APPENDIX A1

HRA for key SPA seabird species during the breeding season

Any plan or project with the potential to affect the qualifying interests of a Natura site must be subjected to a Habitats Regulations Appraisal (HRA) by the Competent Authority, in this case Marine Scotland. In our scoping advice we outlined the HRA requirements for the Forth & Tay offshore wind proposals and discussed how this assessment process should apply to mobile seabird species where offshore wind development may have impacts on seabirds foraging at sea, away from their SPA breeding colonies.

Seagreen and Inch Cape submitted HRA screening reports which we commented on in our responses of 31 January 2012 and 2 November 2012 respectively. We welcome this work as a helpful step towards agreeing the final short-list of SPA and SAC receptors requiring assessment under HRA. **Appendix A3** includes the list of key SPA seabird species thus agreed. **Appendix A7** provides further background on the screening process and discussions at meetings of the Forth & Tay offshore wind developers' group (FTOWDG).

The reference population for HRA is the **breeding population**. Only breeding season impacts are assessed under HRA, when it is possible to assign connectivity between the individual seabirds recorded on a wind farm site and the SPA breeding colonies within foraging range. There is no agreed method to assign connectivity in the non-breeding season, when many of the individuals recorded at sea do not breed at SPA colonies within (breeding season) foraging range – see **Appendix A8** for further discussion.

SNH & JNCC advice for Habitats Regulations Appraisal

We provide the following advice on the cumulative impacts of the Forth & Tay offshore wind developments on SPA seabird interests to inform Marine Scotland's HRA. This addressed the three tests set out under the legislation[1]:

1. **Is the proposal connected with or necessary for SPA conservation management?**

None of the Forth & Tay offshore wind farm proposals are directly connected with or necessary for the conservation management of any SPA.

2. **Is the proposal likely to have a significant effect on the qualifying interests of the SPAs either alone or in combination with other plans or projects?**

Our judgements on **connectivity** – whether there could be any linkage between the proposed wind farm sites and SPA – are informed by review of the 'long-list' of seabird species from FTOWDG, by the survey data collected by developers, and by the consideration of SPAs within foraging range of the proposed wind farms. **Appendix A7** provides further detail.

Where a species is recorded on-site and there are a number of SPAs within foraging range, we **apportion** the birds to each of the SPAs in order to assign effects – see **Appendix A5**.

Appendix A3 lists the key seabird species and SPAs where **likely significant effects** could arise from the Forth & Tay offshore wind proposals, as follows:

- Collision risk and/or displacement to **kittiwake** of Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abbs to Fast Castle SPAs.
- Collision risk and/or displacement to **gannet** of Forth Islands SPA.
- Displacement to **Atlantic puffin** of Forth Islands SPA.

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[1] Further detail on HRA and the under-pinning legislation is available from: http://www.snh.gov.uk/protecting-scotlands-nature/protected-areas/international-designations/natura-sites/habitats-regulations-appraisal/

- Displacement to **common guillemot** of Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abbs to Fast Castle SPAs.
- Displacement to **razorbill** of Forth Islands, Fowlsheugh and St Abbs to Fast Castle SPAs.
- Collision risk to **herring gull** of Buchan Ness to Collieston Coast, Forth Islands*****, Fowlsheugh and St Abbs to Fast Castle SPAs.
- Collision risk to **lesser black-backed gull** of Forth Islands SPA.
- Collision risk and/or displacement to **Northern fulmar** of Buchan Ness to Collieston Coast, Forth Islands* and Fowlsheugh***** SPAs.
- Collision risk and/or displacement to **Common & Arctic tern species** of Forth Islands SPA (Neart na Gaoithe and Inch Cape only).

***** **<u>Note</u>:** SNH & JNCC have checked each relevant SPA citation. Please be aware that this informal review indicates that herring gull at Forth Islands SPA and fulmar at Forth Islands and Fowlsheugh SPAs may not qualify as designated interests. We highlight this issue for information, pending more formal SPA review. In the meantime, we include these interests in our advice below, although there are no predicted impacts on site integrity for either of these species at any of the relevant SPAs.

We confirm that for all other seabird species originally included in the ‘long-list’ for assessment – such as cormorant, roseate tern, sandwich tern and shag – there are no significant effects requiring any further consideration under HRA. These species were either not recorded in significant numbers on-site, or else there is no pathway for significant impact and/or there is no connectivity with any SPAs.

3. Can it be ascertained that the proposal will not adversely affect the integrity of the SPA, either alone or in combination with other plans or projects?

This step is termed **appropriate assessment**, and it is to be undertaken by Marine Scotland, based on information submitted by developers, and with advice from ourselves. Our advice considers the implications of the predicted cumulative impacts arising from the Forth & Tay offshore wind proposals on the conservation objectives for key SPA seabird species.

These are the conservation objectives[2] requiring consideration:

To ensure that site integrity is maintained by:

(i) Avoiding deterioration of the habitats of the qualifying species.
(ii) Avoiding significant disturbance to the qualifying species.

To ensure for the qualifying species that the following are maintained in the long term:

(iii) Population of the bird species as a viable component of the SPA.
(iv) Distribution of the bird species within the SPA.
(v) Distribution and extent of habitats supporting the species.
(vi) Structure, function and supporting processes of habitats supporting the species.
repeat of (ii) No significant disturbance of the species.

For each identified seabird species, the key conservation objective requiring consideration is to ensure the **long-term maintenance of the population as a viable component of each SPA under consideration**. This is because it encompasses all impacts to the species, including significant disturbance to qualifying bird interests when they’re out with an SPA.

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[2] Further information on SPA conservation objectives available from: http://www.snh.org.uk/snhi/

The following species-specific sections contain our advice to inform **appropriate assessment** for each seabird species and SPA. The headline outcomes are highlighted below and in **Appendix A2** (using 'traffic lighting'):

- Adverse impact on site integrity in respect of **kittiwake** at **Forth Islands SPA**
- Adverse impact on site integrity in respect of **kittiwake** at **Fowlsheugh SPA**.
- Adverse impact on site integrity in respect of **gannet** at **Forth Islands SPA.**
- Adverse impact on site integrity in respect of **puffin** at **Forth Islands SPA.**
- For all other key seabirds species and SPAs (Appendix A3) there are **no** adverse impacts on site integrity.

For individuals breeding outwith SPAs and for seabird impact assessment in the non-breeding season – aspects which are not captured under HRA – we are only able to provide a qualitative assessment. This is a **key limitation** to our current advice on the Forth & Tay wind farms, especially for **kittiwake, gannet** and **puffin** where high levels of impact are already predicted for SPA populations during the breeding season. In respect of **kittiwake**, we highlight that there could be high levels of collision risk during the non-breeding season (please see our supporting spreadsheets). Please see **Appendix A8** for further discussion.

Setting thresholds for SPA seabird populations

Most of the thresholds presented in tables 2a & 2b in **Appendix 2** are based on applying the reduced uncertainty method of 'acceptable biological change' (RU ABC) to the outputs from the population viability analyses (PVAs) developed for each seabird population by the Centre for Ecology and Hydrology – see **Appendix 4** for further explanation. The exceptions to this are the gannet thresholds, which were obtained from the SOSS PVA and puffin thresholds which are informed by both PBR and thresholds from proxy species (also discussed in Appendix 4).

We note the following **caveats** on use of these thresholds:

- These thresholds are only indicative as there is considerable uncertainty in the modelling steps.
- The population models for each species incorporate year round natural mortality but only address one form of anthropogenic mortality (wind farm impacts) and only during the breeding season.
- These thresholds have been set without considering the status of the population; whether it is increasing or declining (see Appendix 4). Consequently, thresholds for declining species, such as kittiwakes, should be treated with caution.
- **Consequently, allowing impacts on seabirds that are predicted to be very close to thresholds is a high risk approach and we strongly recommend that limits to additional impacts are not set close to thresholds, especially for declining species.**

In the species-specific summaries that follow, information on population counts and population trends has been obtained from the following sources:

- Seabird Monitoring Programme: http://jncc.defra.gov.uk/smp/
- SNH seabird trends page: http://www.snh.gov.uk/docs/B1163280.pdf
- Seabird Population Trends and Causes of Change:1986-2012. JNCC Report. (July 2013.) http://www.jncc.defra.gov.uk/page-3201.

KITTIWAKE

SPAs considered

- Buchan Ness to Collieston Coast
- Forth Islands
- Fowlsheugh
- St Abbs to Fast Castle

Historic, current and forecast population trends

- Scottish and UK trends show a strong decline (-47%) for kittiwake between 2000 and 2012, following a shallower but significant decline at the end of the 20th century (-25% between the 1985-88 and 1999-2002 census periods).
- Although individual colonies vary, the common pattern is for a strong, possibly increasing, rate of decline. The population model developed by CEH predicted all four kittiwake colonies to decline between 45% and 90% over the next 30 years (Freeman *et al*. 2013).
- The numbers breeding at Forth Islands, Fowlsheugh and St Abbs have declined in line with these general trends.
- Recent counts from Buchan Ness to Collieston Coast are not available but numbers declined from 14091 pairs in 2000 to 12542 pairs in 2007.

Approach to assessment

- There is very little available information on how kittiwakes respond to wind turbines.
- We have assessed both collision and displacement effects (see Appendix A5 and supporting spreadsheets).
- We have apportioned the estimated collision mortality in the breeding season to individual SPAs and converted these to changes in adult survival rates.
- We present outputs for both options 2 and 3 of the Band collision risk model (CRM) to show a range of likely impacts, for the reasons discussed in Appendix 5 (section 1).
- We have taken the worst case displacement effect estimates (changes in adult and chick survival) for each SPA from the CEH displacement model ‘flat’ and ‘GPS’ options – see Appendix 5 (section 2).
- We have added predicted adult collision and displacement effects. This is a precautionary approach and may over-estimate the impacts on kittiwake. However, there is no evidence available to inform an alternative approach. Impacts on chick survival arise only from displacement effects.
- We have derived thresholds that define the maximum declines in the rates of adult and / or chick survival that each kittiwake population can sustain without an adverse impact on the population viability. Appendix A4 provides a detailed explanation of how these thresholds are derived.
- Appendix 2 provides a summary of the impacts, compared against thresholds.

Assessment for kittiwake

Forth Islands	• Predicted displacement / barrier effects are greater than predicted collision effects on adult survival. • The predicted **decrease in adult survival** arising from the Forth & Tay wind farms is between 2.9% (CRM option 2) and 2.0% (CRM option 3). • The predicted **decrease in chick survival** as a result of displacement is 2.1%. • The predicted impacts in adult survival exceed those that can be sustained by the Forth Islands kittiwake population. • **We therefore advise adverse impact on site integrity.**
Fowlsheugh	• Predicted collision effects are greater than predicted displacement / barrier effects on adult survival. • The predicted **decrease in adult survival** arising from the Forth & Tay wind farms is between 2.7% (CRM option 2) and 0.9% (CRM option 3). • The predicted **decrease in chick survival** as a result of displacement is 1.6%. • There has been a 50% decline in the Fowlsheugh kittiwake population since year 2000, and the population is predicted to decrease by a further 90% over the next thirty years. Therefore we advise precaution is needed in considering these predicted impacts. • The predicted impact (CRM option 2) exceeds that which can be sustained by the Fowlsheugh kittiwake population. • **We therefore advise adverse impact on site integrity.**
Buchan Ness to Collieston Coast	• Predicted impacts (displacement and collision risk combined) are minimal – see Appendix A2. • We therefore advise no adverse impact on site integrity.
St Abb's to Fast Castle	• The predicted **decrease in adult survival** arising from the Forth & Tay wind farms is between 0.8% (CRM option 2) and 0.1% (CRM option 3). • The predicted **decrease in chick survival** as a result of displacement is 0%. • These predicted impacts are within the limits that can be sustained by kittiwake at this SPA. • We therefore advise no adverse impact on site integrity.

Conclusions

- We advise **adverse impact on site integrity** for kittiwake at Forth Islands SPA and Fowlsheugh SPA.
- We advise **no** adverse impact for kittiwake at Buchan Ness to Collieston Coast SPA and at St Abb's Head to Fast Castle SPA.

GANNET

SPAs considered

- Forth Islands

Historic and current population trends

- UK gannet populations are exhibiting significant positive growth rates, continuing a long period of expansion over the past 100 years.
- Scotland holds 182,511 breeding pairs of gannets and the Bass Rock is the largest, most important colony on the Scottish east coast.
- The Bass Rock (Forth Islands SPA) gannet population has doubled from 21,591 pairs in 1985 to 48,065 pairs in 2004, and increased further to 55,482 breeding pairs at the time of the last census in 2009.
- At present it does not appear that resources are limiting gannet numbers, however, the current changes in European fisheries policies (including new rules on discards) may be expected to impact on this species in future.

Approach to assessment

- Initial post-construction monitoring at European offshore wind farms indicates that gannet may show high levels of displacement, however, this work relates only to the non-breeding period.[3]
- None of these European wind farms are located in close proximity to large breeding colonies of gannet, so there is little available data on how gannet may respond to wind farm development located within the foraging range of their breeding colonies.
- We therefore assess displacement / barrier effects for gannet as well as collision risk (see Appendix A5 and supporting spreadsheets).
- 99.6% of the estimated collision mortality is apportioned to the Bass Rock gannetry (the other 0.4% is allocated to Gamrie and Pennan Coast Site of Special Scientific Interest).
- We present outputs for both options 2 and 3 of the Band collision risk model (CRM) to show a range of likely impacts, for the reasons discussed in Appendix A5 (section 1).
- Outputs from the CEH displacement modelling are only available for each wind farm individually, and not for the cumulative scenario.
- Displacement / barrier effects are minimal for gannet and there is negligible difference between the ‘flat’ and ‘GPS’ model outputs – see Appendix A5 (section 2).
- These modelled outputs may be explained by species ecology: gannet have large foraging ranges and are adapted for efficient gliding flight, so that the energetic costs of covering extra distances due to displacement / barrier effects will be small.[4]
- We have added predicted adult collision and displacement effects, however, the latter is minimal, as noted.
- Appendix A4 provides explanation on how the gannet threshold has been derived.

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3 Leopold, MF, Dijkman, L. 2011. Local birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ). *Report number C187/11.*

Canning, S., Lye, G., Givens, L., Pendlebury, C. 2012. Analysis of Marine Ecology Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 2) Technical report, Birds. *Report: 1012206*. Natural Power Ltd.

4 Masden, E.A., Haydon, D.T., Fox, A.D., and Furness, R.W. 2010. Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. Marine Pollution Bulletin. 60: 1085-1091.

Assessment for gannet at Forth Islands SPA

- Predicted collision effects are greater than displacement / barrier effects on adult survival.
- Appendix A2 provides a summary of impacts to gannet, compared against the threshold.
- The predicted **decrease in adult survival** arising from the Forth & Tay wind farms is between 1.7% (CRM option 3) and 1.5% (CRM option 2).
- These values equate to adult mortalities of 1664 and 1917 gannet respectively.
- There is **no predicted decrease in chick survival** as a result of displacement.
- The predicted collision impacts exceed those that can be sustained by the Bass Rock gannet population.

Conclusion

- We therefore advise **adverse impact on site integrity** for gannet at Forth Islands SPA.

PUFFIN

SPAs considered

- Forth Islands

Historic and current population trends

- Puffin is a familiar and instantly recognisable species but difficult to census. The UK population at the time of Seabird 2000 was just over 500,000 pairs, following steady and significant increases from previous censuses. The most recent estimate of the Scottish population is 493,000 pairs.
- Puffins in the Forth Islands SPA are some of the most intensively studied in the world, but recent volatility in numbers (periods of increase and population crashes) has frustrated attempts to understand local population dynamics.
- On the Isle of May (the site that holds the majority of the SPA puffin population) a strongly increasing population (12,000 in 1984 and 20,106 in 1992) dropped from 69,300 pairs in 2003 to 44,971 pairs in 2009.
- Within the SPA, the other large colony at Craigleith dropped from 28,000 pairs in 1999 to 12,100 pairs in 2003 and then further to just 4,500 pairs in 2009.
- Overall, the Forth Islands SPA population was most recently estimated as 50,282 pairs.

Approach to assessment

- There is little available information on how puffin respond to wind turbines, as they have not been observed in particularly high numbers at other European offshore wind development sites.
- We do not consider puffin to be at risk of collision, however, due to their low flight heights – none were recorded at collision risk height during any of the Forth & Tay boat surveys.
- We have assessed displacement / barrier effects based on the outputs from the CEH modelling – see Appendix A5 (section 2) for specific discussion in respect of puffin.
- We use the 'flat' displacement outputs for the reasons given in Appendix A5 (section 2).
- Appendix A4 (section 5) provides a detailed explanation on how puffin thresholds have been derived. Due to the complexity of the local population dynamics, CEH have been unable model the puffin population to predict a future population trend with any certainty.
- We have referred to PBR for puffin and PVA and PBR outputs for proxy species (guillemot and razorbill) in order to try and consider the significance of displacement impacts to puffin.

Assessment for puffin at Forth Islands SPA

- Appendix A2 provides a summary of impacts to puffin, compared against thresholds.
- The predicted **decrease in adult survival** arising from the Forth & Tay wind farms is **3.2%** ('flat' displacement option).
- The predicted **decrease in chick survival is 4.9%** ('flat' displacement option).
- These predicted rates of decline exceed those that can be sustained by the Forth Islands puffin population.

Conclusion

- We therefore advise **adverse impact on site integrity** for puffin at Forth Islands SPA.

GUILLEMOT

SPAs considered

- Buchan Ness to Collieston Coast
- Forth Islands
- Fowlsheugh
- St Abbs to Fast Castle

Historic and current population trends

- UK guillemot populations increased strongly between 1970 and 2000, but then slowed markedly in the last decade (4% increase between 2002 and 2012), following declines in productivity in the early 2000s.
- In Scotland, guillemot numbers declined by 24% between 1986 and 2011, with 791,400 pairs estimated to be breeding in Scotland in 2012.
- The four SPAs under assessment here held an estimated 163,920 birds in their most recent counts (see Appendix 3).

Approach to assessment

- There is very little available information on how guillemot respond to wind turbines, with initial studies from European wind farms showing wintering guillemots displaying mixed levels of displacement from site.
- We have assessed displacement / barrier effects using the outputs from the CEH modelling – see Appendix A5 (section 2).
- We do not consider guillemot to be at risk of collision due to their low flight heights – none were recorded at collision risk height during any of the Forth & Tay boat surveys.

Assessment for guillemot

- Appendix A2 provides a summary of impacts to guillemot, compared against thresholds.
- CEH displacement model outputs indicate that only minimal numbers of guillemot from Buchan Ness to Collieston Coast or St Abbs Head to Fast Castle SPAs would be likely to forage in proximity to, or travel beyond, the proposed wind farm sites in the Forth & Tay.
- Greater numbers from Forth Islands and Fowlsheugh SPAs could be affected, however, the effects on adult survival or chick survival are not predicted to be substantial.

Conclusion

- We advise **no** adverse impacts on site integrity for guillemot at any of the above SPAs.

RAZORBILL

SPAs considered

- Forth Islands
- Fowlsheugh
- St Abbs to Fast Castle

Historic and current population trends

- UK razorbill populations increased strongly between 1970 to 2000, but (like guillemot) then slowed (only a 3% increase between 2000 and 2012).
- The most recent population estimate for Scotland is 93,300 pairs.
- Of the three SPAs under consideration, Fowlsheugh holds the high number of razorbills (5,260 birds in 2012) showing a slight declined from the peak count of 6,827 individuals in 1992 (Appendix 3).
- The populations at Forth Islands and St Abb's Head to Fastcastle are smaller and have declined more severely. (Note that the estimate for the latter is based on applying a trend derived from counts undertaken at St. Abb's National Nature Reserve (NNR), a sub-section of the SPA, as discussed further in Appendix 3).

Approach to assessment

- There is very little available information on how razorbill respond to wind turbines, with initial studies from European wind farms showing wintering razorbills displaying mixed levels of displacement from site.
- We have assessed displacement / barrier effects using the outputs from the CEH modelling – see Appendix A5 (section 2).
- We do not consider razorbill to be at risk of collision due to their low flight heights – none were recorded at collision risk height during any of the Forth & Tay boat surveys.

Assessment for razorbill

- Appendix A2 provides a summary of impacts to razorbill, compared against thresholds.
- CEH displacement modelling demonstrated that only minimal numbers of razorbill from Fowlsheugh or St Abbs to Fast Castle SPAs would be likely to forage in proximity to, or travel beyond, the proposed wind farm sites in the Forth & Tay.
- Greater numbers of individuals from Forth Islands SPA could be affected, however, the effects on adult survival or chick survival are not predicted to be significant.

Conclusion

- We advise **no** adverse impacts on site integrity for razorbill at any of the above SPAs.

HERRING GULL

SPAs considered

- Buchan Ness to Collieston Coast
- Forth Islands
- Fowlsheugh
- St Abbs to Fast Castle

Historic and current population trends

- The number of herring gulls breeding in the UK has fallen rapidly since 1970 when current widespread monitoring started. Between 1970 and 1985 the population declined by 48%, followed by a shallower decline to the year 2000 and then a rapid decline again since the start of this century.
- In Scotland the population fell by more than half (-58%) between 1986 and 2011. There are 72,100 pairs currently estimated to breed in Scotland.
- The fortunes of Herring Gulls at the four SPAs mirror this trend. Since 1986 all 4 have shown declines in the populations inhabiting the sites, although the declines have generally been smaller than those seen overall nationally.

Approach to assessment

- Post-construction monitoring data is indicating that wind turbines may present collision risk to gull species.
- Neart na Gaoithe and Seagreen recorded herring gull on-site during the breeding season, flying at collision risk height, so we have undertaken assessment for these proposals (Appendix A5 and supporting spreadsheets).
- Inch Cape recorded insignificant numbers of herring gull on-site so no further assessment is required.
- Collision estimates for Neart na Gaoithe and Seagreen have been apportioned between the SPAs and other breeding colonies within foraging range, then converted into a change in adult survival rates.
- We present outputs for both options 2 and 3 of the Band collision risk model (CRM) to show a range of likely impacts, for the reasons discussed in Appendix 5 (section 1).

Assessment for herring gull

- Appendix A2 provides a summary of impacts to herring gull, compared against thresholds.
- At **Buchan Ness** the predicted **decrease in adult survival** is between 0.03% (CRM option 2) and 0.01% (CRM option 3).
- At **Forth Islands** the predicted **decrease in adult survival** is between 0.16% (CRM option 2) and 0.09% (CRM option 3).
- At **Fowlsheugh** the predicted **decrease in adult survival** is between 0.24% (CRM option 2) and 0.13% (CRM option 3).
- At **St Abb's to Fast Castle** the predicted **decrease in adult survival** is between 0.10% (CRM option 2) and 0.06% (CRM option 3).
- None of these predicted rates of decline are significant and all lie within the limits that can be sustained at each SPA.

Conclusion

- We advise **no** adverse impacts on site integrity for herring gull at any of the above SPAs.

LESSER BLACK-BACKED GULL

SPAs considered

- Forth Islands

Historic and current population trends

- The population of lesser black-backed gulls in Scotland is currently estimated to be 25,000 pairs.
- In the UK as a whole following a period of increase from 1970 to 2000 (29% increase between 1970 and 1985m and 40% between 1985 and 2000) there has been a strong decline since (-51% since 2000).
- All the colonies within the Forth Islands SPA were last counted in 2002 when there were 2011 pairs of Lesser Black-backed Gulls breeding. Since then there have been several partial counts of some islands, which do not reveal any strong trend in the local population. Previous to 2002 all sites except Bass Rock (which only held 1 pair in 2002) were counted in 1999 – the total that year being 2496 pairs. In 2012 Isle of May alone held 2310 pairs.

Approach to assessment

- Post-construction monitoring data is indicating that wind turbines may present collision risk to gull species.
- Neart na Gaoithe and Seagreen recorded lesser black-backed gull on-site during the breeding season, flying at collision risk height, so we have undertaken assessment for these proposals (Appendix A5 and supporting spreadsheets).
- Inch Cape recorded insignificant numbers on-site so no further assessment is required.
- Collision estimates for Neart na Gaoithe and Seagreen have been apportioned between Forth Islands SPA and other non-designated breeding colonies, then converted into a change in adult survival rates.
- We present outputs for both options 2 and 3 of the Band collision risk model (CRM) to show a range of likely impacts, for the reasons discussed in Appendix 5 (section 1).

Assessment for lesser black-backed gull

- Appendix A2 provides a summary of impacts to lesser black-backed gull, compared against thresholds.
- The predicted **decrease in adult survival** is between 0.27% (CRM option 2) and 0.15% (CRM option 3).
- This level of impact falls within the limits that can be sustained by the population at Forth Islands SPA

Conclusion

- We advise **no** adverse impacts on site integrity for lesser black-backed gull at Forth Islands SPA.

FULMAR

SPAs considered

- Buchan Ness to Collieston Coast
- Forth Islands
- Fowlsheugh

Historic and current population trends

- The Fulmar population has undergone a huge increase since the mid 1800s, when the only two breeding sites were in Iceland and on St Kilda.
- By 2004 there were an estimated 501,600 pairs in the UK, with the Scottish total being 486,000 pairs in 2007. This increase is thought to have been fuelled by discards from commercial fishing activity. After growing by 77% between 1970 and 1985, there was a small decline in the UK population between 1985 and 2000, followed by a steeper (13%) decline to 2012. The Scottish population declined by 7% between 1986 and 2011, productivity has declined over the same period.
- The three SPAs with Fulmar as a qualifying interest reflect the general trend in populations, although recent declines have been greater than the national average. At Buchan Ness to Collieston Coast SPA the population peaked in 1995 at 2823 pairs, but had declined to 1389 pairs by 2007, at Fowlsheugh there were 416 pairs in 1992, declining to 119 pairs in 2012. The Forth Islands held 1053 pairs in 1997, but then the population has fallen steadily to 569 by 2012.

Assessment for fulmar

- There is currently very little available information on the behavioural reaction of fulmar to wind turbines, with initial studies from European wind farms showing fulmar displaying mixed levels of displacement behaviour.
- However, fulmar have large foraging ranges and are adapted for efficient gliding flight, so that the energetic costs of covering extra distances due to to displacement will be small and will not give rise to significant impacts on this species (see footnote 4).
- We concur with the assessments undertaken by the developers where insignificant numbers of fulmar have been recorded at collision risk height during survey work. .

Conclusion

- We advise **no** adverse impacts on site integrity for fulmar at any of the above SPAs.

COMMON & ARCTIC TERN

SPAs considered

- Forth Islands

Historic and current population trends

- Arctic terns are much more numerous in Scotland than common terns, approximately 88% of the UK population of 53,400 pairs of Arctic tern breed in Scotland, whereas only 40% of the UKs 11,800 pairs of Common terns breed here.
- Both species increased between 1970 and 1985 (Arctic Tern by 50%, Common Tern by a more modest 9%), but both have suffered substantial reductions in numbers since (Arctic Tern down by 36% since 1985 and common tern by 35%). The declines are due mainly to a sustained period of low of productivity blamed on low prey abundance in summer.

- In the Forth Islands SPA both species formerly bred on a number of the islands. The main colonies are on the Isle of May and Inchmickery, with a fairly large common tern colony on Long Craig. Common terns were most numerous at the end of the 1990s (533 pairs in 1999), with Arctic tern numbers peaking in 2001 (916 pairs). Since then both have declined and in 2012 only 20 pairs of Common terns and 250 pairs of Arctic terns nested in the SPA.

Assessment for common & Arctic tern

- We concur with the assessments undertaken by Neart na Gaoithe and Inch Cape recording insignificant numbers of common or Arctic on-site during the breeding season.
- HRA for these species is not required for Seagreen phase 1, where no connectivity has been identified.

Conclusion

- There are **no** adverse impacts on site integrity in respect of common & Arctic tern species at Forth Islands SPA.

APPENDIX 2 a. Summary table of key SPA seabird impacts and thresholds – changes to adult survival

Please see Appendix 4 for advice on the method for setting thresholds.

			CHANGES TO ADULT SURVIVAL *units are percentage point decrease in adult survival (except for gannet mortalities)*									
Species	**SPA**	**Threshold**	**In Combination** CRM (2) + Displ.	**In Combination** CRM (3) + Displ.	**Seagreen Alpha** CRM (2) + Displ.	**Seagreen Alpha** CRM (3) + Displ.	**Seagreen Bravo** CRM (2) + Displ.	**Seagreen Bravo** CRM (3) + Displ.	**Inchcape** CRM (2) + Displ.	**Inchcape** CRM (3) + Displ.	**Neart na Gaoithe** CRM (2) + Displ.	**Neart na Gaoithe** CRM (3) + Displ.
Kittiwake	Buchan Ness	-1.6%	-0.2	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	0.0	0.0
	Forth Islands	-1.5%	-2.9	-2.0	-0.5	-0.4	-0.5	-0.4	-1.0	-0.5	-1.3	-1.1
	Fowlsheugh	-1.3%	-2.7	-0.9	-1.4	-0.9	-0.7	-0.1	-0.8	-0.2	0.0	0.0
	St Abbs	-1.6%	-0.8	-0.1	-0.2	0.0	-0.2	0.0	-0.4	0.0	-0.1	0.0
Gannet	Forth Islands	850 individuals	1664	1917	469	457	287	280	712	893	196	287
		-0.8%	-1.5	-1.7	-0.4	-0.4	-0.3	-0.3	-0.6	-0.8	-0.2	-0.3
Puffin	Forth Islands	-1.4% (0.5-2.5% range)	-3.2		-1.2		0.0		-1.4		-0.5	
Guillemot	Buchan Ness	-0.5%	0.0		0.0		0.0		0.0		0.0	
	Forth Islands	-0.6%	0.0		0.0		0.0		0.0		-0.3	
	Fowlsheugh	-0.6%	0.0		0.0		0.0		0.0		0.0	
	St Abbs	-0.8%	0.0		0.0		0.0		0.0		0.0	
Razorbill	Forth Islands	-0.9%	-0.1		0.0		0.0		0.0		-0.1	
	Fowlsheugh	-1.0%	0.0		0.0		0.0		0.0		0.0	
	St Abbs	-1.3%	0.0		0.0		0.0		0.0		0.0	
Herring gull	Buchan Ness	-1.9%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Forth Islands	-2.0%	-0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1
	Fowlsheugh	-2.0%	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
	St Abbs	-1.9%	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lesser black-backed gull	Forth Islands	-1.8%	-0.3	-0.2	-0.1	0.0	-0.1	-0.1	0.0	0.0	-0.1	0.0

APPENDIX 2 b. Summary table of key SPA seabird impacts and thresholds – changes to productivity

Please see Appendix 4 for advice on the method for setting thresholds.

		CHANGES TO PRODUCTIVITY *units are percentage point decrease in chick survival*					
Species	**SPA**	**Threshold**	**In combination**	**Seagreen Alpha**	**Seagreen Bravo**	**Inchcape**	**Neart na Gaoithe**
Kittiwake	Buchan Ness	-3.2%	0.0	0.0	0.0	0.0	0.0
	Forth Islands	-3.0%	-2.1	-1.6	0.0	0.0	-1.3
	Fowlsheugh	-2.3%	-1.6	-1.0	-0.4	0.0	0.0
	St Abbs	-3.4%	0.0	0.0	0.0	0.0	0.0
Gannet	Forth Islands	no thresholds but impacts are all negligible	*no in comb. effects available*	-0.1	0.0	0.0	0.0
Puffin	Forth Islands	0.5-2.0% range	-4.9	-0.8	0.0	-1.7	-0.9
Guillemot	Buchan Ness	-0.5%	0.0	0.0	0.0	0.0	0.0
	Forth Islands	-0.6%	0.0	0.0	0.0	0.0	0.0
	Fowlsheugh	-0.6%	0.0	0.0	0.0	0.0	0.0
	St Abbs	-0.8%	0.0	0.0	0.0	0.0	0.0
Razorbill	Forth Islands	-0.9%	0.0	0.0	0.0	0.0	0.0
	Fowlsheugh	-1.0%	0.0	0.0	0.0	0.0	0.0
	St Abbs	-2.0%	0.0	0.0	0.0	0.0	0.0
Herring gull	Buchan Ness Forth Islands Fowlsheugh St Abbs		*no displacement effects therefore no direct impacts on productivity, only on reduced adult survival*				
Lesser black-backed gull	Forth Islands		*no displacement effects therefore no direct impacts on productivity, only on reduced adult survival*				

Key:
- effect well below threshold (<50% of threshold)
- effect approaching threshold (>50% of threshold)
- effect exceeds threshold

APPENDIX A3

Key SPA seabird species requiring HRA, including population estimates

We have used the most recent population estimates in our impact assessment as follows:

(i) to convert the estimated number of collision mortalities for each relevant seabird population into a percentage decrease in adult survival – please see **Appendix A5.**

(ii) to provide the starting population for our calculation of potential biological removal – please see **Appendix A4.**

We decided that we would use most recent available colony counts during the period of the developers' boat-based survey work. These surveys took place across the Forth & Tay proposals from November 2009 to September 2012.

With the exceptions noted below*,* the *'most recent'* population estimates equate to the most recent colony counts available from the Seabird Monitoring Programme database relative to the period of developers' boat-based survey (see the table below). (**P/I:** pairs / individuals).

- The most recent counts for kittiwake and gannet at Forth Islands SPA, and for all species at Fowlsheugh SPA, fall within the identified survey period so are acceptable.

- The counts for Buchan Ness to Collieston Coast SPA are within 5 years of the start of the survey period so we also considered these acceptable.

- Despite the age of the last complete count available for herring gull and lesser black backed gull at Forth Islands SPA (2002), we concluded that this provided the best available estimate of each species' population. We checked the available data on large gulls for more frequently counted sub-sites within the SPA and these showed no obvious trend over the period 2002 – 2012. We also investigated whether we could derive overall SPA population figures based on the sub-sites, however, this approach did not produce reliable estimates.

- Available colony counts at St. Abb's Head to Fast Castle SPA are out-of-date for all species. However, the National Nature Reserve at St Abb's has been counted much more regularly, and most recently in summer 2012. The NNR held 68% of the SPA kittiwakes and 47% of the SPA herring gulls at the time of Seabird 2000, therefore we consider it appropriate to apply NNR population trends for these two species to the whole SPA. We have calculated the annual change in kittiwake and herring gull populations at the NNR over the period from 2000 to 2012. We have then applied this trend to the SPA counts from the Seabird 2000 census in order to determine more up-to-date population estimates for each species.

Species	SPAs with breeding season LSE identified	Forth & Tay wind farms with LSE	SPA citation population	P/I	Most recent population estimates	P/I	Dates of most recent counts
Gannet	Forth Islands	IC, NNG, SG	21,600	P	110,964	I	*2009*
Kittiwake	Buchan Ness / Collieston Coast	IC, NNG, SG	30,452	P	25,084	I	*2007*
	Forth Islands	IC, NNG, SG	8,400	P	7,552	I	*2012*
	Fowlsheugh	IC, NNG, SG	36,650	P	18,674	I	*2012*
	St. Abb's Head to Fast Castle	IC, NNG, SG	21,170	P	12,635	I	*Trend applied*
Herring Gull	Buchan Ness / Collieston Coast	IC, SG	4,292	P	6,158	I	*2007*
	Forth Islands*****	IC, NNG, SG	6,600	P	10,054	I	*2002*
	Fowlsheugh	IC, NNG, SG	3,190	P	518	I	*2012*
	St. Abb's Head to Fast Castle	IC, NNG, SG	1,160	P	712	I	*Trend applied*
Lesser Black Backed Gull	Forth Islands	IC, NNG, SG	1,500	P	4,026	I	*2002*
Fulmar	Buchan Ness / Collieston Coast	IC, NNG, SG	1,765	P	1,389	P	*2007*
	Forth Islands*****	IC, NNG, SG	798	P	569	P	*2012*
	Fowlsheugh*****	IC, NNG, SG	1,170	P	119	P	*2012*
Puffin	Forth Islands	IC, NNG, SG	14,000	P	50,282	P	*2009*
Guillemot**	Buchan Ness / Collieston Coast	IC, NNG, SG	8,640	P	25,857	I	*2007*
	Forth Islands	IC, NNG, SG	16,000	P	29,169	I	*2011*
	Fowlsheugh	IC, NNG, SG	56,450	I	60,193	I	*2012*
	St. Abb's Head to Fast Castle	IC, NNG, SG	31,750	I	58,617	I	*1998/2000****
Razorbill**	Forth Islands	IC, NNG, SG	1,400	P	4,950	I	*2011*
	Fowlsheugh	IC, NNG, SG	5,800	I	7,048	I	*2012*
	St. Abb's Head to Fast Castle	IC, NNG, SG	2,180	I	4,588	I	*Trend applied*
Common tern	Forth Islands	IC, NNG	334	P	131	P	*2011*
Arctic tern	Forth Islands	IC, NNG	540	P	265	P	*2012*

* Please be aware that herring gull at Forth Islands SPA and fulmar at Forth Islands SPA and Fowlsheugh SPA may not qualify as designated interests (see Appendix 1).

** For guillemot and razorbill the counts were converted to 'individuals on land equivalent' then corrected using (x 1.34) to give total breeding adults in population.

*** For guillemot at St. Abb's Head to Fast Castle SPA there is no recent count of the full SPA. We have investigated alternatives and confirm that this is the best available estimate.

APPENDIX A4

This appendix describes how we established impact thresholds to define the maximum long-term declines in the rates of adult and / or chick survival that each population can sustain without an adverse impact on their population viability. Thresholds are set in relation to adult and/or chick survival, against which predicted wind farm impacts are considered.

Key points

- We have considered the predicted impacts to each seabird species against the key conservation objective to maintain the SPA populations in the long-term.
- The impacts are apportioned between each SPA population as described in **Appendix A5**.
- We consider potential effects on population viability using population modelling, as discussed below and in **Appendix 7**.
- CEH undertook population viability analyses (PVAs) for kittiwake, razorbill, guillemot, herring gull and puffin at each of SPA of concern: Buchan Ness to Collieston Coast, Forth Islands, Fowlsheugh and St Abbs to Fast Castle SPAs (**section 1** below).
- With the exception of puffin, which we discuss further in **section 5** below, we use the outputs from these PVAs to inform our HRA advice for each of these species using the draft method of 'reduced uncertainty acceptable biological change' (RU ABC) (**section 2**).
- A gannet PVA had already been developed at a UK-level, commissioned by the Crown Estate under the Strategic Ornithological Support Service (SOSS)[5]. We use the outputs from the 'SOSS PVA' to inform our HRA advice for gannet (**section 3**).
- Each method for setting thresholds has its limitations. Therefore, where feasible, more than one approach to setting thresholds has been used. Alongside the thresholds derived from PVAs, we have also used 'potential biological removal' (PBR) to generate thresholds (see **section 4**). The thresholds derived by different methods for the same colonies are compared in **section 6**.
- These thresholds are indications of the levels of additional mortality that the populations might be able to withstand. Each of the modelling steps is subject to uncertainty and these uncertainties are propagated, and potentially magnified, through the modelling process. Consequently, there is considerable uncertainty around thresholds.
- The thresholds set using PVA assume that the populations are subject to no additional anthropogenic mortality, besides that from the Forth & Tay proposed wind farms during the breeding season. As such, any additional anthropogenic mortality throughout the year will result in thresholds being exceeded and population decline.
- **Consequently, we strongly recommended that limits to additional impacts that these populations are subject to are not set close to the thresholds, especially for species already undergoing and forecast to continue to undergo substantial declines, such as kittiwakes.**

[5] WWT (2012) Gannet Population Viability Analysis – Demographic data, population model and outputs. Available from: http://www.bto.org/science/wetland-and-marine/soss/projects

1. Population Viability Analysis (PVA)

Under contract to Marine Scotland, CEH produced an integrated population model for each species (kittiwake, guillemot, razorbill, puffin, herring gull) using colony counts from 1985 to 2012 inclusive, along with productivity and survival data. The baseline models were fitted to, and compared with, past colony counts to assess their validity. Generally, the models fitted colony counts well, especially for those colonies which had been counted annually. By contrast, the puffin model did not perform well (see discussion in section 5 below). Consequently, CEH advised that it should not be used in any assessment of wind farm impacts on the puffin population at Forth Islands SPA.

A number of impact scenarios were modelled for each species population. Adult survival and productivity were reduced for a 25 year period, corresponding to the lifespan of a wind farm, and were then followed by a five year recovery period during which no reduction in survival and productivity beyond natural mortality was permitted. Survival and productivity was reduced, as follows:

- adult annual survival rates: reduction of 1%, 2%, 3% or 4%;
- annual productivity: reduction of 1%, 5%, 10% or 20%; and
- both annual survival and productivity: 1% survival, 1% productivity; 2% survival, 5% productivity; 3% survival, 10% productivity; 4% survival, 20% productivity.

So the PVA outputs are in the format of annual predicted population sizes from 2015 to 2045. In order to set thresholds we have excluded the 5 year recovery period and use the outputs at year 2040 as the final population. We recommend this approach as we consider that allowing a 5 year recovery period at the end of 25 years of impact in the context of species with average life spans less than 25 years is incompatible with the key conservation objective to ensure the **long-term maintenance of populations as viable components of each SPA under consideration**. We note that projecting population sizes for an additional five years exaggerates the uncertainty in model predictions.

The model was designed to incorporate natural variability in the key vital rates. Each run of the model therefore gave slightly different outputs due to the variance incorporated into the stochastic population model. In order to express this variability the median population size each year plus quantiles of the multiple runs for each scenario were presented. The quantiles given are 5%, 33%, 50%, 66% and 95% and we use these outputs to set thresholds as follows.

2. Interpreting PVA outputs using the draft method of 'Acceptable Biological Change'

The draft method of 'acceptable biological change' (ABC) [6] uses the Intergovernmental Panel on Climate Change (IPCC) terminology to determine thresholds of acceptable change. Due to the format of the PVA outputs from CEH, application of ABC to Forth & Tay seabird populations is limited to using the IPCC 'as likely as not' category (probability range of 0.333-0.667). The median of population sizes forecast for each impact scenario (reduced adult survival rates, reduced productivity or both) are considered against the 66% quantile for the relevant baseline forecast. Where the median forecast population size is larger than the 66% quantile of the baseline, then the impacts are considered 'acceptable', where smaller then the impacts are 'unacceptable'.

While SNH & JNCC have welcomed the proposal we note that '*it would be premature to recommend the ABC method as a standard framework for determining the significance of the predicted impacts from marine renewables development'* and have provided some recommendations to develop the approach[7].

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[6] Draft provided to SNH & JNCC for the meeting of the Renewables Scientific Appraisal Group held 5 September 2013.

[7] Refer to the advice note from SNH & JNCC, 20 September 2013.

In particular, our 'Reduced Uncertainty ABC' method[8] (RU ABC) addresses a known limitation of the ABC method that results in larger decreases in adult survival being determined 'acceptable' for models which have higher variation or uncertainty, even when this variation is an artefact of sampling error with respect to the population in question rather than true natural variability. Setting thresholds that allow for natural fluctuations in population sizes is important, but it is also important to minimise the impact of sampling error.

To overcome this effect the RU ABC method uses uncertainty in the larger regional population to adjust the threshold of acceptable change in SPA specific models. Uncertainty in the regional population model is likely to be caused by extrinsic factors that drive natural annual variation in population size, such as prey fluctuations, weather-induced mortality events, etc. These extrinsic processes will be operating at spatial scales larger than that covered by the regional model, so natural variation in population size will not be 'smoothed' out in the regional model. However, sampling variation will be greatly reduced in the regional model, due to the large amount of data used, compared to the SPA-specific models. So by applying the regional model measure of uncertainty to all SPA-specific models, natural variation in population size is retained but sampling error is minimised and thresholds are more biologically relevant.

A known limitation of the ABC method is that no allowance is made for the status of a population. A decreasing population can be assigned the same threshold as an increasing population, if the two models have similar levels of variance in the model outputs. Therefore, ABC thresholds applied to decreasing populations should be treated with caution.

We applied RU ABC to determine thresholds for all populations that were modelled by CEH, excepting puffin (see section 5 below).

3. Considering the significance of predicted wind farm impacts on gannet

The work commissioned by the Crown Estate for SOSS report 04[9] aimed to build a gannet population model that could assess impacts of additional mortality from collisions with wind farms on gannets in UK waters. Two forms of an age-based stochastic matrix model were developed under the SOSS contract, one with density dependence and the other with no density dependence. Both models gave similar results and model builders recommended using the density-independent model. Colony-specific demographic rates were generally lacking and, where available, showed no significant difference to the generic UK-wide population model, so a non-colony specific model was developed.

The original SOSS model applied collisions across all age classes within the population model, apportioning impacts according to prevalence of that age class in the population. However, 97% of birds recorded within the windfarm footprint were adult gannets. Consequently, the model was reworked, with only adult gannets suffering mortality from windfarm collisions.

The Bass Rock gannet population has been increasing and is predicted to continue to increase. The SOSS model outputs quantified the number of additional adult mortalities the gannet population can withstand without causing the population to start declining. Four models were run, two based on the Bass Rock gannet population size in 2004 and two on the population size in 2009. The latter model was more useful as it is closer to the current state of the colony. Additionally, a model variant was run with an additional five year recovery period of no windfarm mortalities, following the 25 years of additional mortalities. Whilst the outputs from this model provided interesting comparisons with the CEH PVA outputs, projecting population sizes for an additional five years exaggerates the uncertainty in model predictions.

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8 Copy of the JNCC & SNH paper on 'Addressing uncertainty in population models when using the ABC method to set thresholds of change' was provided to MSS on 10 January 2014 and more widely to FTOWDG on 7 February 2014.

9 WWT (2012) Gannet Population Viability Analysis – Demographic data, population model and outputs. Available from: http://www.bto.org/science/wetland-and-marine/soss/projects

Outputs from the model based on the 2009 colony count and without the additional five year recovery period, showed there to be a 5% risk of the gannet population no longer increasing, with an annual mortality of more than 850 adults. With this mortality rate, 5% of the 5000 model runs showed a 5% decrease in population size at any point during the 25 year projection. This indicates that the gannet population can withstand an additional 850 adults dying per year and so this threshold was used to assess windfarm impacts on the Bass Rock gannet population.

4. Potential Biological Removal (PBR)

PBR is a simple form of population modelling, which was first formulated for marine mammals (Wade 1998) to estimate allowable by catch. PBR estimates the number of additional mortalities that can be sustained annually by a population. The data requirements are reasonably simple: population size (Nmin), maximum annual recruitment (Rmax, calculated from age at first breeding and adult survival), and a recovery factor (f). Despite the limited input requirements the model allows for density dependence and stochasticity (Dillingham and Fletcher, 2008).

PBR outputs are very sensitive to f, the recovery factor, and the setting of f is a conservation management decision. Dillingham and Fletcher (2008) recommend that for threatened or endangered species, and SPA populations in decline (Dillingham, *pers comm*) an upper value of 0.1 should be used. They go on to suggest the following for IUCN classes; f = 0.5 for 'least concern' species, f = 0.3 for 'near threatened', and f = 0.1 for all threatened species.

In our calculations we have determined PBRs for each species, at a range of f values (*f* = 0.5 and *f* = 0.3). For our HRA advice we use the outputs for the f value we consider to be appropriate given the condition status and national trend of the qualifying interest. We used adult survival rates and age at first breeding obtained from the CEH PVA report and from the literature.

Appendix A3 provides the most recent population sizes used for calculating PBR values.

5. Considering the significance of predicted wind farm impacts on puffin

Following advice from CEH, we did not use the puffin model to set thresholds for this species. CEH attempted to model the puffin population at Forth Islands SPA but they reported low confidence in the reliability of the PVA outputs due to large uncertainties in the model. Puffins, as burrow nesters, are difficult to count and the Forth Islands population has only been counted sporadically since 1980.

The eight counts of the population between 1980 and 2013 suggest that the population is increasing rapidly (a five-fold increase since 1980), with an exceptionally high count in 1993, followed by a decrease at the next census. These rapidly increasing yet widely fluctuating counts cause the model to predict the puffin population to continue increasing at a fast rate.
It predicts a population greater than 100,000 'apparently occupied nests' (AON) by 2025, with wide credibility intervals illustrating the uncertainty around this prediction. In reality, density dependent population regulation will slow the rate of increase at some point, e.g. areas for suitable nest sites may become limiting. However, without knowing the form the population regulation will take and at what population size it will occur, it is difficult to predict future population size for this puffin population with any certainty.

Repsol developed a second PVA to consider impacts from the Inch Cape development proposal. This PVA, a density-independent stochastic age-based matrix model, was developed for regional populations of kittiwake, guillemot, razorbill and puffin. However, the model developers identified the same limitations of the puffin data, stating that, "...*it is difficult to ascertain whether the recent population declines will be of short or long-term nature, and hence whether the modelled trend provides a reasonable representation of the actual trend.*"

Additionally, the approach for modelling displacement effects on the puffin population makes interpreting the PVA difficult. CEH have developed a sophisticated displacement model to understand how displacement and barrier effects influence chick survival rates and body mass of adults at the start of the non-breeding season and consequent over winter survival (Appendix 5).

The Inch Cape PVA assumes a simplistic 50% displacement rate and that all adults that are displaced will fail to breed. These losses to the population are incorporated directly into the PVA, so that it is not possible to ascertain effects of different decreases in adult survival and productivity on the population. We therefore cannot use the Inch Cape PVA to set thresholds.

In the absence of PVA-informed thresholds, we took two other approaches, PBR and using thresholds from two proxy species, guillemots and razorbills.

We calculated PBR thresholds using a population size (*Nmin*) of 100,564 individuals, which is the most recent 2013 count of the Forth Islands puffin population, an adult annual survival rate of 0.876 (Harris & Wanless, 2011) and an age of first breeding of 7 years. Harris & Wanless (2011) cite age of first breeding as 5 years but the CEH PVA uses a biologically more realistic average age of first breeding of 7 years rather than the earliest possible age of first breeding. These values give PBR thresholds of a decrease in adult survival of -2.3%, using *f*=0.5 and -1.4% using *f*=0.3. Whilst PBR is computationally easy to use to generate thresholds, the inability of more sophisticated population models to predict future population sizes for puffin, means that we can assign only relatively low confidence to these PBR thresholds. For that reason, the threshold of -2.3% should be viewed as a maximum possible limit to a range of thresholds, with -1.4% being a more precautionary threshold.

Given the difficulty with generating reliable thresholds for puffin from models informed by Forth Island puffin demographic rates, thresholds from proxy species are also considered. We selected razorbills and guillemots as proxy species, being the most closely related to puffins. However, they differ from puffins in a number of ways, most importantly nesting on cliff ledges, rather than in burrows. Consequently, their demographics and thresholds may differ and CEH recommended using proxy species' thresholds with caution. Guillemot thresholds, informed by RU ABC, ranged from -0.5% to -0.8% adult survival. Razorbill thresholds, also informed by RU ABC, ranged from -0.9% to -1.3% adult survival (see Appendix A2). These thresholds are similar to the puffin PBR threshold (*f*=0.3) of -1.4%. PBR thresholds for guillemots were also in the same range of -0.9% to -1.1%, using *f*=0.3, and -1.5% to -1.8% using *f* = 0.5. Similarly, razorbill PBR thresholds, using *f* = 0.3, were similar to the RU ABC, with a range of -1.3% to -1.5% but were higher than the RU ABC using *f* = 0.5, with a range of -2.0% to -2.5%. The similarity in both PBR and RU ABC thresholds across these three auk species gives confidence that **the puffin threshold is within the range of -0.5% to -2.5% and is likely to be around -1.4%**.

PBR provides thresholds for adult mortality but does not provide thresholds for decreases in productivity. One advantage of using proxy species is that the productivity thresholds for guillemots and razorbills can be considered for use as thresholds for changes in puffin productivity. Using the RU ABC approach, guillemot productivity thresholds ranged from -0.5% to -0.8% and razorbill productivity thresholds were between 0.9% and 2% (see Appendix A2). **This suggests that an appropriate threshold for puffin productivity could be in the range of 0.5% to 2.0%.**

6. Comparing the different methods for setting thresholds

Thresholds were set using RU ABC with outputs from the CEH PVA, using a 5% risk of population decline with the SOSS gannet PVA, and PBR. Since each method for setting thresholds has its limitations, it is recommended to use more than one approach.

Generally, PBR and RU ABC gave similar thresholds, whereas PBR was markedly different to the gannet thresholds set using a 5% risk of population decline and ABC (see **Table A** below).

ABC and PBR rely on a different set of assumptions so the similarity in thresholds is reassuring.

The substantial difference in gannet thresholds is for two reasons. Firstly, gannet have been studied for many years at the Bass Rock and so adult survival estimates are exceptionally precise (Wanless et al, 2006; Trinder et al 2013). Consequently, the SOSS PVA, with less variance in the model parameters, produces outputs with little variation, compared with the CEH PVA outputs.

The more consistent outputs from the SOSS model result in the 66% quantile lying closer to the median value and so it is more easily exceeded by only small changes to adult mortality, compared with the CEH models. This illustrates a limitation of the ABC method. The PBR gannet threshold is much higher than either ABC or the 5% risk of population decline thresholds. This is due to the PBR threshold being influenced by the very large colony size at Bass Rock (>100,000 individuals). When considering the PBR threshold as a change in adult survival, a value of 1.5% is obtained, which is similar to other species.

Table A. Comparison of thresholds generated using different approaches, showing the similarity between PBR values (using *f* = 0.3) and RU ABC. All values are percentage point 'acceptable' decreases in adult survival, with the exception of gannet which are numbers of individual adults due to the different format of the SOSS model outputs.

Species	**SPA**	**RU ABC**	**PBR (*f* = 0.3)**	**5% risk of population decline**
Kittiwake	Forth Islands	1.5	1.9	
	St Abbs	1.6	1.8	
	Fowlsheugh	1.3	2.0	
	Buchan Ness	1.6	2.0	
Gannet	Forth Islands	250 / 950*	1669	850
Guillemot	Forth Islands	0.6	1.0	
	St Abbs	0.8	1.1	
	Fowlsheugh	0.6	1.0	
	Buchan Ness	0.5	1.0	
Razorbill	Forth Islands	0.9	1.2	
	St Abbs	1.3	1.3	
	Fowlsheugh	1.0	1.5	
Herring gull	Forth Islands	2.0	1.9	
	St Abbs	1.9	0.6	
	Fowlsheugh	2.0	1.9	
	Buchan Ness	1.9	1.9	
Lesser black-backed gull	Forth Islands	1.8	1.8	

* Using Reduced Uncertainty ABC a threshold of 250 individuals is obtained; using an alternative approach to applying ABC gives a threshold of 950 individuals (*pers. comm.* Jared Wilson, MSS).

APPENDIX A5

Quantifying the magnitude of impacts to key SPA species

In this appendix, we provide a summary of the methods used to quantify the key impacts that may arise from wind farm development on seabird species – collision risk and displacement. This quantification of impacts is used to inform our advice on HRA for key seabird species during the breeding season, as presented in **Appendix A1**.

1. Collision Risk

1a. Use of the Band 2012 offshore wind collision risk model

SNH and JNCC support the use of Band Collision Risk Modelling (CRM) when attempting to predict potential impacts from offshore wind farms on seabirds. Band (2012) provides guidance on how to perform CRM for seabird species in respect of offshore wind farms.[10] It includes a 'basic' model (Options 1 and 2) and an 'extended' version (Option 3) as described below.[11]

Option 1 – The 'Basic' model. It assumes a uniform distribution of flight heights between lowest and highest levels of the rotors. It also uses figures for the proportion of birds at risk height derived from site-specific surveys.

Option 2 – As option 1 but the proportion of birds at risk height is derived from height data in Cook *et al*. (2012[12]).

Option 3 – The 'Extended' model. This differs methodologically from the 'Basic' model in that it does not assume that the density of flying birds is uniform across all heights between the minimum and maximum rotor swept height. Instead, this option uses meter by meter flight height values from Cook *et al.* (2012) to calculate collision rate in each part of the rotor swept area and then integrates that across the rotor disk. It accounts for various factors that vary with height across the rotor swept height band which together result in the collision rate varying with height. For example, the breadth of the circle (and therefore the number of birds flying through the circle) varies with height and the collision risk on transit through the swept area also depends on height (due to for example, variation in rotor speed across the radius). If the density of birds in flight also varies with height rather than being uniform, then the result is a different number of predicted collisions than if the flight height distribution were assumed to be uniform (as in Options 1 and 2).

1b. Aspects of uncertainty with the Band model options

- **Assigning flight height distributions**
  Collision risk modelling is undertaken on the assumption that birds are always correctly assigned to their respective flight height bands. This assumption exists regardless of the model option but the implications of violating it may be more significant in the case of Option 3.

- **Flight height and observer error**
  The flight height data for the Forth & Tay proposals is derived solely from boat-based survey work, so there could be associated observer error due to the difficulty of measuring flight heights at sea (and over distance). The Crown Estate may shortly be commissioning a project to investigate the accuracy of flight height data collected by various methods including digital aerial techniques, as well as boat-based survey work.

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10 Band, B. 2012. Using a collision risk model to assess bird collision risks for offshore windfarms. *Report to The Crown Estate, SOSS-02.* Available from: www.bto.org/science/wetland-and-marine/soss/projects

11 A further fourth option exists to use the extended model with site-specific data, provided that the heights recorded on-site are at a suitable resolution.

12 Cook, A.S.C.P., Johnston, A., Wright, L.J., and Burton, N.H.K. 2012. A review of flight heights and avoidance rates of birds in relation to offshore wind farms. *BTO Research Report No. 618*

- **Generic flight height distribution data**
  The dataset produced by Cook *et al.* (2012) is also based only on boat-based survey work, collated from a range of UK wind farms. This generic dataset is used to model the fine-scale flight height distributions applied in Options 2 and 3 and has recently been re-analysed by Johnston *et al*. We are aware of errors in this analysis and that a correction is due very shortly (Cook, *in lit.*). In the meantime, we have retained use of Cook *et al.* (2012) for the collision risk modelling (Options 2 and 3) that we present in our supporting spreadsheets.

- **Avoidance rates**
  A further aspect of uncertainty around use of the different Band model options relates to the suitability of the avoidance rates (AR) used with each model option. There is currently a debate about whether a 98% AR, which has historically been used and applied in conjunction with the 'basic' model (Options 1 and 2), is transferrable for use with the 'extended' model (Option 3). Marine Scotland Science are currently leading a research project to review seabird avoidance rates, but the project will not report in time to inform our advice.

  Due to the complexity of the above issues and the ongoing research to inform such matters, we are mindful that there is considerable uncertainty regarding the modelled predictions of collision mortality from these proposals. Consequently, in the future we may suggest that a) more accurate flight height distribution data be used in the analysis, and b) that a correction factor is applied to the 'extended' model.

1c. SNH & JNCC collision risk modelling for the Forth & Tay

Our advice is informed by the range of collision mortality estimated from the 'basic' Band model (Option 2) and the 'extended' Band model (Option 3) each at a 98% avoidance rate. During the breeding season, the seabirds that may be at risk of colliding with the proposed wind farms will originate from a range of SPAs and other breeding colonies located within foraging range. Therefore the predicted collision mortalities for each species need to be **apportioned** as outlined below. The apportioned collision mortality estimates are then converted to a percentage decrease in adult survival (see **Appendices 2** & **3**).

- **Determine which colonies should be considered.**
  For each species of interest all colonies within foraging range of the development are selected. The foraging range value is the mean maximum (plus 1 standard deviation) presented in the appendix to the paper by Thaxter et al 2012[13]. The location of the colony is the grid reference as presented in the JNCC seabird monitoring database, with the distance (km) measured to the nearest edge of the development.

- **Determine the size of bird populations for assessment.**
  The most recent period when all Forth & Tay seabird colonies were counted was during the Seabird 2000 census (between 1998 and 2002). Some sites have been counted since, with SPAs tending to be counted more recently than SSSIs and non-designated sites. Some species have exhibited significant population change since Seabird 2000 and this would affect the relative balance between SPA and non-SPA colonies if we were to base apportioning on the more recent count data. Therefore we use the Seabird 2000 counts for our apportioning calculation as these provide a known comparison point between all colonies (the values used are breeding adults, converted from pairs where necessary).

- **Determine the area of foraging habitat available.**
  We have referred to the Seagreen HRA addendum which provides a calculation of the area of sea within mean max foraging range for each species. We assume a 'flat' distribution of foraging birds. While we recognise that prey distribution and therefore bird distribution is unlikely to be even across this foraging range, there is insufficient reliable and detailed knowledge of these factors to support more sophisticated assumptions. The calculated density of birds reduces with increasing distance from the colony as the area of sea surface increases.

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[13] Thaxter C.B., Lascelles B., Sugar K., Cooke A.S.C.P., Roos S., Bolton M., Langston R.H.W and Burton N.H.K. (2012) Seabird Foraging Ranges as a tool for identifying candidate Marine Protected Areas. *Biological Conservation* doi 10.10161j.biocon.2011.12.009.

- **Apportioning calculation**
  We apportion collision mortality estimates for each species to each of the colonies within foraging range of each proposed wind farm. To do this we calculate apportioning factors/values for each species/colony combination. These values/factors are the product of weighted factors based on three parameters:

  - **Population –** the size of the colony relative to all colonies with foraging range.
  - **Sea area** – the importance of the sea area (of the wind farm proposal) for the colony relative to its importance for all colonies with foraging range.
  - **Distance** - the distance of the sea are from the colony relative to its distance from all colonies within foraging range.

  We describe the method in detail in the discussion paper we have circulated[14].

Displacement

There is a paucity of information on the behavioural reaction and level of response that seabirds may show to wind farms constructed in their foraging areas. Initial monitoring of other European offshore wind farms shows contrasting results between species and for the same species, (e.g. Leopold *et al.,* 2011, Canning *et al.,* 2012, Furness & Wade, 2013).[15] Also most of this monitoring focuses on the non-breeding season as this is when these wind farms have greatest impact. There is little available data to inform assessment of displacement / barrier effects to seabirds during the breeding season.

2a. Overview of the CEH displacement modelling

Our key concerns in respect of the Forth & Tay wind farms relate to breeding seabirds. Marine Scotland therefore commissioned CEH to develop a time and energy expenditure model to investigate the potential displacement / barriers effects on seabird species that could arise from the proposed wind farms. This modelling was undertaken for guillemot, razorbill, puffin, kittiwake and gannet, addressing these possible responses to the presence of a wind farm:

- **displacement,** where birds that otherwise wanted to forage in the area decide to forage elsewhere, and
- **barrier effects,** where birds that want to forage in locations beyond the wind farm decide to fly around it rather than through it. A 1km barrier has been applied to each of the Forth & Tay wind farm footprints, as supplied by the developers.

The modelling uses a 60% displacement / barrier rate for auk species and gannet, and 40% for kittiwake. It is informed by available tracking data for each species and provides outputs for two types of prey distribution:

- '**Flat**' which assumes an even (homogeneous) distribution of prey across the region.
- **GPS** which uses bird tracking data to inform variable (heterogeneous) prey distribution.

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[14] 'Approaches to apportioning impacts on breeding seabirds among Special Protection Areas arising from marine renewable developments: SNH & JNCC discussion paper' - draft circulated on 7 February 2014.

[15] References on bird displacement behaviour at European offshore wind farm sites:

Leopold, MF, Dijkman, L. 2011. Local birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ). *Report number C187/11.*

Canning, S., Lye, G., Givens, L., Pendlebury, C. 2012. Analysis of Marine Ecology Monitoring Plan Data from the Robin Rigg Offshore Wind Farm, Scotland (Operational Year 2) Technical report, Birds. *Report: 1012206*. Natural Power Ltd.

Furness, R.W., Wade, H.M and Masden, E.A. 2013. Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management* 199: 56-66.

CEH have advised that the flat and GPS modelled outputs encompass the range of possible displacement / barrier effects. As there is uncertainty around the true level of impact we have adopted a precautionary approach and used whichever output ('flat' or GPS) is higher. For a number of species the difference is negligible, so that either output can be used.

Note that both types of output ('flat' or GPS) are based on the model which assumes a moderate prey availability. We consider that this option represents reality more closely (and can account for inter-annual variability over time) than either the low or high prey options.

The CEH modelling, and therefore our assessment, only considers the consequences of adult breeding birds being displaced or extending flights to avoid entering a wind farm. The energetic consequences of this and any associated impacts on the provisioning rate of chicks are not addressed.

There are a number of specific issues relating to use of the displacement modelling for **puffin**, see section 2a(iii) below.

2b. Model iterations

There are a number of key iterations of the displacement modelling, as follows:

- amendments to the calculation of cumulative effects
- revisions to the way barrier effects are modelled
- simplifications to reduce computational time (the 'lite' model).

CEH advise that 'lite' model 0 gives the most realistic calculation of barrier effects, however, the 'full' model better captures the available foraging options for birds in the presence of a wind farm. CEH have therefore calculated an adjustment factor that allows the full model outputs to be used, but incorporates the better estimate of barrier effects. Both the adjustment method and corrected outputs have been provided by CEH to the project steering group and it is these which we have used for our assessment.

The CEH displacement outputs address a cumulative development scenario as well as each individual wind farm (provided for all species, excepting gannet) – presented in **Appendix 2**. Our HRA advice in **Appendix 1** is based on the outputs for the cumulative scenario, although we consider that the outputs for each individual wind farm could be informative, albeit there is a strong caveat from CEH (section 2d).

2c. Use of the displacement modelling for puffin

A tracking study has been undertaken for puffin at the Isle of May, but it was limited to seven birds during a single breeding season.[16] Due to this very small sample size we consider that the GPS model outputs cannot be used for puffin. However, the study did highlight an important issue – the tracking data from the tagged birds may under-represent shorter foraging trips.

From the limited data available it is not possible to ascertain the frequency or destination of these shorter foraging trips (Daunt, pers comm), however, the concern is that the displacement model may under-estimate the impacts on puffin from wind farms closer to the Isle of May and over-estimate those from wind farms at greater distance. Due to this possibility, **we advise that only the displacement outputs for the cumulative wind farm scenario are used for puffin, and that the outputs for each individual wind farm are <u>not</u> used in any ranking.**

[16] Harris, M.P., Bogdanova, M.I, Daunt, F. and Wanless, S. 2012. Using GPS technology to assess feeding areas of Atlantic Puffins *Fratercula arctica. Ringing and Migration* 27(1): 43-49

2d. Areas of uncertainty in the modelling

We note that there are a number of limitations to the modelling, particularly in relation to:

- Sensitivity to parameters which are poorly understood such as intraspecific competition and behavioural response of central-place foragers in terms of trip frequency.
- The calculation of the mass to adult survival relationship in adults.
- Decision-making for adult birds in terms of prioritising their own survival over survival of their chicks. For example, when an adults energetic requirements is not met, then their body mass is reduced. Should an adults mass be <80% the adult switches from provisioning its offspring to abandoning the breeding attempt, and is assumed to have died if its mass is <60%.

CEH have therefore provided the following caveat on interpretation of the displacement model outputs:

Overall, it is our considered opinion that there are various qualitative statements that we can make with a fair degree of confidence, but that we cannot confidently make statements about whether the change in survival is greater than or less than 1% (or any other small threshold).

APPENDIX A6

Wind farm & turbine parameters used in collision risk modelling

We have used the following turbine and wind farm parameters in our collision risk modelling (CRM) for each of the Forth & Tay proposals. For each species and CRM model option (please see discussion in Appendix 5) we present the outputs that are 'worst case'.

For **Neart na Gaoithe**, scenario 9 is the worst case for all species and options, excepting gannet CRM option 3 where scenario 12 is worst.

For **Inch Cape** the 'large' turbine scenario is worst case for all species and options, excepting kittiwake option 3 where the 'small' turbines are worst. No matter the choice of turbine, Inch Cape present a total of 213 turbines in each of their scenarios. The maximum site capacity is 1050MW, so we highlight that the outputs for the 'large turbine' scenario are likely to over-estimate collision risk as we think the turbine number is over-estimated.

Seagreen have refined their project envelope prior to application so they present a single design scenario for each of the alpha & bravo sites.

	NNG scenario 9	**NNG scenario 12**	**Inch Cape 'small'**	**Inch Cape 'large'**	**Seagreen alpha**	**Seagreen bravo**
Latitude (degrees)	56.27	56.27	56.40	56.40	56.37	56.37
Number of turbines	90	75	213	213	75	75
Tidal offset (m)	2.65	2.65	-	-	-	-
Turbine model	5MW	6MW	small	large	7MW	7MW
Rotation speed (rpm)	10.2	8	7.85	7.39	10.64	10.64
Rotor radius (m)	67.5	77	60	86	83.5	83.5
Hub height (HAT)	92.35	101.85	84.975	110.975	107	107
Max blade width (m)	4.8	5	4.5	6	5.4	5.4
Pitch (degrees)	15	15	10	10	10	10

Calculating hub height and use of tidal offsets

We have used the hub height calculations provided by each developer. In collision risk modelling we use hub height values corrected to mean sea level (MSL) so that the results are comparable between developments and also with the Cook *et. al* 2012 bird flight height dataset (Appendix 5). The developers used different methods to correct to MSL: Neart na Gaoithe was the only developer to use the tidal offset option to undertake this calculation.

Calculating turbine rotation speed during the breeding season

We used the turbine rotation speeds (rpm) provided by each developer as follows:

Neart na Gaoithe provided a single rpm value, i.e. the same value was used over the whole year.

Inch Cape and **Seagreen** both provided monthly rpm values, which we used to calculate a mean rotation speed for the breeding season for each species and likewise for the non-breeding season. (The breeding seasons we use for reference are noted in our supporting CRM spreadsheets.)

Amount of time turbines are operational

The amount of time that turbines are predicted to be operational also influences the collision risk modelling. There is an argument that, for the purposes of cumulative impact assessment, standard values should be used to ensure comparability across each of the wind farm proposals. However, as requested, we have used each developer's own estimate of turbine down-time for maintenance and weather conditions, as follows:

Monthly proportion of time operational	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Neart na Gaoithe scenario 9	88.0%	84.6%	84.9%	82.7%	83.1%	82.2%	81.2%	79.4%	83.5%	84.9%	87.2%	83.8%
Neart na Gaoithe scenario 12	88.5%	86.4%	87.1%	85.5%	85.8%	84.7%	84.2%	82.4%	85.8%	86.6%	88.9%	85.7%
Inch Cape 'small'	91.7%	92.2%	91.9%	90.5%	89.7%	89.1%	89.3%	91.0%	92.0%	92.4%	92.0%	92.0%
Inch Cape 'large'	92.3%	92.3%	92.0%	90.5%	89.7%	90.4%	89.1%	89.3%	91.0%	92.1%	92.6%	92.3%
Seagreen alpha & bravo	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%

APPENDIX A7

Background to screening the HRA for SPA seabird species

The Forth & Tay Offshore Wind Developer's Group (FTOWDG) – comprising Mainstream for Neart na Gaoithe; Repsol for Inch Cape, and Seagreen for proposed development in the Round 3 zone – facilitated pre-application dialogue on bird interests. Marine Scotland, Crown Estate, developers and consultants and SNH & JNCC attended meetings.

SNH & JNCC provided scoping advice for each proposal (scoping response and HRA advice for Neart na Gaoithe, 28 January 2010 and 31 August 2010 respectively; for Seagreen, 8 September 2010 and for Inch Cape, 29 October 2010). In these responses we outlined the process of Habitats Regulations Appraisal (HRA) for a range of seabird species under consideration as qualifying interests of Special Protection Areas.

Further to this, the developers (as FTOWDG) indicated how they would approach cumulative impact assessment for bird interests in a number of discussion documents, which we have commented on. All parties worked from an initial 'long-list' of bird species (first submitted 22 October 2009) including all relevant SPA seabirds within foraging range of the wind farm sites, based on data available from the Birdlife International seabird database[17], and any other available sources such as the Future of the Atlantic Marine Environment (FAME) project[18]. This 'long list' informed the scope of potential impacts and, through FTOWDG discussions, was worked up into the 'short-list' of key SPA seabird species provided in **Appendix A3.**

At scoping stage, SNH & JNCC advised all parties that the HRA process would take precedence over EIA for the key SPA seabird species of concern. We asked FTOWDG to undertake a 'preliminary analysis' of the potential cumulative impacts on these key SPA species from the proposed offshore wind farms in the Forth & Tay. Following the meeting held 19 August 2011, FTOWDG commissioned Niras to undertake this work and provided a report on 21 March 2012.

This report concluded that the "preliminary analysis clearly indicates that cumulative impacts on bird species are a key concern and potentially a limiting factor for offshore wind development in the Outer Forth & Tay". Further to this, Marine Scotland commissioned two key projects to help inform the ornithological impact assessment for the Forth & Tay wind farm proposals[19], undertaken by Centre for Ecology and Hydrology (CEH):

- Review of population viability analyses for seabird populations on the east coast of Scotland.
- Population consequences of displacement from proposed offshore wind developments for seabirds breeding at Scottish SPAs.

The outputs from each of these projects have been essential to inform the HRA advice we provide in **Appendix A1**: it would not be possible to base this advice solely on the environmental statements and ES addendums submitted by each of the developers.

Crucially, during pre-application discussions, the participants in FTOWDG could not agree a common methodology for each step in the overall ornithological impact assessment. This means there is no commonality of approach ('common currency') in developers' submissions, either in respect of reference populations for each species, how to apportion impacts between different populations (SPA and/or non-SPA breeding colonies), nor in the approaches to collision risk modelling and assessment of displacement impacts where different assumptions had been made and a range of parameters used.

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[17] Birdlife International seabird database, available at: http://seabird.wikispaces.com/

[18] http://www.rspb.org.uk/ourwork/projects/details/255106-future-of-the-atlantic-marine-environment-fame-

[19] Project information available from: http://www.scotland.gov.uk/Topics/marine/marineenergy/Research

SNH and JNCC have worked together, along with MSS, to agree common approaches and methods that we can use to undertake cumulative impact assessment for the Forth & Tay proposals in respect of bird interests. These assessments are informed by the displacement modelling and population viability analyses (PVAs) undertaken by CEH. These enable us to combine and compare the impacts of the three proposals to assess whether there are any long-term population consequences arising from potential wind farm impacts (collision risk and / or displacement). In respect of SPA seabirds, this informs the conclusion as to whether or not there could be any adverse impacts on SPA site integrity, as presented in **Appendix A1.**

APPENDIX A8

Advice on environmental impact assessment for ornithological interests

1. Seabird species

During the breeding season a large proportion of the seabirds recorded at the proposed Forth & Tay offshore wind sites will originate from (show 'connectivity' to) SPA breeding colonies located within foraging range, on which we provide our HRA advice in **Appendix A1**. For individuals breeding outwith SPAs and for assessment in the non-breeding season (i.e. aspects not captured under HRA), we can only provide a qualitative assessment. This is a **key limitation** to our current advice on the Forth & Tay wind farms, especially in relation to **kittiwake, gannet** and **puffin**, where high levels of impact to SPA breeding populations are predicted under HRA.

We note that the planned development of renewable energy in UK waters could involve multiple developments, and their associated impacts, operating across a species range over many years. This could have the potential to impact on seabird species at large spatial scales. Continued strategic discussion is therefore required between UK regulators (including Marine Scotland) and statutory nature conservation advisers (including JNCC & SNH) to develop a robust framework for cumulative impact assessment across UK waters as a whole.

In this regard, a UK-wide research contract has recently been let to establish the scale at which non-breeding populations of seabirds should be defined, and the outcomes of this work should be helpful to inform any such wider-scale assessments. We also note that MSS also commissioned a report on the strategic collision risk of Scottish wind farms to migratory bird species[20]. We welcome this work as a preliminary step, however, there are a number of outstanding questions relating to seabirds on migration, therefore the project outputs for seabird species are not for use in any project-specific impact assessments.

Under EIA these are the issues to consider for the following key seabird species:

Kittiwake

The total annual collision risk figure for kittiwake (including numbers apportioned for HRA during the breeding season) ranges between **2,481 (Option 2)** and **445 (Option 3)** which is substantial compared to the predictions in our HRA advice (713 – Option 2). Acknowledging the lack of thresholds for this additional annual mortality at an EIA level[21], and noting that we have no data for displacement-related mortality outside of the breeding season, we advise Marine Scotland that the additional potential mortality highlighted from the FTOWDG developments could contribute a significant proportion of total UK cumulative mortality.

Northern gannet, great black-back gull, lesser black-backed gull, razorbill

In respect of these species, there may be significant cumulative impacts at a UK-level arising from consented and proposed wind farm development in UK waters. For further detail, please see the assessments that have been submitted for the East Anglia and Hornsea offshore wind proposals. [22,23]

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[20] Project information available from: http://www.scotland.gov.uk/Topics/marine/marineenergy/Research

[21] Due to a lack of an appropriate Biologically Defined Minimum Population Scale (BDMPS) for this species at these sites, at this time.

[22] East Anglia JNCC Written Rep: http://infrastructure.planningportal.gov.uk/wp-content/ipc/uploads/projects/EN010025/2.%20Post-Submission/Representations/Written%20Representations/Natural%20England%20and%20JNCC%20-%20Dr%20Sophy%20Allen%20expert%20report%20on%20Offshore%20Ornithology%20EIA.pdf

[23] Hornsea Natural England Representation: http://infrastructure.planningportal.gov.uk/wp-content/ipc/uploads/projects/EN010033/2.%20Post-Submission/Representations/Written%20Representations/Natural%20England.pdf

Herring gull, Atlantic puffin, common guillemot
There are considerable collision and/or displacement impacts predicted on these species across a range of projects that are currently within the English consenting process. We highlight the potential for impacts to populations of these species at a UK-wide level. However, any assessment of such impacts is limited by the lack of available data on the impacts of Rounds 1 and 2 projects and the lack of a UK-wide agreed process for assessing impacts to these species outwith the breeding season.

2. Advice on potential collision risk to migratory wildfowl and waders

Our discussion at FTOWDG meetings concentrated on assessment of impacts to seabirds. We recognised, however, that the potential collision risk presented by offshore wind farms to migratory wildfowl and waders would also need to be addressed (please see our scoping advice on each proposal and note that the original 'long-list' included wildfowl and waders as well as seabird species).

To inform early consideration of these issues, SNH undertook collision risk modelling for Svalbard barnacle geese where there is only one population that over-winters in Scotland – found at the Upper Solway Flats & Marshes SPA. We modelled the "worst case" collision risk that could be presented to these barnacle geese from the offshore wind farm proposals in the Forth & Tay.

We assumed a "worst case" that the entire Svalbard population wintering at the Solway flies through the collision risk window presented by the Forth & Tay turbines once during autumn, and once back in spring. The outputs from this modelling indicated that there would be no significant collision risk to this species from the Forth & Tay proposals, and we shared the results with Marine Scotland and FTOWDG for the meeting held on 7 April 2011.

While we were able to do this work for the Svalbard barnacle geese, we advise that it is not currently possible to apply a site-specific HRA process to any other migratory wildfowl or waders. This is because we cannot identify which particular SPA(s) any individuals may be travelling to or from. SNH & JNCC therefore support use of the strategic collision risk assessment commissioned by Marine Scotland where it relates to migratory wildfowl and waders (see footnote below).