



# Humber Gateway OWF

## EON Climate & Renewables

### Pre-construction Ornithological Monitoring Programme (OMP)

Report: 401\_012\_R\_NPC\_EON\_HG03

Author: Dr Chris Pendlebury, Graeme Garner & Richard Walls

Issued: 07/05/2012

Natural Power  
McKinven House  
George Street  
Falkirk  
Scotland, UK  
FK2 7EY

Tel: +44 (0) 1324 616 700



Client: E.ON Climate &amp; Renewables

Report: 401\_012\_R\_NPC\_EON\_HG03

## Humber Gateway OWF Pre-construction Ornithological Monitoring Programme (OMP)

Author	Graeme Garner and Dr Chris Pendlebury	07/05/2012
Checked	Dr Chris Pendlebury	07/05/2012
Approved	Richard Walls	07/05/2012

Classification COMMERCIAL IN CONFIDENCE

Distribution E.ON Climate &amp; Renewables

NATURAL POWER CONSULTANTS LTD, THE NATURAL POWER CONSULTANTS LTD, NATURAL POWER SARL, NATURAL POWER LLC, AND NATURAL POWER S.A (“NATURAL POWER”) shall not be deemed to make any representation regarding the accuracy, completeness, methodology, reliability or current status of any material contained in this document (“Report”), nor shall NATURAL POWER assume any liability with respect to any matter or information referred to or contained in the Report, nor shall any person relying on the Report (“Recipient”) or any party to whom the Recipient provides the Report or information have any claim against NATURAL POWER arising out of such Report. The Recipient shall treat all information in the Report as confidential if and to the extent so provided in the report. All facts and figures correct at time of print. All rights reserved. ZephiR® and VENTOS® are registered trademarks of NATURAL POWER. Melogale™, WindCentre™ and OceanPod™ are trademarks of NATURAL POWER. Copyright © 2010 NATURAL POWER.

### Revision History

Issue	Date	Changes
A	22/11/2011	First issue
B	23/11/2011	Second issue
C	19/03/2012	Third issue
D	07/05/2012	Fourth issue

<b>1. HUMBER GATEWAY OFFSHORE WIND FARM.....</b>	<b>4</b>
<b>1.1. CURRENT VERSION OF THE OMP .....</b>	<b>4</b>
<b>2. FEPA LICENCE.....</b>	<b>5</b>
<b>3. ORNITHOLOGICAL MONITORING PROGRAMME .....</b>	<b>7</b>
3.1. CONSTRUCTION AND POST-CONSTRUCTION MONITORING .....	7
3.2. REPORTING.....	8
3.3. LITTLE TERN FORAGING AND PREY-PREFERENCE SURVEYS .....	8
3.4. BOAT-BASED MONITORING .....	9
3.5. GOOSE MIGRATION SURVEYS .....	12
3.5.1. <i>Evaluating the need for radar surveys.....</i>	<i>12</i>
3.5.2. <i>Goose migration survey methods.....</i>	<i>13</i>
<b>4. REFERENCES .....</b>	<b>14</b>

## 1. HUMBER GATEWAY OFFSHORE WIND FARM

Humber Gateway Offshore Wind Farm (OWF) was recently given full planning consent to be constructed off the Holderness Coast. The location of the wind farm is shown in Figure 1. An Ornithological Monitoring Programme (OMP) was required as part of the FEPA licence (Section 2).

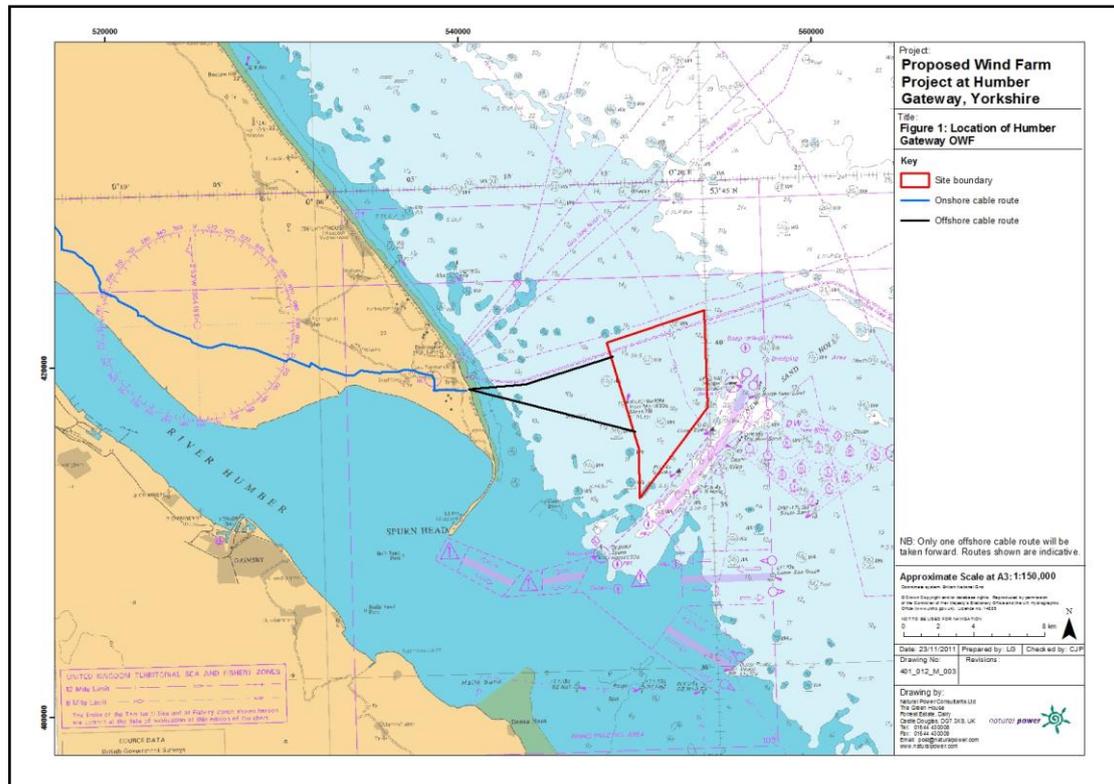


Figure 1: Location of Humber Gateway Offshore Wind Farm

### 1.1. Current Version of the OMP

This document is based on the version of the OMP provided to Natural England and Marine Management Organisation (MMO) for comment in 2011. Comments were then provided via the MMO on 13 January 2012 (reference: REN 014). This version of the OMP incorporates these comments, which had involved making the following additions:

- Inclusion of little gull as a target species for 'collision predictions'.
- Proposed goose migration surveys.

In addition, the following additional information has been provided:

- Clarity that each survey will take place over a 1-2 day period.
- Rational for re-arranging the month of survey for mid-winter (from January 2012 to December 2012).

In addition to the information provided in the current version of the OMP, a request was made by Natural England and the MMO for a power analysis to be undertaken in order to estimate the likelihood of detecting changes in bird numbers based on the proposed boat-based transect design. Once data from the Environmental Statement are available, this power analysis will be undertaken; the details of which will be submitted separately to the MMO as an appendix to the OMP.

## 2. FEPA LICENCE

The relevant sections of the FEPA Licence that specify what is require in terms of ornithology monitoring is provided in Table 1.

<b>Table 1. Ornithological-related FEPA Licence requirements.</b>	
<b>FEPA Licence Ref.</b>	<b>Description</b>
9.38	The Licence Holder shall carry out ornithological monitoring as outlined in Annex 2 attached to this Schedule. The Licence Holder must submit the Ornithological Monitoring Programme (OMP) at least two months prior to the commencement of pre-construction monitoring. The Licence Holder shall not commence construction until the full specification for the OMP has been agreed with the Licensing Authority following consultation with Natural England The Ornithological Monitoring Programme must include a timetable for an annual and interim reporting mechanism.
9.39	The Licence Holder shall submit the reports required under the Ornithological Monitoring Programme to the Licensing Authority at the appropriate time in accordance with the agreed timetable. Each report must be forwarded to the Licensing Authority and Natural England by the date specified in the OMP.
9.62	The Licence Holder must undertake a dedicated pre construction Little Tern foraging and prey preference survey. The survey methodology and survey submission date must be agreed with the Licensing Authority in consultation with Natural England as part of the Ornithological Monitoring Programme mentioned at condition 9.38.
ANNEX 2	Monitoring will comprise a Before and After Control Impact (BACI) design and will be undertaken at the survey areas consisting of the wind farm site, a 1km and 2-4km buffer zone surrounding the wind farm and the selected reference site. The monitoring programme will include a 1 year contiguous pre-construction period and continue through the construction phase. This monitoring period will serve the dual purpose of identifying any possible changes in the ornithological value of the area (since ES surveys), and providing an immediate baseline for comparison with data collected during the construction phase. There is also a requirement to conduct post-construction monitoring to provide a minimum of three years data from the operating phase. The detailed specification for the co-ordinated monitoring programme (which will include both aerial and boat-based surveys, Radar studies and any other appropriate monitoring techniques), will be subject to separate written agreement with the Licensing Authority following consultation with Natural England four months prior to the proposed commencement of the monitoring work. These data will need to be empirically comparative with baseline data provided within the project's Environmental Statement. There will be a requirement to conduct a radar study (or suitable alternative) to validate predicted estimates of Pink-Footed Geese avoidance rates and collision mortalities with Humber Gateway offshore wind farm. The detailed specification for this will be subject to separate written agreement with the Licensing Authority following consultation with Natural England four months prior to the proposed commencement of the monitoring work. The need for additional ornithological monitoring, on-going during the lifetime of the wind farm's operation, will be determined, in consultation with Natural England and the Licensing Authority and reviewed at agreed periods. This will have regard to the magnitude of any change in bird populations observed during the initial three years operational monitoring period. The ornithological monitoring programme may have to be adapted and amended as new technologies and research findings become available, as determined by Natural England and the Licensing Authority. Ornithological monitoring reports will be provided to Natural England on a quarterly basis as a draft report update and as a final annual report. This may be more frequent where the results of the data may trigger further, more intensive monitoring work. Monitoring of the

	<p>agreed reference site will also continue parallel to the wind farm site and the 1km and 2-4km buffer zones surrounding the wind farm. Monitoring will need to fulfil the following objectives: 1. Determine whether there is change in bird distribution, use and passage, measured by species (with particular reference to Gannet, Guillemot, Little Gull, Kittiwake and Terns), abundance and behaviour, of the wind farm site, 1km and 2-4 km buffer zones and the reference site. 2. Validate the collision risk modelling to identify avoidance rates of the Humber Gateway Offshore Wind farm site with reference to Pink-Footed Geese. This is to be achieved by a minimum three year radar study during the autumn migration period. Specific periodicity and geographic coverage is to be determined with Natural England and the Licensing Authority. 3. Verify that the Humber Gateway offshore wind farm does not pose a significant collision risk to Little Gulls roosting at Hornsea Mere.</p>
--	---

### 3. ORNITHOLOGICAL MONITORING PROGRAMME

A proposed pre-construction Ornithological Monitoring Programme (OMP) is presented here, which meets each of the pre-construction requirements listed in Table 1. This OMP will need to be agreed with the Licensing Authority following consultation with Natural England. All work for the OMP would be carried out by experienced ESAS ornithological surveyors/modellers/analysts with a track-record for OWF work.

**The key components of the pre-construction OMP are:**

- Little tern foraging and prey preference survey;
- Boat-based survey of the wind farm site and buffer zone, and a reference area; and
- **Goose migration surveys.**

**The aim of the pre-construction surveys will be to:**

- Identify any changes in the ornithological value of the area since the surveys undertaken for the ES surveys; and
- Provide an immediate baseline for comparison with data collected during the construction phase and post-construction phase.

**The aims & Indicative hypothesis of the OMP and boat-based monitoring are:**

1. To test whether there is any significant change to the number of birds recorded (of the species listed under disturbance/displacement in Table 2) within the wind farm area, relative to the reference area.
2. The null hypothesis (where data availability allows from the construction and post-construction surveys) to be tested by the subsequent analysis would be proposed “that there has been no change in numbers and distribution for these species listed below at the 5% significance level.
3. To compare the number of birds predicted to collide with turbines using current analysis methods (Band 2011) to calculate macro-avoidance estimates.

The key species that will be investigated by the 2 above aims are listed in Table 2.

<b>Table 2: Key potential impacts highlighted by the Humber Gateway ES.</b>		
<b>Species</b>	<b>Aim 1 (disturbance/displacement)</b>	<b>Aim 2 (collision predictions)</b>
Pink-footed goose		✓
Fulmar	✓	
Gannet	✓	✓
Little gull	✓	✓
Kittiwake	✓	✓
Common gull		✓
Lesser black-backed gull		✓
Great black-backed gull		✓
Sandwich tern		✓
Common/ Arctic tern		✓
Guillemot	✓	
Razorbill	✓	
Puffin	✓	

#### 3.1. Construction and post-construction monitoring

Proposed methods for the monitoring during construction and optional phases will be agreed separately in advance of these periods.

### 3.2. Reporting

For the pre-construction monitoring **quarterly reports** will be provided to Natural England for the first three quarters of the year, followed by an **annual report** at the end of the year. The quarterly reports will include details of the surveys undertaken during the quarter along with a summary of the results, as well as details of the surveys due to be undertaken in the following quarter. The annual report will include details of the surveys undertaken during the year along with analysis of the year's data and comparisons with data collected for ES for both Humber Gateway and Westernmost Rough sites. On the assumption that surveys commence in January 2012, the reporting schedule will be as follows:

- First quarterly report covering surveys undertaken in February to April, to be submitted to Natural England in May 2012;
- Second quarterly report covering surveys undertaken in May to July, to be submitted to Natural England in August 2012;
- Third quarterly report covering surveys undertaken in August to October, to be submitted to Natural England in November 2012; and
- Annual report covering surveys undertaken in February to December, to be submitted to Natural England in January 2013.

### 3.3. Little tern foraging and prey-preference surveys

A study on little tern foraging behaviours has been undertaken previously for the Scroby Sands OWF, in 2003 and 2004 (Perrow *et al.*, 2006). This involved the use of radio telemetry to identify the relative importance of different foraging areas, along with data on foraging trip durations, distances travelled, distances travelled from the shore, and home ranges. A total of 5 birds were radio-tracked in each of 2003 and 2004. A key finding of the surveys was that foraging by this species was in near-shore areas, with mean location being 473 m and 489 m for the two years of study, with maxima being 2.3 km and 3.4 km.

Due to the preference for near-shore areas of foraging little terns, surveys undertaken by the JNCC of foraging little terns at three sites (Ythan Estuary, Aberdeenshire; Long Nanny, Northumberland; and Point of Ayr, North Wales), involved the use of coastal-based observations (Mark Lewis, pers. Comm.). This involved surveyors walking along the coast, stopping at 500-1000 m intervals, and recording little tern numbers and behaviour.

We therefore propose an approach based on this involving the following:

- The surveys will focus on the colony at Beacon Ponds, Easington.
- The survey will take place 8 times between late April and early August (Table 3).
- A survey will comprise of observations undertaken on two consecutive days, one day focussing on the period of low water and the other on the period of high water. On each survey day, one observer will walk north from the colony and another will walk south from the colony, each for approximately 6 km. The observers will stop every 500 m during the first 3 km, and every 1 km thereafter. At each stop the observer will scan with a telescope and record all little terns recorded within a 30 minute period along with behavioural information (behaviour, flight direction, and details of any prey being carried).
- During chick-rearing period, June/July, information will be collected on prey items brought to the colony by little terns, in conjunction with Spurn Bird Observatory who employs wardens to monitor the little terns. Observations would be undertaken for 3-4 hours per day over 8 days during June, with an observer using a telescope from a hide/hut. Details will be recorded on prey type and size.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
N <sup>o</sup> of surveys				1	2	2	2	1				

### 3.4. Boat-based monitoring

These surveys would be comparable to those undertaken for the ES, although recommendations are provided in order to update the methods as per latest guidance (Camphuysen *et al.*, 2004; MacLean *et al.*, 2009). The main aim will be to determine whether there is change in bird distribution and/or use of key species (gannet, guillemot, little gull, kittiwake and terns), within the wind farm site compared to the reference area. An additional aim will be to verify that the Humber Gateway OWF does not pose a significant collision risk to Little gulls roosting at Hornsea Mere.

To allow comparisons with the ES, the boat-based ornithological monitoring will follow the basic methodology carried out during the baseline surveys (with changes described below). This follows the technique described in Camphuysen *et al.* (2004), which is the standard seabird monitoring method used for boat based surveys, and uses a *band transect with snapshot* method. The vessel used for the surveys will comply with COWRIE recommendations by being between 20m and 100m in length, by providing a stable, forward-looking, viewing platform a minimum of 5m above sea level, and by having a survey speed of c.10 knots (range 5-15 knots).

As part of the ES boat-based surveys undertaken from June 2004 till the end of surveying, a total of 9 transects were surveyed (each 10.5km): 6 transects in the wind farm area plus a 1+km buffer, and 3 transects in the reference area to the north. It is proposed that the overall area to be surveyed pre-construction shall remain the same (site, buffer and reference area) to maintain consistency and to provide adequate monitoring of the site and the surrounding area. **However, rather than also undertaking aerial surveys (with poorer detection and identification abilities) it is proposed that the number of boat-based transects shall be increased from the number used during the ES surveys to increase effort and therefore the likelihood of detecting changes in bird numbers.**

Instead of using the original spacing of 2.5km between transects, the transects shall be placed 1km apart for future monitoring work. This will increase the total number of transects from 9 to 21 (Figure 2). This is important as it is recommended that for *Distance* analysis a minimum number of 20 transects be used in order to increase the power to detect a change or increase the confidence to say that no change has occurred. The original spacing of 2.5km between transects was decided upon in order to prevent double counting of rafting birds that may have been carried on the tidal current from one transect to the one adjacent to it. However it is our opinion (based on advice from CREEM; Centre for Research into Ecological and Environmental Modelling) that this is likely to have a negligible impact on data recording. Should this not be the case then surveys can be carried out against the tidal current, so that rafting birds are taken away from the direction of surveying. In terms of data analysis, only bird records from within the 300m transect are used in determining population estimates, so reducing the spacing of transects to 1km does not impact upon this.

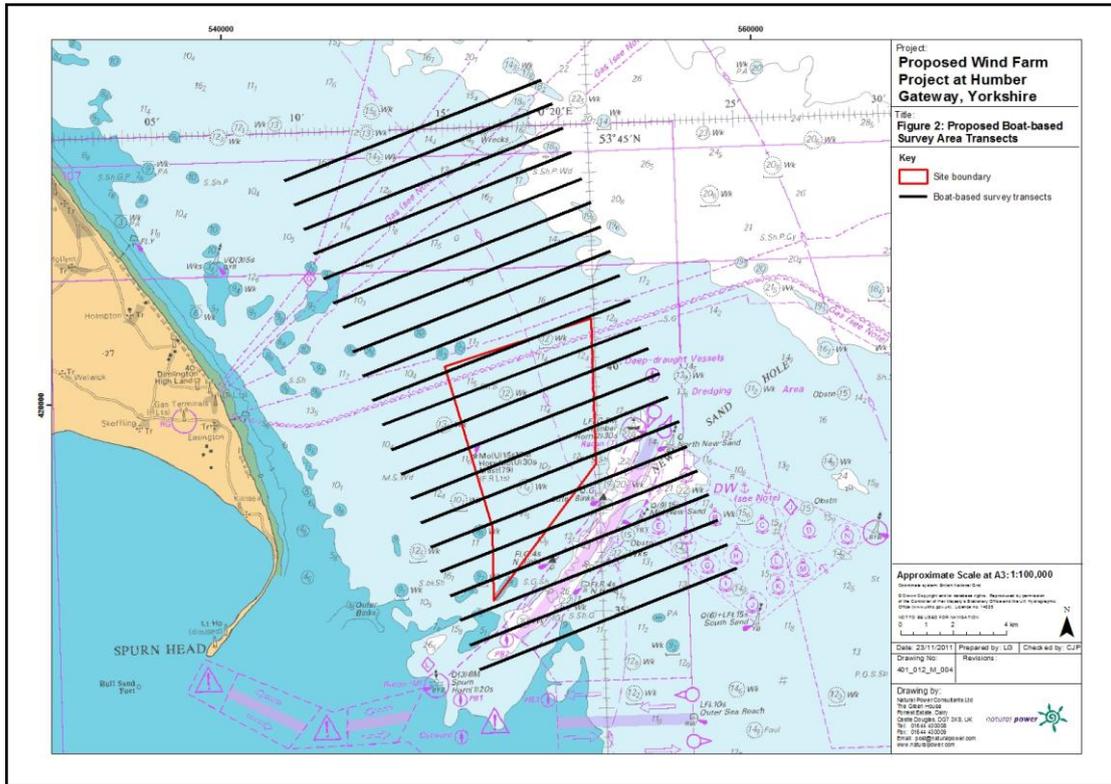


Figure 2. Proposed boat-based survey area with transects shown (indicative only)

Seventeen boat surveys shall be undertaken within a calendar year. However these will be timed to coincide with peak abundance of target species on site, based upon the findings of the ES survey. Therefore there will be an increased number of surveys in the summer months and a reduced number over the winter period. (Peak counts of target species occurred during the breeding and post-breeding season). The proposed time-table for the boat surveys is shown in Table 4.

**Table 4: Timetable of boat-based surveys (17 per year).**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nº of surveys	0	1	1	1	1	2	2	2	2	2	2	1

The previous version of the OMP had a mid-winter survey to be undertaken in January instead of December. A survey could not be undertaken in January 2012, so as a consequence this has been moved to December 2012 instead. In terms of the numbers to be present for each of the target species, there is not expected to be a significant difference between the months of December and January.

The boat-based surveys will be undertaken over two days rather than a single day. Due to the increase in the number of transects, a survey undertaken at 10-12 knots (as per COWRIE guidance) will take 11-14 hours. It is therefore not possible for the full survey to take place in a single day, especially during winter months. The plan will therefore be for the survey to take place on two days, with these being on consecutive days whenever possible (though this will be subject to weather and sea conditions).

It is normal practice for surveys of large sites to take place over a period longer than a day. It will actually be beneficial for the survey design for the survey to take place over two days rather than one, as this will allow sampling at different times of the day at both the wind farm site and in the reference area.

The approach that we recommend for future surveys, based on the methods of Camphuysen *et al.* (2004) is as follows:

- Surveys shall be undertaken by European Seabirds at Sea (ESAS) accredited surveyors.
- One surveyor acts as Observer and scans a 90° viewing angle in front of, and to one side of, the survey vessel. The observer chooses the viewing angle based upon the side of the vessel with the best viewing conditions (e.g. taking into account sun glare, wind direction, etc). The survey is 'by eye' but the use of binoculars is used to confirm identification and to look ahead of the boat for easily flushed species, such as divers.
- A second surveyor acts as Scribe, which allows the other surveyor to concentrate on observing.
- A third observer is also present to allow for breaks, in order to avoid fatigue and reduced observational acuity. Rotations between observing, scribing and resting will take place at the end of each transect. The third surveyor will carry out the navigational and environmental recording.
- Birds on the water are recorded into a series of distance bands, perpendicular to the survey vessel, which are as follows: Band A (0-50m), Band B (50-100m), Band C (100-200m), Band D (200-300m) and Band E (>300m). Distances are determined by range-finders. Birds within Bands A-D are within the band transect used for the survey (300m width) and thus are recorded as being 'in transect'.
- Birds in flight are recorded differently. All birds are recorded but only those recorded in a 'snapshot' are recorded as being in transect, and hence used for data analysis. Snapshots are used to prevent over-estimation of the number of birds in flight within the survey area, as the number of flying birds present during the duration of a survey will be many more than the number present at any given moment in time. When a snapshot occurs (marked by a timed repeat alarm) flying birds are in transect if they are within a 300m X 300m 'box' within the surveyors 90° viewing angle. The frequency of snapshots is dependent on speed: at 10 knots a snapshot is undertaken every 60 seconds. Categories to be used for recording flight heights: Band 1 (1-10m), Band 2 (10-25m), Band 3 (25-200m), Band 4 (200-250m) and Band 5 (>250m).
- Bird sightings shall be recorded to the nearest minute (hh:mm). This means that when the bird registrations are mapped, the position of the birds shall be accurate to 300m (at a survey speed of 10 knots), which is considered to be adequate detail for this survey.
- All birds seen shall be recorded, including 'non-seabirds' such as migrating passerines. For each bird sighting the following parameters shall be recorded: 1. Species, 2. Number, 3. Whether or not in transect, 4. Whether in flight or on the sea, 5. Distance (as described above), 6. Height band (for flying birds), 7. Direction (for flying birds), 8. Sex/ age/ plumage details, etc, 9. Other notes, e.g. behaviour, associations, etc.
- Any marine mammals recorded shall also be included on the survey forms. An additional fieldsheet shall record environmental data, start and finish times, observer's names (two letter codes) and navigational data.
- The survey routes undertaken shall be recorded on a hand-held GPS in addition to any routes saved by the vessel's own GPS system.
- Surveys shall only be carried out in sea states of four or below.
- The data collected for birds 'in transect' shall be analysed using *Distance* to produce estimates of abundance and density.

The differences in the methods used for the ES, and the rationale are:

- The previous ornithological surveying of the site involved surveyors each observing either side of the survey vessel, which could lead to observers missing birds by doing their own scribing or lead to double counting of birds passing across the front of the vessel. In the analysis, data from only one side of the vessel were used in any case, so the revised approach will remain consistent with the ES data.
- The use of three ornithological surveyors will reduce fatigue amongst the surveyors.

- Previous bird surveying on the site used two-minute time intervals for allocating locations of birds; but using 1-minute intervals means the data will be more precise, but can still be compared with the ES data where required.

In addition to the standard ESAS survey, it is proposed that during certain times of year an extra surveyor is present to act as a dedicated Migration Observer. This surveyor would record target species that might otherwise be missed from the standard methodology (e.g. by scanning out with the usual 90° viewing angle). Target species would include geese, terns and little gulls as well as other 'scarce' seabirds and migrating 'non-seabirds'. Such migration surveys would take place from August to November as it is autumn migration that was found to be significant during the initial surveys.

### 3.5. Goose migration surveys

The aim of these surveys would be to validate predicted estimates of pink-footed goose avoidance rates and collision mortalities with Humber Gateway OWF. These surveys will be undertaken during three autumn periods. The FEPA conditions state that these surveys should be undertaken for three years, but it is unclear which years these refer to. It is our recommendation that the surveys take place during one pre-construction year and the first two post-construction years, in order for comparisons to be made.

Pink-footed geese start to arrive in northern Britain from early September, with numbers peaking in mid-October at favoured northern sites. Some geese remain in wintering grounds in Scotland and north-west England over the winter, but many move south to East Anglia. Up to half the UK population of wintering pink-footed geese have been recorded in Norfolk. Geese reach their peak here in mid-winter (Mitchell and Hearn, 2004). Some geese migrate to Norfolk from Scotland across land via NW England, but there is also a regular passage of birds down the east coast each autumn, and it is these birds that may be at potential collision risk with turbines in the Humber Gateway OWF. Surveys would be targeted to cover the timing of these east coast migrations. We recommend an 8-week survey period, from late September to mid-November, as per the period used for the goose migration surveys at Lynn and Inner Dowsing OWFs.

There are the following options for the goose migration surveys:

- Land-based radar studies, as per the FEPA conditions (but note the issues with this method below);
- Dedicated boat-based goose migration observations (method described below); or
- Both of the above to be conducted.

#### 3.5.1. Evaluating the need for radar surveys

A detailed radar-monitoring program has been undertaken at Lynn and Inner Dowsing Offshore Wind Farms (OWFs), focussing on migrating pink-footed geese (Austin *et al* 2010, Hill & Trinder 2010). This has taken place for at least four years (1 year during construction and 3 years post-construction), providing an understanding of flight lines and temporal variations in movements across the sites.

This work has recently been presented to the SOSS (Strategic Ornithological Support Services) group. During the study 979 skeins were detected, of which 43249 in 630 skeins were identified as pink-footed geese. No geese were recorded colliding with turbines. Flights of goose flocks were recorded over the sea at a variety of heights, with about a third of these at turbine blade height. The proportion of geese flying through the turbine arrays has changed through the study, with 48% recorded in 2007 (pre/during construction), 26% in 2008, 38% in 2009, and 19% in 2010 (latter 3 years were post-construction). This implies that there has been far-avoidance of the turbine arrays by geese.

Lynn and Inner Dowsing OWFs were ideal for this monitoring program since the sites are within the distance of detection for radar (approximately 8 km). This is not the case for Humber Gateway OWF, which is approximately 8.2 km from the coast at the nearest point. During the initial ES surveys of the

Humber Gateway OWF a radar survey was trialled using a unit sited on Spurn Point. However it was found that much of the development site was beyond the range of the radar unit. A radar positioned on the coast would therefore only record movements of geese migrating inshore of the site, and would not be definitive in providing data on movements through the site. There is also no infrastructure available within the site which could be utilised for this purpose.

**We suggest that a radar survey would only record migrating geese in near-shore areas, thus resulting in no data being collected on geese migrating through the wind farm area.**

### 3.5.2. Goose migration survey methods

**As an alternative to the use of radar which would only record migrating geese in the near-shore area, the following are proposed in order to meet the FEPA conditions:**

- **A dedicated boat-based survey; and**
- **A dedicated Migration Observer on the ESAS survey vessel.**

Our recommendation is that a dedicated boat-based survey is undertaken on 12-18 days (2-3 days per week) between late September and mid-November. On a survey day the vessel would be moored halfway along the northern edge of the wind farm site for 8 hours. To observe southerly migration movements, two observers would each scan a 90° viewing angle covering either side of the vessel in order to record goose flocks approaching the wind farm. All goose flocks within 2-3 km of observers should be detected due to the birds' large size and tendency to fly in flocks rather than individually. Only small groups of geese flying low over the water are likely to be missed by the observers. Therefore the survey will give adequate coverage of the whole northern edge of the wind farm and of pink-footed geese approaching the site. Once a flock of geese has been seen they will be watched to monitor their behaviour. Observers will record the following parameters: species; number; initial direction of flight; flight direction at 30 second intervals; initial flight height; and flight height at 30 second intervals. Flight height will be estimated using the following height bands: Band 1 (1-10m), Band 2 (10-25m), Band 3 (25-200m), Band 4 (200-250m) and Band 5 (>250m).

The above would be in addition to the standard ESAS surveys which would continue during the same period, but with a dedicated Migration Observer onboard during the eight surveys taking place between August and November.

A summary of the timings of the proposed goose migration surveys is provided in Table 5. The results from the migration surveys proposed above for the pre-construction year would feed into designing the methods to be used for the two years of post-construction goose migration surveys.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dedicated boat-based survey									✓	✓	✓	
Migration Observer on ESAS survey								✓	✓	✓	✓	

#### 4. REFERENCES

Austin, M., Simms, I., Turner, L., Trinder, M. & Pendlebury, C. J. 2010. Lynn & Inner Dowsing Offshore Wind Farm: remote sensing of pink-footed geese autumn passage by Bird Detection Radar. Report to Centrica Renewable Energy Ltd.

Band, W. 2011. Using a collision risk model to assess bird collision risks for offshore windfarms. Report published by SOSS.

Camphuysen, C.J., Fox, A.D., Leopold, M.F. & Petersen, I.K. 2004. Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK: a comparison of ship and aerial sampling methods for marine birds, and their applicability to offshore wind farm assessments. Koninklijk Nederlands Instituut voor Onderzoek der Zee report commissioned by COWRIE.

Hill, C. And Trinder, M. 2010. Interim summary of radar ornithology studies at Lynn, Inner Dowsing and Lincs offshore windfarm sites, 2010. Report to Centrica Renewable Energy Ltd.

MacLean, I.M.D, Wright, L.J., Showler, D.A. & Rehfisch, MM. 2009. A review of assessment methodologies for Offshore Windfarms. British Trust for Ornithology report commissioned by COWRIE.

Perrow, M.R., Skeate, E.R., Lines, P., Brown, D. & Tomlinson, M.L. 2006. Radio telemetry as a tool for impact assessment of wind farms: the case of Little Terns *Sterna albifrons* at Scroby Sands, Norfolk, UK. *Ibis* **146**: 57-75.