colony rose slightly to 0.73 chick fledged per pair (624 chicks from 852 pairs), the highest values recorded since 2013 when 0.80 chicks fledged per pair. In 2019, productivity decreased to 0.533.' (Joint Nature Conservation Committee (JNCC) 2021). Horswill and Robinson (2017) report a national productivity figure of 0.702 (SD 0.372), which would of course include colonies subject to predation/disturbance. JNCC also note that in 2019, average UK productivity was 0.41 chicks fledged per pair.	The Applicant notes that the estimates of Sandwich tern breeding success at Sands of Forvie are clearly stated to be minimum estimates based on a count of the number of fledglings present at the end of the breeding season (Short 2020) and therefore underestimate actual productivity as the count will not include fledglings that have already left the colony. Short (2020) states *"The method of relying on peak counts to assess breeding success tends to underestimate productivity. The usual fast dispersal of fledged young away from the breeding site during early to mid-July is likely to have suppressed the peak fledgling count. Therefore, once again, the true total of fledged young is likely to have been higher than the recorded number'.* Furthermore, the Sands of Forvie colony is not protected by a predator-proof fence, but only by an electric fence. Short (2020) describes how foxes manage to cross that fence in most years, though only on rare occasions, but it is evident that fox predation still affects productivity at Sands of Forvie to some extent in most years, as can predation by stoats, American mink and otters (Short 2020). According to Short (2020) a minimum of 622 chicks fledged from 590 pairs at Sands of Forvie in 2011, so it is clear that breeding success can potentially exceed 1.05 chicks per pair in years when the food supply is good and predation by foxes can be limited. Indeed, Short (2020) notes *"Disturbance and predation have been major impacting factors on the breeding success of terns at Forvie. Predation of birds and eggs has been common in some years, and may be exacerbated by disturbance from human visitors and dogs".* Therefore, we can reasonably expect that a colony at Loch Ryan where mammal predators are excluded and human disturbance is excluded would have a significantly higher breeding success than seen at Sands of Forvie. This also makes comparison with data summarised by Horswill and Robinson (2017) or JNCC (2021) inappropriate as their data include breeding by birds at colonies subject to heavy predation impacts. On this basis, although breeding success can exceed a minimum estimate of 1.05 chicks per pair in the best years at Sands of Forvie, it seems reasonable to expect breeding success to be around 0.8 chicks per pair where predation and disturbance are controlled.
5	Paragraph: 8 Excerpt: The key to achieving breeding success of 0.8 chicks per pair or better is to minimise risk of predation by mammals and human disturbance. Comment: As above, Natural England requests more detail is provided in regards the productivity figure of 0.8 for colonies not subject to mammalian predation or human disturbance.	
6	Paragraph: 8-11 and Table 1 Excerpt: Stress testing.	The Applicant is of the view that there is limited value in further stress-testing exercises beyond the details that are described below in **Section 3.2** of this report and summarised in **Table 2**. Based on reasonable estimates of the

ID	Natural England Comment	Applicant Comment
	Comment: Natural England advises that more detailed stress-testing/ scenario exploration should be carried out to identify if the proposed colony size is sufficient and identify how long the measure should be in place to ensure compensation fully accounts for the mortality debt accrued. These scenarios should include realistic worse and likely case scenarios in regards colony establishment time, initial establishment size, colony growth rate, colony size and productivity. Other considerations should include the fact that predictions of increased storminess and sea-level change under climate change scenarios may lead to increased prevalence of inundation events - leading to greater variability in productivity and increased incidences of total colony failure.	numbers of Sandwich terns likely to breed at Loch Ryan at a restored breeding site and best estimates of demographic rates, the provision of the new nesting habitat at Loch Ryan has the capacity to compensate for the predicted mortality due to the Projects. Although the stress-test undertaken is not explicit in accounting for the possibility of a mortality debt accruing, the available evidence suggests that such a situation is unlikely to arise. If it were to arise, then it is expected that the 'debt' would accrue for a small number of years only, in which case it could, if required, be accounted for by extending the duration over which active management was undertaken at the Loch Ryan site (i.e. potentially beyond the Projects' operational period) to ensure that sufficient levels of breeding success are maintained over a sufficient number of years to balance the mortality predicted to have occurred during the Projects' operational periods. However, if throughout the operational phase of the Projects', the scale of compensation being provided increased to a level sufficient to offset any mortality debt accrued in the early years, then extending the duration over which active management was undertaken at the Loch Ryan site would not be required. The Applicant also considers that scenarios for reasonable worse-case in terms of initial colony establishment size, colony growth rate, colony size and breeding productivity (e.g. which could arise due to climate change effects leading to higher frequency of colony inundation events) are essentially already encompassed by the stress-test exercise that has been undertaken. Attempting to refine the stress-testing further would, in the Applicant's view, require highly speculative assumptions and be highly unlikely to provide any greater insight into the likely efficacy of the proposed compensation. However, the Applicant would be willing to consider this further if Natural England are able to provide greater detail on the scenarios that they consider would be worth investigating, the extent to which such scenarios can be considered to be realistic / reasonable and, importantly, a greater underlying basis to the likely consequences of these scenarios in terms of the colony establishment, growth and demographics.
7	Paragraph: Section 2.3 15-18 Excerpt: Improved Breeding Success at SPA sites other than North Norfolk Coast – Farne Islands SPA.	See the Applicant's response at ID 1 of this table.

ID	Natural England Comment	Applicant Comment
	Comment: Please refer to Natural England's comments in our Relevant Representation [RR-063] (detailed comments 15, 17) regarding our concerns with the measures proposed for the Farnes.	
8	Paragraph: 15 Excerpt: 1,092 chicks were produced by 1,950 AONs (pairs) in 2000, a breeding success of 0.56 chicks per pair, also well below the average for Sandwich tern in colonies in the UK (JNCC 2021). Comment: In 2019, average UK productivity was 0.41 chicks fledged per pair. (JNCC 2021).	The Applicant notes that productivity varies considerably from year to year. 2019 was a poor year compared to many others. For example, in 2000 average UK productivity was 0.86 chicks fledged per pair (JNCC 2021). However, the Applicant considers that these annual averages are not very informative because they are strongly influenced by the amount of predation occurring at the relatively few colonies where productivity is monitored. According to JNCC (2021) *"Predation on eggs and chicks by foxes Vulpes vulpes is probably the most prevalent factor determining productivity, and abandonment of a colony is often the result. Fox populations are thought to have increased during the past few decades due to less intensive management by gamekeepers".*
9	Paragraph: 16 Excerpt: and, as noted above, at the Farne Islands in 2019 was only 0.15 chicks per pair (JNCC SMP database). Comment: However, we note that a year later productivity was 0.56, so it is fair to say that there is not a very clear picture.	Noted
10	Paragraph: Section 2.4 Excerpt: Uncertainty Regarding Potential for Accrued Mortality Debt Comment: Natural England advises that despite some evidence from other sites (e.g. Schwartz et al 2022) it will take an unknown length of time for Sandwich tern to both form a colony of the size predicted and reach productivity at the rate modelled. Please see our comment 6 above regarding the requirement to explore this via modelled scenarios.	See the Applicant's response to ID 6 of this table.
11	Additional Comment: Natural England continues to note that the Loch Ryan site at Scar Point has not been secured. Until greater confidence is gained that the primary measure can indeed be delivered at Scar Point, Natural England would encourage ongoing exploration of opportunities at other sites.	See response at ID 4 of this table

3 Quantification of Productivity benefits

3.1 Background

6. Based on the current approach advised by Natural England, the level of compensation required would be to increase Sandwich tern numbers by more than the equivalent of the 95% upper confidence limit of ca. 12-17 adults (mean ca. 6-7 adults) which are estimated to be subject to annual mortality during operation (see the **Apportioning and Habitats Regulations Assessment (HRA) Updates Technical Note** [document reference 13.3] submitted at Deadline 1). The Applicant's project-led proposal is to provide compensation for Sandwich tern by creating a new breeding site at Loch Ryan as well as improving nesting conditions for this species at the Farne Islands, or the possibility of creating a new breeding site at Foulness Island.

7. It is worth emphasising that the evidence indicates that the most effective compensation measure for impacts of offshore wind developments on Sandwich terns in UK North Sea waters, and on several other seabird species, would be to reduce fishing pressure on sandeel stocks in order to maintain sandeel total stock biomass above the "one-third for the birds" threshold (Cury et al. 2011, Hill et al. 2020). It is for this reason that the Applicant felt it appropriate to set out this measure explicitly as a component of its proposed package of compensatory measures for Sandwich tern but as a measure that requires strategic delivery from the UK Government (see the **Strategic and Collaborative Approaches to Compensation and Measures of Equivalent Environmental Benefit** [APP-084] and the **Habitats Regulations Assessment Derogation and Compensatory Measures Update** [document reference 13.7] document submitted at Deadline 1). There is strong evidence that allowing sandeel stocks to recover from their current depleted state would greatly increase seabird populations within a few years, and for sandeel-dependent seabirds such as Sandwich tern would give much greater gain than the precautionary estimates of the cumulative impact of the offshore wind industry; for example, Ecopath/Ecosim modelling by Natural England predicts a 42% increase in seabird numbers in the North Sea within 15 years of closure of the North Sea sandeel fishery (Bayes and Kharadi 2022, Natural England 2023).

3.2 Sandwich Tern Nesting Habitat Improvements and Restoration of Lost Breeding Range at Scar Point, Loch Ryan – Inland Pool

8. The site at Loch Ryan can confidently be predicted to be able to support at least 120-150 pairs of Sandwich terns (similar to the numbers that nested there before the island on which they nested was destroyed by gravel extraction and erosion). It is uncertain if the local habitat can provide food to support much larger numbers of Sandwich terns, but since these birds prefer to nest in dense colonies, the amount of nesting habitat being provided could potentially support much larger numbers if food supply allowed more to breed than did in the past. There is evidence that sprat abundance in the Clyde Sea area is higher now (Lawrence and Fernandes 2021) than it was when terns nested at Loch Ryan so it is likely that several hundred pairs may be able to breed there (see **Appendix 2 – Sandwich Tern Compensation Document** [APP-069] for further details).

9. If a colony of 150 pairs of Sandwich terns can be restored at Loch Ryan and these birds achieved the average breeding success of this species at Scottish colonies when the birds are not subject to mammal predation or human disturbance (about 0.8 chicks per pair per year; Short 2020, Joint Nature Conservation Committee (JNCC) 2021) this would produce an average output of about 120 fledglings per year. The Applicant considers these numbers to be realistic and likely to be achievable. The key to achieving breeding success of 0.8 chicks per pair or better is to minimise risk of predation by mammals and human disturbance. That can be achieved by having a suitable buffer zone around the colony site, either of water or of open ground but probably more effective if water, and by having predator-proof fencing around the site to exclude mammal predators.[1] Evidence suggests that a buffer zone of about 200 m would be ideal (Schwartz et al. 2023), although the successful colony at St John's Pool has a smaller buffer than that (Hughes et al. 2021). Schwartz et al. (2023) found no benefit for Sandwich terns for an increase in buffer beyond 250 m, and because Sandwich terns tend to nest at high density on small areas of ground, the size of islands for nesting is unlikely to constrain nesting numbers. Based on the demographic rates recommended for population modelling by Horswill and Robinson (2015) these 120 fledglings would have a first year survival of 0.358, giving 43 birds of one year old. With an immature survival of 0.741 these would be reduced to 32 birds of two years of age, and 24 birds of three years of age. Sandwich terns breed when three years old, so an average of 24 birds would join the breeding population each year from the production at Loch Ryan. This exceeds even the higher estimate of the 95% upper confidence limit for the precautionary estimate of the impact of SEP and DEP, and is about four times higher than the mean estimate. This calculation is based on average values; numbers will be likely to vary from year to year, but around an average of 24 recruits into the population each year. Since there are no Sandwich tern colonies in the west of Scotland, these birds will be from a colony that has been restored in an area of favourable foraging habitat for the species that lacks suitable colony sites. The production will therefore be novel extra birds joining the population based on the recolonisation and associated use of unoccupied suitable habitat for foraging.

10. If only 100 pairs recolonised but achieved the likely breeding success of 0.8 chicks per pair then 80 chicks would fledge on average each year, producing an average of 16 recruits into the adult breeding population each year, which is at the upper end of the range of the 95% upper confidence limit of 12-17 birds.

11. As requested by Natural England, stress test calculations based on differing colony sizes has been provided. If the colony only averaged 100 pairs with an average breeding success of 0.6 chicks per pair (which is less than the long-term national average for this species and considerably less than would be expected for a colony free from mammal predation and human disturbance (Short 2020, JNCC 2021)), that would equate to 60 x 0.358 one-year olds (i.e. 21.48 on average), and 21.48 x 0.741 two-year olds (i.e. 15.92), and 15.92 x 0.741 three-year olds joining the

[1] The Applicant is committed to ongoing management of the inland pool for the operational lifetime of the authorised development with anticipated maintenance activities including maintenance of the predator proof fence, upkeep of any installed bird hides, removal of vegetation and any measures necessary to maintain water levels and water quality.

breeding population (i.e. 11.79). Despite these breeding numbers and productivity being pessimistic, this is still similar to the upper 95% confidence limit for the estimated impact of SEP and DEP, and considerably more than the mean predicted impact.

12. It is possible to fully stress-test this calculation by considering how small a population, with breeding success considerably less than might be expected for a colony protected from mammal predators and human disturbance, could provide the necessary compensation. Even if only 50 pairs nested with a breeding success of 0.6 chicks per pair (which is lower than at colonies protected from mammal predators and human disturbance; Short 2020, JNCC 2021) that would produce 30 fledglings per year, resulting in 11 one-year olds, 8 two-year olds, so 6 three-year olds joining the breeding population, approximately equal to the precautionary mean estimated impact of SEP and DEP (which as pointed out in **Section 4** is highly likely to overestimate the impact).

13. Since almost 100% of Sandwich terns in the UK breed on SPAs where the species is a breeding feature of the SPA (see the **Sandwich Tern and Kittiwake Ecological Evidence** [APP-066]), and there is very high mobility of immature Sandwich terns between breeding areas (van Bemmelen et al. 2022, Henderson 2022), it is reasonable to anticipate that almost all of the birds from the Loch Ryan colony will recruit into the metapopulation but at a variety of different colonies. These calculations suggest that a relatively small colony at Loch Ryan would on its own be highly likely to produce new birds into the metapopulation in excess of the number lost due to SEP and DEP (summarised calculations are given in **Table 2**).

Table 2 Summary of the potential quantification of productivity benefits for Sandwich tern at Loch Ryan based on varying mean number of breeding pairs and varying mean breeding success

Mean number of breeding pairs	Mean breeding success (chicks per pair)	Number of chicks fledging per year	Number of adults recruiting from output	Number of adult recruits as percentage of 95% upper confidence limit of impact (15 birds)	Number of adult recruits as percentage of mean estimate of impact (6.5 birds)
300	0.8	240	48	320%	738%
300	0.6	180	36	240%	554%
150	0.8	120	24	160%	369%
150	0.6	90	18	120%	277%
100	0.8	80	16	107%	246%
100	0.6	60	12	80%	185%
50	0.8	40	8	53%	123%
50	0.6	30	6	40%	92%

3.2.1 Qualitative Benefits of Restoring Lost Breeding Range

14. Restoring breeding status to a geographical region from which the species has been extirpated represents a major qualitative conservation gain which is recognised by Natural England in Appendix C of their Relevant Representation [RR-063]. The Applicant considers that such a large qualitative conservation gain is more than sufficient to compensate for the quantified losses and any accrued mortality debt (**Section 3.3**) based on highly precautionary assessments of collision risk mortality (**Section 4**).

15. Restoring Sandwich tern breeding in the west of Scotland will not only allow growth in breeding numbers in the population as a whole, but also provides greater resilience by spreading the breeding distribution over a wider geographical area. This helps to counter the long-term trend of Sandwich tern nesting in fewer sites with an increasing proportion in just two or three large SPA populations. It will therefore help to reduce the high vulnerability of Sandwich tern to potential catastrophic impacts on the sites holding high proportions of the entire population. In this sense, the measure goes beyond the requirement to maintain the coherence of the network (see Section 2.2 of **Appendix 2 – Sandwich Tern Compensation Document** [APP-069]) by significantly improving and restoring the geographical coherence of the Sandwich tern breeding range in Britain and Ireland.

3.3 Improved Breeding Success at SPA sites other than North Norfolk Coast – Farne Islands SPA

16. The Applicant has proposed three measures that are not in previous Management Plans and, based on early informal discussions with National Trust during pre-application, were not understood to be in the new (2022-2026) but as yet unpublished current Management Plan for the Farne Islands SPA. These are provision of nest boxes/chick shelters to reduce predation of eggs and chicks by large gulls, use of cameras to monitor predation rates to inform adaptive management, and if predation rates remain high then the use of bamboo canes to reduce gull predation on tern eggs and chicks. Predation rates by large gulls on tern eggs and chicks have long been known to be a major problem on the Farne Islands (Mitchell et al. 2004, Boothby et al. 2019), and have contributed to the prolonged decline in breeding numbers of Sandwich terns from 3,400 pairs in 1989 to 417 pairs in 2019 (JNCC Seabird Monitoring Programme (SMP) database, **Appendix 2 – Sandwich Tern Compensation Document** [APP-069]). According to Mitchell et al. (2004) "*large gulls compete for breeding space with terns, cause disturbance to nesting attempts and prey upon eggs and chicks, such that tern colonies decline and are ultimately abandoned*" and "*control of expanding gull populations on offshore islands such as those in Northumberland and the Firth of Forth is necessary to prevent Sandwich terns abandoning these sites*" and "*interactions of nesting habitat availability, competition and predation are clearly important determinants of Sandwich tern population trends*". Breeding success of Sandwich terns is not routinely monitored on the Farne Islands so the impact of predation is uncertain but thought to be high (Gwen Potter, pers. comm.). That is supported by the very limited published data on breeding success in the JNCC SMP database; 292 chicks were produced by 1,946 AONs (pairs) of Sandwich terns on the Farne Islands in 1999, a breeding success of 0.15 chicks per pair, one of the lowest rates achieved by

Sandwich tern in the UK, and 1,092 chicks were produced by 1,950 AONs (pairs) in 2000, a breeding success of 0.56 chicks per pair, also well below the average for Sandwich tern in colonies in the UK (JNCC 2021).

17. It is uncertain whether Sandwich terns will choose to nest inside tern nest boxes in large numbers, but there is strong evidence that chicks use nest boxes/shelters to avoid predation (**Appendix 2 – Sandwich Tern Compensation Document** [APP-069]). Chick shelters can be expected to reduce predation of Sandwich tern chicks by at least 50% (Boothby et al. 2019, Babcock and Booth 2020a,b, Steel and Outram 2020, **Appendix 2 – Sandwich Tern Compensation Document** [APP-069]). Breeding success of Sandwich tern colonies where predation is not a major influence tends to be around 0.8 chicks per pair, whereas in colonies subject to predation it is often below 0.5 chicks per pair (Babcock and Booth 2020a,b, Steel and Outram 2020, JNCC 2021, JNCC SMP database), and, as noted above, at the Farne Islands in 2019 was only 0.15 chicks per pair (JNCC SMP database).

18. An increase in breeding success of about 0.25 chicks per pair resulting from measures that reduce the impact of large gulls, as suggested in the literature referred to above to be highly plausible, would be predicted to increase chick production at a colony of 400 pairs (approximately the current number of Sandwich terns at the Farne Islands) by 100 chicks per year in the first instance, and by larger numbers on average as the population numbers recover towards their historical level of several thousand pairs. Similarly, experimental deployment of bamboo canes at the Farne Islands reduced predation attacks of terns by large gulls (and so reduced losses of chicks) by 50% (Boothby et al. 2019), so has the potential also to contribute to significantly reducing predation rates and thereby increasing breeding success of Sandwich terns (though may be proved not to be necessary if nest boxes/shelters provide sufficient protection on their own). Despite the proven success of bamboo canes by experiment at the Farne Islands, and the proven success of nest boxes/shelters at other sites, these measures were not included in the most recently published Management Plan that expired in March 2021. Based on early informal discussions with National Trust, it is the Applicant's understanding that these measures are also not included in the new Farne Islands Management Plan that came into effect in March 2021 but has not yet been published (Gwen Potter, pers. comm.), so the proposed compensation at the Farne Islands can be regarded as additional to routine planned management measures at that site. However, since DCO submission, National Trust has raised concerns regarding additionality within its Relevant Representation [RR-061] and more recently following a meeting held on 14 December 2022. See Section 4.1 of the **Habitats Regulations Assessment Derogation and Compensatory Measures Update** [document reference 13.7] submitted at Deadline 1 for further details.

19. An average increase in chick production of 100 chicks per year would lead to about 20 extra birds recruiting into the breeding population each year based on the demography of this species (Horswill and Robinson 2015), more than the upper 95% confidence limit of the estimated number lost from the North Norfolk Coast SPA as a result of collisions. This measure would therefore be adequate to compensate regardless of the success of measures at Loch Ryan. Since almost 100% of Sandwich terns in the UK breed in SPAs where the species is a breeding feature of the SPA (**Sandwich Tern and Kittiwake Ecological Evidence** [APP-066]), and

there is very high mobility of immature Sandwich terns between breeding areas (van Bemmelen et al. 2022, Henderson 2022), it is reasonable to anticipate that almost all of these birds will recruit into the SPA metapopulation.

3.4 Uncertainty Regarding Potential for Accrued Mortality Debt

20. It is uncertain how quickly Sandwich terns will colonise a new site created at Loch Ryan. This may not occur for several years, in which case a mortality debt could arise if impacts of SEP and DEP occur before Sandwich terns are restored to Loch Ryan. The Applicant aims to minimise that risk by creating the nesting habitat for Sandwich terns at Loch Ryan as soon as possible, and by taking actions at the Farne Islands to provide compensation through reduction in predation of eggs and chicks at that site. Calculations show that reducing egg and chick losses at the Farne Islands could in itself exceed the required level of compensation (see **Section 3.2.1**), and therefore would be able to ensure that no mortality debt accrued if the Loch Ryan site was not immediately colonised by Sandwich terns.

21. A recent study of colonisation of 154 restored small islets created in 2007-2016 in the south of France for nesting habitat for Laridae (family of seabirds in the order Charadriiformes that includes the gulls, terns, skimmers and kittiwakes) (Schwartz et al. 2023) found that Sandwich terns were strongly attracted to such sites, with the proportion of the population nesting on the restored islets (rather than at 594 natural nesting sites along the 470 km coastline) increasing from zero in 2010 to 73% by 2016. Colonisation probability very strongly increased on restored sites already colonised by other species. Colonisation probability was not affected by the depth of water around the newly created islets but increased for islets further from the shore up to a distance of 250 m (Schwartz et al. 2023). Breeding numbers of Sandwich terns were higher on islets made of sand and without vegetation, and on islets surrounded by deeper water. These features provide further guidance on the design of a new breeding site for Sandwich tern at Loch Ryan and suggest that although it is not certain that a site in Loch Ryan will be colonised immediately, creation of new artificial islets can be highly effective in restoring and conserving Sandwich tern. The new sites in the south of France that were colonised by Sandwich terns were mostly colonised within four years of the site being constructed, but often a year after another species had immediately colonised the island (Schwartz et al. 2023). Although ecological differences between the south of France and west Scotland may mean that the French model may not be directly applicable to sites in the UK, this further suggests that provision of high quality new islets for Sandwich terns to colonise is likely to be attractive to these birds.

22. Calculations of the likely breeding numbers and breeding success that would be achieved by Sandwich terns at Loch Ryan (**Table 2**) suggest that output would be likely to be much higher than the mean number of Sandwich tern predicted to be subject to annual mortality, and would exceed the 95% upper confidence limit for the estimate of impacts in all circumstances except those where breeding success is assumed to be unrealistically low for a site that will be protected from human and mammal disturbance. Additionally, the assessments which have informed the required levels of compensation are based upon Natural England's highly precautionary calculations that do not take account of recent evidence of low collision risk at offshore wind farms and high macro-avoidance by Sandwich terns

(**Section 4**). Therefore, if a small accrued mortality debt did occur, the Applicant has demonstrated that in all likelihood it could be compensated by the production of young at Loch Ryan exceeding compensation requirements once the colony was established, and by measures at the Farne Islands.

4 Contextual Information Regarding Seabird Collision Risk Modelling (CRM) and Assessment

23. Natural England provides guidance on seabird avoidance rates that offshore wind farm developers are expected to use in Band model estimates of collision risk. These avoidance rates were very recently revised by Natural England (see Appendix B1 Natural England Draft Updated CRM Parameters of the Natural England Relevant Representation [RR-063]) in 'interim' revised guidance provided to the Applicant post-submission of the DCO application, in September 2022 as part of their Discretionary Advice Service (DAS) on draft versions of the assessments. The Applicant notes that the scientific analysis underpinning these new estimates has not yet been made public and so it is not possible for industry to assess the suitability of the new guidance. However, Natural England indicated at the Expert Topic Group meeting on 22 November 2022 that it is mainly based on a re-analysis of data mostly collected many years ago from a large number of terrestrial wind farms with very much smaller turbines than those installed or due to be installed at offshore wind farms. Although the revised guidance includes data from the Offshore Renewables Joint Industry Partnership (ORJIP) study at Thanet offshore wind farm in 2014-2017 (Skov et al. 2018), it does not incorporate evidence from more recent studies at offshore wind farms which are discussed below. The use of predominantly terrestrial wind farm data to predict avoidance at offshore wind farms is not ideal, but until recently there have been few relevant data from offshore wind farms. The use of the less appropriate data was a pragmatic approach when appropriate data were lacking but becomes inappropriate when more suitable data have been published from studies at offshore wind farms.

24. Estimates of avoidance rates recommended by Statutory Nature Conservation Bodies are intended to be precautionary. Some years ago, in the absence of empirical data, an avoidance rate of 95% was recommended for Band model estimation of collision risk for most species of birds. With some data becoming available to show that rate was over-precautionary, the recommended avoidance rate was increased to 98% except for particular species where more evidence allowed a species-specific value. In most cases, recommended species-specific values were 99% or higher (NatureScot 2018). Use of the peak numbers present in aerial surveys rather than the mean numbers adds further precaution; actual numbers are more likely to be lower rather than higher than peak counts in baseline surveys.

25. Use of precautionary estimates is appropriate where data are lacking, limited or uncertain, but will be likely to overestimate collision risk, possibly by large margins. Natural England have apparently not taken the opportunity to include more appropriate recent studies of actual avoidance by seabirds at offshore wind farms which would have permitted the calculation of more evidence-based avoidance rates that would be more appropriate for offshore wind farm assessments. For

example, extensive evidence has been published from work at Aberdeen offshore wind farm in summer 2020 (Tjørnløv et al. 2021) yet apparently these data have not been included in the scientific assessment underpinning revised guidance from Natural England that the Applicant understands will be published some time in 2023, despite the Aberdeen offshore wind farm data being available since May 2021 (Tjørnløv et al. 2021). Further evidence from Aberdeen offshore wind farm has been collected in summer 2021 (Tjørnløv et al. 2022) and could also be used to support evidence-based avoidance. Data from deployments of radar and cameras at Luchterduinen offshore wind farm in the Netherlands have also now been collected and analysed, but the final report on that work has not yet been published.

26. Natural England's guidance in relation to quantifying compensation requirements requires that compensation should at least match the upper 95% confidence limit for the estimated number of birds from the SPA population that might be killed based on the Band model estimate using precautionary estimates derived mainly from terrestrial wind farm collision data. This adds precaution to precaution. The avoidance estimates in Natural England guidance are precautionary, so that the actual number of collisions is likely (though not certain) to be considerably smaller than the mean number estimated by the Band model, and therefore likely to be very much smaller than the 95% upper confidence limit.

27. Recent studies (Leemans et al. 2022; Tjørnløv et al. 2021; van Bemmelen et al. 2022, cited in Leemans et al. 2022) have also shown that Sandwich terns show a strong degree of macro-avoidance. However, it is recognised that Natural England do not agree with the application of a macro-avoidance factor to collision estimates for Sandwich tern (which is reflected in the **Draft Statement of Common Ground: Natural England (Offshore Ornithology)** to be submitted at Deadline 2) and therefore in order to move forward, the Applicant has agreed not to apply these to the updated assessment within the **CRM Updates (EIA Context) Technical Note** [document reference 13.2] and the **Apportioning and HRA Updates Technical Note** [document reference 13.3]. However, application of a macro-avoidance factor to Sandwich tern collision estimates would further reduce collision estimates and therefore the required levels of compensation.

5 Conclusion

28. Although strategic compensation by Government to reduce fishing mortality on sandeels is predicted by Natural England to be highly effective, the Applicant recognises that approach cannot be delivered by the Applicant and so proposes site-based (project-led) compensation measures.

29. Reasonable estimates of numbers of Sandwich terns likely to breed at Loch Ryan at a restored breeding site and best estimates of demographic rates, suggest that a new colony at Loch Ryan would provide compensation greater than required even when accounting for the high levels of precaution within the assessments. In addition, restoring lost breeding range represents a major qualitative conservation gain.

30. Estimates of gains in breeding success as a result of measures to reduce predation on tern eggs and chicks at the Farne Islands also indicates that gains there would be likely to exceed compensation requirements by a large margin.

31. The Applicant's proposed measures at Loch Ryan and the Farnes Islands SPA combined are considered capable of fully compensating for the predicted impacts of SEP and DEP accounting for the inherent risks and uncertainties associated with each proposal, and any mortality debt that might occur during the earlier stages of implementation and delivery.

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