Joint SNCB[1] Interim Displacement Advice Note

Advice on how to present assessment information on the extent and potential consequences of seabird displacement from Offshore Wind Farm (OWF) developments

January 2017 (updated January 2022 to include reference to the Joint SNCB Interim Advice on the Treatment of Displacement for Red-Throated Diver)

Summary of input requirements for displacement assessment

Inputs required:

- Full details of survey techniques.
- Site-based density estimates to include birds on water and in flight.
- Proportions of different age classes of birds (where possible).
- Monthly population estimates presented for minimum two years[2] pre-consent monitoring.
- Raw count data to be included in report appendices.
- Counts to be assessed as mean seasonal peaks[3] (averaged over the years of survey).
- Population estimates for the development footprint and also for the development footprint plus a standard displacement buffer. Buffer of 2km for all species with the exception of divers and sea ducks where a 4km displacement buffer is recommended and red-throated diver where a 10km[4] buffer is recommended.
- Full details of the development (with worst case and typical scenarios) including size of development footprint alone and size plus appropriate outer buffer – usually 2km[5]. (Abundance estimates will be required for site with and without buffer zone).

[1]SNCB – Statutory Nature Conservation Bodies in this case comprising Natural Resources Wales (NRW), Department of Agriculture, Environment and Rural Affairs / Northern Ireland Environment Agency (DAERA/NIEA), Natural England (NE), Scottish Natural Heritage (SNH) and Joint Nature Conservation Committee (JNCC)
[2]Lower level of data provision may be agreed in some cases (e.g. 18 months ensuring 2 breeding season periods covered if other baseline data available).
[3] Mean seasonal peaks – the mean of the peak counts for each season assessed. If season is April – July and monthly counts of 338, 720, 418 and 552 are recorded the season peak is 720. If three repeat seasons are assessed and the peak counts from the three seasons are 720, 979 and 501 the mean seasonal peak value is the mean of these three counts i.e. 733.
[4] Joint SNCB Interim Advice On The Treatment Of Displacement For Red-Throated Diver (2022).
[5] 2km for most species, 4km for sensitive species (e.g. divers and seaducks) with the exception of red-throated diver (see Joint SNCB Interim Advice On The Treatment Of Displacement For Red-Throated Diver (2022)).

Advice on the treatment of displacement for red-throated diver

Specific advice on the treatment of displacement for red-throated diver is provided within an annex[6] to this main advice note.

[6]Joint SNCB Interim Advice On The Treatment Of Displacement For Red-Throated Diver (2022)

Summary of data treatment for displacement assessment

Data manipulation and assessment criteria:

- A 'power analysis' should be used to identify the probability of being able to detect specified levels of change in abundance associated with varying survey effort. Surveys should provide complete seasonal coverage.
- Any count adjustment and correction to be fully documented (e.g. for availability bias, distance sampling effects).
- Species to be assessed should be selected based on sensitivity scores and local observation or empirical data.
- Breeding season[7] assessment to be done against an appropriate regional population scale, as agreed with SNCBs (but likely to cover total colony counts[8] within mean-max foraging range[9]).
- Non-breeding season assessment done against appropriate population scale (e.g. Furness 2015), as agreed with SNCBs.
- Use published indices of disturbance (e.g. Furness *et al*. 2013) to assign a range of displacement levels for each species individually. The SNCBs note that further evidence is emerging that may confirm or suggest modifications to these scores and likely displacement levels (e.g. Wade *et al. 2016).*
- Use published indices of habitat flexibility (e.g. Furness *et al*. 2013), other empirical evidence if available, and discussions with SNCBs; to agree appropriate levels of likely adult mortality associated with particular displacement levels, for each species individually (acknowledging data very limited at this time).
- Use above two metrics to compile a 'Matrix Approach' table (i.e. representing proportions of birds potentially displaced/dying as a result of OWF development). Table should be presented from 0-100%, in 10% increments for displacement levels. Percentage increments for mortality should also be presented between 0-100%, but including smaller increments at lower values (e.g. 0%, 1%, 2%, 5%, 10%, 20%…..). At this time impacts to breeding success, although plausible are not being considered, unless site specific information exists. The approach here assesses mortality of full grown individuals connected to the development site.
- Impacts to be assessed for a minimum of two seasons (i.e. breeding and non-breeding season). For some species more than two seasons may be appropriate (e.g. based on post-breeding dispersal periods for auks or migration seasons defined for species in Furness 2015), on discussion with SNCBs.
- Seasonal impacts should be summed across seasons. While acknowledged that this could result in birds being assessed in more than one season, and thus double counted, the precautionary approach is required in absence of empirical information on seasonal turnover on development sites.
- Displacement impacts and collision impacts will be added together for assessment of total impacts. This is acknowledged to involve some degree of double counting, but is adopted as a precautionary approach in the absence, at present, of being able to distinguish between birds which might be subject to collision and those that may be displaced.

[7]Potentially suitable seasons/periodicity can be found in Furness (2015), but can vary by location so should also be agreed with SNCBs.
[8] JNCC Seabird Monitoring Programme a good source of most recent UK colony count data.
[9]See Thaxter *et al.* (2012), although more recent tracking data to be used, in discussion with SNCBs, if more up-to-date.

1. Aim of document

This interim displacement advice note replaces an earlier NE and JNCC joint advice note from 2012 (NE and JNCC 2012). It updates the previous note to take account of potential areas of disparity in approaches that have arisen in casework since the original note was issued. It also follows on from a Displacement Workshop (6-7 May 2015), run by JNCC and the Marine Renewables Ornithology Group (MROG) and funded by The Crown Estate, which sought to make progress towards developing a more refined best practice approach to assessing displacement impacts.

Following recommendations made at the workshop, it was agreed that this Joint SNCB interim displacement advice note would contribute towards achieving one of the recommendations (i.e. the creation of a short-term SNCB advice position). This document is intended to address critical areas of clarification and SNCB positioning. It will not attempt to cover (or make progress towards) the more complex issues of displacement assessment at this time. Nor will it cover the expert elicitation recommendation that came out of the displacement workshop, as it was agreed at a meeting of the SNCBs in June 2015 that this could more realistically be produced against a medium-term objective, in a further round of SNCB guidance.

SNCB advice and positioning on displacement assessment methods and approaches will be an iterative process, with at least three stages expected (see Displacement Workshop report 'Next Steps' section, for more details).

The key changes to this document since the earlier advice note are:

- A clearer definition of displacement and barrier terms.
- Further clarity on the application of the 'Matrix Approach'.
- Further clarity on the use of sensitivity scores in relation to the 'Matrix Approach' (based on evidence obtained since the original NE and JNCC advice note (NE and JNCC 2012)).

In addition, this interim advice note aims to provide:

- Advice on how to present information to enable comparable and transparent assessment of the magnitude and potential impacts of seabird displacement from OWFs.
- A method to enable displacement impacts to be compared and potentially combined across multiple sites/projects/activities, with an eye to improving Cumulative Impact Assessment (CIA) approaches for this impact.

Future revision of this advice note is anticipated when new empirical evidence of displacement levels and associated population-level impacts (e.g. changes to productivity or mortality levels) becomes available. Currently our recommendations are aimed at capturing the full range of potential impacts, while encouraging developers to present any species-specific evidence to further refine this as part of both Habitat Regulations Assessment (HRA) and Environmental Impact Assessment (EIA) processes. It is anticipated we will be able to narrow down predicted range of impacts as more results from post-consent monitoring and other studies are produced.

2. Background

Individual species react differently to the construction, operation and decommissioning of OWFs (and other offshore developments). Several species groups display avoidance of operational OWFs. However, for all development types during operation, construction and decommissioning, activities such as towing, pile driving or presence of maintenance/service vessels in the vicinity may cause disturbance (Fox and Petersen 2006; Krijgsveld *et al*. 2011; Vanermen *et al*. 2014). Displacement (see definitions below) can pose a potential ecological threat to seabirds as it can result in habitat loss, in the form of foraging or rafting areas. For adaptive species this may not be a problem, but for less adaptive or constrained species/individuals (e.g. during breeding season) this may result in ecological and/or population level consequences.

3. Definitions of disturbance, displacement, and barrier effects

Disturbance

Disturbance exists when a bird's normal pattern of activity is interrupted by an anthropogenic activity. Birds using a given area of sea for a range of activities e.g. feeding, resting, commuting etc. may be disturbed by the occurrence of human activities or artifacts in or near those areas. Birds may choose to avoid such sources of disturbance (e.g. by swimming or flying away during the disturbance event to continue their activity elsewhere) and may not return until sometime later. The duration of return times coupled with the frequency of disturbing events, may combine to result in longer term and potentially continual reductions of numbers in an area of impact (i.e. displacement) which may be partial or total.

Displacement

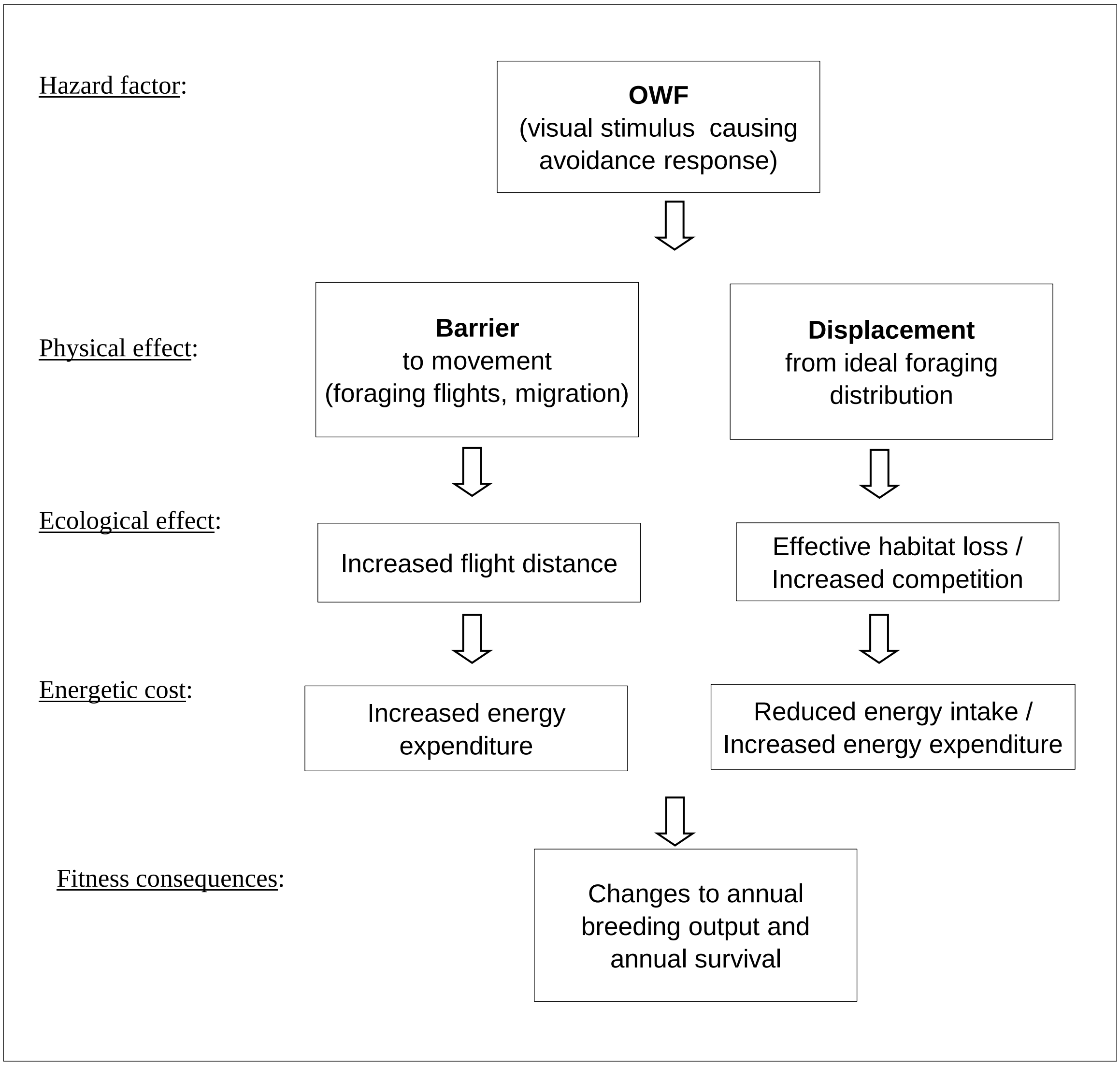
In relation to offshore wind farm development, Furness *et al*. (2013) define displacement as 'a reduced number of birds occurring within or immediately adjacent to an offshore wind farm'. Displacement, as an effect, may occur both in the area of the disturbance or development and to some distance beyond it – known as a 'buffer' (e.g. Mendel *et al*. 2014). The degree of displacement, both in terms of length of time and proportion of the original source population affected, may vary seasonally and between species. We define **displacement as affecting birds present both in the air and on the water**. This is in contrast to the definition in Cook *et al*. (2014) which included only birds on the water as capable of being displaced (birds in flight which were deterred from entering the wind farm are considered to form the component of 'macro-avoidance'), but while these birds are not at risk of collision they are potentially at risk of impacts arising from their displacement from wind farm areas. Birds that would have previously passed through the footprint of the disturbance area to a more distant feeding, resting or nesting area, but now choose either to stop short or detour around the location are said to be affected by barrier impacts (see below).

Barrier

A barrier is a physical factor that limits the migration, or free movement of individuals or populations, thus requiring them to divert from their intended path in order to reach their original destination. This effect is expected to increase the energy expenditure of birds if they have to fly around the area in question in order to reach their goal. Birds experiencing barrier effects are typically in flight, but not necessarily always so. For the purposes of this description, however, **we interpret barrier effects to mean applying to birds in flight**. Barrier effects are more likely to result in individual/population level impacts, if they occur during the breeding season (and at colonies close to an OWF). Individuals may repeatedly deviate from their normal foraging trajectories at this crucial stage in their annual cycle. Individuals are less constrained during the non-breeding season (i.e. no longer central-placed foragers). Therefore, increases to overall flight costs due to barrier effects while on migration are likely to be very small (Topping and Petersen 2011).

A key distinction between barrier and displacement is that birds experiencing barrier effects typically travel longer distances (i.e. to some point beyond the OWF) and did not intend to forage/utilise the OWF site itself, but some area beyond it. However, it is hard to define where an individual may have intended to travel to, even using tracking data. Therefore, in this advice note we do not provide specific recommendations on the treatment/assessment of barrier effects. As and when technological advances allow for quantitative distinction between these two effects, it may be possible to separate these two impacts within future Displacement Assessment Frameworks (DAFs).

Figure 1. Barrier and displacement effects illustrated (adapted from Petersen *et al*. 2006).



SNCB advice section – barrier and displacement effects

It is recognised that a proportion of the birds recorded in wind farm areas may be transiting through the site (and therefore potentially affected by barrier effects, rather than displacement from the wind farm area) and that this is more likely to be the case for flying birds. However, at present we do not have enough evidence to separate these impacts out and apportion to the two groups. Therefore it is assumed that total numbers of birds on site (flying and on water) are subject to displacement impacts. However, as remote tracking of seabirds continues to expand our knowledge on seabird behavior it may be possible to provide further information on the relative impacts of both issues – this position will be kept under review.

4. Data recording and presentation

In order to address displacement impacts for offshore wind developments, developers should present the following minimum level of data collected in the manner described in guidance documents elsewhere (see Appendix 1). That information should include:

- Full details of survey techniques (platform, transects, temporal and spatial extent of surveys) and how density estimates (and derived abundance estimates) have been calculated.
- Details of if/how density estimates have been corrected to account for availability bias and detection probabilities.
- Accurate information on size of OWF area plus appropriate buffer area calculations.
- Total abundance estimates of birds on water and in flight (and summed). This should be presented separately for the OWF site plus appropriate buffer area, with the extent of buffer area clearly indicated (see Section 6).
- Age or age-class of birds (where this can be determined).

SNCBs recommend **assessing impacts of displacement based on the overall mean seasonal peak numbers of birds (averaged over the years of survey)** in the development footprint and appropriate buffer (see Section 6 on defining appropriate buffer zones). This is a combined estimate of the **number of birds on the water** (corrected for survey coverage and distance analysis/diving species availability bias, if appropriate) and of the **number of birds in flight** (corrected for survey coverage). Methods for estimating birds at sea, both on the water and in flight, have advanced dramatically in recent years. However, standard methodologies for correcting for diving species availability bias are still in development. Hence, decisions made with regards to these components of input data (both for Collision Risk Models (CRM) and displacement) should be discussed and agreed with SNCBs at the time.

Where possible, the ratio of detected age classes should be reported. Age class ratios may differ seasonally and regionally, and ratios obtained from on-site survey data are preferred (if of sufficient quality). Where site specific data on age class ratios are not available there may be other sources of evidence that can be used such as other offshore datasets, colony studies of age ratios or ratios from stable age structures generated from population models. While separation of age classes is not directly used in the 'Matrix Approach' (the matrix should include abundance figures that relate to all birds in the project area, across all age classes), it can be crucial for later stages in the assessment process (e.g. when applying appropriate biologically relevant population scales and making assessments of population-level impacts).

SNCBs advise that at least two full years of monthly survey data should be collected pre-construction. This should be considered the bare minimum for assessment purposes. However, a more appropriate approach is to initially conduct a power analysis to confirm how many years survey data are required to adequately characterise any potential changes to bird abundances (on a species-by-species basis) in response to future OWF development. The number of years survey effort is likely to vary between species, site, and data collection method (e.g. digital aerial versus boat-based observers). Ideally, survey programmes should commence at the beginning of a clearly defined biological season, such that the period of survey will provide complete seasonal coverage in terms of data collection (without the need to combine incomplete data for seasons across different years, when calculating mean seasonal peak abundance estimates).

Data should be provided in a format that allows the calculation of **mean seasonal peak population estimates based on several years data**. For example, for a species with a breeding season from April to July, this requires the average of the peak count between April and July in year one, and the peak count between April and July in a second year. This may require the counts to originate from different months in the two years (e.g. May in the first year and June in the second year). In practice this requires consistent monthly abundance estimates for each year of survey. This allows for year-to-year variation in the precise time (and magnitude) of peak abundance estimates to be taken into account in arriving at a mean peak population estimate. To allow recalculation of values, best practice requires presentation of monthly values in summary and full data from all surveys in an appendix to any report.

5. Selection of species for displacement assessment

Sensitivity to displacement differs considerably between seabird species. To focus impact assessment, SNCBs recommend that consideration is given to each species observed within a development site and informed by:

- i) Species presence at the development site (or development sites in the case of in-combination assessments).
- ii) Susceptibility to disturbance and habitat specialisation scores for species found in Scottish waters (Furness *et al.* 2013), and the expanded list for wider UK waters (Bradbury *et al.* 2014), covering additional species not previously included in Furness *et al.* (2013).

Furness *et al*. (2013) assessed seabird species occurring in Scottish waters by; 1) scoring species for sensitivity to disturbance by wind farm structures, ship and helicopter traffic, and 2) the degree of habitat specialisation. These two metrics together give an indication of which species are expected to be most susceptible to displacement impacts. The same scoring system and scores were used by Bradbury *et al*. (2014), although they expanded the species list to account for additional species that occur in English waters. Reference to these values will help developers and SNCBs determine the most relevant species for assessment at the site-specific level.

SNCB advice section – screening species for displacement assessment

It is recognised that, regardless of these scores, it is unlikely that cormorant and gull species will need to be routinely assessed for displacement, as a number of empirical studies have demonstrated these species can also be attracted as well as display no noticeable reaction to the presence of OWFs (e.g. Leopold *et al*. 2013; Vanermen *et al.* 2014; Petersen *et al.* 2006; Mendel *et al.* 2014). **The priority species for assessment of displacement effects will typically be diver and sea duck species, guillemot, razorbill, puffin and gannet.**

As a general guide, any species scoring 3 or more under either category (‘*Disturbance Susceptibility*’ or ‘*Habitat Specialization’*) in Table 1, and which is present in the OWF site or buffer should be progressed to the matrix stage unless there is strong empirical evidence to the contrary. Gannet, with a score of 2, is an obvious exception to this general guide as there are empirical studies demonstrating they are sensitive to displacement and barrier effects (Krijgsveld *et al*. 2011, Vanermen *et al.* 2013). The scores for this species have been revised in a recent publication by Wade *et al. (2016.)*.

Table 1. 'Disturbance Sensitivity' and 'Habitat Specialization' scores from Bradbury *et al*. (2014) (expanded from Furness *et al.* 2013). No 'real' value is implied by these scores, although species with higher scores are considered more sensitive to displacement. (Grey content = species with scores of 3 or higher in either category).

Species	**Scientific name**	**Disturbance Susceptibility**	**Habitat Specialization**
Common scoter[$]	*Melanitta nigra*	5	4
Red-throated diver[$]	*Gavia stellata*	5	4
Black-throated diver[$]	*Gavia arctica*	5	4
White-billed diver[$]	*Gavia adamsii*	5	4
Velvet scoter[$]	*Melanitta fusca*	5	3
Great northern diver[$]	*Gavia immer*	5	3
Greater scaup[$]	*Aythya marila*	4	4
Common goldeneye[$]	*Bucephala clangula*	4	4
Goosander[$]	*Mergus merganser*	4	4
Great cormorant†	*Phalcrocoax carbo*	4	3
Common eider[$]	*Somateria mollisima*	3	4
Long-tailed duck[$]	*Clangula hymalis*	3	4
Red-breasted merganser[$]	*Mergus serrator*	3	4
Great-crested grebe	*Podiceps cristatus*	3	4
Slavonian Grebe	*Podiceps auritus*	3	4
Black guillemot*	*Cepphus grylle*	3	4
Shag	*Phalacrocorax aristoltelis*	3	3
Common guillemot	*Uria aalge*	3	3
Razorbill	*Alca torda*	3	3
Little tern	*Sternula albifrons*	2	4
Sabine's gull*	*Xena sabini*	2	3
Black tern	*Childonias niger*	2	3
Sandwich tern	*Sterna sandivicensis*	2	3
Roseate tern	*Sterna dougalii*	2	3
Arctic tern	*Sterna paradisaea*	2	3
Atlantic puffin	*Fratecula arctica*	2	3
Mediterranean gull*	*Larus melanocephalus*	2	2
Common gull*	*Larus canus*	2	2
Great black-backed gull*	*Larus marinus*	2	2
Black-legged kittiwake*	*Rissa tridactyla*	2	2
Little auk	*Alle alle*	2	2
Northern gannet[&]*	*Morus bassanas*	2	1
Lesser black-backed gull*	*Larus fuscus*	2	1
Herring gull*	*Larus argentatus*	2	1
Iceland gull*	*Larus glaucoides*	2	1
Glaucous gull*	*Larus hyperboreus*	2	1

Species	Scientific name	Disturbance Susceptibility	Habitat Specialization
Black-headed gull*	*Chroicocephalus ridibundus*	1	3
Grey phalarope	*Phalaropus fulicarius*	1	2
Red-necked phalarope	*Phalaropus lobatus*	1	2
Pomarine skua	*Stercorarius pomarinus*	1	2
Arctic skua	*Stercorarius parasiticus*	1	2
Great skua	*Stercorarius skua*	1	2
Long-tailed skua	*Stercorarius longicaudus*	1	2
Northern fulmar	*Fulmaris glacialis*	1	1
Cory's shearwater	*Calonectris diomedea*	1	1
Great shearwater	*Puffinus gravis*	1	1
Sooty shearwater	*Puffinus griseus*	1	1
Manx shearwater	*Puffinus puffinus*	1	1
Balearic shearwater	*Puffinus mauretanicus*	1	1
Wilson's storm petrel	*Oveanites oceanites*	1	1
European storm petrel	*Hydrobates pelagicus*	1	1
Leach's storm petrel	*Oceanodroma leucorhoa*	1	1

& Species to be progressed to 'Matrix Approach' regardless of scores, due to more recent empirical data (see main text for references).
† Species not usually to be progressed to 'Matrix Approach', due to more recent empirical data demonstrating frequent attraction to OWFs (see main text for references).
* Species where some age class differentiation is expected in survey counts.
$ Species where buffer distance for assessment would be 4 km (2 km being the default for others).

In previous SNCB advice on displacement assessment (NE and JNCC 2012), a 1% threshold of regional population scales was given as a guide for species to be taken forward to quantitative displacement assessment, with the exception of those species with a significant element of turnover (i.e. passage migrants, which might be undercounted). This is no longer recommended as a suitable guide due to the potential for species to be screened out of predictive displacement impact assessments at an individual project level, which might otherwise have been flagged as an issue at the CIA level.

There is an issue with how to appropriately treat species that are more likely to be encountered in development areas as passage migrants (i.e. likely to be transiting through the area and where there may be a high degree of turnover of individuals at a particular site). For these types of species (e.g. skuas and shearwaters) it might be predicted that, as individuals are using the development area only briefly and rarely, they might be more realistically examined solely from the perspective of barrier effects. However, as there is no standardised method for examining barrier effects (albeit some developers have developed useful passage migrant models to predict impacts, largely for collision, on these types of species) we recommend that if turnover is thought to be an issue for a given species at a particular site, this be considered on a site-by-site basis.

6. Displacement buffers

Seabirds showing avoidance reactions to OWF areas may not only be displaced from the footprint itself, but may also be displaced (possibly to a lesser degree) from the surrounding area (or buffer zone). This additional area must be considered, alongside the OWF site footprint, and included in any displacement assessment.

SNCBs recommend for most species a **standard displacement buffer of 2 km** with the exception of the species groups of divers and sea ducks. Divers and sea ducks have been assessed as being the most sensitive species groups to offshore development and associated boat and helicopter traffic. **Therefore for divers and sea ducks a 4 km displacement buffer** is recommended. This is based on evidence of displacement distances which extend beyond 2km for those species groups (e.g. Percival 2010; Kaiser 2002; Percival 2014; Petersen *et al*. 2006; Fox & Petersen 2006; Petersen *et al.* 2013). **For red-throated diver, a 10km displacement buffer** is recommended in line with the Joint SNCB Interim Advice On The Treatment Of Displacement For Red-Throated Diver (2022).

The SNCBs acknowledge that the evidence for displacement effects leading to reduced densities post-construction beyond 2km from operational wind farms in these sensitive species is mixed but note that there is some evidence of displacement effects up to at least 3km (Percival 2010), and even up to 13km (Petersen *et al.* 2014). Extrapolation of the evidence from Percival (2010) suggests an effect that may radiate out to 5.5km before post-construction densities match those pre-construction. While this is an extrapolation, this effect is considerably less than the extent of significant reductions in diver density reported around Horns Rev (Petersen *et al.* 2013). SNCBs acknowledge that in reality there is likely to be a gradient in the reduction of density with increasing distance from OWF site, but the evidence regarding the slope of this gradient beyond 2km is limited. Until further evidence is gathered, it is recommended that a standard displacement level (%) is applied out to 4km for these more sensitive species groups.

SNCB advice section – use of buffer zones for Offshore Wind Farms

All species taken forward to the matrix stage of displacement assessment should be assessed against impacts to development site plus appropriate buffer. For most species the buffer should be 2km outside the OWF footprint. Exceptions for more sensitive species (i.e. divers and sea ducks) require a 4km buffer zone be applied. In both cases no gradient of impact of displacement level should be applied to the buffer zone, as there is not sufficient evidence to underpin any such gradient application on a species-by-species basis. However, as displacement levels in some instances may exceed 4km, the SNCBs feel this flat application of displacement level across the OWF site plus buffer is sufficiently precautionary. For red-throated diver a 10km buffer zone and gradient should be applied as per the Joint SNCB Interim Advice On The Treatment Of Displacement For Red-Throated Diver (2022).

7. Displacement levels

There is a small but increasing evidence-base on species-specific displacement levels from post-construction monitoring of OWFs. However, at present the published evidence remains sparse and often contradictory. SNCBs consequently need to ensure adequate precaution while at the same time taking due account of emerging evidence. Therefore, developers are encouraged to seek and present emerging sources of empirical evidence to provide support for their displacement assessment.

In the face of limited empirical evidence regarding the percentage of individuals likely to be displaced from an OWF footprint and buffer, SNCBs recommend that the full range of potential displacement (from 0% to 100% of the mean seasonal peak bird numbers observed pre-construction) is presented within a 'Matrix Approach' (see Section 12 for further details). The values should be presented in 10%

intervals. Matrix tables should be presented with and without appropriate buffer data included, to allow for future changes in understanding regarding buffer zones and effects.

Presentation of 0-100% displacement levels in a matrix is a necessary step for all species taken forward to this stage of the assessment, in the face of current levels of uncertainty. However, it may be appropriate to highlight particular sections within the matrix where displacement levels are most likely to fall (i.e. through interpretation of the 'Disturbance Susceptibility' scores and/or reliable empirical data for a given species). Sufficient evidence should be presented to support selection of any highlighted area within the matrix on a species-by-species basis. Moreover, presentation of the full range of figures should not be interpreted as an indication that the SNCBs will inevitably focus their attention and formulate their advice on the most precautionary scenario.

The use of the collected age class data does not occur at the matrix stage, where the total number of full-grown birds is used. Later stages of the process may use the age data to refine what the impacts to sub-sets of the development site population will be.

8. Translating 'Disturbance Susceptibility' scores into displacement levels for 'Matrix Approach'

The 'Disturbance Susceptibility' scores from ship and helicopter traffic (and to a lesser extent OWF) in Bradbury *et al.* (2014) (Table 1) give a possible indication of potential displacement levels that may be exhibited by each species. Without any additional evidence it is assumed that the scores give a crude, but useful, approximation of the levels of displacement that may be experienced by seabirds and can be used to inform the most likely range of displacement for a given species). However, the SNCBs would note that further evidence is emerging that may confirm or suggest future modification to these scores and likely displacement levels (e.g. Wade *et al. 2016*).

SNCB advice section – translating 'Disturbance Susceptibility' scores

The SNCBs intend to use 'Disturbance Susceptibility' scores as a general guide to appropriate displacement levels on a species-by-species basis, rather than to prescriptively read across to particular levels of displacement. That said, for those species lacking in empirical data on likely displacement levels resulting from OWF construction, there is potential utility in using the scores in order to maintain consistency of approach across different developments (where appropriate). For example, for auk species the SNCBs would typically advise a displacement level of 30-70% (Guillemot and Razorbill have a 'Disturbance Susceptibility' score of 3). For diver species a displacement level of 90-100% is likely to be advised (red-throated diver has a 'Disturbance Susceptibility' score of 5 and empirical studies report high levels of displacement). Some species with 'Disturbance Susceptibility' scores of 1 (e.g. northern fulmar) may not be displaced or hardly displaced. If assessment of these species is recommended in a particular case, usually a displacement level of 10% or less is assumed.

9. Displacement impacts - adult mortality and productivity

Displaced individuals, and other individuals with which displaced birds subsequently interact and compete, may experience fitness consequences (i.e. changes to their likelihood of survival and level of reproductive output). Individual fitness may be impacted due to immediate increases in energy expenditure and/or reduced energy intake as a result of relocating to other foraging grounds and experiencing increased competition (an indirect impact resulting from localised habitat loss). Individual fitness may thus be impacted over longer time frames due to negatively affected energy budgets if birds have to relocate to alternative habitat. This impact might operate through increased intra/inter-specific competition due to a higher density of individuals competing for the same resources and/or through a lower quality/quantity of prey (e.g. Burton *et al*. 2006; Durell *et al*. 2001, 2000). This would result in an increase in the energetic cost of average foraging bouts and consequently to a change in daily energy and time budgets (McDonald *et al.* 2012; Searle *et al.* 2014). During the breeding season this in turn could lead to reduced chick provisioning rates and therefore reduced reproductive success. Young birds fledging at lower weights may also have reduced survival. The increased stress on adult birds that are provisioning chicks means they may end the breeding season in poorer condition than they otherwise would have. This might be expected to have consequences on adult survival during the rest of the year, particularly over winter.

However, there is a lack of empirical evidence on the consequence of displacement to seabirds, in terms of both their mortality and productivity. For other types of birds, e.g. waders, it has been established that displaced individuals are more likely to die than other individuals (Burton *et al.* 2006). Behaviour-based computer simulation models of waders, geese and sea ducks have also demonstrated that displacement can, through changes to the energy budgets of individuals, lead to changes to mortality levels (Pettifor *et al.* 2000; West *et al.* 2003; Kaiser *et al.* 2002). However, Topping and Petersen's model showed no such effects on wintering divers (Topping and Petersen 2011). Searle *et al.* (2014) have recently developed a simulation model that predicts changes to seabird productivity and adult survival arising from simulated displacement and barrier effects associated with OWFs in the Forth & Tay regions of Scotland. However, whether an impact on demographic rates is predicted by such models is highly dependent upon the particulars of the case being modeled and no simple generalities can be drawn.

It seems probable that the fitness consequences of displacement (in terms of productivity and mortality) might vary between stages of the annual life cycle. However, once again, empirical data on this is lacking. Until supporting data can be collected this is considered theoretically plausible but unproven.

SNCB advice section – productivity impacts not assessed

Due to the large degree of uncertainty regarding the impact of displacement on different components of seabird demography (for example, impacts on chick survival arising from displacement effects experienced by adult birds) the SNCBs currently advise that only **mortality of individuals displaced from the development site (plus buffer)** be considered in the 'Matrix Approach' at this time.

10. Selecting appropriate mortality levels for the 'Matrix Approach'

As highlighted in Section 9, Searle *et al.* (2014) demonstrated through simulation modelling, that displacement and barrier effects could impact both breeding season productivity and adult mortality throughout the year. However, as this model operated at an individual-based and colony level, it is not possible to directly translate percentages (of productivity and mortality) from this study into useful application with the 'Matrix Approach' as the latter is based on site-based abundance estimates.

Bird species showing limited flexibility in habitat use will be expected to experience greater fitness consequences from displacement compared to those species that are more generalised (at least in non-marine habitats e.g. Colles *et al*. 2009; Duraes *et al*. 2013). Therefore, the scores of species-specific 'Habitat Specialisation' (Table 1) can be used to provide an indication of the relative scale of mortality arising from displacement for each species. Species considered less flexible in their habitat use, are likely to be more vulnerable to displacement from favoured habitats. A high score for specialisation would therefore be expected to indicate a higher level of potential mortality.

Although it appears to be a sound principle, there is very little, if any, evidence connecting 'Habitat Specialization' scores (Bradbury *et al.* 2014) of individual species with potential mortality levels as a consequence of displacement. Therefore the SNCBs do not advise a standardised translation of these scores across to mortality percentages within the matrix. **It is recommended that the presentation of 0-100% mortality of displaced birds for all species taken forward to the matrix stage. Once again, this should be presented in 10% increments.** However, in acknowledgement that for some less constrained species (e.g. shearwaters) the level of both adult mortality and reduced productivity resulting from displacement are likely to be in the lower range (i.e. 1-10%) it is appropriate to have a finer gradation of percentage mortality impacts at the lower range of the scale (see Table 3).

While the SNCBs do not recommend a direct translation of the 'Habitat Specialisation' score into a specific mortality level, this information is still useful, when combined with expert opinion, as to the likely range of possible mortality impacts resulting from particular levels of displacement.

Finally, it is important to recognise and (qualitatively) account for the quality of habitat being lost at an OWF site and its importance relative to alternative available habitat, which displaced birds may reasonably utilise instead. Expert opinion on mortality levels should take account of site-specific characteristics in coming to a judgement on likely mortality levels. In future it is hoped that, with more empirical evidence linking displacement levels to mortality/productivity consequences, a more quantitative approach can be developed.

SNCB advice section – mortality and productivity

At present the 'Matrix Approach' should only be applied, in relation to **predicted adult mortality levels for birds present on the site (plus buffer)** for each defined season. In other words, a separate productivity matrix is not required at this time. However, this is something which may be revised in subsequent advice should suitable methods be developed along with an improved evidence-base. Appropriate **mortality levels** should be selected based on **expert opinion and in discussion with SNCBs**. The selected mortality levels should be appropriately precautionary, given it is currently intended to (qualitatively) address the potential population level impacts of displacement on both mortality and productivity combined.

As with displacement levels, **mortality levels should be presented for the full range of 0-100%**. However, for mortality the assessment should be presented at **10% increments, as well as 1% increments from 0-5%**, with expert opinion focusing in on highlighting likely potential ranges within this complete range.

11. Seasonality

In addition to the complexity introduced by the uncertainty over likely impacts to different demographic parameters (i.e. mortality versus productivity), there is also the potential for displacement levels and impacts to vary according to season. Given there is currently no empirical evidence on the impacts of displacement to seabirds, the SNCBs do not view it as appropriate at this time to apply varying mortality levels by season. This is because the theoretical arguments, as highlighted in previous sections, regarding breeding versus non-breeding season impacts, could be made in either direction. Therefore, the SNCBs recommend that, for the time being, seasonality in the assessment process, in terms of predicted impacts, should be treated consistently. However, the same need not apply to the treatment of varying abundance estimates for the OWF site (plus buffer) by season.

SNCBs recommend that mean seasonal peak abundance be used to produce, as a minimum, two seasonal matrices (breeding and non-breeding season). However, for a number of species there may be evidence to support an additional breakdown of the non-breeding period to account for periods when distribution, activity or population mix are distinctly different (for example post-breeding aggregations of some auk and sea duck species associated with flightless periods, migration periods etc.). Furness (2015) provides a guide to suggested seasonal divisions for a range of species based on evidence for distribution and abundance of species in UK offshore waters at different times of the year.

The ecology of several species supports a need to consider additional seasons (e.g. the post-breeding season) as a distinct period in their annual cycle, during which the impact of displacement may differ from other periods. A lack of empirical evidence requires that the full range of potential mortality (0 – 100%) be presented (albeit with a selected likely range of percentages being highlighted, according to the sensitivity score proxies, for example).

The predicted mortality levels should be summed across seasons. SNCBs acknowledge that this is a precautionary approach, as it is clearly possible that the same bird may be assessed more than once. However, since a large proportion of the birds present in the non-breeding season are often predicted to be different individuals from those present in the breeding season, assessing against different populations for each season is justified. The relevant SNCB should be contacted for advice on the appropriate population scale to use for each season. Therefore, in apportioning impacts back to SPA colonies (e.g. for HRA), only a small number of mortalities in the non-breeding season will be attributed to a particular colony decreasing the likelihood that these will be the same individuals that were assessed during the breeding season. Similarly, in assessing displacement impacts at a wider population scale (e.g. in EIA), it is assumed that individuals present in the project area in the breeding season will be dispersed over a much larger area during the non-breeding season. This reduces the probability that individuals present at the project site at that time will be the same individuals present in the breeding season. Methods that do not consider mortality impacts on populations across all seasons may result in potential impacts being underestimated.

SNCB advice section – seasonality and summing across seasons

The ‘Matrix Approach’ should be applied to a minimum of two seasons (breeding and non-breeding season) using mean seasonal peak abundance estimates for the OWF site (plus buffer). Where appropriate, additional matrix tables should be created for other discrete seasons (e.g. post breeding and migration periods for relevant species). However, decisions regarding how to treat seasonality in any displacement assessment should be made on a site and species-specific basis, in discussion with SNCBs.

When a multi-season assessment is taking place, the predicted mortalities from these various tables should be summed across seasons, **where the relevant geographical range and population scale remains the same or where the assessment involves apportioning back to an SPA colony**. However, an alternative approach for EIA may have to be taken where the appropriate population scale varies with each season. In these instances, the assessment of potential impacts may need to be undertaken against the most appropriate population scale, for each season in turn, although the default position is to assess the summed annual mortality against the largest population scale in the annual cycle for EIA.

12. ‘Matrix Approach’

Data on predicted displacement of seabirds from an OWF site should be presented in the form of a gridded matrix table (or tables) as shown below (Table 3). While presenting the full range of potential displacement and mortality impacts, SNCBs encourage developers to indicate their interpretation of the most likely displacement levels and mortality scenarios by highlighting a range of cells within the matrix, and simultaneously to provide sufficient empirical/modelling evidence to support any highlighted subset of cells.

SNCBs also advise that a range of displacement values are taken through to the assessment of population impacts and not a single figure. The range of population impacts can then also be presented as a matrix so that those levels of displacement which might exceed a particular level of population impact can be easily identified and evaluated. But if only a single figure can be taken forward, this in most cases should be the more precautionary of the sub-set selected (e.g. 20% displaced, 50% mortality, in the below example).

Table 3. Example of Matrix Approach. Cell entries present the estimated number of birds of a given species predicted to be at risk of adult mortality following displacement during a particular season given; i) the seasonal mean peak population within the impacted area (5,000 individuals in this example) ii) the proportion of those birds assumed to be displaced from the impact area; and iii) the assumed proportion of those birds deemed to be at risk of adult mortality as a result of displacement. Cells which are considered, in the light of empirical evidence, to represent the more realistic scenarios can be colour-coded with increasing intensity (shades of green in this instance).

Species (season)		Mortality Level (% of displaced birds that die)												
Displacement Level (% of all birds on site)		0%	1%	2%	3%	4%	5%	10%	15%	20%	30%	50%	80%	100%
	0%	0	0	0	0	0	0	0	0	0	0	0	0	0
	10%	0	5	10	15	20	25	50	75	100	150	250	400	500
	20%	0	10	20	30	40	50	100	150	200	300	500	800	1000
	30%	0	15	30	45	60	75	150	225	300	450	750	1200	1500
	40%	0	20	40	60	80	100	200	300	400	600	1000	1600	2000
	50%	0	25	50	75	100	125	250	375	500	750	1250	2000	2500
	60%	0	30	60	90	120	150	300	450	600	900	1500	2400	3000
	70%	0	35	70	105	140	175	350	525	700	1050	1750	2800	3500
	80%	0	40	80	120	160	200	400	600	800	1200	2000	3200	4000
	90%	0	45	90	135	180	225	450	675	900	1350	2250	3600	4500
	100%	0	50	100	150	200	250	500	750	1000	1500	2500	4000	5000

Note: This matrix table would need to be replicated for each screened-in species, each season, and for the OWF site with and without buffer zones included (in terms of total abundance estimates).

In order to determine whether the figures presented in tables (e.g. Table 3 above) are likely to lead to population level effects (i.e. changes to population abundance) it will be necessary to determine which reference population scale(s) (or BDMPS) it is appropriate to relate these predicted displacement impacts to. This will vary between EIA and HRA processes as well as sites and seasons and may range from the breeding population of a species at a single designated site to a north-west European biogeographic migratory or wintering population of a species, possibly even wider. Note that in the case of HRA, where displacement effects take place within areas that are known to be used or likely to be used by birds associated with particular SPAs, assessment of the overall figures must be made at the scale of the populations of each of those individual SPAs (apportioned where necessary between SPAs). The relevant SNCB should be contacted for advice on the appropriate population scale for a given season. For project proposals in English, Irish or Welsh waters the respective SNCBs recommend consideration should be given to the Natural England and JNCC advice on Habitats Regulations Assessment (HRA) screening for seabirds in the breeding season (NE & JNCC 2013) and the non-breeding season populations of seabirds in UK waters report by Furness (2015), when considering appropriate population scales for a given season, for an HRA. For project proposals in Scottish waters, advice should be sought from Scottish Natural Heritage (SNH) on the appropriate population scale to use for each season.

Therefore, unless one particular population scale can be identified as being the only one appropriate to consider for a particular species/season/site combination, the numbers presented in the tables outlined above are thereafter considered in the context of a range of possible reference populations (but see separate guidance on these elements).

13. Combining collision impacts and displacement impacts

The number of birds at risk of reduced individual fitness (i.e. mortality and productivity losses) as a result of displacement is based on the numbers of birds present within a development area and buffer both on the water and in flight. Assessment of the number of birds at risk of mortality as a result of collisions (e.g. with wind turbines) is based on the number of birds present within a development area that are in flight only. The mortality impacts estimated from CRM are assumed to be in addition to any mortality caused by displacement impacts. Productivity impacts due to displacement would be a further addition (but this is not currently quantitatively accounted for under existing methods/advice).

Therefore, at present, the SNCBs regard the **two impacts (collision and displacement) as additive and advise that they should be summed**. In summing the predicted mortalities that arise via these two mechanisms, there is a risk of some degree of double counting as a bird that collides with a turbine cannot be displaced and vice versa. Thus, it is acknowledged that this simplistic approach will therefore incorporate a degree of precaution. The level of precaution is difficult to gauge, but will be highest when the number of birds recorded flying at turbine height (and therefore the predicted number of collisions) is greatest.

SNCBs are seeking further evidence from ongoing and proposed studies into avoidance rates that will help clarify the relationship between collision risk, displacement and so called ‘macro’ avoidance. A recent review of avoidance rates has been completed by the BTO on behalf of Marine Scotland (Cook *et al.* 2014). At some point in the future it is possible that SNCB advice may revisit this additive approach, in light of more advanced techniques for discriminating between birds in flight and birds on the water (in terms of pre-construction abundance data) and between barrier, macro-avoidance and displacement effects.

14. Cumulative impact assessment for displacement

While there is currently no established standardised method for undertaking a CIA process for displacement (or for collision), the **SNCBs recommend that a similar approach be taken to additively combining multiple project’s displacement impacts, to that undertaken for a single project.** In other words, for projects undertaking a CIA for displacement across multiple projects, provided density information and OWF site footprint data (plus appropriate buffer zones) are available, it should be feasible to standardise displacement assessment approaches across even historic projects. Ideally, historic projects will have conducted a displacement assessment along similar lines to those laid out in this interim displacement advice note. However, it is recognised that there are likely to be discrepancies, in terms of variation in displacement levels used for different species, as well as likely mortality levels, and seasons presented, etc.

Several North Sea developers have now undertaken cumulative and in-combination displacement impact assessments for a range of species. Moreover, they have also applied a method to calculate predicted displacement impacts for historic projects that did not present displacement figures for particular species – See:
http://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/2.%20Post-Submission/Representations/ExA%20Questions/20-11-2014%20-%20ExA%20Second%20Written%20Questions/Forewind%20-%20Final%20HRA%20In-combination%20ornithology%20tables.pdf

Use of such methods (or refinement of displacement assessments from historic projects required to feed into CIA for future OWF development applications) should be done in consultation with the SNCBs. Finally, it is not within the scope of this displacement advice note to address all aspects of cumulative assessment. Guidance is available to assist with this elsewhere (King *et al*. 2009).

SNCB advice section – assessing cumulative displacement impacts

In broad terms, displacement impacts from different OWF development sites (plus appropriate buffer zones) should be considered cumulatively (i.e. additively). Any differences in assumptions about species sensitivity to displacement or habitat flexibility between individual project sites should be clearly identified, explained and agreed with SNCBs prior to further analysis. All areas should be assumed to be at carrying capacity, unless there is specific evidence to the contrary. Where displacement assessments may have varied between historic and more recent projects, efforts should be made to standardise approaches. If necessary historic assessments and matrices should be revisited to re-analyse site-based abundance data and bring it into line with current thinking on likely displacement levels, mortality rates, seasons and buffer zones for relevant species.

15. Future development of a 'Displacement Assessment Framework '(DAF)

Several areas of displacement (and barrier) impact assessment remain problematic and there is a need for further investigation and gathering of empirical evidence to support decisions. Nearly all aspects of the assessment of displacement and barrier impacts would benefit from robust and rigorous post-consent monitoring.

The SNCBs recognise that, in several areas, the current document outlines an approach that incorporates high levels of uncertainty. As a consequence aspects of the advised method may be somewhat precautionary (although this does depend on the selection of appropriate displacement and mortality levels within the matrix tables).

Displacement assessment methods are an area of active interest for industry, SNCBs and regulators and needs to be reflected in post-consent monitoring where displacement effects remain uncertain. This joint SNCB interim displacement advice note will be reviewed and updated when new information or approaches are brought to light.

As captured in recommendations from a recent Displacement Workshop (May 2015) organised by JNCC and the MROG, this joint SNCB advice note is intended to address only a short-term gap in advice provision and standardisation of DAF methods within the OWF industry sector. It is anticipated that further steps, with regards to both medium and long-term displacement method development and advice, will follow the publication of this note. Recommendations from the Displacement Workshop are currently being progressed through MROG and SNCB discussions with industry. It is anticipated that further displacement advice revisions may be produced by the SNCBs jointly in the next year.

This advice note was prepared by the Marine Industry Group for ornithology (MIG-Birds), with contributions from Joint Nature Conservation Committee, Natural England, Natural Resources Wales, Northern Ireland Environment Agency and Scottish Natural Heritage

JNCC
Joint Nature Conservation Committee

Cyfoeth Naturiol Cymru
Natural Resources Wales

NATURAL ENGLAND

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

NIEA Northern Ireland Environment Agency
www.daera-ni.gov.uk

An Agency within the Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

INVESTORS IN PEOPLE

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Appendix 1: - Links to guidance on associated topics.

SNH Guidance

Recommendations for the presentation and content of interim marine bird, mammal and basking shark survey reports for marine renewable energy developments. **Available at <**http://www.snh.gov.uk/docs/A1325759.pdf > Accessed 23 March 2016.

Guidance on Methods for Monitoring Bird Populations at Onshore Wind Farms. Available at <http://www.snh.gov.uk/docs/C205417.pdf> Accessed 23 March 2016.

The Crown Estate Guidance

Guide to an onshore wind farm. Available at <http://www.thecrownestate.co.uk/media/5408/ei-a-guide-to-an-offshore-wind-farm.pdf> Accessed 23 March 2016

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COWRIE reports

Available at <http://www.thecrownestate.co.uk/media/5491/cowrie_reports_held_by_the_crown_estate.pdf > Accessed 23 March 2016

RSPB Information

Offshore wind farms and birds : Round 3 zones . Available at <http://www.rspb.org.uk/Images/langston_2010_tcm9-203501.pdf> Accessed 23 March 2016

SOSS Projects

Available at <http://www.bto.org/science/wetland-and-marine/soss/projects > Accessed 23 March 2016